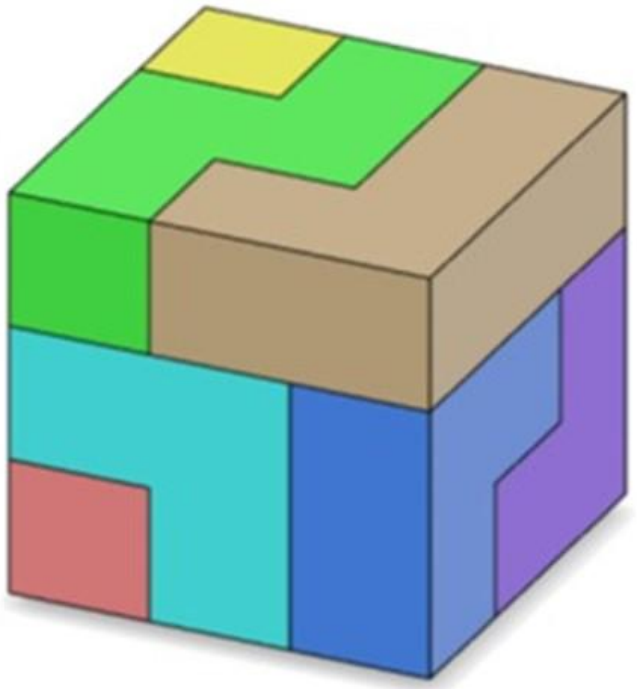
SOLIDWORKS

DESIGN PROJECTS

TEACHER GUIDE

3DEXPERIENCE



PUZZLE CUBE

DASSAULT SYSTEMES

INTRODUCTION/GENERAL GUIDELINES

Welcome to the Design Projects Teacher Guide for the Puzzle Cube. 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 more aspects of CAD design. This project is suitable for individuals and teams to eventually design and build their own Puzzle Cube.

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 YOUTUBE VIDEO
1. **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 STEP-BY-STEP

BACKGROUND

The Puzzle Cube Project teaches students about constraint-based modeling, design iteration, and manufacturing processes. Puzzle cubes are commonly used in education to enhance problem-solving skills and spatial visualization.

In this project, students will learn:

- **Design Intent** – Creating parts that fit together accurately in CAD.
- **Master Model technique**– starting with an overall or finished shape, and creating individual components based on it.
- **Manufacturing Constraints** – Optimizing designs for 3D printing or other fabrication methods.

Encourage students to research famous puzzle cube designs, such as the Rubik's Cube or Soma Cube, to gain inspiration and understand how interlocking pieces function.

KEY DESIGN TERMS

- **Design Intent –** Ensuring parts maintain function when dimensions are changed.
- **Additive Manufacturing –** Layer-by-layer fabrication using 3D printing.
- **DFM/DFAM –** Design for Manufacturing/Additive Manufacturing, considering material and process constraints.
- **Nesting –** Efficiently arranging parts on the print bed to reduce material waste.

COMPONENT DESIGN

Students will design interlocking pieces using CAD software. Start off by creating the overall cube, then splitting it into 27 smaller cubes. These will then be joined to create at least five individual puzzle pieces. Each piece must meet the following criteria:

- Fit together to form a complete 60mm x 60mm x 60mm cube.
- Follow dimensional constraints to ensure printability and assembly.

Encourage students to prototype and test their designs digitally before fabrication.

3D PRINTING

Discuss printing orientation, material usage, and support structures before students proceed with fabrication.

Consider these factors:

- Print Orientation – Parts should be optimized for strength and minimal warping.
- Tolerance Adjustments – Ensure proper fit and assembly.
- Material Conservation – Reduce waste and manage filament usage. Avoid overhangs or excessive support structures in 3D printing.

Alternatively, students may fabricate the puzzle pieces using laser cutting (stacked layers) or CNC machining, depending on available tools.

CLASS DISCUSSION

Encourage students to reflect on their design process with questions like:

- What challenges did you face when designing interlocking pieces?
- How do small tolerance changes affect the fit of the parts?
- What would you change to improve assembly or usability?
- How can this project be applied to real-world manufacturing?

PROJECT TASKS (ASSESSMENT CRITERIA)

Students should complete the following:

1. Design & Model Puzzle Pieces – Create the interlocking parts in CAD.
2. Assemble Digital Model – Ensure all pieces fit together correctly.
3. Fabricate Puzzle Cube – Manufacture and assemble the physical model.
4. Test Functionality – Ensure the puzzle can be taken apart and reassembled.

Additional Assessment Criteria:

- **SUSTAINABILITY** – Did the design minimize material waste?
- **ASSEMBLY** – How well do the pieces fit together?
- **MANUFACTURABILITY** – Can the design be efficiently produced with available tools?
- **DESIGN COMPLEXITY** – Are the interlocking features innovative and challenging?

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.

EDUCATIONAL CONCEPTS

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

SCIENCE

- Explore friction, force distribution, and material properties affecting assembly.
- Test how different materials affect part durability.

TECHNOLOGY

- Use CAD software to design and simulate puzzle pieces.
- Explore 3D printing techniques and slicing software.

ENGINEERING

- Optimize designs for functionality and ease of assembly.
- Compare different interlocking mechanisms and their applications.

MATHEMATICS

- Apply geometric constraints and spatial reasoning.
- Calculate dimensional tolerances and material usage.

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:

- Complex Puzzle Design – Create a larger or multi-layered puzzle cube.
- Parametric Design – Use CAD tools to create scalable puzzle variations.
- Material Analysis – Compare different fabrication methods for efficiency and durability.
- Team-Based Design – Assign different aspects of the project to collaborative groups.

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