

**AC 2007-1142: EXPERIENCE AND REFLECTION ON AN INQUIRY AND  
BLENDED LEARNING MODULE FOR SENIOR ENGINEERING DESIGN**

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## **Experience and reflection on an inquiry and blended learning module for senior engineering design**

Our full-year capstone design course, “Mechanical and Manufacturing Engineering Design Methodology and Application”, provides students with an opportunity to learn basic knowledge and concepts through lectures and tutorials on a variety of subjects important to the design process. However, an open-ended design project at the heart of this course is the primary team-based experiential “vehicle” used for student learning.

This course focuses on both design methodology and design application. The methodology involves gaining an understanding of the product development process (PDP), the fundamentals of project management, and aspects of design theory (e.g., design for manufacture, design for the environment, robust design, etc.). Currently, this material is taught in the standard format of lectures and tutorials and is assessed using quizzes.

The second and larger aspect is design application, where the design methodology is applied to a team-based, open-ended project. Assessment of this aspect of the course is primarily through reports and design reviews strategically placed throughout the academic year to correspond with each phase of the design process.

Students often become so deeply involved in their projects that they fail to see “the forest for the trees”. More specifically, they often fail to see how the design process applies to their project and potentially miss the methodology message of the course. As a result, students need to be provided with a more meaningful presentation of the design process before they embark on their major project than they would obtain from lectures and tutorials alone.

To address this issue of how to more effectively prepare students for the “application” aspect of the course we have developed a short inquiry-based learning exercise. This exercise provides student teams with a very compressed project, or ‘mini-project’, at the beginning of the term before they have any pre-conceived notions about the design process.

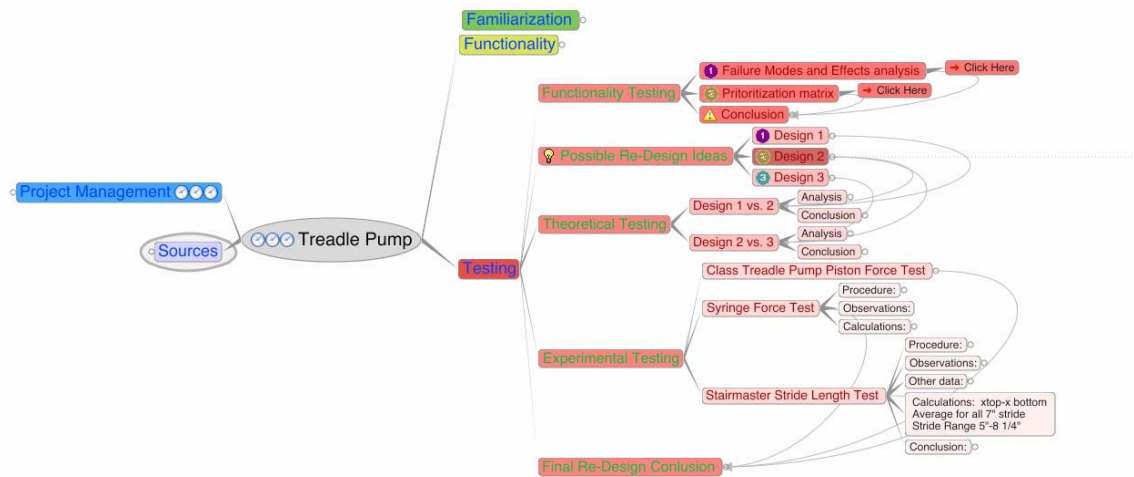
This paper reports on our first year of experience with an inquiry-based mini-project exercise two weeks in duration, where students perform a hands-on exercise during and outside of class time. In piloting this exercise, students proposed mini-projects that focus on campus improvement as part of a campus-wide competition. It was felt that after 4 years on campus, students have many improvement ideas.

One of the key learning objectives of this exercise is for students to gain an appreciation of the relationships between each phase of the PDP and the importance of following a process for product design. The deliverables for this exercise were structured to allow student teams to both report and reflect on their progress during each phase of the mini-project. The focus of the exercise was on “doing” rather than reporting, so reporting was required to be seamless.

Rather than using a traditional journal or logbook for reporting, student teams were required to develop mindmaps [1] of their group thought process. The intention is to provide a relatively intuitive, graphical tool that can be used to communicate their thought process to the course instructors and their peers during in-class critiques, and more importantly, show the connection between the phases of the design process.

The mini-project was implemented with FreeMind [2], a freeware mindmapping software, an example of which is shown in Figure 1. The advantage of this approach is that students provide the requirements of the mini-project exercise online, and are also invited to publish and share their content. Additionally, it was hoped that the campus wide competition was relevant to the students and they could tap into their own experiences.

Finally, in order to facilitate the implementation of the mini-project over a relatively short period of time, the core hands-on exercise was blended with e-learning tools. In particular, Blackboard [3] was used to manage the submission of team deliverables and facilitate online discussion between team members, and teams were required to use a common electronic submission format for these deliverables.



**Figure 1.** A mindmap for a treadle pump design

The paper begins with background on the Mechanical and Manufacturing Engineering Design Methodology and Application capstone design course and its relationship to the proposed mini-project. Next, we describe our mini-project and identify how the mindmapping software gave the students an overall view of the design process. A comparison of first and fourth year student design thinking as reflected in mindmaps will also be examined by contrasting the capstone design mini-project pilot against a first year design course mindmapping pilot project.

## References

1. Buzan, T, B., *The Mind Map Book: How to Use Radiant Thinking to Maximize Your Brain's Untapped Potential*, Plume, 1996.
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3. Blackboard, *Website*, <http://www.blackboard.com>, 2006.