

Cantilever Invention Design Challenge

DESIGN PROBLEM STATEMENT

Your challenge is to build a prototype for a *cantilevered* structure that can be quickly assembled and used in emergency rescue situations. Cantilevers are structures that are anchored on one end and extend outward, just like a diving board. Your prototype will be built out of Popsicle sticks and hex nuts. In this part of the engineering design process, you are just starting to test out some ideas and see how different models/structures work.

We don't expect anyone to know how to build a cantilever already!

UNDERSTANDING THE DESIGN ENVIRONMENT

You will build the cantilevers on your tables.

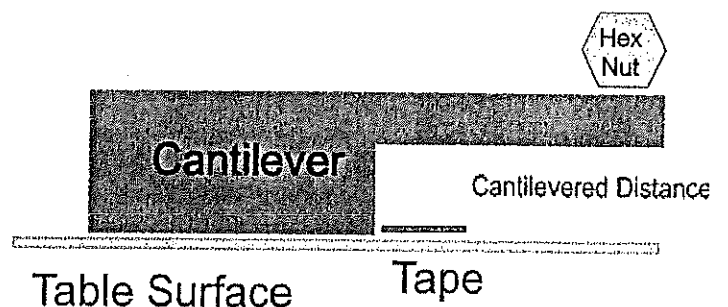
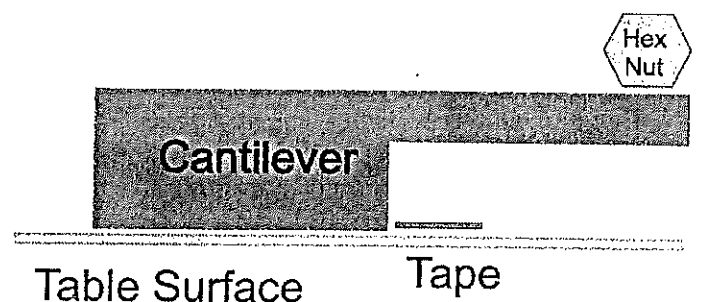
- Notice the tape on your table. On one side of the tape (e.g., the table surface to the left of the tape), you will build your cantilever on the table.
- The cantilever should extend over to the other side of the tape, but not touch the table on that side (e.g., the table surface to the right of the tape).
- You will have 20 craft sticks and 7 hex nuts to work with.

Challenge #1: Distance Design a cantilever that supports a hex nut the farthest distance past the tape.

In this part of the design process, you should focus on building a cantilever that can support ONE hex nut.

You should try to support it as far away from the tapeline as possible. As you build, think of a seesaw... that might help you in your design!

When time is up, you will measure how far out from the tape you are able to hold the ONE hex nut. This is your "Cantilevered Distance" below.



Challenge #3: Lean Engineering—working with less.

One of the challenges facing engineers today is how to do more with less, or lean engineering.

In this challenge, return to challenge #1 or #2, but reduce your number of Popsicle sticks by 5 (or more! How low can you go?).

When time is up, you will measure how far out from the tape you are able to hold the hex nuts and record how many hex nuts you've supported, if you focused on challenge #2.

Challenge #3: Analysis

Number of Popsicle sticks used _____

Number of hex nuts used as counterweights _____ (all the hex nuts used in your structure, except for the those held out over the tape)

Number of hex nuts supported at end of cantilever _____

Cantilevered distance (include units) _____
(measure from back of tape to the furthest point of the hex nut)

How would you describe the skills you used to solve this problem? Are they similar or different than the skills you used to solve the other challenges?

Describe how you shifted your design to compensate for the lack of sticks.

Cantilever Invention Design Challenge (Teacher Edition)

ACTIVITY OVERVIEW

In this activity, student groups of two or three work together to build cantilevers out of Popsicle sticks and hex nuts to accomplish various challenges.

If desired, measurement data after each round can be entered on a Google Spreadsheet and a real-time scatter plot will be generated.

MATERIALS

For every group of two or three:

1 quart-sized Ziploc bag

20 large Popsicle sticks (for example: <https://amzn.com/B00380E7RQ>)

7 hex nuts (size doesn't really matter, but as long as they are all the same; 1/2 inch size works well)

Masking tape/painter's tape

Rulers

Timer

Lab handout or slips of paper and pens/pencils to collect data

ACTIVITY PREP

For every table, distribute bags of cantilever materials. Place a strip of tape down on the table for each team. Distribute data collection slips/handouts as appropriate.

ACTIVITY IMPLEMENTATION

1. Introduce the activity with the slides and/or handout (about 5 minutes). Include background information on cantilevers and as much or little additional prior knowledge as you wish students to have. You can do team building as well – coming up with team names, etc.

2. Introduce Challenge #1 (balancing 1 hex nut as far out as possible), allowing about 5 minutes for building. You can choose to pause and debrief each challenge, or flow seamlessly between challenges as students finish.

3. As students accomplish Challenge #1, introduce Challenge #2 (hold maximum weight, distance an option component) and allow about 5 minutes for building.

4. As students accomplish Challenge #2, introduce Challenge #3 (accomplish Challenge #1 or #2 with 5 less sticks). After each challenge, remind students to be collecting data on how far their cantilever reaches, how many hex nuts they are able to balance and the number of sticks they are using. The entire activity should be about 35-40 minutes.

WAYS TO EXPAND THIS ACTIVITY

- Students can take the mass of the materials to determine a correlation between the mass used and mass held by the cantilever.
- Questions can be asked about the scatter plot generated by the Google spreadsheet, including comparing the scatter plots from the different challenges
- Additionally, you could graph the mass held vs. distance
- Students could also brainstorm alternative materials to build with and, if time and resources allow, try the challenges again using these alternative materials.