DISCOVER GIRL DAY
FEBRUARY 21, 2019

Four Easy Ways To Engage Girls (and Boys) In Engineering

1. Talk about engineering.

Most kids don't know any engineers or technicians and they don't really know what engineers do. This leads them to make interesting assumptions—like engineers sit in a cubicle doing math problems all day.

Share what you do! Be sure to tell them about the creative, problem-solving aspects of your work. Check yourself for engineering jargon. Tip: think about how you'd tell a 3rd grader what you do.

2. Do hands-on activities.

Activities that feature the engineering design process and an authentic, real-world challenge are a great way to engage students. They provide you with an opportunity to share how engineers approach a problem, give students an open-ended challenge that allows for an iterative development process, and allows you the chance to make connections to your work.

3. Focus on engineering outputs.

A lot of kids (and their parents) think engineers have to be straight A students to be a successful engineer. Rather than talk about what course requirements students need, talk about the rewards of being an engineer. Tell them how engineers dream up creative practical solutions and work with other smart, inspiring people to invent, design, and create things that matter.

4. Connect engineering to helping people.

Research shows when engineers share how their work makes a difference in people's lives, girls (and boys) are more interested in the field. When you describe your work, share more than what you do (e.g., I design satellites). Talk about how your work benefits people or society in general (e.g., I design satellites that help detect draught or are used to predict the weather).

Putting It All Together

Now that you know what to say, it's time to set up a visit to classroom or afterschool. Check with your employer or engineering society to see if they have a relationship with girl-serving organizations. If not, use our guide on setting up a visit.

Want More?

- Take our self-guided tutorial on Effective Ways to Talk to Kids about Engineering.
- Visit DiscoverE's robust library of engineering activities.

Introduce a Girl to Engineering Day is a program of DiscoverE. For more ideas and resources on engaging girls in engineering, visit DiscoverE.org.

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SWE RESEARCH

FAST FACTS

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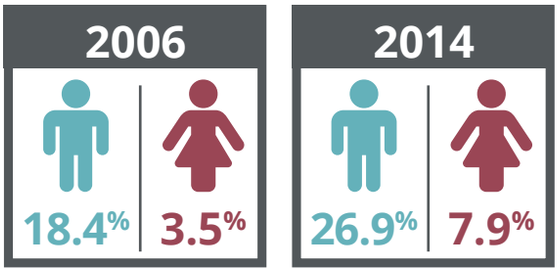
FRESHMEN INTENTIONS TO MAJOR IN ENGINEERING, MATH, STATISTICS, OR COMPUTER SCIENCE:



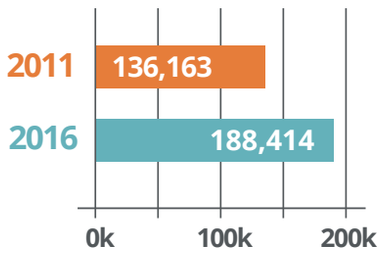
WOMEN LEAVING ENGINEERING/STEM

OVER 32% of women switch out of STEM degree programs in college.

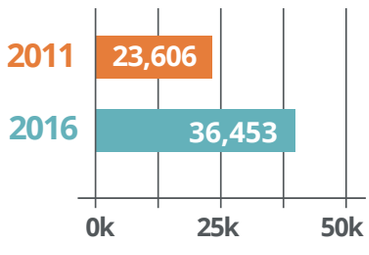
ONLY 30% of women who earn bachelor's degrees in engineering are still working in engineering 20 years later.

30% of women who have left the engineering profession cite organizational climate as the reason.

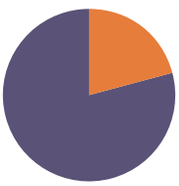
Degrees Awarded



38% increase in total bachelor's degrees awarded in engineering and computer science.



54% increase in bachelor's degrees awarded in engineering and computer science to women.



21.3% of bachelor's degrees awarded to **women in engineering and computer science**.

5.6% of bachelor's degrees in engineering awarded to **women of color**.

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SWE RESEARCH

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IN THE WORKFORCE

ONLY 13% of engineers are women.

ONLY 26% of computer scientists are women.

Female engineers earn **90 CENTS** for every **$1** male engineers earn.

ONLY 17% of tenured/tenure-track faculty in engineering are women.

TOP 10 Engineering Degrees: Female | 2016-17

1	Mechanical	6	Industrial/Manufacturing/Systems
2	Chemical	7	Electrical
3	Civil	8	Computer Engineering
4	Biomedical	9	Environmental
5	Computer Science	10	Metallurgical & Materials

[1]National Science Board. *Science and Engineering Indicators 2016*, Appendix Table 2-16.
[2]Chen, X. (2013). *STEM attrition: College students' paths into and out of STEM fields*.
[3]Corbett, C., & Hill, C. (2015). *Solving the Equation: The Variables for Women's Success in Engineering and Computing*. Washington, DC: American Association of University Women.
[4]Fouad, N. A., Singh, R., Fitzpatrick, M. E., & Liu, J. P. (2012). *Stemming the tide: Why women leave engineering.* University of Wisconsin, Milwaukee.
[5]U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, *Digest of Education Statistics 2017*, Tables 325.35 and 325.45.
[6]U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, *Digest of Education Statistics 2017*, Tables 325.35 and 325.45.
[7]Yoder B. L. (2018). *Engineering by the numbers*. American Society for Engineering Education.
[8]https://www.nsf.gov/statistics/2017/nsf17310/digest/fod-wmreg/
[9]https://www.bls.gov/cps/cpsaat11.htm.
[10]https://www.bls.gov/cps/cpsaat11.htm.
[11]2016 American community survey (5-yr estimates): Tables B24122 and B24123.

DISCOVER GIRL DAY

Pen Factory!

60 minutes | Grades 6–12

Like an industrial engineer, design the most efficient way to assemble as many pens as possible in two minutes flat.

Introduction

Industrial engineers design the most efficient, ergonomic ways to make a product or provide a service. In addition to designing methods for new production, they are expert troubleshooters who can evaluate a production process and find ways to improve it. In every sphere you can think of—manufacturing, agriculture, aerospace, banking, IT—industrial engineers are collaborating with company managers and other engineers to improve productivity and profit as well as conditions for the people who do the work.

Materials

- ☐ Click pen with 5 or 6 parts (30 per team)
- ☐ A stopwatch or smartphone timing app
- ☐ Writing materials and paper for collecting data

Preparation

Click pens are constructed in many different ways—before buying pens in bulk, check the model to make sure it disassembles easily into 5 or 6 pieces. Count out 30 pens for each team into ziplock bags.

Instructions

DEFINE THE PROBLEM

1. Hold up a functioning click pen and ask students, "How do you think a pen like this is put together in a factory? What actions must happen for it to be built perfectly each time?" Make a list of their ideas.

2. If nobody has mentioned it, introduce the term assembly line. Invite students to offer definitions. As needed, explain that products that have different parts get put together by the people or robots working in an assembly line. Each person or robot works on a different step in the process of putting something together.

A click pen assembled and disassembled

3. Optional: show some photos of human assembly lines that you find through a web search for products that are relevant to your students.

4. Ask students why assembly lines might make the work of putting together a large number of pens easier or faster than each person or robot assembling all the parts of a pen themselves.

5. Tell students that they will work in teams to design their own assembly lines in order to put together as many click pens as possible in two minutes.

6. Give students the specs:

   • Your team will have exactly two minutes to assemble as many pens as possible.

   • Each pen has to be assembled completely and accurately in order to be counted.

   • Each assembled pen must click and write correctly in order to be counted.

SET UP

7. Divide students into teams of five or six.

8. Give each team their bag of pens.

BRAINSTORM SOLUTIONS

9. Have each student take a pen apart and put it back together to explore how the pen is assembled. Instruct them to write down the steps they took to assemble the pen and to make sure that it works properly.

10. Tell the teams they will design an initial assembly line where each student has an assembly role (or two as needed). If needed as an example, have one team come to the front of the room, and give them each an assembly station and role(s). Have them assemble a pen as an assembly line.

11. Have each team figure out what order they think is best for putting together the parts, which student is at each assembly station, and what actions will happen at each station.

Guiding Questions ?

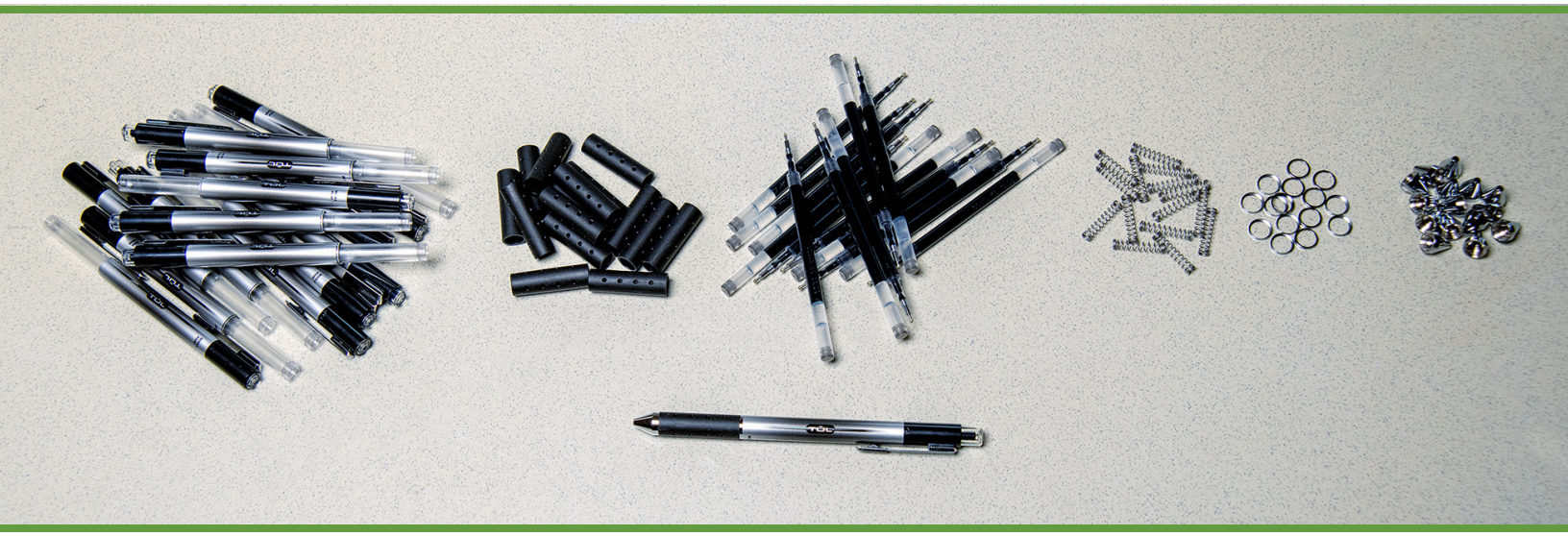
At what step(s) did the pen parts pile up? In other words, where were the bottlenecks?

Did anyone find themselves idle at any point in the process? How could tasks be changed to keep everyone productive throughout the assembly?

Was anyone reaching for parts awkwardly? Could positions be changed to make movement easy?

Were any of the pens not clicking or writing properly—a quality issue? At what point in the process did the problem occur? How are you checking quality?

Would it help to assemble certain parts before the main assembly? This is known as subassembly. If so, which parts would you put together prior to doing the main assembly?



The pen parts are sorted into piles for assembly

TEST

12 Tell students that they will begin by gathering baseline data on how well their assembly line works. (Explain to younger students that baseline data means gathering information that will help them see if their new ideas for an assembly line are better than this basic one.) Have students disassemble all of the pens in the bag, sorting the pieces into piles for an assembly line.

13 Remind students that they will have exactly two minutes to put together as many pens as they can, which means one student in each group will need to be timekeeper in addition to assembler. Give the teams time to complete a first run. Ask each team to check if each pen clicks and writes properly with no missing parts, and then report how many pens they assembled. Have the teams discuss their results, noting what problems they encountered.

EVALUATE AND DESIGN

14 Explain that the next task is to think about what could be improved so that their process of assembling pens is more efficient. They can make any changes they like to the process itself.

15 Share the guiding questions to help students consider improvements.

16 Have students disassemble all of the pens and get set up with their redesigned assembly line. Give groups time for another assembly line run. Remind students to check all of their completed pens. Ask each team to record their results and assess their latest process. Were they able to make more pens?

17 Have groups keep going through this cycle of redesigning their assembly line and testing it out, making sure to check pens at the end and record the results.

18 To debrief the activity, find out which team(s) had the most efficient assembly line processes, and discuss with the group about which assembly line processes worked the best.

EXTENSIONS

- To save money and reduce the number of pens needed per team: rather than have each team assemble as many pens as possible in two minutes, have them time how quickly they can assemble 20 (or 15) pens.
- Have the students add a pen with a different color ink. Does their assembly line design work when you have two different color pens?
- Divide the class into engineers and operators. The engineers devise the assembly processes, and the operators follow their instructions. How does communication factor into the efficiency of the process?

Use any click pen that has 5 or 6 parts

- Ask students to conduct a cost analysis. Students will be given a cost per unit for each pen component. They will determine the total cost of making each pen and what each pen will sell for. At the end of each trial, students would factor in the cost of pens not completed and what their profit will be.

Pen Factory! is adapted from an activity created by Northrop Grumman industrial engineers for use in their student outreach efforts.