Sustainable Design in Engineering and Technology Education: A Multidisciplinary Model

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Abstract

The current paper describes a model for integrating a sustainable design course that can be open to all students within an Engineering and Technology curriculum. It identifies the rationale for such a course, topics covered in an introductory review of sustainable design issues, methods and learning strategies useful in teaching in a multidisciplinary venue and associated criterion from ABET 2000 that are integrated into the course design. This paper provides a sample syllabus for the course as well as a suggested project to be assigned to each multidisciplinary team.

I. Introduction

With emerging international implications for global industrial ecology, the need for the inclusion of sustainable design principles into the engineering and technology curriculum cannot be denied. According to Richards and Frosch, industrial ecology has become jargon for describing systems of production and consumption networks that have minimal impact on the environment as the primary objective and environmentally sustainable economic expansion as an overarching objective.[1] Green topics that will become part of many future professions include issues of indoor air quality, utilization of dwindling natural resources, efficient use of energy and reduction of greenhouse gases. The value of discovering the variety of fields that are involved in developing the use of recycled materials to create newly manufactured products and processes also supports teamwork in the green environment. A multidisciplinary emphasis on these topics within a course benefits future employers focusing on an "environmental thrust" in product development and manufacturing. Such a course offered across the engineering and technology curriculum at the beginning phases of study supports the opportunity for students to later apply their specific disciplinary knowledge within the rubric of environmental issues.

II. Course Description

Sustainable Design in Engineering and Technology is designed to sensitize engineering and technology students to the value of understanding global environmental issues. The course assists them in later creating ecological solutions within their unique disciplines. A theoretical framework on Green Design developed by the author enables students to identify and apply sustainable concepts while working in multidisciplinary teams.[2] Sustainable topics discussed in the course emphasize environmental concerns for better indoor air quality in commercial, residential

and industrial buildings and facilities. Other topics of emerging green technologies include:

- Selection of green building materials and commercial mechanical systems
- Day-lighting design protocols
- Green building techniques including material use and re-use
- Design ramification of consumer products
- Product life-cycle including production and disposal issues
- Design concepts for alternative energy utilization
- Green standards rating systems for industrial processes, products and buildings

The overall course goal is to expand the students understanding of sustainable design and its implications within engineering and technology. Upon completion of the course, the student should be able to:

1. Identify green concepts and apply them in various design problems
2. Define appropriate terminology related to sustainable buildings and products
3. Utilize electronic design aids meant to factor in many ecological variables when working on sustainable design problems
4. Work in multidisciplinary teams to accomplish ecological design protocols for a specific client's needs
5. Create a prototype of an ecological product within a multidisciplinary team setting

By utilizing learning strategies that include team problem solving, students develop a grasp of the fundamentals of sustainable design and apply them to real world environmental problems and solutions. This model encourages students from various disciplines to form deeper appreciation of the interrelationships among basic knowledge, technological advances and human needs while creating ecological products and systems for the global marketplace.

Two recommended texts used for the course are A Primer on Sustainable Building, RMI, 1995, ISBN# 1-881071-05-7 and Natural Capitalism, P. Hawken, A. Lovins and H. Lovins, Little Brown and Company, ISBN 0-316-35300-0(pb). Selected readings and handouts would also be distributed to be read prior to the week of the case study on a particular topic.

A multidisciplinary team project for the semester should connect with a real design problem. It is recommended that the project support a competition to design a product in collaboration and partnership with a local industry that supports sustainable practices, products or processes. This link would also allow the students to view the real world value of their efforts.
The course syllabus and topics for each week can be seen in Figure 1.

Figure 1. Syllabus for Sustainable Design in Engineering & Technology

INTR 198 SUSTAINABLE DESIGN IN ENGINEERING AND TECHNOLOGY
COURSE OUTLINE & SCHEDULE
(Dates may be subject to change due field trip availability)

WEEK	SUBJECT AREA	READING ASSIGN.
1	Course overview and instructor introduction. Intro to Sustainable Design Green Concepts Theoretical Framework	 Handouts NC pp.1-21
2	Design: Residential Buildings Case Studies	RMI pp.7-50
3	Design: Commercial Buildings Case Studies	RMI pp. 51 - 91 NC pp.82 p - 110. Speaker: Sam Miller
4	Design: Industrial Buildings Case Studies	Handouts
5	Alternative Energy Technologies Energy Efficiency	Handouts Speaker: Lynn Coles
6'	Green Maintenance - Commercial	NC. pp. 111-124. Handouts Speaker: Peter Orono
7	Alternative Lighting Technologies	Video Handouts
8	Green Chemistry	Ely Lilly Project
9	Midterm Exam	
10	**SPRING BREAK**	
11	Green Product Evaluations Recycling in Indiana	 Speaker: Gary Davis
12	Final Project Assignment Team Assignments	"Recycle Receptacles"
13	Materials Research Design Development	Handouts
14	Design Process: Schematics Development	
15	Material Selection & Specification Writing Begin Prototype	
16	Complete Fabrication of Model Presentation to Client	

III. Assessment Strategies

The program outcomes and assessment of ABET 2000 criteria that could be documented in this course are (**d**) an ability to function on multi-disciplinary teams, (**h**) the broad education necessary to understand the impact of engineering solutions in a global and societal context and (**j**) a knowledge of contemporary issues.[3] Measurements of these objectives could be completed by evaluation of the design project by the multidisciplinary team as well as of concept knowledge acquisition from the Pro and Con grid and Problem Recognition.[4] In multidisciplinary courses, Bhavnani and Aldridge found that each discipline represented in student teams must be challenged equally in semester project assignments in order for fairness of workload to occur.[5] Their experience and suggestions should be utilized when the professor is assisting with team assignments. Student projects should be developed that are realistic and emphasize direct applications of ecological knowledge within different engineering and technology disciplines. Current and proposed case studies of sustainable projects help to identify green solutions for ecological problems within industry and commerce.

IV. Summary

This paper provides an overview of steps to initiate an engineering and technology multidisciplinary sustainable design course. The course is preferably suited for beginning level students interested in global sustainable issues that cut across many disciplines. The syllabus and assessment techniques can be modified to fit the mission of the school, the geographic location and the connection with industry that has developed locally. Expert speakers will vary but application of concepts identified in the framework for Green Design can serve as a guideline for many different settings.

V. End Notes

[1] Richards, D. and Frosch, R., The Ecology of Industry, p.1 Washington, DC: National Academy Press, 1998, "Industrial ecology has become jargon for describing systems of production and consumption networks that have a minimal impact on the environment as a primary objective and have an over-arching objective of environmentally sustainable economic expansion."

[2] Coles, E.A., Interior Products: Are They Green?, p.25, Master's Thesis, Colorado State University, Fort Collins, CO, Spring, 1998.

[3] Accreditation Board for Engineering and Technology, ABET Engineering Criteria 2000, January 1998.

[4] Angelo, T, & Cross, K.P., Classroom Assessment Techniques –A Handbook for College Teachers, Jossey-Bass Publishers, pp168-171 and pp/214-217.

[5] Bhavani, S. and Aldridge, M. Teamwork Across Disciplinary Borders: A Bridge between College and the Work Place, p.14. Journal of Engineering Education, ASEE, Vol. 89, No. 1, January, 2000.

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