The Herbert J. and Selma W. Bernstein Class of 1945 Internship Report
Summer 2012
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Introduction
In an effort to strengthen the mechanical design curriculum, I took this summer as an opportunity to overhaul many aspects of the MEAM 101: Introduction to Mechanical Design course. In addition to providing insight into mechanical design and developing practical skills in rapid prototyping, I wanted to ensure that this course grows to be a productive precursor to MEAM 201 and IPD 501.

Goals
Among the ideas listed in my application, I decided to focus on MEAM 101 in order to better prepare students for the mechanisms and mechanical constraints they are likely to experience in MEAM 201, as well as their lab courses. As a result, I narrowed my goals to the following:

- Choosing a textbook that can be used across MEAM 101, MEAM 201, and IPD 501
- Creating a “Library” of additive layer manufacturing artifacts to highlight common and more advanced techniques
- Introducing machine elements and relevant analysis
- Gathering a collection of objects that can be used to illustrate said elements and concepts
- Creating projects where these new resources can be demonstrated and applied

Accomplishments

After comparing five textbooks concerning machine and mechanical design, I chose the Mott textbook because it gives clear instruction and insightful examples covered throughout the MEAM curriculum.

The range of detail presented is well suited for the MEAM Design curriculum, from an introduction to mechanical elements for MEAM 101, to analysis of forces and stresses in complex machines for MEAM 201 and IPD 501. This textbook will serve as a resource to aid students during these courses, provide technical insight for other work such as senior design, and inspire personal projects. See Appendix A for list of books and brief details.

Library of Additive Layer Manufacturing Artifacts
I have created a collection of 3D printed objects that highlight the more advanced geometries that cannot necessarily be captured with machining or other common manufacturing techniques. This includes: advanced shapes, ball and socket joints, pin joints, slip fits, press-fits, and threads. Additionally, I created parts that take advantage of the material properties of the ABS plastic used in the Dimension Elite 3D Printer, such as a wave spring. In order to capture the significant differences in surface finish that arise from part orientation, I created a cube with various shapes, both debossed and embossed, on every side.

These artifacts can be viewed in Appendix B.

Lectures on Machine Components
Many students have not been introduced to the various machine components associated with machine design and mechanical engineering. By providing them with introductory information about these topics and discussing them in class, we are able to further develop their understanding of these topics. I have created detailed lectures on the following topics to be covered in class and supported by the new textbook:

- Springs
- Linear Motion Elements
- Gears
• Belt and Chain Drives
• Shafts, Keys, and Couplers
• Bearings and Lubrication
• Clutches, Brakes, and Flywheels

These lectures are focused on introducing students to these machine components, their proper usage, and the basics behind the forces involved. In many cases, such as for springs, understanding the forces and stresses is essential in understanding their practicality.

Due to file size, lecture samples can be viewed upon request.

Collection of Mechanical Objects

This idea was developed at the end of the summer, with the help of my project advisor, I will be continuing to collect objects throughout the semester for use immediately.

New Projects

CNC Project

Often the analysis behind machining is over looked, especially by those without any first had experience.

In an effort to introduce the MEAM 101 students the machine shop and the analysis associated with it, I have created an optional project that will require some knowledge of forces, heat transfer, and lubrication.

Given a set piece of ¼” stock with two-predrilled through holes, five students in good standing will have the opportunity to design the exterior shape of a keychain and create an ANSI standard engineering drawing. Upon completion of these requirements, they will then need to attend additional lectures in order to gain enough understanding of the milling process that they can design and cut their part under the direct supervision of a qualified Teaching Assistant.

To be clear, students will be supervised while creating the CAM for their part and will not be operating any machinery in the machine shop. They will be required to undergo safety training and will only be watching the Teaching Assistant operate the Haas MiniMill.

The project page can be viewed at:
http://medesign.seas.upenn.edu/index.php/Courses/MEAM101-12C-CNC

Weekly Engineering Drawing Interpretation and Engineering Drawing Requirement

Creating and interpreting engineering drawings is a valuable skill in mechanical engineering. Introducing students to engineering drawings earlier in their studies will give them one of many required skills for MEAM 201, the ability to create drawings for subsequent lab work, and ultimately an advantage over other engineering disciplines.

Weekly “Teasers” and “Exercises” were modeled in SolidWorks and converted into ANSI standard engineering drawings for use by the MEAM 101 teaching staff. They are designed to aid students in interpreting engineering drawings while practicing new skills in SolidWorks. This is an effort to prepare students to create engineering drawings on their own for the CNC Project as well as the Final Project.

Final Project - Machine Design

In the past, the final project for the MEAM 101 course has been a “Game” project. This semester, with the more thorough introduction of machine design, the final project will instead be the design of a “mini-machine” which must complete some predefined task in competition with other teams in the class.

The idea here is that they will be able to use the textbook, lectures, and other resources to create a simple mechanical machine, using the skills and knowledge they have acquired throughout the course. Some of the requirements include creating engineering drawings for all parts (specifically for those being created by MEAM 201 students) and applying mechanical elements appropriately based on simple calculations and analysis.
Conclusion

I believe that students coming out of MEAM 101 will be well prepared for what awaits them in MEAM 201 and their other MEAM labs courses. With this focus on understanding mechanical elements, I believe that students will gain a deeper appreciation for the application of engineering theory. As a teaching assistant for MEAM 101, I will continue to better this course, by giving

Appendix A: Book Options

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<tbody>
<tr>
<td>Relevance of Topics</td>
<td>All basic mechanical components. No info on pulleys. Goes into intro of motors. Little to none on manufacturing processes. Does not discuss flywheels. Touches on CES.</td>
<td>Small amount on manufacturing processes. Touches on simple analysis, material properties and basics of mechanical components.</td>
<td>Nothing on belt/chain drives and manufacturing processes. Touches on simple analysis, material properties and basics of mechanical components.</td>
<td>Focus on ‘Manufacturing Techniques’, which are mostly too advanced for MEAM 101.</td>
</tr>
<tr>
<td>Quality of Readings</td>
<td>Easy to read and find relevant information. All information in Shigley and Norton, with extra info on motors and detailed examples of machine components.</td>
<td>Good information. Generally has the same topics as Mott, but Mott has a bit more.</td>
<td>Very good description of spring analysis. Generally more difficult to read.</td>
<td>Informative on manufacturing techniques of mechanical elements, but not enough on how or why they’re used.</td>
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<tr>
<td>Quality of Examples</td>
<td>Details how to design components within examples. More realistic with given information.</td>
<td>Common textbook examples, do not necessarily emulate vagueness of given parameters.</td>
<td>Common textbook examples, do not necessarily emulate vagueness of given parameters.</td>
<td>Not enough analysis on element use.</td>
</tr>
<tr>
<td>Conclusion</td>
<td>The best in quantity and quality of readings.</td>
<td>Good information on present topics, but lacking in some topics.</td>
<td>Skips important information. Analysis section is not very detailed.</td>
<td>Useful, but too manufacturing focused.</td>
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Appendix B: Library of Additive Layer Manufacturing Artifacts

Armillary – pin Joints, press fit metal marble

Human Skull Model – advanced shapes
Snake – hinge joints

Lightsaber – slip fit parts

Bolt and Nut – threads
Binoculars – pin joint

Xbox Game Controller – ball and socket joints

Springs – material properties

Sample Text Block – extruded text, effect of orientation on part quality