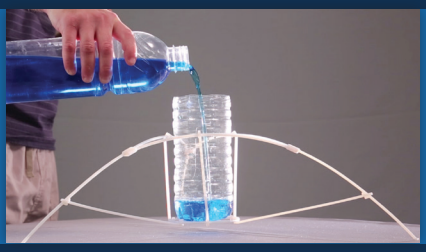
LESSON GUIDE



Designing a Weight Supporting Structure

This challenge can be helpful in teaching subjects such as:

- Structural design
- Strength and failure calculations
- CAD design
- Simulation
- Design optimization

Guiding Design Questions

1. What can you learn from the design of existing support structures?
   a. Bridges
   b. Cranes
   c. Tripods
   d. Tensegrity structures
2. How are the problems these structures are designed to solve similar to the current challenge and in what ways are they different?
3. What are the common features of these structures? How can they be applied to the challenge?
4. How can 3D printing technology allow you to create more effective designs (complex shapes and profiles, weight savings by “trimming” non-load bearing areas)?

Lesson Guidelines

1. Build a structure that can support a weight that is suspended 2 cm above the surface. The structure can touch the surface only at points of contact that are 30 cm or more away from the center.
2. To measure the load bearing capacity of the structure, place a cup or bottle in the holder and fill it up slowly until the structure breaks off and the center touches the surface.
3. The center of the structure must have a cup/bottle holder 10 cm in diameter and 2 cm above the surface.
4. The structure can touch the surface only at points 30 cm or more away from the center holder.
5. Maximum weight for the entire structure limited to less than 50 g.
6. Only printed parts are allowed - no adhesives, screws, etc.

Design Tips for 3D Printed Parts Using PolyJet Technology™

1. The minimum wall thickness that can be reliably printed is 0.6 mm. For load bearing parts, the preferred wall thickness is over 1.5 mm with a column diameter over 2.5 mm.

2. The required structure is too big to fit on a single printer tray so it must be made of multiple parts. No adhesive is allowed in this challenge so some type of printed connector must be used. Connectors can be based on friction, snaps or forces that form when the structure is loaded. As a design rule of thumb, leave a clearance of ~0.1-0.3 mm between parts.

3. After you have an initial design that works - refine it. See where the load is concentrated and how these areas can be made stronger and where load and weight can be saved. Consider creating a more complex structure (beams that are hollow tubes or made out of grid structure, add finer reinforcements, etc.) Printing a smooth, complex design is just as easy as printing a simple box.

4. Know the material limitations. Look at the datasheet; print a simple model to feel in your hand and design accordingly.

5. You can estimate the structure's weight using the built-in function in the CAD software. This can allow you to compare designs without printing them. You may need to print a test part to calibrate the density value in the software to get realistic weight estimations.

Optional:

6. Use mechanical analysis/simulation software to help you compare and optimize your design.

7. Print prototypes of your design, test them and improve accordingly.

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