

Concord Evaluation Group

Invent It. Build It. 2016: Evaluation Report

January 2017

Citation

Paulsen, C.A. and Burke, L. (2017). *Invent It. Build It. 2016: Evaluation Report*. Concord, MA: Concord Evaluation Group.

Support for this study

This research was performed on behalf of Society of Women Engineers, 203 N. La Salle Street, Suite 1675, Chicago, IL 60601, with support from the ExxonMobil Foundation.

Contact

For questions or more information about the *evaluation study*, please contact:

Christine Andrews Paulsen, Ph.D.
President
Concord Evaluation Group
PO Box 694
Concord, MA 01742
(978) 369-3519
cpaulsen@concordevaluation.com

For questions about the *Invent It. Build It.* event, please contact:

Randy Freedman, M. Ed
Associate Director of Educational Programming
Society of Women Engineers
203 N. La Salle Street, Suite 1675
Chicago, IL 60601
(312) 596-5232
randy.freedman@swe.org

Table of Contents

Table of Contents	2
Summary	1
Background	1
Findings: Middle School Girls	2
Findings: High School Girls	4
Findings: Parents and Educators	4
Findings: EXPO Exhibitors	6
Background	8
Study Design	10
Participants	11
Middle School Girls	11
High School Girls	12
EXPO Exhibitors	12
Parents and Educators	13
Findings	14
Middle School Girls	14
Attitudes and Beliefs about Engineering	14
Knowledge of Engineering	16
Confidence in Engineering-related Skills	17
Feedback on the Event	18
Suggestions for Improvement	21
High School Girls	23
Feedback on the Event	23
Attitudes and Beliefs about Engineering	26
Parents and Educators	27
Suggestions for Improvement	32
Educators' Responses to Open Ended Questions	33
When teachers were asked what they learned that they didn't know before the event, many shared comments about resources and careers.	34
EXPO Exhibitors	36
Suggestions for Improvement	37
Appendix A: Schedules of Events and Activities	A-1

Appendix B: Activity Sheets	B-1
Appendix C: Survey Instruments	C-1

Summary

Background

The Society of Women Engineers (SWE) with funding from the ExxonMobil Foundation and in partnership with Girls Scouts of the USA, WGBH's Design Squad and Techbridge held the seventh annual *Invent It. Build It. (IIBI)*. The event took place at the SWE annual conference in Philadelphia, PA. Participants included 412 middle school girls, 96 high school girls, plus 148 of their parents/guardians and educators.

In addition, 296 SWE members volunteered at the event to facilitate the activities, act as role models, and work closely with the middle school and high school girls throughout the day. Thirty-two exhibitors provided information about camps, competitions and resources as part of the *Invent It. Build It. EXPO*.

Concord Evaluation Group was hired to conduct an independent evaluation of the event. This report summarizes the evaluation findings.

The evaluation found strong evidence, as it has year after year, that SWE continues to achieve its goals for *Invent It. Build It*. Once again, the event...

- Changed girls' attitudes about engineering careers by exposing them to different ways of thinking about engineering.
- Engaged girls in two different hands-on engineering activities to build their self-confidence and critical thinking skills as they relate to engineering.
- Enabled girls, parents and educators to meet and network with engineering role models.
- Helped girls draw connections between their career passions and engineering by sharing personal stories and celebrating the accomplishments of women engineers.
- Developed girls' understanding of what engineers do by interacting with the SWE volunteers.
- Enabled girls to identify what the next steps of becoming an engineer are by interacting with the SWE volunteers and local STEM organizations at the EXPO.

Findings: Middle School Girls

After the event, nearly every girl agreed that engineering was creative (98%) and hands-on (96%), that engineering could be used in many different careers (96%), allowed one to help one's community (96%), and was a good career choice for women (92%). Most girls also agreed that engineering was fun to do (90%). Overall, girls' perception of engineering was slightly less positive than last year's girls' perception of engineering, but still quite positive. Since the program approach did not change, and we see slight variation from year to year typically, we attribute the variation to these differences in the individual populations being assessed (every year the event is held in a different city).

We asked girls to report how their attitudes and interest in engineering changed, if at all, as a result of participating in the *Invent It. Build It.* event. Thirty-six percent of girls told us they were interested in becoming an engineer before the event, and this increased to 57% after the event (Figure 3). In fact, similar to the past two years, the difference between girls' reported interest in engineering before and after the event was statistically significant and large. Further, 74% of girls saw a connection between their interests/passions and engineering.

Since engineering activities typically play a significant role in Girl Scouts' programming, we asked girls about their level of interest in joining Girl Scouts after attending the event. Slightly more than one-third of the sample of girls reported that they already were Girl Scouts (35%). Of the remaining girls, another one-third (35%) reported that they definitely or might be more interested in being involved with the Girl Scouts after attending the *Invent It. Build It.* event.

We asked girls if they knew what an engineer did before and after the event. Sixty-nine percent of girls reported that they knew what an engineer did before the event. This number increased to 95% after the event. Again, similar to the past two years, the difference between girls' reported engineering knowledge before and after the event was statistically significant and large.

Additionally, as in prior years, most of the girls (83%) reported that they know how to find out more about engineering and technology if they want to (after participating in the event).

We found that most girls reported improvements in: their ability to think of many different possible ways to solve a problem (84%), their confidence in building (83%) and designing (80%) things, and their confidence in problem-solving (75%).

Nearly all girls rated the event highly, grading it 'A' (74%) or 'B' (21%). We asked girls what they liked most about the event. Several responded that they liked the

whole day and described it as fun. Of the 410 girls who responded to this question, nearly two-thirds (62%) reported that they enjoyed the activities the most. The EXPO was also a big hit. Twenty-two percent of girls reported that this was their favorite part of the day. The next most frequently reported “favorite aspect” of the event was the fact that girls were able to meet new friends and work together with others (reported by 11%). Another common response was that girls enjoyed the opportunity to be creative (reported by 11% of girls). Ten percent of the girls reported that their favorite part of the event was learning about what engineers do and the types of jobs that could be available to them if they became engineers someday.

The highest rated activity overall was Seismic Shake-Up (90% rated it as very good or excellent), followed by Helping Hand (86%). Regarding relevance to engineering, most girls reported that Seismic Shake-Up and Helping Hand were both successful at demonstrating the connection to engineering (93% and 89%, respectively). We asked girls to tell us whether they felt the activities were fun. Significantly more girls reported that the Seismic Shake-Up activity was fun (90%) than the Helping Hand activity (86%)

Finally, we asked girls to rate the extent to which each activity enabled them to be creative. Seismic Shake-Up was the significantly higher-rated activity (95% agreed or strongly agreed that it enabled them to be creative), while 92% agreed or strongly agreed that Helping Hand enabled them to be creative.

We also asked girls to rate the EXPO using the same criteria. Most girls found the EXPO to be fun (89%), rated the EXPO highly overall (88%), saw the connection between the EXPO and what engineers do (88%), and felt the EXPO allowed them to be creative (85%).

Most girls reported that they would recommend that other kids participate in events like IIBI (88%); 12% said “maybe” and only three girls reported that they would not. Most girls reported that they enjoyed the fact that the event was just for girls (89%), similar to last year (91%) and up from two years ago (83%).

As we did last year, we asked four questions about the girls’ experiences with the role models they worked with during the event. Nearly all girls reported that the role models were approachable (95%), listened actively to the girls’ ideas (94%), provided support and encouragement (93%), and guided them during the activities (93%).

We asked girls to tell us what they would change about the event, if they could. Less than one-fifth (23%) reported that they wouldn’t change anything about the event. This proportion is down from 34% last year. The most frequently reported change that girls said they would make was to add more activities or different

activities (19%). Another popular response girls gave was that they would add more time, especially for the EXPO (15%).

Findings: High School Girls

Ninety-four percent of high school girls reported that they know their families support their interest in engineering or technology.

Ninety percent of high school girls reported that they know how to find out more about engineering and technology if they wished.

Eighty-eight percent reported that they know their friends would support their interest in engineering or technology.

Eighty-three percent of high school girls reported that they saw a connection between their interests and passions and a career in engineering or technology.

Nearly all high school girls rated the event highly, grading it 'A' (32%) or 'B' (53%). We asked girls what they liked most about the event. Almost all of the girls who responded reported that they liked the EXPO and activities. Others valued the chance to meet other girls like them, with similar interests. Others reported that they enjoyed learning from engineers, including the panel.

Girls rated the Keynote presentation less strongly than other aspects, grading it 'A' (24%) or 'B' (42%), with one-third (34%) grading it C or below. Girls rated the EXPO highly, grading it 'A' (62%) or 'B' (23%). Almost all of the comments indicated the girls would have liked more time to explore the EXPO. Girls rated the lunchtime presentation highly, grading it 'A' (53%) or 'B' (26%). High school girls rated the Shock Absorber Activity (Ariel Biggs) very highly, grading it 'A' (76%) or 'B' (15%).

Most girls reported that they would recommend that other students participate in events like IIBI (80% said "yes" with an additional 17% saying "maybe").

Findings: Parents and Educators

The feedback from adults (engineers and non-engineers alike) who attended the event was very positive. All of the adults replied "yes" (94%) or "maybe" (6%) when asked if they would recommend the *Invent It. Build It.* event to others. As we observed last year, adults rated the event highly, with all but seven adults grading it 'A' (69%) or 'B' (26%).

We asked adults to rate each segment of the event with a grade. Most adults gave 'A' or 'B' ratings to each segment and, just like last year, even when we analyzed the data by removing engineers from the sample and looking only at non-engineers' responses.

Nearly all the participants, regardless of whether they were engineers, agreed or strongly agreed with the following statements:

- This event helped me learn where to find resources for girls/my daughter (94% of all adults and 94% of non-engineers, compared to 98% and 97% last year).
- I feel empowered to help more girls/my daughter become an engineer someday if they want to (93% of all adults and 92% of non-engineers, compared to 97% of all adults, including non-engineers, last year).
- This event helped me feel well-equipped to talk with girls/my daughter about a career in engineering (96% of all adults and 95% of non-engineers, compared to 97% of all adults, including non-engineers, last year).
- This event helped me understand why engineering is a good career choice (92% of all adults, including non-engineers, compared to 97% of all adults, including non-engineers, last year).
- This event taught me some activities I can do with girls/my daughter (86% of all adults and 85% of non-engineers, compared to 97% of all adults, including non-engineers, last year).
- This event helped me understand what engineers do (91% of all adults and 92% of non-engineers, compared to 95% of all adults, including non-engineers, last year).
- I had a chance to meet professional engineers today (94% of all adults, including non-engineers, compared to 95% of all adults and 94% of non-engineers last year).
- I had fun today (93% of all adults, including non-engineers, compared to 95% of all adults, including non-engineers, last year).
- My goals were met today (81% of all adults and 79% of non-engineers, compared to 92% and 91%, respectively, last year).

- This event helped me to understand what it takes to become an engineer (83% of all adults, including non-engineers, which represents a decrease from 90% of all adults last year).

Two areas with which parents were not uniformly satisfied were getting all their questions answered and understanding why there are so few women in engineering:

- All my questions were answered today (78% of all adults and 79% of non-engineers, compared to 80% of all adults, including non-engineers, last year).
- This event helped me understand why there are so few women in engineering (79% of all adults, including non-engineers, which represents an increase from 65% of all adults, including non-engineers, last year).

We asked adults to report what they learned at the event that they didn't know beforehand. The most popular response was that they generally learned about resources that could help their daughters/students (42%) and several mentioned specific organizations and programs available. Nearly one-half (46%) of adults reported that they learned about the wide range of engineering jobs within the field of engineering.

We asked the adults what features they liked most about the event. The most popular response was that adults enjoyed learning from the panel (29%). Similarly, more than one-quarter of adults (29%) mentioned the EXPO and the hands-on activities as what they liked the best. Adults also appreciated all the informative resources shared with them at the event (9%).

We asked adults to make suggestions for enhancing the event. Almost one-third (31%) reported that they would not change anything about the event. Of the adults who did make suggestions, 15% reported that they would add more time and/or space for the EXPO. One-quarter (25%) of those who made suggestions for improvement noted the very long lines and the long waits at registration.

Findings: EXPO Exhibitors

This year, EXPO Exhibitors were surveyed while EXPO participants were not given a survey as they left the hall. EXPO Exhibitors rated the EXPO positively, grading it 'A' (37%) or 'B' (59%).

All of the exhibitors (100%) enjoyed the fact that this was an event for girls and enjoyed interacting with the adults and children who visited their booths. Almost

all of the exhibitors agreed or strongly agreed that their booth received enough interest and foot traffic (96%), the exhibitor registration went smoothly (93%), and the on-site check in process was helpful to them (82%).

More than half of the exhibitors agreed or strongly agreed that SWE's IIBI EXPO compares favorably with others where they have exhibited (63%), the fee for exhibitor registration was reasonable (58%), and they received help during set-up and tear-down of the booth (55%). Less than one-third (30%) of exhibitors indicated that food and drink was easily accessible to them.

We asked exhibitors what they liked most about the EXPO. Over half (56%) liked interacting with the girls, noting their enthusiasm and engagement. In addition, forty-one percent of the exhibitors noted that the event was well organized, the volunteers were helpful or the space was good. Other comments from exhibitors about what they liked most included the opportunity to meet different types of professionals and people (4%) and the collaboration with local non-profits (4%).

Background

On Saturday, October 29, 2016 the Society of Women Engineers (SWE), Girl Scouts of the USA, WGBH's Design Squad Global, the ExxonMobil Foundation, and Techbridge held the seventh annual day-long collaborative event *Invent It. Build It.* for middle school girls at the SWE annual conference in Philadelphia, PA. SWE invited middle school girls, high school girls, their parents/guardians, and educators (both formal and informal educators) to participate.

A total of 412 middle school girls attended the event, along with 148 parents and/or educators, and 96 high school students. Deysi Melgar, a cast member from Season 2 of WGBH's *Design Squad*, served as the special host of the event. In addition, 296 SWE members volunteered at the event to facilitate the activities, act as role models, and work closely with the middle school girls throughout the day, including acting as "Roving Engineers" during check-in. Thirty-two exhibitors provided information about camps, competitions and resources as part of the *Invent It. Build It. EXPO*. The schedule of events and activities for the girls as well as their parents and educators are included in Appendix A.

The purpose of the event was to:

- Change girls' attitudes about engineering careers by exposing them to different ways of thinking about engineering.
- Engage girls in two different hands-on engineering activities to build their self-confidence and critical thinking skills as they relate to engineering.
- Enable girls, parents and educators to meet and network with engineering role models.
- Help girls draw connections between their career passions and engineering by sharing personal stories and celebrating the accomplishments of women engineers.
- Develop girls' understanding of what engineers do by interacting with the SWE volunteers.
- Enable girls to identify what the next steps of becoming an engineer are by interacting with the SWE volunteers and local STEM organizations at the EXPO.

The middle school kids spent the majority of their day engaging in two different hands-on engineering activities with engineer mentors. These activities included:

- **Seismic Shake-Up** – Kids were asked to design and build a structure using coffee stirrers and clay that's stable and sturdy enough to survive

an earthquake's vibrations, build a shake table and then test, evaluate and redesign their structure.

- **Helping Hand** – Kids were asked to design and build a device that lets them grab different objects and drop them into a container that's at least two feet away from them.

The kids' detailed activity sheets are included in Appendix B.

Parents and educators were invited to spend the day engaged in a separate set of activities—networking with engineers and each other, participating in two panel discussions with SWE members and outreach experts, and doing a hands-on activity of their own (Design Squad's Touchdown – design and build a shock-absorbing system to protect two “astronauts” when they land).

Study Design

Concord Evaluation Group (CEG) conducted an evaluation study to learn about the event’s impact on girls as well as to discover ways to enhance future *Invent It. Build It.* events. CEG collaborated with SWE to refine three surveys and a comment card to collect feedback on the event from its participants. These data collection instruments are included in Appendix C.

The student surveys were administered to girls at the end of the day. The adult survey was administered to parents/educators at the end of the day. Another survey was administered to exhibitors who participated in the EXPO. During the event, we also asked girls to complete a comment card after they completed both of the hands-on engineering activities and the EXPO (Figure 1).

Activity allowed me to be creative. <i>disagree 1 2 3 4 5 agree</i> <i>neutral</i>	Overall this activity was... <i>poor 1 2 3 4 5 excellent</i> <i>good</i>	I see the connection between this activity and what engineers do. <i>disagree 1 2 3 4 5 agree</i> <i>neutral</i>
	<u>Expo</u>	
	This activity was fun. <i>disagree 1 2 3 4 5 agree</i> <i>neutral</i>	

Figure 1. Comment card.

Participants

Middle School Girls

As in previous years, the girls who attended the event were from diverse backgrounds. Almost half of the girls identified themselves as white (45%), Nearly a quarter (24%) of participants were Black or African-American, 14% were Asian American, 13% preferred not to answer, and 10% were Hispanic, Latina, or Spanish. An additional 4% were Native Hawaiian, Native Alaskan, Native American or Pacific Islander. And 9% selected “other”, some indicating they were of multiple races or ethnicities. Compared to last year, fewer girls this year identified themselves as White or as Hispanic, Latina, or Spanish. A greater percentage this year identified themselves as Black or African-American or Asian American. The grades the girls were in ranged from fifth to ninth, with two-thirds (68%) in either seventh or eighth grade.

**Table 1:
Middle School Girls’ Background Characteristics**

	Number and Percent
<i>Race/ethnicity</i>	N = 412
White or European American	188 (45.0%)
Black or African-American	98 (23.5%)
Prefer Not to Answer	56 (13.4%)
Hispanic, Latina, or Spanish	41 (9.8%)
Asian American	58 (13.9%)
Native American or Alaskan Native	12 (2.9%)
Native Hawaiian or Pacific Islander	5 (1.2%)
Other	38 (9.1%)
<i>Grade</i>	N = 402
Fifth	5 (1.2%)
Sixth	107 (25.6%)
Seventh	157 (37.6%)
Eighth	125 (30.0%)
Ninth	8 (19.1%)

Note: Some girls selected more than one ethnicity, so percentages do not add up to 100%.

Each girl was asked if she was a member of SWENext. Of the girls who responded (N=392), 93% were not members and 7% were members of SWENext.

High School Girls

For the second year, SWE also collected data from a sample of high school girls. More than half the high school girls identified themselves as White (52%), 24% were Black or African-American, and 17% were Asian American. The high school girls were in grades nine through twelve. Their background characteristics are summarized below.

**Table 2:
High School Girls' Background Characteristics**

	Number and Percent
<i>Race/ethnicity</i>	N = 96
White or European American	46 (52.3%)
Black or African-American	21 (23.9%)
Asian American	15 (17.0%)
Hispanic, Latina, or Spanish	7 (8.0%)
Other	2 (2.3%)
Prefer Not to Answer	2 (2.3%)
<i>Grade</i>	N = 89
Ninth	14 (40.9%)
Tenth	21 (27.3%)
Eleventh	36 (27.3%)
Twelfth	18 (4.6%)

We asked the high school girls if they were members of SWENext. Of the 83 girls who provided an answer, 37% indicated they were, while 63% indicated they were not.

EXPO Exhibitors

SWE surveyed EXPO exhibitors. In total, 27 exhibitors completed surveys. Demographic information was not collected.

Parents and Educators

Parents, educators, and troop leaders attended the conference and completed surveys at the end of the day. In total, 148 adults completed surveys. Table 3 summarizes their background characteristics. Similar to the girls, adults more frequently self-identified as White (49%) or Black or African-American (23%) than Asian American (14%) or Hispanic, Latino/a, or Spanish (7%) or other races/ethnicities.

**Table 3:
Adults' Background Characteristics**

	Number and Percent
	N = 148
<i>Race/ethnicity</i>	
White or European American	73 (49.3%)
Black or African-American	34 (23.0%)
Asian American	20 (13.5%)
Hispanic, Latino/a, or Spanish	10 (6.8%)
Prefer Not to Answer	5 (3.4%)
Other	3 (2.0%)
Native American or Alaskan Native	2 (1.4%)
<i>Relationship to girls attending the event</i>	
Mother	102 (68.9%)
Father	23 (15.5%)
Troop Leader	22 (14.9%)
Teacher	20 (13.5%)
Other (aunt, grandparent, engineer, etc.)	9 (6.1%)
<i>Professional engineer</i>	
No (includes engineering students)	120 (85.7%)
Yes	20 (14.3%)
<i>Affiliation with SWF</i>	
Not Affiliated	94 (68.6%)
Parent/Guardian of SWENext Member	36 (26.3%)
Member	8 (5.8%)
K-12 Educator Member	1 (1%)

Findings

Middle School Girls

Attitudes and Beliefs about Engineering

Since one objective for the event was to encourage girls to think about engineering as a future career choice, we asked middle school girls to indicate the extent to which they believed that engineering embodied desirable characteristics of a future job. Nearly every girl agreed that engineering was creative (98%) and hands-on (96%), that engineering could be used in many different careers (96%), allowed one to help one's community (96%), and was a good career choice for women (92%). Most girls also agreed that engineering was fun to do (90%) (Figure 2).

Overall, girls' perception of engineering was slightly less positive than last year's girls' perception of engineering, but still quite positive. Since the program approach did not change, and we see slight variation from year to year typically, this could be due to differences in the individual populations being assessed (every year the event is held in a different city).

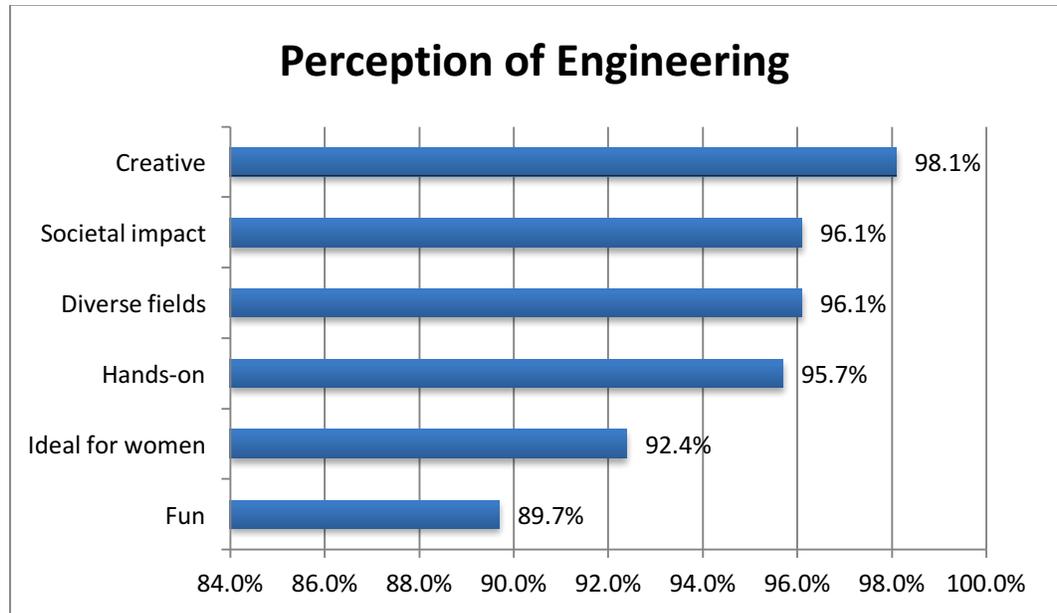
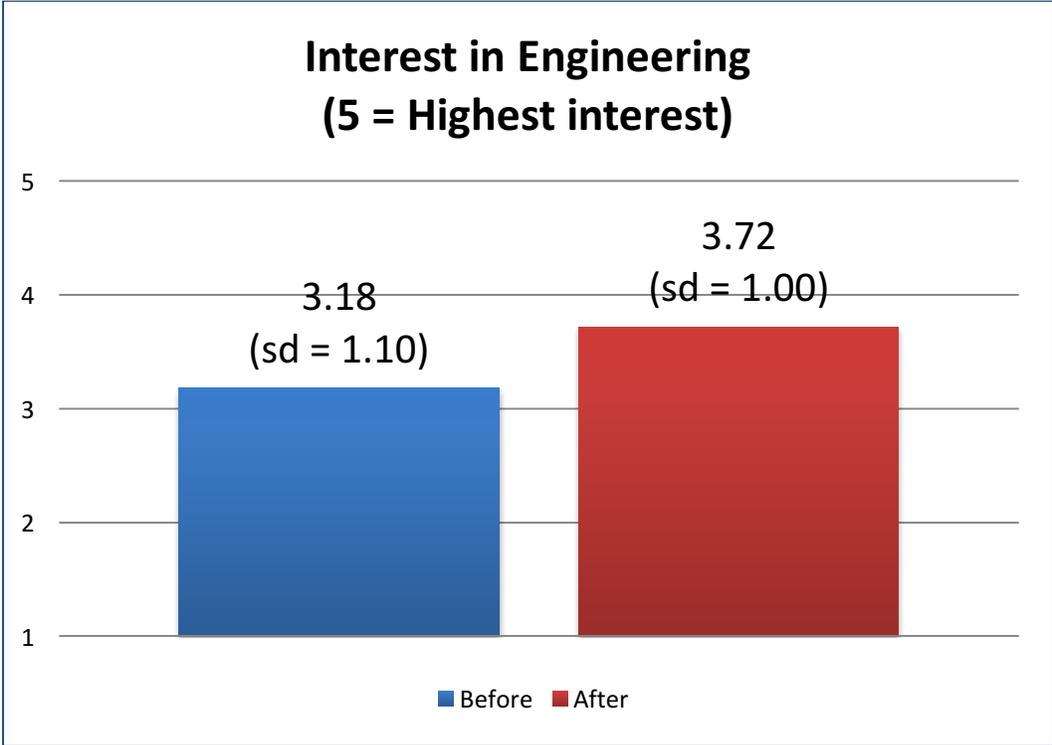


Figure 2. Perceptions of engineering.

We asked girls to report how their attitudes and interest in engineering changed, if at all, as a result of participating in the *Invent It. Build It.* event. Thirty-six percent of girls told us they were interested in becoming an engineer before the

event, and this increased to 57% after the event (Figure 3). In fact, similar to the past two years, the difference between girls' reported interest in engineering before and after the event was statistically significant and large. Further, 74% of girls saw a connection between their interests/passions and engineering.¹



Note: Paired t-test (df = 406) = 12.621, p < 0.000, Cohen's d effect size = 1.22.

Figure 3. Average level of self-reported interest in becoming an engineer before and after *Invent It. Build It.*

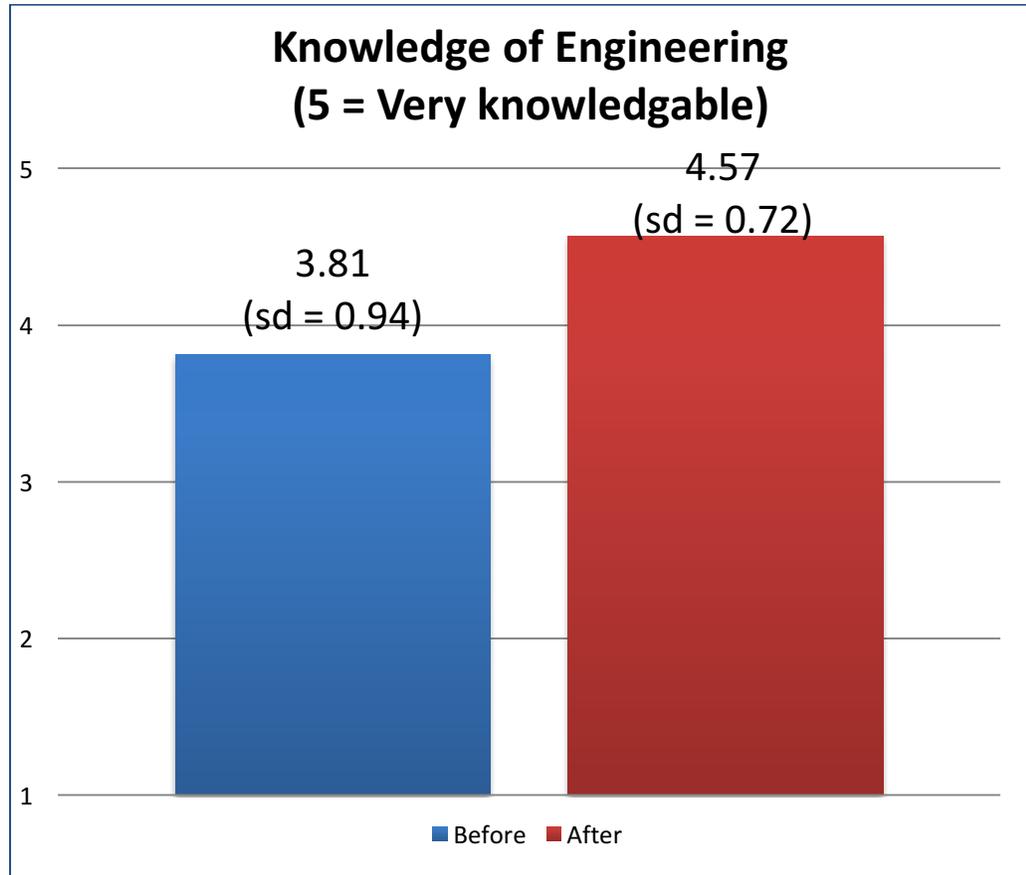
Like last year, most girls also reported that they know their friends would support their interest in engineering or technology (77%) and that their families would support their interest in engineering or technology (86%).

Since engineering activities typically play a significant role in Girl Scouts' programming, we asked girls about their level of interest in joining Girl Scouts after attending the event. Slightly more than one-third of the sample of girls reported that they already were Girl Scouts (35%). Of the remaining girls, another one-third (35%) reported that they definitely or might be more interested in being involved with the Girl Scouts after attending the *Invent It. Build It.* event.

¹ We did not ask girls to report whether their perceptions of these connections were impacted by the event, so we have no way of knowing whether IIBI caused these connections to form or whether girls attending the event saw these connections before coming to the event.

Knowledge of Engineering

We asked girls if they knew what an engineer did before and after the event. Sixty-nine percent of girls reported that they knew what an engineer did before the event. This number increased to 95% after the event. Again, similar to the past two years, the difference between girls' reported engineering knowledge before and after the event was statistically significant and large.



Note: Paired t-test (df = 414) = 15.752, $p < 0.000$, Cohen's d effect size = 1.55.

Figure 4. Average level of self-reported knowledge about engineering before and after *Invent It. Build It.*

Additionally, as in prior years, most of the girls (83%) reported that they know how to find out more about engineering and technology if they want to (after participating in the event).

Confidence in Engineering-related Skills

Another one of the event goals was to increase girls' confidence in engineering-related skills. We found that most girls reported improvements in: their ability to think of many different possible ways to solve a problem (84%), their confidence in building (83%) and designing (80%) things, and their confidence in problem-solving (75%).

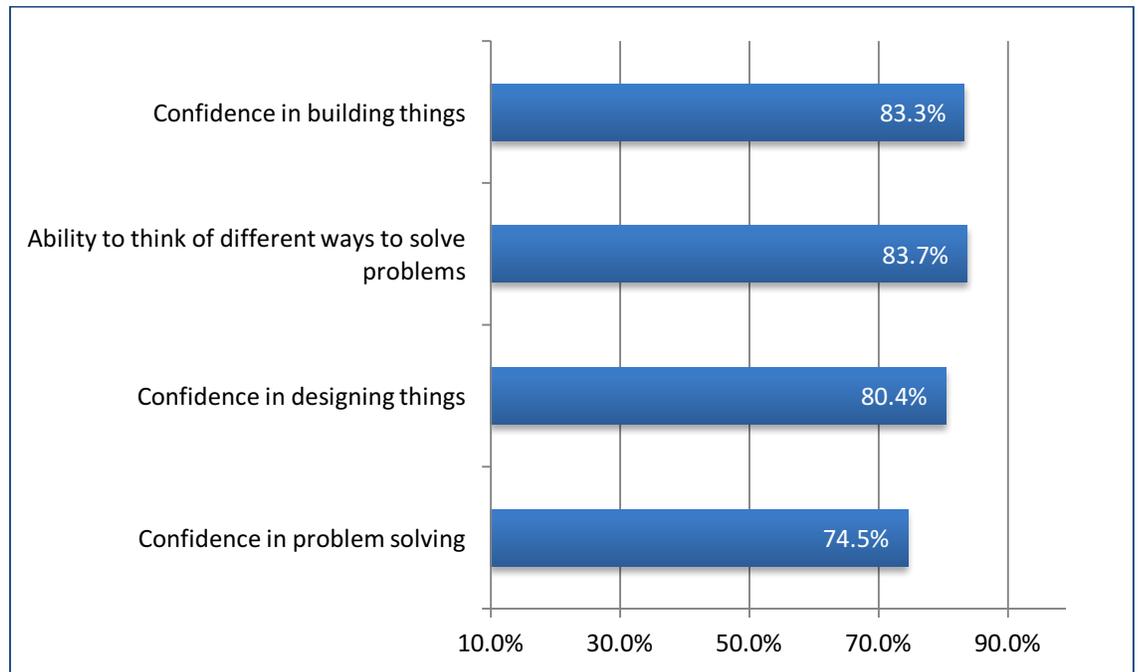


Figure 5. Proportion of girls' who reported improvements in engineering-related confidence and abilities after participating in the *Invent It. Build It.* event.

Feedback on the Event

General Feedback

Nearly all girls rated the event highly, grading it 'A' (74%) or 'B' (21%). We asked girls what they liked most about the event. Several responded that they liked the whole day and described it as fun. Of the 410 girls who responded to this question, nearly two-thirds (62%) reported that they enjoyed the activities the most. For example, some girls reported:

- *Building a stable house that could survive an earthquake.*
- *The helping hand activity, and the seismic shake-up.*
- *I especially loved the hands and the earthquake activity! They were both so fun! Thank you so much!*
- *I liked the activities because they helped build my knowledge about engineers and people around the world.*
- *Helping hand was my favorite because we had no directions and could be creative.*
- *I liked building the different contraptions.*
- *I liked doing the Helping Hand experiment.*
- *I liked making the clay tower.*
- *I liked the helping hand. I also liked the seismic activity too.*

The EXPO was also a big hit. Twenty-two percent of girls reported that this was their favorite part of the day. For example, some girls reported:

- *I liked the EXPO and the helping hands activity because the EXPO lets you see lots of different things.*
- *I liked the EXPO area. It let me explore and be creative.*
- *I enjoyed going around and exploring the EXPO center.*
- *I liked going around to the booths that you could interact with like LEDs or hand generators.*
- *The different booths we were able to go to and do different things at.*
- *I liked walking around and seeing different technology companies.*

The next most frequently reported "favorite aspect" of the event was the fact that girls were able to meet new friends and work together with others (reported by 11%). For example, some girls reported:

- *I liked to learn how to work with others' creativity and how to combine ideas.*
- *Getting to make stuff with other people and testing in out.*

- *I liked learning how to keep a house together. It didn't work at first, but after some suggestions, it worked!*
- *I liked meeting new people and trying to create things with a different perspective.*
- *I loved making new designs and actually putting them to work. Also, getting to make new friends.*

Another common response was that girls enjoyed the opportunity to be creative (reported by 11% of girls). For example, some girls reported:

- *I mostly liked that I could let my creativity go wild.*
- *I liked that the event let us be creative and gave us guidelines but then let us do what we wanted.*
- *It was really cool because it got us to explore our imagination.*
- *The fact that I could be creative. Creating and designing these tools and inventions.*
- *The thing I liked most was trying out my creations. It was fun.*

Ten percent of the girls reported that their favorite part of the event was learning about what engineers do and the types of jobs that could be available to them if they became engineers someday. For example, some girls reported:

- *Learning about engineers and how to make different things.*
- *I liked being and talking/working with women engineers from many engineering fields.*
- *That you learned about how engineers work and what they do.*
- *Getting to see the different kinds of engineers and how their jobs benefit us.*
- *I liked all the stands in the beginning. I like seeing possibilities for my future career.*
- *Asking the engineers questions.*

To gather additional feedback on the activities, we asked the girls to comment on both activities, Helping Hand and Seismic Shake-Up, immediately after they completed them. For each activity, we asked the girls to rate the extent to which they thought the activity was poor to excellent, the extent to which they saw a connection between this activity and what engineers do, whether the activity was fun, and whether the activity allowed them to be creative.

The highest rated activity overall was Seismic Shake-Up (90% rated it as very good or excellent), followed by Helping Hand (86%). Seismic Shake-Up was rated slightly higher than Helping Hand, but the difference was not statistically significant ($t_{(df=847.342)} = 1.52, p = 0.13$).

Regarding relevance to engineering, most girls reported that Seismic Shake-Up and Helping Hand were both successful at demonstrating the connection to engineering (93% and 89%, respectively). There was no statistically significant difference between the activities in terms of the relevance to engineering ($t_{(df=820.459)} = 1.64, p = 0.10$).

We asked girls to tell us whether they felt the activities were fun. Significantly more girls reported that the Seismic Shake-Up activity was fun (90%) versus the Helping Hand activity (86%) ($t_{(df=826.101)} = 2.12, p = 0.03$).

Finally, we asked girls to rate the extent to which each activity enabled them to be creative. Seismic Shake-Up was the significantly higher-rated activity (95% agreed or strongly agreed that it enabled them to be creative), while 92% agreed or strongly agreed that Helping Hand enabled them to be creative ($t_{(df=817.727)} = 1.71, p = 0.09$).

We also asked girls to rate the EXPO using the same criteria. Most girls found the EXPO to be fun (89%), rated the EXPO highly overall (88%), saw the connection between the EXPO and what engineers do (88%), and felt the EXPO allowed them to be creative (85%).

Most girls reported that they would recommend that other kids participate in events like IIBI (88%); 12% said “maybe” and only three girls reported that they would not. Most girls reported that they enjoyed the fact that the event was just for girls (89%), similar to last year (91%) and up from two years ago (83%).

As we did last year, we asked four questions about the girls’ experiences with the role models with which they worked during the event. Nearly all girls reported that the role models were approachable (95%), listened actively to the girls’ ideas (94%), provided support and encouragement (93%), and guided them during the activities (93%).

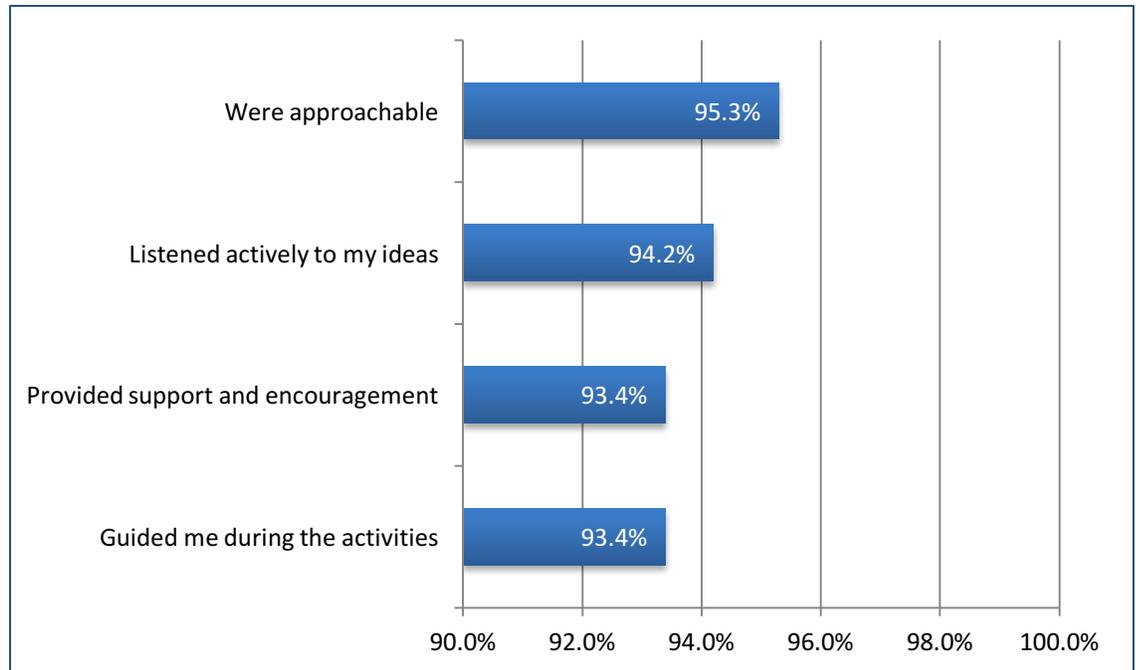


Figure 6. Proportion of girls' who reported improvements in engineering-related confidence and abilities after participating in the *Invent It. Build It.* event.

Suggestions for Improvement

We asked girls to tell us what they would change about the event, if they could. About one-quarter (23%) reported that they wouldn't change anything about the event. This proportion is down from 34% last year, which may be largely attributable to the number of suggestions regarding the food (see below). For example, some girls reported:

- *I wouldn't change this event, it was awesome.*
- *I wouldn't change anything. It was so fun!!*
- *I would not change anything; it was put together well.*
- *I would not change it because it was cool.*

The most frequently reported change that girls said they would make was to add more activities or different activities (19%). For example, some girls reported:

- *Have more activities in more complex thinking.*
- *I would add more activities because they were so fun!*
- *I would add some more engineer related activities, and have more creative and challenging projects.*
- *I would expend the horizons of the experiments.*
- *If I was in charge of this event, I would do a lot more fun experiments.*

Another popular response girls gave was that they would add more time, especially for the EXPO (15%). For example, some girls reported:

- *I would probably give more time for the EXPO. I definitely didn't get to see everything possible.*
- *I would love to have more time to go to the booths.*
- *I would have more time in the EXPO because I didn't get to see very much of it.*
- *I would give more time for the EXPO hall, because there is so much to do.*
- *I would make the event longer!!!*

Other aspects that girls reported they would change included:

- *Better and more appropriate food options at lunch (12%),*
- *Better acoustics so it would be easier to hear the speakers (4%), and*
- *Letting girls sit with and work wherever and with whomever they want (3%).*

For example, some girls reported:

- *I would have made sure that everyone could hear the speaker, got the lunch they picked when signing up, and were aware of the ingredients in the sandwiches.*
- *Make the food more "kid friendly". The sandwich contains a sauce that kids at my table hated.*
- *I would make the speakers louder (I sat in the back and could not hear) and then I would move the speakers towards the sides (I could not see because of them.)*
- *If I were in charge the only things I would change would be the food, and the noise. You couldn't really hear anything in the back.*
- *Put speakers in the back - I couldn't hear anything. I would have everyone change tables and work with whoever they want to work with.*
- *I would have let people choose one person to be together in a group. Although I liked having to meet new people, I wanted to be with a friend.*
- *I would let the girls pick where they wanted to sit corresponding to what engineering field they are interested in.*
- *Not just stay at the same table the entire time.*

High School Girls

Feedback on the Event

Nearly all high school girls rated the event highly, grading it 'A' (32%) or 'B' (53%). We asked girls what they liked most about the event. Almost all of the girls who responded reported that they liked the EXPO and activities:

- *Building the car because we got to do something hands-on and have freedom with our design.*
- *I enjoyed the luncheon with engineers and hearing about Ariel Biggs' experiences, and doing the hands-on activity.*
- *I liked making the car and I liked that at the EXPO there were many things for me to try and do.*
- *I liked the EXPO because I got to explore different companies and connect it to the engineering careers I can choose.*
- *I liked the EXPO fair, where we had the opportunity to talk to different companies and organizations about STEM.*
- *I liked the car activity the most because you had to problem solve and it was fun.*

Others valued the chance to meet other girls like them, with similar interests:

- *I liked meeting startups and other kids.*
- *The opportunity to meet new friends and speakers with amazing experiences about life and engineering.*

Others reported that they enjoyed learning from engineers, including the panel:

- *I like meeting with the women engineers. It makes me forget the barriers.*
- *I liked meeting new people and meeting Ariel Briggs, I also liked that I got the opportunity to talk to engineers.*
- *The presentations were both interesting/motivating.*
- *I really liked the woman that came in who was a race car driver. I also liked the woman that works at Purdue University.*
- *The race car speaker, Ariel ... it was cool to hear her story.*

We asked high school girls to rate four distinct aspects of the event, including the Keynote presentation (Beth Holloway), the EXPO, the lunchtime presentation and the Shock Absorber Activity (Ariel Biggs).

Girls rated the Keynote presentation less strongly than other aspects, grading it 'A' (24%) or 'B' (42%), with one-third (34%) grading it C or below. Some girls reported:

- *She was very inspiring.*
- *Very informative, great advice.*
- *Great presentation, more interactive.*
- *Great speaker.*
- *I loved how she was supportive and encouraging.*
- *It was long but very interesting.*
- *It was alright but I couldn't really identify with her.*
- *A little too long.*
- *Too long, took up EXPO time, and didn't really inform us about engineering.*
- *Things she said were dull and repetitive.*
- *I am a freshman so I didn't relate to all the "college talk".*
- *Needed to be more interactive.*
- *Better if it was more on a variety of careers.*

Girls rated the EXPO highly, grading it 'A' (62%) or 'B' (23%). Almost all of the comments indicated the girls would have liked more time to explore the EXPO. Some girls reported:

- *A lot of good booths to educate you.*
- *Was very engaging and had a wide variety of stations!*
- *Very inspirational.*
- *Fun learning & creating.*
- *I loved all the different companies that were presented, wanted more time.*
- *Everything I saw was amazing but I didn't have enough time.*
- *I didn't get to see everything.*
- *It was awesome. I wish I could have visited more booths.*
- *Did not have enough time.*

Girls rated the lunchtime presentation highly, grading it 'A' (53%) or 'B' (26%). Some girls reported:

- *Very nice.*
- *Food was good and it was nice to be in a group and be recognized.*
- *Great food!*
- *Wow!! Awesome & encouraging (Northrop Grumman).*
- *Nice meeting new people.*
- *Not enough time but very nice.*

- *Although it was interesting, I would have liked more presenters.*
- *Need to be more focused to us.*
- *Wasn't really much of a presentation.*
- *Did not offer other options for lunch if you were allergic or didn't like the food.*

High school girls rated the Shock Absorber Activity (Ariel Biggs) very highly, grading it 'A' (76%) or 'B' (15%). Some girls reported:

- *Ariel was so cool and the experiment was really fun.*
- *Ariel's story was very interesting!*
- *Awesome presentation – great story!*
- *Great activity.*
- *I liked how hands on it was.*
- *She was interesting and engaging.*
- *It was nice to be creative and create our own cars.*
- *Fun but needed more time.*
- *Interesting but did not have a lot of time to build cars.*
- *Interesting to see how [engineering] relates to the outside world.*
- *It is amazing how one task uses so many people.*
- *It was cool to work with someone else to make something.*
- *Inspiring.*

Most girls reported that they would recommend that other students participate in events like IIBI (80% said “yes” with an additional 17% saying “maybe”).

When asked to report on what they could change about the event, if they were in charge, many reported that they would allow more time to explore the EXPO:

- *A lot more time in the EXPO.*
- *Give more time for the EXPO, it was very rushed.*
- *I believe we should have more time at the EXPO as most of us wanted to talk to more companies.*
- *I would add two more hours to see the EXPO.*
- *Have more time for the EXPO.*

Other feedback included comments on registration, lunch, and an interest in more hands-on activities:

- *A more efficient check-in for the program. I would find a way to make registration faster.*
- *Give more time for activities like building the wind cars and going around to places at the EXPO.*

- *I would have stations that girls could choose based on the engineering field they have an interest in.*
- *Kid-friendly lunch. Little-to-no speakers. More hands-on activities.*
- *I would add more activities like the car one.*
- *I would make the speakers have less presentation time and have more collaboration with others.*
- *I would shorten the speeches and plan more time for hands on workshops/activities where we learn new concepts/skills.*
- *Shorten speaker presentations or make them more interactive. Give us more time at the EXPO.*
- *I would let the students choose the food.*

Other suggestions included:

- *I would have a whole table group work on any given project.*
- *I would have engineers teach sessions about in basics of their fields such as teaching the beginning of python or talking about chemistry.*
- *Maybe the girls could choose what sessions they attended?*
- *Treat us like adults. We don't need our hands held – if you tell us to do something, we'll do it the first time.*

Attitudes and Beliefs about Engineering

Ninety-four percent of high school girls reported that they know their families support their interest in engineering or technology.

Ninety percent of high school girls reported that they know how to find out more about engineering and technology if they wished.

Eighty-eight percent reported that they know their friends would support their interest in engineering or technology.

Eighty-three percent of high school girls reported that they saw a connection between their interests and passions and a career in engineering or technology.

We did not ask these questions before girls attended the event, so it is possible that girls came to the event with these attitudes and beliefs already and we cannot conclude with certainty that the event itself impacted these beliefs.

Parents and Educators

The feedback from adults (engineers and non-engineers alike) who attended the event was very positive. All of the adults replied “yes” (94%) or “maybe” (6%) when asked if they would recommend the *Invent It. Build It.* event to others. As we observed last year, adults rated the event highly, with all but seven adults grading it ‘A’ (69%) or ‘B’ (26%).

We asked adults to rate each segment of the event with a grade. Most adults gave ‘A’ or ‘B’ ratings to each segment and, just like last year, even when we analyzed the data by removing engineers from the sample and looking only at non-engineers’ responses (see Table 4).

**Table 4:
Adults’ Event Segment Ratings**

	Number and Percent (All adults)	Number and Percent (Non-engineers)
<i>EXPO</i>	N = 140	n = 115
A	88 (62.9%)	71 (61.7%)
B	33 (23.6%)	29 (25.2%)
C	11 (7.9%)	8 (7.0%)
D	3 (2.1%)	2 (1.7%)
F	1 (0.7%)	1 (0.9%)
Did not attend	4 (2.9%)	4 (3.5%)
<i>Panel Discussion 1: Why Engineering?</i>	N = 142	n = 118
A	84 (59.2%)	68 (57.6%)
B	39 (27.5%)	34 (28.8%)
C	11 (7.8%)	10 (8.5%)
D	5 (3.5%)	4 (3.4%)
F	1 (0.7%)	1 (0.9%)
Did not attend	2 (1.4%)	1 (0.9%)
<i>Touch Down Hands-on Activity</i>	N = 143	n = 118
A	95 (66.4%)	78 (66.1%)
B	38 (26.6%)	33 (28.0%)
C	6 (4.2%)	5 (4.2%)
D	1 (0.7%)	0 (0.0%)
F	0 (0.0%)	0 (0.0%)

	Number and Percent (All adults)	Number and Percent (Non-engineers)
Did not attend	3 (2.1%)	2 (1.7%)
<i>Panel Discussion 2: Preparing for Engineering Success</i>	N = 139	n = 116
A	98 (70.5%)	84 (71.2%)
B	32 (23.0%)	25 (21.2%)
C	4 (2.9%)	2 (1.7%)
D	1 (0.7%)	1 (0.9%)
F	1 (0.7%)	1 (0.9%)
Did not attend	3 (2.2%)	3 (2.5%)

We further analyzed the evaluation of the two panel discussions, by looking at ratings of parents (mother or father), troop leaders and educators. The feedback from educators in particular was very positive, with most (85%) giving a rating of 'A' or 'B' to Discussion 1, and all giving a rating of 'A' or 'B' to Discussion 2.

**Table 5:
Ratings of Panel Discussions by Parents, Educators and Troop Leaders**

	Number and Percent (Parents)	Number and Percent (Educators)	Number and Percent (Troop Leaders)
<i>Panel Discussion 1: Why Engineering?</i>	N = 46	N = 20	N = 22
A	13 (28.3%)	12 (60.0%)	10 (45.5%)
B	21 (45.7%)	5 (25.0%)	8 (36.4%)
C	6 (13.0%)	2 (10.0%)	1 (4.6%)
D	3 (6.5%)	1 (5.0%)	3 (13.6%)
F	1 (2.2%)	0 (0.0%)	0 (0.0%)
Did not attend	2 (4.4%)	0 (0.0%)	0 (0.0%)
<i>Panel Discussion 2: Preparing for Engineering Success</i>	N = 116	N = 20	N = 21
A	82 (70.7%)	15 (75.0%)	11 (52.4%)
B	26 (22.4%)	5 (25.0%)	6 (28.6%)
C	4 (3.5%)	0 (0.0%)	2 (9.5%)
D	1 (0.9%)	0 (0.0%)	0 (0.0%)
F	1 (0.9%)	0 (0.0%)	0 (0.0%)
Did not attend	2 (1.7%)	0 (0.0%)	2 (9.5%)

Nearly all the participants, regardless of whether they were engineers, agreed or strongly agreed with the following statements:

- This event helped me learn where to find resources for girls/my daughter (94% of all adults and 94% of non-engineers, compared to 98% and 97% last year).
- I feel empowered to help more girls/my daughter become an engineer someday if they want to (93% of all adults and 92% of non-engineers, compared to 97% of all adults, including non-engineers, last year).
- This event helped me feel well-equipped to talk with girls/my daughter about a career in engineering (96% of all adults and 95% of non-engineers, compared to 97% of all adults, including non-engineers, last year).
- This event helped me understand why engineering is a good career choice (92% of all adults, including non-engineers, compared to 97% of all adults, including non-engineers, last year).
- This event taught me some activities I can do with girls/my daughter (86% of all adults and 85% of non-engineers, compared to 97% of all adults, including non-engineers, last year).
- This event helped me understand what engineers do (91% of all adults and 92% of non-engineers, compared to 95% of all adults, including non-engineers, last year).
- I had a chance to meet professional engineers today (94% of all adults, including non-engineers, compared to 95% of all adults and 94% of non-engineers last year).
- I had fun today (93% of all adults, including non-engineers, compared to 95% of all adults, including non-engineers, last year).
- My goals were met today (81% of all adults and 79% of non-engineers, compared to 92% and 91%, respectively, last year).
- This event helped me to understand what it takes to become an engineer (83% of all adults, including non-engineers, which represents a decrease from 90% of all adults last year).

Two areas with which parents were not uniformly satisfied were getting all their questions answered and understanding why there are so few women in engineering:

- All my questions were answered today (78% of all adults and 79% of non-engineers, compared to 80% of all adults, including non-engineers, last year).
- This event helped me understand why there are so few women in engineering (79% of all adults, including non-engineers, which represents an increase from 65% of all adults, including non-engineers, last year).

We asked adults to report what they learned at the event that they didn't know beforehand. The most popular response was that they generally learned about resources that could help their daughters/students (42%) and several mentioned specific organizations and programs available. For example, adults reported they learned:

- *Where to find resources.*
- *The resource information list supplied.*
- *The large impact of SWE.*
- *That there were so many resources available online; this is very beneficial to the students.*
- *That there are work co-ops at some colleges to get experience while getting a degree.*
- *That there is a great deal of info that is out there to help with funding.*
- *That the SWENext program has a regional conference. Also, that NSBE offers free summer programs.*

Nearly one-half (46%) of adults reported that they learned about the wide range of engineering jobs within the field of engineering. For example, some adults reported:

- *A better understanding of the engineering career.*
- *Being an engineer myself I have quite a bit of understanding on opportunities but I think there are a lot of parents who don't know what engineering is, what the curriculum is, and all of the different disciplines and job paths that exist.*
- *How many different careers involve engineering.*
- *I had no idea how many types of engineering there are!*
- *That engineering is needed in all aspects of life to improve our quality of life.*
- *That engineers are a part of every product used.*

We asked the adults what features they liked most about the event. The most popular response was that adults enjoyed learning from the panel (29%). For example, some adults reported that they enjoyed:

- *Great presentation, especially the second session which highlighted the importance of co-op. Good overall discussion and very good with answers.*
- *I liked that the panel for parents addressed college/work.*
- *Loved the question/answers panel format.*
- *Panel discussion with educator was excellent.*

Similarly, more than one-quarter of adults (29%) mentioned the EXPO and the hands-on activities as what they liked the best. For example, some adults reported that they enjoyed:

- *Expo in morning was best. It was fantastic to have so many booths.*
- *EXPO-loved it for girls-very hands and engaged them.*
- *The EXPO was wonderful. The kids loved the hands-on experiences and the presenters really engaged them in discussion. The exposure to the different careers was fantastic.*
- *The EXPO was great, specifically the hands-on activities and one-on-one networking with women engineers.*
- *EXPO-hands on experience was awesome.*
- *The EXPO and the volunteers (very informative & helpful).*

Adults also appreciated all the informative resources shared with them at the event (9%). For example, some parents reported that they enjoyed:

- *The resources discussed during panel discussions.*
- *College information.*
- *Teacher resources.*
- *Ideas on where to go for resources and information; ideas on how to bring STEM back to local areas, Girl Scouts, etc. Visibility of all different kinds of opportunities for engineers.*
- *Very informative, will be very useful for me and my daughter.*
- *Real world experiences, professional educators and engineers, things that make engineering look like fun and not as intimidating as previously thought.*
- *Handout on common requirements or recommendations on getting into engineering school. Would have liked a "salary" hand out listing engineering and other career choices.*
- *Information on accessing scholarships.*

Several adults had positive feedback on the entire event. Other specific aspects of the event that parents and teachers appreciated were:

- *That the event was well-organized (6%),*
- *Being exposed to engineering role models (4%),*
- *The volunteers (2%), and*
- *Discussion with others (1%).*

Suggestions for Improvement

We asked adults to make suggestions for enhancing the event. Almost one-third (31%) reported that they would not change anything about the event. Of the adults who did make suggestions, 15% reported that they would add more time and/or space for the EXPO. Some adults suggested:

- *Just to have the EXPO a little bit longer.*
- *Separate the tables in the EXPO area to allow increased visibility and ease of hearing. EXPO was too crowded to see exhibits & participate appropriately.*
- *Allow a little more time to visit with each representative at the EXPO since there was so much valuable information.*

One-quarter (25%) of those who made suggestions for improvement noted the very long lines and the long waits at registration. Comments for improving the registration process included:

- *Add registration helpers. The line is quite long/slow. I enjoyed speaking with engineers while waiting however.*
- *More help at registration tables. We stood in line for more than an hour. The girls missed out on time in the EXPO.*
- *Registration! What a mess!*

Other suggestions for improvement included:

- *More hands-on activities (3%),*
- *Advertising the event more widely (2%),*
- *Expanding some of the issues addressed (2%), and*
- *Providing time for adults to network with each other (1%).*

For example, some adults reported:

- *Add more hands-on activities.*

- *Reaching out to churches to include. Other ways to get the information out about this event.*
- *Send out more information to area schools.*
- *I would leave out discussion on race in engineering. The first panel discussion focused on advocating for black success in engineering. If this is to be included at this event, you may want to consider adding an advocate for individuals with physical disabilities.*
- *More from engineers, their stories, and where they came from. More in-depth activity like the "toothpaste" one. More info on schools, scholarships, itinerary ahead of time!*
- *More one-on-one, more insight on scholarship opportunity & co-op opportunities & partnerships.*
- *Wish there was an opportunity to talk more with engineers in different disciplines one-on-one or in small groups.*
- *Provide information about scholarships and more information for parents of kids in high school about programs for the students or the path for classes to get into engineering in college.*

Educators' Responses to Open Ended Questions

In the interest of better understanding feedback from educators in particular, we identified the teachers' responses to open ended questions and gathered them below.

When asked what they liked most about the event, educators shared positive feedback about the panel discussions, the EXPO, and the overall event.

Educators reported the following about the panel discussion sessions:

- *I liked how Session 2 was in a small group for educators.*
- *Education panel was very insightful & informative, excellent discussion. Resources were excellent.*
- *Very personable and very clear. The panelists & volunteers were so eager to help and passionate about SWE!!*
- *All the women on the panels were amazing.*
- *The teacher session was the better part of the "parent presentation".*
- *Educators panel discussion hands-on activities.*
- *Educator's panel, activity demonstrations.*
- *Networking – talking to women engineers. It was amazing to hear first-hand experience about jobs & what the ladies do.*
- *Hands on.*
- *I enjoyed hearing the panel discussions.*
- *Panel discussions*
- *Panels and teacher resources.*

- *The panel for educators.*

Regarding the EXPO, educators reported that they liked:

- *EXPO everything.*
- *EXPO exhibitors!! I thought we got a lot for our 5 & 7 price tag. When gas prices are this high, and tolls & parking fees are added in I appreciate the cost being this reasonable.*
- *I liked the EXPO and exposing the students to endless career options in the engineering field.*
- *EXPO hands-on.*
- *The EXPO hall was great.*
- *EXPO activities.*
- *EXPO was great!*

Other educators commented on the event overall. For example:

- *The amount of diversity for the girls.*
- *I like the overall ... that everything will benefit and help other young girls.*
- *Well-run based on number of people attending.*

When teachers were asked what they learned that they didn't know before the event, many shared comments about resources and careers.

Educators commented about the resources about which they learned. For example:

- *Great variety of outreach & resource activities.*
- *So many resources to share!!*
- *Can't wait to read [the book mentioned].*
- *Tons of resources!!*
- *I learned about the resources available to me as an educator.*
- *All different resources I was not aware of.*
- *So many resources!*

Others shared comments relevant to careers. For example:

- *The variety of career options for girls.*
- *All the different types of engineers.*
- *How to talk to or encourage girls to join the engineering field.*
- *More about engineering as a career.*

Teachers also had more general feedback regarding what they learned. For example:

- *I learned that we can create instead of being consumers.*
- *Implicit bias.*

When asked how they would change the event for the future, teachers suggested specific additional content and offerings; adding more time and access to the EXPO; and providing more information in advance of the event.

Some educators had suggestions for additional content and offerings. For example:

- *Create more engineering education for parents & educators (why would someone want to go into engineering?).*
- *Add more small group talks based upon interests. For example, middle school educators, hands-on activities, starting a club, etc.*
- *More insight into careers, various aspects of engineering.*
- *More hands-on activities.*
- *Circular tables to foster discussion.*
- *Something that would have been helpful for my daughter, who doesn't think she wants to be an engineer, would be practical applications of engineering in areas where she has interests. For example, she wants to be something in the marine science field. So maybe seeing 'real world' engineers making a difference in a career field that children don't necessarily associate with engineering.*
- *At the panel today, another mom said her daughter liked science but not math so maybe an actual example of an engineer (who doesn't use much math) and stuff they actually do and jobs they can really get. No one really asked as far as I can tell what my daughter's interests are and then taking that information and showing her what engineering careers are out there. [Home School Teacher]*
- *In the future, have more programs to keep girls involved.*
- *More time with panels.*

Similar to feedback from adults overall, some educators shared suggestions for increasing access to the EXPO. Suggestions included:

- *Exhibitors need more space in hall. They had great hands-on activities but not many girls could fit at the tables/booths. And there were a lot of girls.*
- *Different times for EXPO attendees (students vs. educators).*

- *EXPO time without kids; talking & networking with exhibitors would be helpful but was impossible with all the kids.*
- *More time for H.S. girls in EXPO.*
- *The hands-on activity was rushed & could have been better structured.*

Teachers also suggested some more information be shared before the event. For example:

- *Make sure parents & educators understand ahead of time that students will be separated from adults. It was confusing to start the day that way.*
- *Map of EXPO hall ahead of time.*
- *Give a heads-up about the three different groups & what to expect.*
- *Please be more specific with when & where we should be at what time. My HS daughter was sent to the hall and almost missed her 1st session.*

EXPO Exhibitors

EXPO Exhibitors rated the EXPO positively, grading it 'A' (37%) or 'B' (59%).

All of the exhibitors (100%) enjoyed the fact that this was an event for girls and enjoyed interacting with the adults and children who visited their booths. Almost all of the exhibitors agreed or strongly agreed that their booth received enough interest and foot traffic (96%), the exhibitor registration went smoothly (93%), and the on-site check in process was helpful to them (82%).

More than half of the exhibitors agreed or strongly agreed that SWE's IIBI EXPO compares favorably with others where they have exhibited (63%), the fee for exhibitor registration was reasonable (58%), and they received help during set-up and tear-down of the booth (55%). Less than one-third (30%) of exhibitors indicated that food and drink was easily accessible to them.

We asked exhibitors what they liked most about the EXPO. Over half (56%) liked interacting with the girls, noting their enthusiasm and engagement. For example, some reported they most liked:

- *The attending girls were very engaged and excited about engineering.*
- *Interacting with all of the girls was great. There are a lot of bright young women at this conference.*
- *The energy was great! Loved interacting with both parents & girls.*
- *Youth were excited, asked questions and participated.*
- *Meeting awesome new faces!*
- *Diversity of participants, focus on STEM.*
- *Interaction with kids.*

- *The students were very engaged.*
- *The mixed age levels were great!*
- *Interacting with students, talking about what we offer for them.*
- *The excitement of the girls.*

In addition, forty-one percent of the exhibitors noted that the event was well organized, the volunteers were helpful or the space was good. For example, some reported:

- *It was very well organized.*
- *There was a variety of exhibitors. Easy registration, good flow of students.*
- *Lots of different activities and booths as well as networking opportunities.*
- *Timing & structure seemed well balanced.*
- *Volunteers were very helpful and friendly.*
- *The EXPO was easy to enter and it was easy for us to set the booth up.*
- *Location of our space.*
- *Proximity to the Reading Terminal.*
- *It was well organized and easy to participate.*
- *Open spaces.*

Other comments from exhibitors about what they liked most included the opportunity to meet different types of professionals and people (4%) and the collaboration with local non-profits (4%).

Suggestions for Improvement

We asked exhibitors how they would change the EXPO for the future. Suggestions included:

- *Difficult to talk to patrons with music of conference next door/ Loud microphone was annoying. (3)*
- *Don't charge so much for organizations to participate. (2)*
- *It would have been great if we had water, coffee and snacks. (2)*
- *Better visibility for booths in front and back. (2)*
- *Add EXPO hours after classes/Make it longer. (2)*
- *Missing Local organizations? Many in Philly not here.*
- *Better Breakdown of the exhibit hall schedule based on what age girls will be walking around the hall of a certain time period.*
- *Would like to see SWE members – we want to connect with professional women to offer volunteer opportunities.*
- *Make power free?*
- *"Open to public" portion not as long, wasn't very busy. More time for IIBI participants.*

- *End our EXPO exhibits earlier (1pm).*
- *More teachers.*
- *Put degree/job on name tag.*
- *A lot of people later in the afternoon did not visit our booth because it was in the back.*
- *More hands-on activities in the schedule of events.*
- *Better communication about when/where girls will be.*
- *Website for people to put their handouts/activities for points to refer to after the event.*
- *Change the setup of the EXPO. It was very cramped and more people may have come to our booth if it was more open.*
- *Too many middle schoolers at once.*

Appendix A: Schedules of Events and Activities

Invent It. Build it. 2016 Middle School Girl's Program Schedule

9:00-11:00 Registration and EXPO

10:30 Registration Closes

11:05– 11:25 Welcome

11:25-11:35 Table Icebreaker

11:35 – 11:40 Seismic Shake Up SWE Member Introduction

11:40-12:30 Seismic Shake Up

12:30-1:15 Lunch

1:05 – 1:15 Table Icebreaker

1:15 – 1:20 Helping Hand SWE Member Introduction

1:20 – 2:10 – Helping Hand

2:10-2:20 Evaluations

2:20 - 2:30 Dance Party

2:30 -2:50 Welcome of the parent/educator group and girls sharing

2:50 -3:00 Banner Presentation to ExxonMobil Foundation

3:00 – 3:15 Raffles

3:15- 3:30 Dismissals

**Invent It. Build It. Event
High School Girls Schedule
SWE, GSUSA, WGBH**

9:00- 9:25	Open ended Activity
9:25 9:30	Techbridge Icebreaker
9:40-9:45	Housekeeping
9:45-10:30	Keynote
10:30-12:00	EXPO
12:00-1:00	Lunch
1:00 - 2:50	Design Challenge
2:50-3:00	Evaluations
3:00-3:10	Sharing
3:10-3:25	Raffles
3:20 -3:25	Dismissal

Invent It. Build It. Event 2016
PARENT AND EDUCATOR PROGRAM (PEP) SCHEDULE

9:00 – 11:00	Sign-In and Expo open
11:00 – 11:10	Transition to PEP room / coffee break
11:10 – 11:15	Welcome and Partner introductions
11:15 – 11:30	Ice Breaker
11:30 – 12:15	Panel Discussion 1: Why Engineering?
12:15 – 12:45	Techbridge Hands-On (Touchdown)
12:45 – 1:25	Lunch
1:25 – 2:20	Panel Discussion 2: Preparing for Engineering Success (Parents) Panel Discussion 2: Educators – SWENextEd, SWENext and SWE in the Classroom Panelists: Debra Kimberling, Euridice, Sadaf
2:20 – 2:30	Evaluations
2:30 – 3:30	Parent Educators Join the Girls

Appendix B: Activity Sheets

SEISMIC SHAKE-UP!

CHALLENGE SHEET



FOR MORE GREAT ACTIVITIES:
PBSKIDS.ORG/DESIGNSQUAD

YOUR CHALLENGE

Design a structure that can survive an earthquake—then put it to the test!

DEFINE THE NEED

Hundreds of millions of people live in places around the world where earthquakes are common. Most of the destruction earthquakes cause is the result of collapsing structures, like skyscrapers, hospitals, and bridges. That's why earthquake engineering is so important. By designing buildings and other structures that can withstand the violent shaking of an earthquake, engineers save lives.



About 90% of all earthquakes take place along the Ring of Fire—a zone stretching around the rim of the Pacific Ocean.

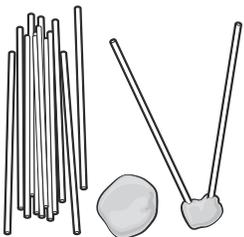
MATERIALS

Structure (per person)

- 20–30 wooden or plastic coffee stirrers (5–6 in long, or about 14 cm)
- ¼ lb (100+ grams) modeling clay (about half the size of a fist); non-hardening Plasticine® preferred
- manila file folder or thin piece of cardboard (8½ x 11 in or A4), as the base of your structure
- ruler

Shake Table

- 2 pieces sturdy cardboard (about 8½ x 11 in or A4)
- 2 thick rubber bands
- 2 tennis balls
- 2 large binder clips
- ruler or paint stirrer to make a handle
- masking tape



BRAINSTORM & DESIGN

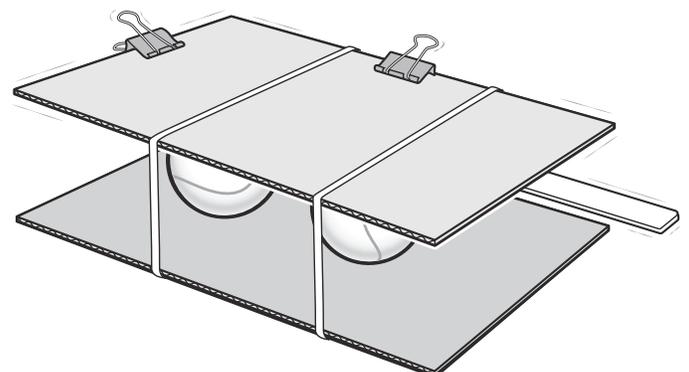
Using coffee stirrers and clay, can you design a structure that's stable and sturdy enough to survive an earthquake's vibrations? It must be **at least 8 inches tall**. Sketch your ideas on a piece of paper.

BUILD

Build your structure directly on top of the file folder, fixing the base of it to the surface of the folder. Use the ruler to make sure it's the minimum height.

Build a shake table, which is a device engineers use to simulate the back-and-forth shaking of an earthquake.

1. Wrap the rubber bands around the width of both pieces of cardboard. Space them about 4 inches apart.



2. Slide the two tennis balls in between the pieces of cardboard, and position them underneath each rubber band.
3. Tape the ruler (or paint stirrer) under the top piece of cardboard to make a handle.

TEST, EVALUATE, & REDESIGN

- Test your structure using the shake table. Attach the file folder with your structure on top of it to the table with the binder clips.
- Use one hand to hold the bottom of the shake table against a surface, pull the handle with the other, and let go! Earthquake!
- How did your structure hold up during the seismic shake-up? If it wobbled, swayed, tipped over, or collapsed, it's time to redesign. You want your structure to be as strong and stable as possible.
- Success? Take it to the next level and build an even taller structure!

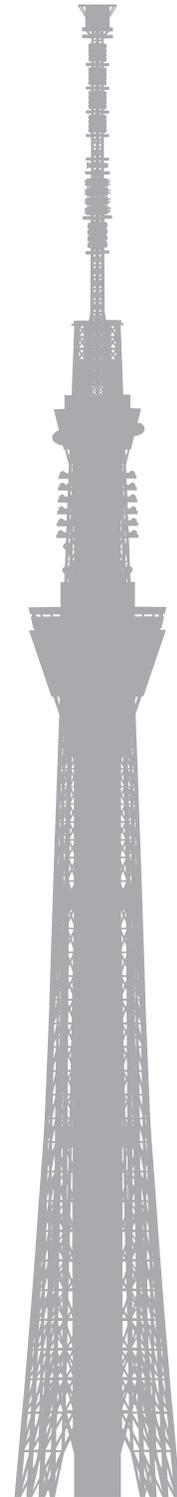
Problem-Solving Tips

WHAT IF YOUR STRUCTURE . . .

- **tips over?** Maybe your base is too small. Make it wider and sturdier.
- **collapses?** Add triangular shapes. Triangles are stronger than squares or rectangles because all three sides of a triangle carry some of the load (weight).
- **wobbles?** Try cross-braces. Turn squares into triangles by adding diagonal supports that go from one corner of the square to the other.

ENGINEERING AND INVENTION IN ACTION

Tokyo Sky Tree is the tallest tower in the world (634 m; 2,080 ft). It's also located right in the heart of an earthquake zone. So its engineers and architects needed to build a tower with the latest anti-earthquake technology. One way they did this was by standing the tower on a triangular, pyramid-shaped base. Another was by including massive dampers—shock absorbers that cushion the building during an earthquake. In March 2011, while still under construction, the tower was put to the test when a tremendous 9.0-magnitude earthquake struck Tokyo. Sky Tree's earthquake-resistant features worked beautifully—there was no structural damage and none of the construction workers caught in the building during the quake were injured.



Tokyo Sky Tree



DESIGN SQUAD GLOBAL is produced
by WGBH Boston

MAJOR FUNDING



PROJECT FUNDING

the Lemelson foundation
improving lives through invention

Major Funding is provided by the National Science Foundation. Project funding is provided by The Lemelson Foundation.

TM/© 2015 WGBH Educational Foundation

The DESIGN SQUAD GLOBAL material is based on work supported by the National Science Foundation under Grant No. DRL: 1422236. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

HELPING HAND



YOUR CHALLENGE

Design and build a device that lets you grab different objects and drop them into a container that's at least two feet away from you.

BRAINSTORM & DESIGN

Look at your materials and think about the questions below. Then sketch your ideas on a piece of paper or in your design notebook.

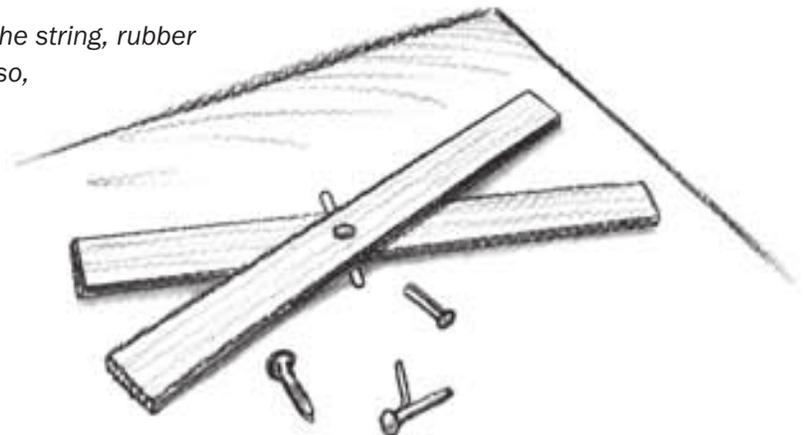


1. Using these materials, what can you build to grab objects that are two feet away from you?
2. How will your grabbing device open and close so it can grip an object and let it go?
3. How will you attach your grabber to the end of the stick?
4. How will you control your grabber when it's at the end of the stick?

BUILD, TEST, EVALUATE & REDESIGN

Use the materials to build your grabber. Then test it by trying to pick up different objects. When you test, your design may not work as planned. When engineers solve a problem, their first solution is rarely their best. Instead, they try different ideas, learn from mistakes, and try again. Study the problems and then redesign. For example, if your grabber's jaws:

- have a weak grip—*Increase their force. Each arm of the jaw is a **lever**—a bar that pivots around a **fulcrum**. In this case, the fulcrum is the brass fastener. Change the strength of your jaw's grip by adjusting the length of the arms and the fulcrum's position. (See illustration.)*
- keep dropping things—*Make sure that the jaws close enough to actually hold something. Also see if the jaw's gripping surface is big enough and shaped right to have a firm grip.*
- bend or twist—*Reinforce them with something stiff. Also, check if the jaw's arms are longer than necessary—short arms don't bend as easily as long ones.*
- don't work at the end of the stick—*Make sure the string, rubber bands, and moving parts aren't getting stuck. Also, move the jaws with your hands. If they don't work the way they should, readjust the parts.*



as built on TV™
pbs.org/designsquad

MATERIALS (per person)

- 4 brass fasteners
- corrugated cardboard
- hole punch
- objects to pick up (e.g., tennis balls, cotton balls, plastic soda bottles, and paper cups)
- 2 rubber bands
- sandpaper
- scissors
- string
- tape (duct or masking)
- 4 toothpicks
- 4 wooden skewers
- yardstick (or long paint stirrers for 5-gallon buckets, a thin wooden slat, or lath 2–3 feet long)

TAKE IT TO THE NEXT LEVEL

- Supersize me! Build a grabber that can pick up two objects at once.
- Smooth moves! Add a second motion to your grabber, such as making the stick that holds the jaws able to bend like an elbow or extend another two feet and then retract.

MAKE IT ONLINE

Blast me a marshmallow, would ya?

Build an air-powered marshmallow launcher out of plastic pipe and marshmallows. See how on Make Magazine's project page at makezine.com/designsquad.

ENGINEERING IN ACTION

There's something unique about four-year-old Michael—he has four hands! Born with six inches of his left arm missing, Michael wears a standard prosthetic (i.e., artificial) hand. It has some limitations—Michael can pick up and hold things but can't squeeze or press very hard. Michael's father wanted him to be able to do more with his prosthetic hand and have some fun in the process. With this in mind, he contacted engineers at the Open Prosthetics Project. Together, they built Michael two more hands—hands unlike any you've seen! One is a dinosaur puppet. Michael grips things by controlling its jaws. The other is a fishing rod. Michael uses it to catch fish as well as to reel in stray toys. Michael's father continues to think up and build more hands for Michael. "Once you have the training," he says, "you can conceive, design, and build whatever your imagination pictures."



Watch the **DESIGN SQUAD Water Dancing** episode on PBS or online at pbs.org/designsquad.



Major funding for *Design Squad* is provided by the Corporation for Public Broadcasting and the Intel Foundation. Additional funding is provided by the National Council of Examiners for Engineering and Surveying, United Engineering Foundation (ASCE, ASME, AIChE, IEEE, AIME), Noyce Foundation, Northrop Grumman Foundation, the IEEE, and the Intel Corporation.

© 2008 WGBH Educational Foundation. *Design Squad* and logo are trademarks of WGBH Educational Foundation. All rights reserved. All third party trademarks are the property of their respective owners. Used with permission. *Design Squad* is produced by WGBH Boston.



Appendix C: Survey Instruments

Invent It. Build It. – Student Feedback Form

Thank you for your participation. Please take a few minutes to fill out this survey.

Your comments and ideas will help make this event better in the future.

If you have questions, please ask a volunteer.

1. What grade would you give today’s event? Please circle the letter to show your answer.

A	B	C	D	F
----------	----------	----------	----------	----------

2. What did you like most about the event today? What else did you like?

3. Please tell us how much you agree with the following statements about today’s event.
Please check the box to show your answer.

	Strongly Disagree	Disagree	Not Sure	Agree	Strongly Agree
Before this event, I knew what an engineer did.					
After this event, I know what an engineer does.					
Before this event, I was interested in becoming an engineer.					
After this event, I am interested in becoming an engineer.					
I see a connection between my interests/passions and a career in engineering or technology.					
I enjoyed the fact that this was an event for girls.					
I know how to find out more about engineering and technology if I want to.					
I know my friends would support my interest in engineering or technology.					
My family supports my interest in engineering or technology.					

4. Please tell us how much you agree with the following statements about today's event.
Please check the box to show your answer.

	Strongly Disagree	Disagree	Not Sure	Agree	Strongly Agree
My confidence in problem solving improved.					
My ability to think of different ways to solve a problem improved.					
My confidence in designing things improved.					
My confidence in building things improved.					
The role models I worked with listened actively to my ideas.					
The role models provided support and encouragement.					
The role models were approachable.					
The role models guided me during the activities					

5. Please tell us how much you agree with the following statements. Please check the box to show your answer.

	Strongly Disagree	Disagree	Not Sure	Agree	Strongly Agree
Engineers are creative.					
Engineers do work that is hands-on.					
Engineers do work that is fun.					
Engineers do work that allows them to help their community and/or society.					
Engineers work in many different kinds of career fields.					
Engineering and technology are good career choices for women.					

6. If you were in charge, how would you change this event?

7. Would you recommend that other kids participate in events like this?
- a. Yes
 - b. Maybe
 - c. No (please explain): _____
8. What grade are you in? _____
9. Are you a member of SWENext? a. Yes b. No
10. With what races or ethnicities do you most identify? (Choose all that apply.)
- a. White or European American
 - b. Hispanic, Latino, or Spanish
 - c. Black or African-American
 - d. Asian American
 - e. Native Hawaiian or Pacific Islander
 - f. Native American or Alaskan Native
 - g. Other: _____
 - h. Prefer not to answer
11. Are you more interested in being involved with the Girl Scouts after attending this event?
- a. Yes
 - b. No
 - c. Maybe
 - d. I am already a Girl Scout

Thanks very much for your help! Please hand in your completed survey.

Invent It. Build It. – High School Student Feedback Form

Thank you for your participation. Please take a few minutes to fill out this survey.

Your comments and ideas will help make this event better in the future.

1. What grade would you give today’s event? Please circle the letter to show your answer.

A	B	C	D	F
----------	----------	----------	----------	----------

2. What did you like most about the event today? What else did you like?

3. Please tell us how much you agree with the following statements. Please check the box to show your answer.

	Strongly Disagree	Disagree	Not Sure	Agree	Strongly Agree
I see a connection between my interests/passions and a career in engineering or technology.					
I know how to find out more about engineering and technology if I want to.					
I know my friends would support my interest in engineering or technology					
My family supports my interest in engineering or technology.					

4. If you were in charge, how would you change this event for the future?

5. Would you recommend that other students participate in events like this?

- a. Yes
- b. Maybe
- c. No (please explain): _____

6. Please rate each segment of today's event by circling a letter grade. Add any comments you have.

Keynote Presentation (Beth Holloway)	A	B	C	D	F
---	---	---	---	---	---

Comments: _____

EXPO	A	B	C	D	F
-------------	---	---	---	---	---

Comments: _____

Lunchtime Presentation	A	B	C	D	F
-------------------------------	---	---	---	---	---

Comments: _____

Shock Absorber Activity (Ariel Biggs)	A	B	C	D	F
--	---	---	---	---	---

Comments: _____

7. What grade are you in? _____

8. Are you a member of SWENext? _____

9. With what races or ethnicities do you most identify? (Choose all that apply.)

- a. White or European American
- b. Hispanic, Latino, or Spanish
- c. Black or African-American
- d. Asian American
- e. Native Hawaiian or Pacific Islander
- f. Native American or Alaskan Native
- g. Other: _____
- h. Prefer not to answer

Thanks very much for your help! Please hand in your completed survey.

Invent It. Build It. – Adult Participant Feedback Form

Thank you for your participation. Please take a few minutes to fill out this survey.
Your comments and ideas will help make this event better in the future.

1. What grade would you give today's event? Please circle the letter to show your answer.

A	B	C	D	F
----------	----------	----------	----------	----------

2. What did you like most about the event today? What else did you like?

3. Please check the boxes below to indicate how much you agree with each statement.

	Strongly Disagree	Disagree	Not Sure	Agree	Strongly Agree
This event helped me feel well-equipped to talk with girls/my daughter about a career in engineering.					
This event helped me understand what engineers do.					
This event helped me understand why engineering is a good career choice.					
This event helped me understand what it takes to become an engineer.					
This event helped me understand why there are so few women in engineering.					
This event taught me some activities I can do with girls/my daughter.					
This event helped me learn where to find resources for girls/my daughter.					
I had a chance to meet professional engineers today.					
All my questions were answered today.					
My goals were met today.					
I feel empowered to help girls/my daughter become an engineer someday if they want to.					
I had fun today.					

4. What did you learn that you didn't know before today's event?

5. How would you change this event for the future?

6. Please rate each segment of today's event by circling a letter grade. Add any comments you have.

EXPO	A	B	C	D	F	Did not attend
-------------	---	---	---	---	---	----------------

Comments: _____

Panel Discussion 1: Why Engineering?	A	B	C	D	F	Did not attend
---	---	---	---	---	---	----------------

Comments: _____

Touch Down Hands-on Activity	A	B	C	D	F	Did not attend
---	---	---	---	---	---	----------------

Comments: _____

Panel Discussion 2: Preparing for Engineering Success *****Circle One: a. Parent/Guardian b. Educator	A	B	C	D	F	Did not attend
--	---	---	---	---	---	----------------

Comments: _____

7. Would you recommend that others participate in events like this?
- a. Yes
 - b. Maybe
 - c. No (please explain): _____

8. What is your relationship to the girl(s) participating in the event today?
- a. Mother
 - b. Father
 - c. Guardian
 - d. Troop Leader
 - e. Teacher
 - f. Other _____

9. With what races or ethnicities do you most identify? (Choose all that apply.)
- a. White or European American
 - b. Hispanic, Latino, or Spanish
 - c. Black or African-American
 - d. Asian American
 - e. Native Hawaiian or Pacific Islander
 - f. Native American or Alaskan Native
 - g. Other: _____
 - h. Prefer not to answer

10. Are you an engineer or do you have an engineering degree?
- a. Yes
 - b. No

11. How are you affiliated with SWE? (Choose all that apply.)
- a. Member
 - b. K-12 Educator Member
 - c. Parent/Guardian of SWENext Member
 - d. Not Affiliated

Thanks very much for your help!

Please hand in your completed survey. Stay in touch with SWE at www.swe.org.

Invent It. Build It. – EXPO Exhibitor Feedback Form

Thank you for your participation. Please take a few minutes to fill out this survey.
Your comments and ideas will help make this event better in the future.

1. What grade would you give **the EXPO**? Please circle the letter to show your answer.

A	B	C	D	F
----------	----------	----------	----------	----------

2. What did you like most about the EXPO? What else did you like?

3. How would you change the EXPO for the future?

4. Please tell us how much you agree with the following statements about today’s event. Please check the box to show your answer.

	Strongly Disagree	Disagree	Not Sure	Agree	Strongly Agree
Exhibitor registration went smoothly.	<input type="checkbox"/>				
The fee for exhibitor registration was reasonable.	<input type="checkbox"/>				
The on-site check in process was helpful to us.	<input type="checkbox"/>				
We received help during set-up and tear-down of the booth.	<input type="checkbox"/>				
Food and drink was easily accessible to exhibitors.	<input type="checkbox"/>				
SWE’s IIBI EXPO compares favorably with others where we have exhibited.	<input type="checkbox"/>				
Our booth received enough interest and foot traffic.	<input type="checkbox"/>				
We enjoyed the fact that this was an event for girls.	<input type="checkbox"/>				
We enjoyed interacting with the adults and children who visited our booth.	<input type="checkbox"/>				

Thank you very much for your help!