Chapter 12
Materials and Mechanics:
A Multidisciplinary Course Incorporating Experiential, Project/Problem-Based, and Work-Integrated Learning Approaches for Undergraduates

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ABSTRACT

The Madison Engineering Department is an undergraduate non-discipline specific engineering program at James Madison University. The program acknowledges that future engineers should not be constrained by disciplinary boundaries but demonstrate the ability to adapt and work across disciplines within team atmospheres. The program blends engineering science fundamentals with sustainable design to integrate environmental, social, economic, and technical contexts plus systems thinking while maintaining the university-wide liberal arts core. Madison Engineering is dedicated to the development of engineering versatilists who can readily integrate knowledge from historically different fields of engineering. In support of this development, several courses within the curriculum integrate topics that are traditionally taught separately. This chapter described ENGR 314: Materials & Mechanics, a course that integrates concepts from the traditional content of stand-alone courses (materials science and mechanics of materials) via a semester long design project in which students must incorporate knowledge of both sets of content.

INTRODUCTION

Madison Engineering, the name given to the engineering program at James Madison University, is a relatively young program that is the sole engineering program at a state funded university in Virginia, USA. Madison Engineering is designed to be a progressive program unrestricted by the boundaries of traditional engineering disciplines. The program employs a range of student-centered learning approaches within its curriculum and intentionally builds students potential for higher

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order thinking. A synopsis of the engineering program and university are offered in order to provide context for the course and project. This chapter describes the application of multiple pedagogies that are used to engage students in creating their processes and procedures for discovering viable solutions. Pedagogies incorporated into the Materials & Mechanics course include experiential learning, project/problem-based learning, and work integrated learning in addition to more traditional approaches. The chapter outlines individual and team assignments performed by students that underscore the relationships between material structure, properties, processing and performance. The chapter also examines the semester long, team-based, experiential, open-ended, and non-directed (problem based learning) course project that acts as the comprehensive integrator between the mechanics and materials portions of the class. Additionally, the chapter reviews the industry-professional society collaboration that facilitated the industrial partnership, which enabled the work integrated learning component.

The significance of this chapter lies in the thorough description of a course that integrates concepts traditionally found in separate courses and frequently taught by separate departments. The primary integrative component is a semester long project that is portrayed in detail. One issue that is prevalent with integrated courses is that portions of traditional content must be trimmed in order to integrate complementary content. This chapter provides enough particulars of the course to inform the reader of what topics are covered and to what extent.

BACKGROUND

James Madison University is a public regional university located in Harrisonburg, Virginia (USA), within the Shenandoah Valley. James Madison University has a total enrollment of approximately 20,000 students across all of its seven colleges with approximately 1,700 of those students enrolled in a graduate program. The College of Integrated Science and Engineering (CISE) was established in 2012 when the departments of Integrated Science and Technology and Computer Science merged with the School of Engineering. After the creation of CISE, the School of Engineering now exists as the Department of Engineering (Madison Engineering).

Madison Engineering was founded in 2005 with the first cohort of students starting in fall of 2008. The program was designed based on the following description of the Engineer of 2020 by the National Academy of Engineering: one who possesses strong analytical skills, strong communication skills, and a strong sense of professionalism, creativity, and versatility (National Academy of Engineering, 2004; 2005). Since the founding of the program, Madison Engineering has graduated three classes of students. The alumni from this program have the opportunity to become “engineering versatilists” through the learning approaches that are utilized throughout the department and within individual courses. The term *Engineering versatilist* is a phrase invented by Garner, Inc. and popularized by Friedman that described an individual who can “apply depth of skill to a progressively widening scope of situations and experiences, gaining new competences, building relationships, and assuming new roles” (Friedman, 2005, p. 291).

Curriculum

The Madison Engineering program is ABET accredited (10/01/2011 – present) under the Engineering Accreditation Commission (EAC). The program is not discipline specific and has a current enrollment of approximately 450 students as of August 2014. The Madison Engineering program was established to train the engineering versatilist. With this backdrop, the program affords students with opportunities outside of the traditional academic environment that include