

Design a Truss Worksheet

Design Challenge Problem Statement

Identify the need and constraints: Your engineering team has been tasked to create the strongest possible truss structure that will be used to design a bridge to cross one of our local rivers. Your objective is to design a truss that supports the weight of the vehicle traffic that will drive over the bridge. The truss must be sturdy and stable. You are also asked to design a truss that is abstract and unique; the clients do not want a truss structure simply made of plain triangles. You have been tasked to use different regular polygons in the construction of your truss designs.

Objectives

1. Build a unique and creative truss following the steps of the engineering design process.
2. Explain how the deformation of a shape affects the sum of its interior angles.
3. Explain why a triangle might be the strongest geometric shape.

Materials List

- | | | |
|---------------|-----------------------|------------------------------------|
| • graph paper | • pencils | • hot glue gun, hot glue sticks |
| • protractors | • scissors | • 6 stickers, to tag target angles |
| • ruler | • 100 Popsicle sticks | |

Requirements and Constraints

1. You must design a truss structure that is abstract and unique.
2. You must use combinations of 3 different polygons; 1 must be a triangle.
3. You may use up to 100 Popsicle sticks.
4. Your truss structure may not exceed 3 feet in length.
5. You must identify and tag 2 angles for each of the three polygon types used in your design, which you will measure and analyze throughout the design process.

Procedure

1. *Research the problem:* Read the problem statement and objectives.
2. As a team, choose 3 different polygons for your truss design. One must be a triangle. Choose from this list for the other two: square, pentagon, hexagon, heptagon, octagon, nonagon and decagon.

Our three selected polygons are: triangle, _____ and _____.

3. *Imagine: develop possible solutions:* Brainstorm ideas with your group for how you might want to construct your truss structure.
4. *Plan: select a promising solution:* Sketch your truss design, making sure to use all three chosen polygons to form the truss. You have 15 minutes to create your drawing on graph paper.
5. Find the sum of the interior angles in all of the polygons that you used to build your truss. Record the sums in the **Sum of Interior Angles** column on the data collection sheet.
6. Select 2 target angles in each polygon type; that means a total of 6 target angles. Mark these target angles on your truss drawing.
7. Get your truss design and angle measurements approved by the teacher.

Design approval by teacher: _____

Name: _____ Date: _____ Class: _____

8. *Create: build a prototype:* Get your materials and start building your truss!
9. After the truss is built, use a protractor to accurately measure 6 target angles. Record your measurements in the **Measure of Angle 1** and **Measure of Angle 2** columns of your data collection sheet. Tag each target angle with a numbered sticker.
10. Make predictions for how you think your truss will perform during testing under a load:
How much weight (in books) will your truss be able to hold?
How much deflection will your target angles undergo?

Predictions: Load: _____ books Deflection: _____ degrees

11. *Test and evaluate prototype:* Next, test your truss's load capacity. Take your truss to the test area and place textbooks of equal size on top of your truss—one at a time. Apply load until the truss experiences deformation of the target angles.
12. Use a protractor to measure the angles of deflection of your target angles. Record the results in the **Deflection of Angle 1** and the **Deflection of Angle 2** columns on the data collection sheet.
Tip: How to determine the deflection angle? You have the initial measurements of the target angles. Once you apply load to your truss, the target angles change. *Calculate the change* between the initial target angle and the deformed angle. The change is called the deflection angle.

13. Record the number of books your truss was able to support before angle deformation.

Our first truss design supported _____ books.

14. Analyze your results by creating two graphs on your data collection sheet.
15. Before moving on to the “Redesign” part, communicate with your team and ensure that you all are on the same page with your results. Take some time to discuss and reflect on what you all discovered.
16. *Improve: redesign as needed.* The first attempt at a new design is rarely considered final. Engineers learn from their initial and subsequent prototypes and testing results, including failures. They look at why things don't work and work to make them better. Each revised effort is called an *iteration*.

What are you and your team planning to change from your first design?

List the changes that you will implement in the second iteration of your truss.

