

Proposed curricular roadmap for integrating sustainability into the engineering curriculum

During the completion of their senior project, the student should be able to:

Create and evaluate a life cycle assessment using the 12 principles of green engineering and a software tool like SimaPro. This analysis must include data that indicates the ecological (environmental, toxicological) and energy demands associated with alternative designs.

GOAL Year 1: Awareness of Issues	
1. Imbue students with the engineering profession's social responsibility.	<p>CURRICULAR ACTION: Introduce to NSPE Code of Professional Ethics Engineer's Creed</p> <p>LEARNING OBJECTIVES: <i>State the purpose of the engineering profession (i.e., that the engineer dedicates his or her professional knowledge and skill to the advancement and betterment of human welfare.)</i></p>
2. Illustrate how technology has affected the quality of life.	<p>CURRICULAR ACTION: Examine unintended negative consequences of technology and the need for vigilance to avoid negative impacts.</p> <p>LEARNING OBJECTIVES: <i>Generate a list of both positive and negative impacts of a particular technological application on the quality of life.</i></p>
3. Communicate to students the reality of "trade-offs" in engineering design decisions.	<p>CURRICULAR ACTION: Demonstrate that engineering decisions have consequences beyond the performance of the engineered product and that these consequences must be factored into the design phase of the product.</p> <p>LEARNING OBJECTIVES: <i>Identify multiple, specific consequences that producing an engineered product could have on society</i></p>
4. Orient students toward holistic thinking.	<p>CURRICULAR ACTION: Introduce concept that the advancement and betterment of human welfare requires a balance of economic, environment and social interests (the "triple bottom line")</p> <p>LEARNING OBJECTIVES: <i>List the three major categories of interests that must be balanced in any engineering endeavor, generate aspects of the engineering endeavor for each of the three categories (economic, environment, social justice)</i></p>
5. Educate students with facts of present state.	<p>CURRICULAR ACTION: Provide data regarding waste in production (e.g., less than 10% of raw materials that are input into a product actually show up in the product), consumption/waste figures, pollution rate figures, toxicity figures, loss of arable land figures, etc.</p> <p>LEARNING OBJECTIVES: <i>Generate ideas by which engineers can improve human welfare by applying their knowledge</i></p>
GOAL Year 2: Perspective on Constraints	
6. Enable students to realize that earth is a closed system.	<p>CURRICULAR ACTION: Introduce analysis too of viewing all processes as systems (system boundaries, surroundings, inputs, outputs)</p> <p>LEARNING OBJECTIVES: <i>Distinguish between open and closed system and recognize that the source for inputs is earth, the sink for output is earth</i></p>
7. Educate students with earth's inherent capacity to recover from human and natural activity (regenerative rate).	<p>CURRICULAR ACTION: Introduce concept of ecological footprinting</p> <p>LEARNING OBJECTIVES: <i>State one's personal consumption rate ("environmental footprint"), Identify activities that lead to large consumption rates of arable land, Generate ideas by which engineers can improve human welfare by applying their knowledge</i></p>
8. Expose students to new ways of thinking about product life cycle and design.	<p>CURRICULAR ACTION: Introduce concept of cradle-to-grave production versus cradle-to-cradle (waste of one process=food for another process) and the 12 Principles of Green Engineering (developed the Environmental Protection Agency)</p> <p>LEARNING OBJECTIVES: <i>Case studies: Cherry trees, Society within Kerala, India and product "take back" initiatives</i></p>
GOAL Year 3: Accounting Methods for Designs	
9. Provide students with a systematic means of accounting for process inputs and outputs.	<p>CURRICULAR ACTION: Introduce to concept and practice of Life Cycle Assessment</p> <p>LEARNING OBJECTIVES: <i>Conduct a life cycle inventory for a simple product</i></p>
GOAL Year 4: Evaluation and Design of Solutions	
10. Enable students to generate their own assessments and evaluation of their product designs.	<p>CURRICULAR ACTION: Utilize computational tools (such as Sima Pro) to assess the relative merit of competing product life cycle designs</p> <p>LEARNING OBJECTIVES:: <i>Generate the process flows models for products and assess the relative merit of the competing product life cycle models in relation to several factors (human toxicity, environmental impact, energy consumption)</i></p>