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

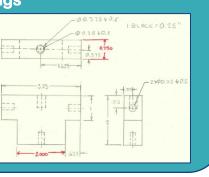*3D design skills:* Model, print accessories, evaluate prints, redesign CAD models

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

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

Station 4 (Dowel connectors): Vise with hacksaw.
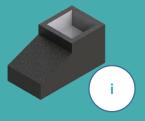
Station 5 (General cuts): Bandsaw with push sticks.

Student Part 2: Build components from wood using dimensioned drawings

I. Each student should be responsible for building one component (the dowels constitute one component).

II. While building, students should note errors (e.g., missing dimensions, missing hidden lines) in the sketches using provided red pens.

III. Students paint and assemble character.

IV. 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.
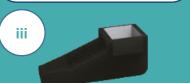
i

ii

iii

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

* 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