



Engineering students learn and apply the triple bottom line through a multi-faceted educational experience: Design for the Environment Course



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Overview

A *Design for the Environment* (DfE) course was developed as a dynamic mix of non-traditional lectures and hands-on DfE laboratory experiments that are infused with real-world interactions. DfE is a set of design practices aimed at creating eco-efficient products and processes. As all engineers must understand the limits on natural resources, this course offers the opportunity for students to incorporate sustainability into product and process design as a necessary constraint. Since environmental concerns such as global warming and energy security continue to weigh on society, the next generation of engineers will need to be prepared to solve complex sustainability challenges.

Course objectives

- Become aware of sustainability challenges faced by organizations and society at large and understand the impact of engineering solutions
- Develop tools and skill sets to address sustainability challenges within industry and organizations
- Develop viable and marketable solutions that are both sustainable and practical employing DfE tools
- Network with potential employers and gain exposure to green career opportunities
- Develop cross-discipline communication and presentation skills

Engineering teams (E-Teams)

Multidisciplinary E-Teams are assembled (approximately 3 to 4 students per team) from the class members; the E-Teams will be challenged to identify a sustainability-related problem with one of the industry/organization partners and to propose a DfE solution that is both practical and sustainable. Throughout the semester, the teams will develop a plan and DfE solution. Funded by the NCIIA curriculum improvement grant, E-Teams have a prototyping budget to enable them to actually build and test their design solutions. E-Teams will present their final product innovations during a design competition at the close of the term.

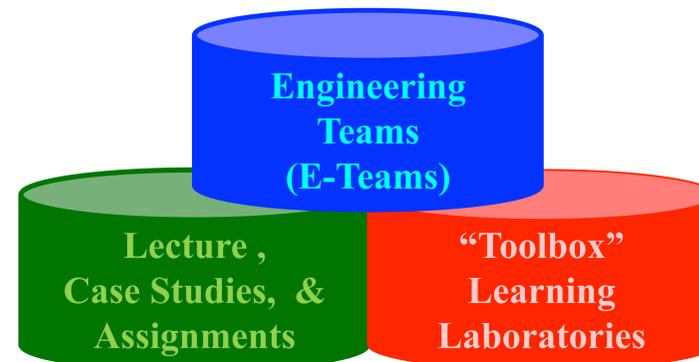


Table 2. Delivery Methods for Learning Goals of a Design for Environment Course

Learning Goal	Delivery Method			
	Lecture	Discussion/Assignments	Learning Laboratories	E-Team Project
Product Development	❖			❖
DfE Guiding Principles	❖	❖		❖
Impacts of Design on Energy Usage	❖	❖	❖	❖
Material Selection and Impacts	❖	❖	❖	❖
End of Life Impacts	❖	❖	❖	❖
Utilizing Relevant Standards in Design	❖	❖	❖	❖
Life Cycle Assessment	❖	❖		❖

Table 1. ABET Criteria and DfE Course Learning Goals

ABET Criteria	DfE Course Learning Goals						
	Product Design	DfE Guiding Principles	Impacts of Design on Energy Usage	Material Selection and Impacts	End of Life Impacts	Utilizing Relevant Standards in Design	Life Cycle Assessment
3.c- Ability to design a system or product that meets multiple constraints	❖	❖	❖	❖	❖	❖	
3.d- Ability to function on multidisciplinary teams	❖		❖	❖	❖	❖	
3.e- Ability to identify, formulate, and solve engineering problems	❖	❖					❖
3.f- Understanding of professional and ethical responsibilities	❖	❖	❖	❖	❖	❖	
3.g- Ability to communicate effectively	❖						
3.h- Understand impacts of solutions in multiple contexts	❖	❖					❖
3.i- Knowledge of contemporary issues	❖	❖					❖
5.b- Ability to iteratively apply basic science, math and engineering to solve a problem	❖						

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“Toolbox” Learning Laboratories



Design for end-of-life

Objectives:

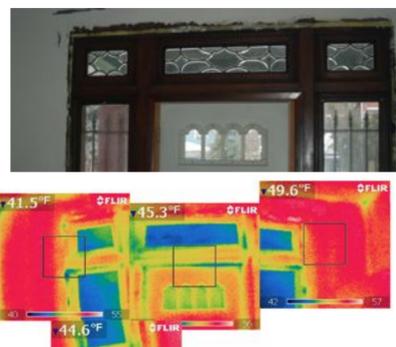
- Understand the impact of design choices on the ability to disassemble a product
- Develop an awareness to design for disassembly
- Determine the amount of material in a simple product that can be reused, recycled, and disposed



Energy and efficiency

Objectives:

- Understand the application of an infrared camera to an “energy audit”
- Determine the heat loss through an imperfection and calculate the yearly energy cost of the imperfection
- Design an improvement to an imperfection in a building and determine the related energy impact



Lessons learned/ student feedback

- Students enjoyed the opportunity to learn the design for environment principles as they worked with their hands and realized the impacts of design choices
- Students have a specific cognitive load that requires careful design of learning experiences to create learning without distracting or over-burdening the learner
- The end of life experience effectively allowed students to realize the impacts of design choices on the disassembly of a product
- Computers have to many parts and materials to effectively reinforce the impact of material selection, future laboratories will utilize a different product for this experience
- Energy and efficiency laboratory was very beneficial and has led to further funding to develop an experience for students in three different courses