

Introducing Design Revision into a Freshman Level Engineering Graphics Course

N. E. Study

*Department of Mechanical Engineering Technology
Penn State Erie - The Behrend College*

E. R. Evans Jr.

*Department of Mechanical Engineering Technology
Penn State Erie - The Behrend College*

Abstract

To better prepare students for their upper level design courses including a senior capstone course, a simple design project was introduced in a freshman level engineering graphics course. This project required the students to initially sketch design ideas while in class, then additional refined sketches were required as a homework assignment. From these sketches, one design idea was selected by the instructor and feedback was given on the design ideas. At the completion of the project, students submitted their sketches, a model of their product, working drawings and a cost estimate prepared using spreadsheet software.

Introduction

In the School of Engineering at Penn State Erie - The Behrend College, a two course sequence of introductory engineering graphics courses is offered as part of the Mechanical Engineering Technology program. The first course covers sketching, multiview projection, dimensioning, 3D modeling methods, assemblies, and an introduction to detail drawings. The second course covers section and auxiliary views, threads and fasteners, detail drawings, and advanced CAD applications. In the second course, during the sixth week of a fifteen week semester, a design project was introduced. This project included many of the topics addressed in the two semesters of engineering graphics course sequence.

Project Overview

The students were given the following description of the project along with a graphic that included specific details about the air compressor:

I bought a new air compressor for my workshop. Your task is to design a device which can be used to easily move the compressor and its associated accessories and tools around in the workshop. The result of your design effort is a complete set of working drawings

for the device which will convey all the necessary information to make it. You also need to use a spreadsheet to create a bill of materials listing the materials and parts that need to be purchased. This spreadsheet will also serve as a material cost estimate.

Function of the Device:

- To store and transport a pancake type air compressor and its associated accessories and tools.

Design Requirements:

- It shall be compact, stable and portable
- Must be inexpensive
- Safe to use
- Has to be made using tools found in a typical home workshop (saws, drills, hammers, etc.)
- The compressor weight and dimensions are defined in the catalog cut above
- The air hose is 1/4" diameter (1/2" OD) and is 50-ft long
- Device is to be human powered, not motorized in any fashion
- The compressor is used with a pneumatic nailer which is shown in the figure below

Project Timeline

During a lecture session in week six, the students were given the project information and approximately 30 minutes at the end of class to sketch three different design ideas. These sketches were initialed by the instructor and retained by the students with the instructions that they should analyze their sketches, think about their design ideas, and in one weeks' time turn in a set of detailed sketches based on their initial ideas. During week seven, the original in-class sketches were to be turned in along with revised sketches which were to include basic dimensions, initial material choices, and any necessary notes. From the detailed sketches, one of the three design ideas was chosen by the instructor for further sketching/ideation and students were given detailed feedback from the instructor.

In week eleven, the following was due: the original sketch of the design idea that was selected for the student to refine; a new sketch, including notes describing any substantial or required changes made to the design; an isometric sketch of the final design idea; detailed orthographic sketches including dimensions of the non-standard components including any necessary detail sketches; and a detailed parts list including specific materials, costs, and the names of the local vendors where the necessary items can be obtained.

The sketches and parts lists were returned to the students in week twelve. The returned items included detailed feedback on the design and selected materials as well comments on the

effectiveness of the design in meeting the original project scope and needs of the end user. In the initial assignment, a budget was not specified beyond “inexpensive” and the total cost for the designs ranged from approximately \$50 to over \$300. Students were instructed during week twelve that the total budget for the project could not exceed \$75. This required a few designs to be changed substantially. Most students were able to meet the new budget by changing the specified material instead of making major configuration changes to their design.

The completed final project was due in week fifteen and the requirements were expressed as follows:

Based on the feedback on your refined sketches, create the following:

- Creo assembly (.asm) that includes all parts, including fasteners, wheels, etc.
- Exploded assembly drawing (.drw) with BOM that indicates how each part fits together; also include smaller scaled view of full assembly
- Dimensioned detail drawings (.drw) of all parts that are not standard
- Instruction sheet complete with graphics (created in Word or PowerPoint) that has all the steps for building the cart including:
- Tools necessary to build the cart (saws, screwdrivers, glue, etc.)
- Notes and any necessary graphics that indicate specifically how and in what size/length to cut plywood, dowels, pipes and any other material that needs to be modified from its purchased state
- Cost sheet (in Excel) that has the price of all items and where they can be purchased - total cost not to exceed \$75

Project Examples

Figure 1 shows two examples of the first sketches completed in class during week six after the project was initially introduced. There were no specific instructions given on the format of the initial sketches. Some students used standard orthographic views like the example on the right, others created only isometric views, and some used a combination of view types and notes as in the example on the left. In Figure 2 are examples of the detailed sketches that were based on the initial design ideas. The examples in Figure 3 are of the final set of sketches that were required to include detail sketches, a parts list and costs. Figure 4 shows assemblies and exploded assemblies created using Creo.

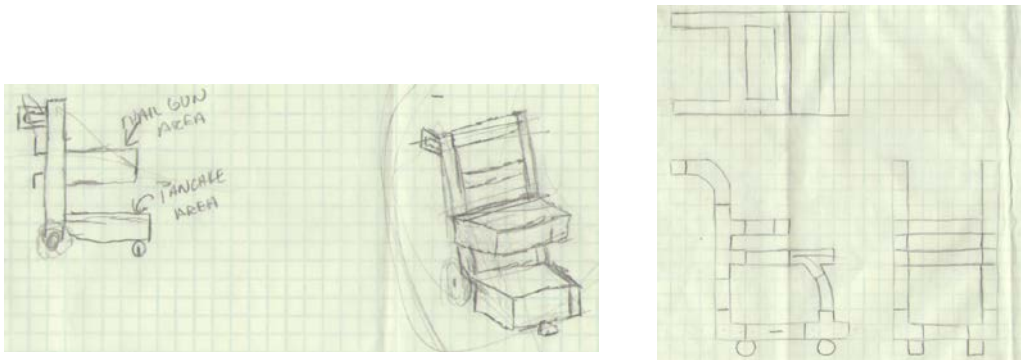


Figure 1. Initial sketch examples

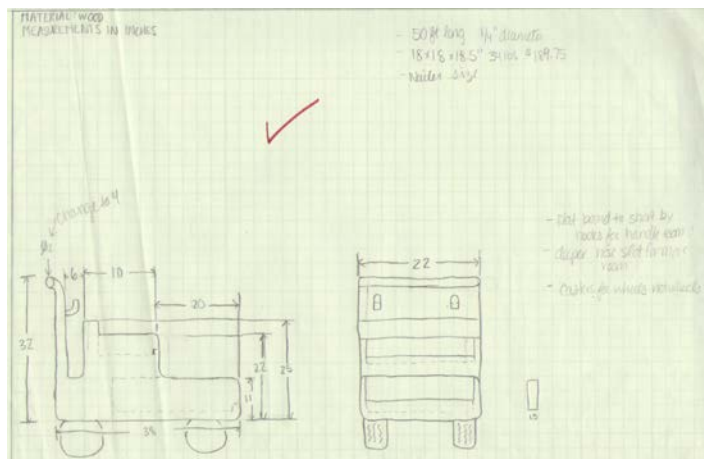
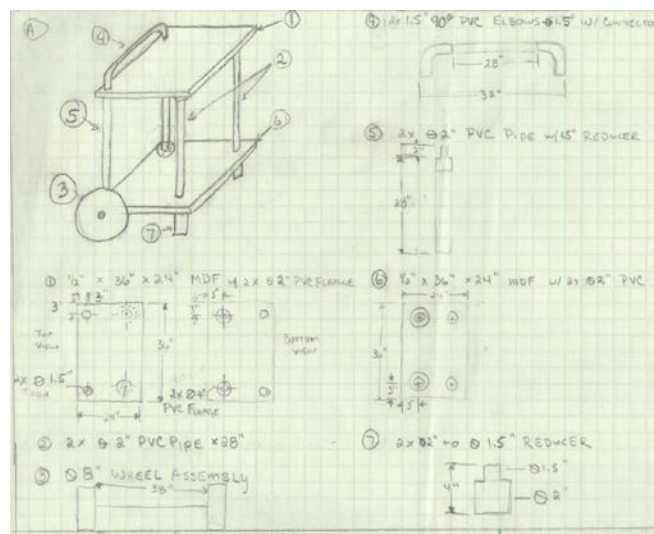


Figure 2. Detailed sketch examples

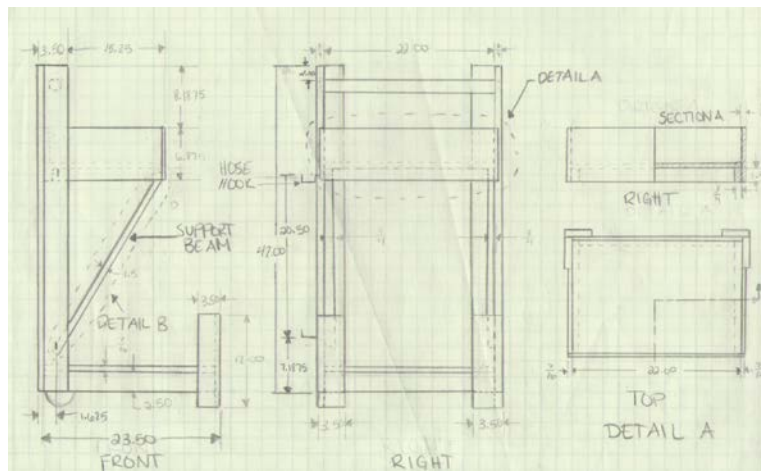
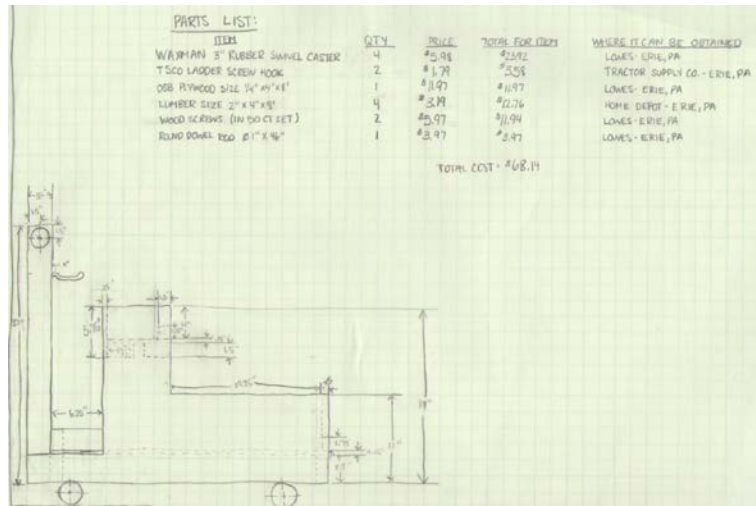


Figure 3. Final sketch examples

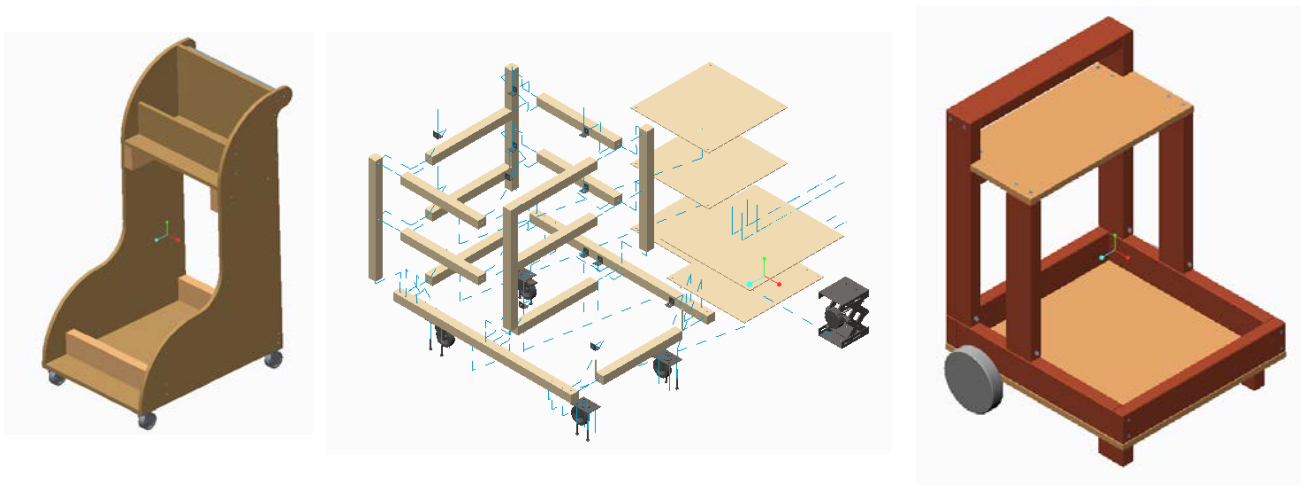


Figure 4. Creo assembly examples

Conclusions

Overall, the project was effective in that it required students to consider different design solutions along with implementing a variety of engineering graphics techniques in the finished project. Student feedback included comments like: (instructor) didn't choose the design I liked best; sometimes things that are easy to sketch are actually hard to model and build; I wish we'd had more time to do the Creo work; I thought my design looked good but couldn't figure out how to attach everything together so I had to change it; project was interesting and fun but harder than it sounded when (instructor) first assigned it.

The requirement of having students list the specific tools needed to make the cart, along with finding local vendors for all of the components added a practical element to the project. Some students even commented that going to the store along with searching online for parts helped them make specific changes to their designs, especially for fasteners and wheels. The requirement of multiple sets of sketches and revision of ideas before CAD modeling began, along with the instructor selecting which design idea to go forward with, prevented the issue seen previously in different courses where students would start to design using CAD software instead of sketching and then have difficulty and express frustration in making design changes because of the time already invested in modeling.

In future offerings of the course, students will be given smaller assignments earlier in the semester to introduce them to the process of looking for alternative ways of designing specific features. For example, they would have to sketch three different ways two boards can be assembled to form a 90° corner. Time allowed for CAD modeling will also be reconsidered, along with the overall scope of the project since student comments and instructor observation both indicated that time required outside of class to complete the final project may have been a little too extensive.