

## **Sketching, Building & 3D Printing: Implementation of a Non-Discipline Specific Making Activity in a First-Year Engineering Design Course**

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Susan Beyerle is an Instructor of Cornerstone Engineering Design at The Pennsylvania State University. She has a background in manufacturing, having worked at several Corning plants and as a manufacturing engineering consultant. She holds an MS in Materials Science and Engineering from UT Austin and a BS in Industrial and Systems Engineering from Ohio State.



## Sketching, Building & 3D Printing: Implementation of a Non-Discipline Specific Making Activity in a First-Year Engineering Design Course

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The Pennsylvania State University

**Student Learning Objectives:** Learn the basics of multiview sketching and dimensioning and then apply this knowledge by constructing a multi-part (wooden) assembly. Then, employ CAD skills to design and 3D print accessories for the assembly, while considering additive manufacturing characteristics such as tolerances, feature size, and orientation.

### Skills and Core Learning Elements (individual & team components):

**Teamwork:** 3 or 4 person teams

**Unique drawings:** Modified assignment per team

**Sketching skills:** Individually complete dimensioned multiview drawings

**Making skills:** Using another team's drawings, individually manufacture piece(s) from wood with basic shop tools; assemble using press fit, paint

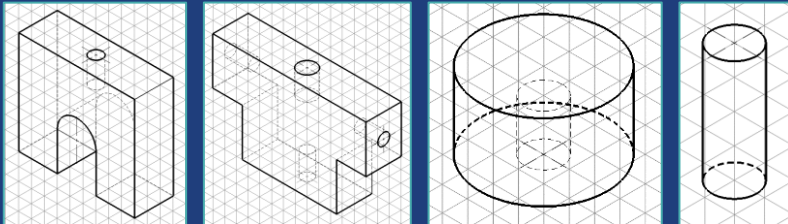
**Evaluation skills:** Interpret / critique drawings during build; critically evaluate 3D print

**3D design skills:** Model, print accessories, evaluate prints, redesign CAD models

**Implementation:** This assignment takes place over a number of assignments – a timeline is provided to the right, with approximate timing for in- and out-of-class activities. The instructor provides instruction and supplies. Students work individually and as teams to complete the multi-part assignment. Details on the instructor and students steps are below.

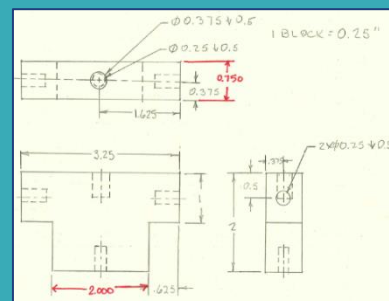
### Instructor Part 1: Provide isometric views of parts for students' drawings

- I. Prepare CAD models of parts\*.  
\* Each team provided set with unique dimensions.
- II. Prepare isometric view of each part with appropriate scale.
- III. Here, each box represents 0.25".



### Student Part 1: Complete dimensioned multiview drawings

- I. Students individually draw and dimension multiview sketches of the provided parts\*.  
\* Each team provided with a unique set
- II. Each team of ~ 4 students selects the "best set of drawings" from their own team.
- III. Each team swaps drawing set with another team for construction and evaluation.



1 week

### Instructor Part 2: Prepare materials and tool stations

- 1x4" lumber
- Sandpaper
- Paint & brushes
- 0.25" dowels
- 0.375" dowels



**Station 1 (Head):**  
Hand drill or drill press with 1.25" hole saw.



**Station 3 (Legs):**  
Hand drill with 0.75" spade bit.



**Station 5 (General cuts):**  
Bandsaw with push sticks.



**Station 2 (Holes):**  
Drill presses with 0.25" and 0.375" drill bits.



**Station 4 (Dowel connectors):**  
Vise with hacksaw.

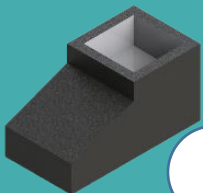


### Student Part 2: Build components from wood using dimensioned drawings

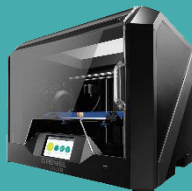
- Each student should be responsible for building one component (the dowels constitute one component).
- While building, students should note errors (e.g., missing dimensions, missing hidden lines) in the sketches using provided red pens.
- Students paint and assemble character.
- Reflect on lessons learned (e.g., value of measuring twice, cutting once; usefulness of dimensions; confidence in using a new tool; teamwork).



### Student Part 3: (i) Design 3D models of accessories\* in SolidWorks for character & send to 3D printer; (ii) show & tell with printed components & evaluate; (iii) redesign based on evaluation.



i

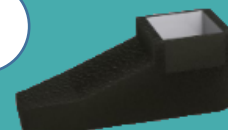


ii



**Evaluate against 3D print quality & DfAM:**  
Fit (tolerance), scale, complexity, appearance, print orientation

iii



\* 3D printed components should attach to wooden pieces without use of glue.

[30 min]

[before class]

[2 hrs]

[in class]

i

2 weeks

ii

1 week

iii