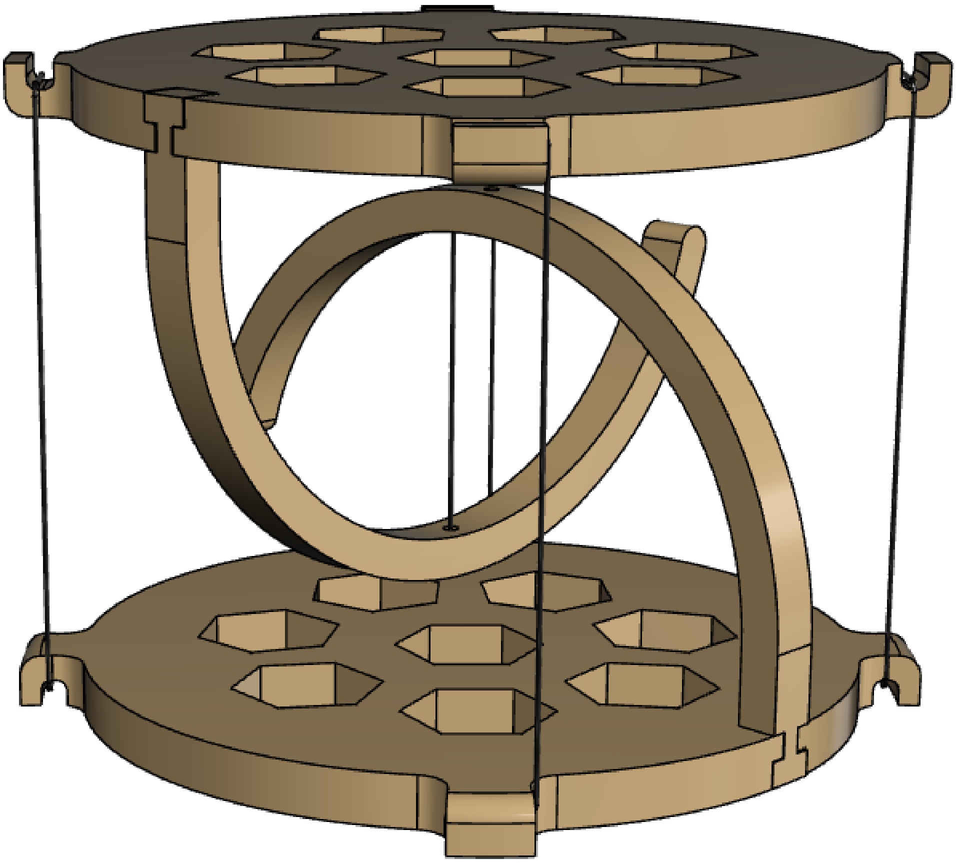
SOLIDWORKS / xDesign

DESIGN PROJECTS

Teacher Guide

3DEXPERIENCE



TENSEGRITY TABLE

DASSAULT SYSTEMES

INTRODUCTION/GENERAL GUIDELINES

Welcome to the Design Projects Teacher Guide for the Tensegrity Table. This activity presents a wide range of possibilities for the instructor. The individual components are simple enough for beginners to learn the basics of designing with CAD and the result is a model that can be used to explore the aspects of Tensegrity Table design. This project is suitable for individuals and teams to eventually design and build their own Tensegrity Table.

It is recommended that you have a completed model to pass around the class during the Presentation. As an instructor, you have several resources at your disposal:

1. **Overview PDF**
    - The initial document that introduces the project providing a brief overview.
2. **Teacher Guide**
    - This document contains information that corresponds to the sections of the Presentation PowerPoint (see below). Each section discussed in this guide provides further details on how you can use the PowerPoint.
    - Also included are additional ideas you may want to use to enhance the activity in the classroom or adjust it for different skill levels.
3. **Student Guide**
    - This document is intended for students and provides basic guidelines for the activity such as deliverables, tips for creating the individual components and 3D printing guidelines.
4. **Presentation PowerPoint**
    - The PowerPoint is used to introduce the project to the class.
    - Feel free to customize any part of the presentation such as history, design concepts or any STEM related materials.
5. **Video**
    - The video is located on YouTube, and is intended to provide an overall approach to how the model could be created in CAD.
    - You may want to watch it together with the students in class.
    - LINK TO PHASE 2 (YouTube VIDEO)
6. **Step-by-Step Course**
    - This is where every step of the design process is demonstrated with short easy to follow procedures and video clips as well as overall videos showing the entire process.
    - LINK TO PHASE 3 (RISE CONTENT)

BACKGROUND

This section provides students with an introduction to the concept of tensegrity. Provided is a list of famous tensegrity structures from around the world. You can look these up online and have further discussions regarding them.

Since this project focuses on creating a tensegrity table, a slide with several styles of tables is included. Use these examples as a starting point for discussing the advantages and disadvantages of this design concept.

Also included in this section is a slide for the discussion of key design terms.

- **Flat-Pack Design** – This type of design features components that are primarily flat. During the 3D printing process, such a design helps minimize waste and reduces the need for support materials.

- **Design Intent** – In the context of CAD modeling, Design Intent refers to how a model adapts when dimensions are changed. For example, it describes how a hole is created and dimensioned in a block. In product design, Design Intent encompasses how a product is intended to look, function, and feel from the user's perspective.

- **Additive Manufacturing** – This refers to the process of creating a 3D object by adding material layer by layer. 3D printing is a specific form of additive manufacturing.

- **DFM/DFAM** – These acronyms stand for Design for Manufacturing and Design for Additive Manufacturing, respectively. In these contexts, it is essential to consider both the materials used and the capabilities of the 3D printer to achieve a functional design while minimizing waste.

- **Nesting** – In manufacturing, nesting involves arranging cutting patterns on raw material to reduce waste during processes such as laser cutting. In 3D printing, nesting refers to the arrangement of parts on the printer's bed to optimize space and allow for the simultaneous printing of multiple components.

COMPONENT DESIGN

This section contains slides of each component to discuss applying Design Intent and DFAM to each part.

For detailed dimensions and step by step instructions for the parts, refer to LINK TO PHASE 3 (RISE CONTENT), in the **ADDITIONAL RESOURCES** section below.

3D PRINTING

This section provides an opportunity to discuss how the individual components will be oriented and prepared for 3D printing on the available machines in the classroom.

You may want to develop classroom procedures for using the machines and a method for keeping account of the materials used cost of each project. The way the components are designed and oriented on the 3D printer will have an impact on this. Here is also an opportunity to discuss sustainability, being mindful of our environmental impact when designing and making things.

PROJECT TASKS (ASSESSMENT CRITERIA)

Depending on the goals of the class, students should be able to accomplish the following tasks at a minimum.

1. Create the following components in CAD:
    a) Base
    b) Arm
2. Create an assembly of the Base and Arm in CAD.
3. Create a cutout in the Base to mount the Arm.
4. Print the physical components on a 3D printer.
5. Assemble the table.
6. Balance an object.

Some other possibilities for assessment may include the following categories:

- SUSTAINABILITY – How much waste is generated during manufacturing?
- ASSEMBLY – What additional methods can be developed for assembling the table?
- MANUFACTURABILITY – Do the components fit within the parameters of the 3D printer or laser cutter?
- PERFORMANCE – How much weight can the table support?

CLASS DISCUSSION

This section includes a couple of questions to start the conversation. The intent is to tailor the discussion to your course goals and the student's needs. Some additional questions may include:

- Why did some tables collapse while others remained stable?
- How do minor adjustments in string tension affect stability?
- What are the underlying physics of the structure?
- What improvements could be made to support more weight or enhance stability?
- What is the minimum number of strings required to maintain balance, and why?
- What other examples of Tensegrity can you identify?

ADDITIONAL RESOURCES

LINK TO DOCUMENTS
LINK TO YOUTUBE VIDEO
LINK TO STEP-BY-STEP

The following sections do not correspond to the PowerPoint and are included here for added benefit.

ADVANCED OPTIONS

For more experienced students, you can challenge them with more advanced concepts and tasks that encourage creativity, engineering principles, and real-world application. Below are some ideas that could be suitable for this level:

Advanced Tensegrity Table

- Stronger table: Design a Tensegrity Table to bear higher loads.
- Different shapes: Experiment with different shapes or designs, such as the examples shown in the Design Project gallery to maintain the same or a higher load.

Material Efficiency and Load Analysis

- Finite Element Analysis (FEA): Students can use CAD software to conduct Finite Element Analysis to simulate how their table design will perform under various loads and stresses and determine where failure would occur without having to print and assemble the parts physically.

Collaboration

- Team-based Design: Have students work in teams to design different table parts, with each team member responsible for different tasks, such as load-bearing analysis, aesthetics, materials, or safety.

By including these advanced design elements, students will be pushed to develop critical thinking skills and a deeper understanding of engineering concepts.

EDUCATIONAL CONCEPTS

A tensegrity table design and construction project is an excellent way to integrate multiple STEM concepts. Here are some potential teaching approaches:

SCIENCE

- Discuss properties of materials like tensile strength, compression, elasticity, and their suitability for a tensegrity structure.
- Test the strength of different materials, like yarn, fishing line, thread, etc.

TECHNOLOGY

- Teach students to use 3D modeling for creating their designs.
- Demonstrate how 3D printers work, from slicing software to the actual printing process.

ENGINEERING

- Compare designs, which student has the least or most components, which design holds the most weight, and test to see which design is the most stable.
- Challenge students to select a design type based on specific constraints (e.g., number of components, weight capacity, stability).

MATHEMATICS

- Measure and analyze load capacities of printed models, comparing results to predictions.
- Have students estimate material costs, factoring in 3D printer filament usage.