SOLIDWORKS

# DESIGN PROJECTS

## TEACHER GUIDE

3DEXPERIENCE



# PEN HOLDER

DASSAULT SYSTEMES

# INTRODUCTION/GENERAL GUIDELINES

Welcome to the Design Projects Teacher Guide for Pen Holders. 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 design. This project is suitable for individuals and teams to eventually design and build their own pen holder.

As an instructor, you have several resources at your disposal:

1. **Overview**–
    - This document provides an overview of the project, including design objectives, lesson topics, optional challenges, and assessment criteria.

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 to share with the 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 expand 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

6. **Step-by-Step Course** –
    - This is where every step of the design process is demonstrated in short easy to follow video clips.
    - LINK TO STEP-BY-STEP

## BACKGROUND

This section is intended to provide students with an introduction to key design terms.

- **Flat-Pack Design** – Materials are expensive. Encourage students to create designs that minimize waste *and* meet design requirements.

- **Design Intent** – It is always best to have a clear definition of how a product should look, function and feel to the user. This is referred to as form, fit and function. Spend some time discussing this vital step in the process of designing a solution to a problem.

- **DFM/DFAM (Design for Manufacturing, Design for Additive Manufacturing**) - In addition to Design Intent, the concepts of DFM/DFAM are equally important. When designing anything, the question, "How will this be made?", should be considered. This particular project is designed to be 3D printed. As such, it is important that students understand the capabilities of the machine you have available.

- **Nesting -** In manufacturing, nesting refers to laying out cutting patterns on raw material to minimizing waste during manufacturing processes, such as laser cutting. In 3D printing, it is the process of laying out parts to fit on the bed of the 3D printer to print several components at one time. It is important to discuss how parts should be prepared for manufacture, specifically 3D printing.

## COMPONENT DESIGN

This section contains slides for each of the components. The purpose of this section is to discuss how Design Intent and DFAM is to be applied to each part.

- For detailed dimensions and step by step instructions for the parts, refer to the **LINK TO STEP-BY-STEP,** in the **ADDITIONAL RESOURCES** section below.

## 3D PRINTING

This section provides an opportunity to discuss the specific ways the component will be oriented and prepared for 3D printing on whatever machines that are available to the students in the classroom.

It is recommended that you develop classroom procedures for using machines and a method for keeping account of materials used. One thing you may want to do is have the students calculate the cost of each project. The way the components are designed and oriented on the 3D printer, will have an impact on this. This can also be an opportunity to discuss sustainability, being mindful of the environmental impact we have when designing and making things.

## CLASS DISCUSSION

Included in this section are a couple questions to get the conversation started. The intent here is for you to tailor the discussion to suite your specific course goals and students needs. Some ideas may include:

- How does adding the fillets improve the strength of the pen holder?
- Can the size of the pen holder be changed?

## PROJECT TASKS

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

- Create the pen holder component in CAD.
- Print the physical component on a 3D printer.
- Fill the pen holder with pens, pencils, and markers.

Some other possibilities for assessment may be in the following categories:

- **SUSTAINABILITY** – How much waste is generated in the manufacturing process?
- **ASSEMBLY** – What are the maximum and minimum size split keyrings that will fit?
- **MANUFACTURABILITY** – Do the components fit within the parameters of the 3D printer? Laser cutter?
- **PERFORMANCE** – How thick should the walls be?

## 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 high school or college-level 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:

### Adjust Model Size

- **Height**: Adjust the height of the pen holder walls to better accommodate your pens and pencils.
- **Compartments:** Add more or fewer compartments to suit your organizational needs.
- **Thickness**: Increase the pen holder of the pen holder walls for more strength, or decrease the thickness to save material and printing time.
- **Bottom:** Add a bottom to the design by reusing the same sketch again. Note that this will change your printing costs and time.
- **Scaling**: Increase or decrease the overall size of the model using scale with a percentage.

### Material Efficiency and Load Analysis

- **Finite Element Analysis (FEA):** Students can use CAD software to conduct Finite Element Analysis to simulate how their pen holder design will perform under various loads and stresses.

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

**SCIENCE**

- Test the strength of different 3D printing materials, such as PLA vs. ABS.

**TECHNOLOGY**

- Teach students to use 3D modeling for creating their designs.
- Demonstrate how 3D printers work, from slicing software to the actual printing process.
- Discuss additive manufacturing principles and how they differ from traditional methods.
- Emphasize the importance of DFAM, Designing for Additive Manufacturing, by minimizing waste through smart design.

**ENGINEERING**

- Challenge students to select a design type based on specific constraints (e.g., length, thickness).
- Focus on problem-solving and overcoming design failures.

**MATHEMATICS**

- Calculate angles, lengths, and dimensions for accurate CAD modeling.
- Have students estimate material costs, factoring in 3D printer filament usage.
- Compare budget-friendly designs to more elaborate ones.