Integrating Holistic Thinking into Cornerstone Engineering Curriculum

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Introduction

- Classroom walls often separate students from the practical implications of their work. Through curriculum development for Engineering Design 100 (EDSGN 100), we aimed to break down those walls by emphasizing a holistic framework.
- EDSGN 100 is a first-year course taught to virtually all engineering students at Penn State. In support of team-based design projects, the course incorporates themed educational modules comprising multiple lessons. We improved upon the two modules most related to holistic thinking.

So What?

- A holistic/systems framework accounts for the interplay of socioeconomic, policy, health, and environmental factors in design.
- Effective curriculum is necessary for students to gain the attributes of World Class Engineers, notably: teamwork, ethics, and global engagement. These will help them in their careers and are essential to instigating global change.
- We cannot effectively solve climate change—or any problem—without comprehensive, holistic thinking that understands problems and their solutions within the intricate web of different factors.

Goal

Create **engaging, interactive course materials** that **emphasize a global, systems approach to engineering design**. Ultimately, we hope such a background will lead students to create **appropriate and inclusive engineering designs**.

Module: Seeing the Big Picture

Nothing engineers create exists in a vacuum. Lessons in this module emphasize that Engineering Design encompasses five main spheres:

Social **Economic** **Health** **Environment** **Policy**

Lesson 1 Systems Thinking + Concept Maps

- **Key student takeaway**: Ability to identify quantitative and qualitative variables in their "systems" outlook on design.
- **Activity example:** Student groups must design a rec center. The goal of the activity is to emphasize the importance of using a full systems outlook in design: with limited prompts, their rec centers are incomplete.

Lesson 2 Life Cycle Analysis (LCA)

- **Key student takeaway**: Ability to see the big picture, including the environment, throughout the lifetime of a design, from sourcing, manufacturing, distribution, use, and recovery.
- **Activity example:** Paper or plastic? Students must consider the impact of material choices in every step of the life cycle of their product, cradle to grave.

Lesson 3 Root Cause Analysis

- **Key student takeaway**: Ability to use, and understand the importance of, careful problem assessment, leading to the development of longer lasting and more effective engineering solutions.
- **Activity example:** Why did the Titanic sink? Students use root cause analysis to get to the bottom of this infamous maritime disaster.

Module: Goals for Change

Our complex, interconnected world presents complex, interconnected problems. The UN Sustainable Development Goals (SDGs) and Project Drawdown have identified areas where we have the chance to innovate and make positive social, economic, health, and policy change.

Lessons "Goals for Change" is a three-lesson student-led project which explores links between international goal systems and challenges students to find their own engineering solutions to issues important to global communities.

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- **Key student takeaway**: Recognize the interconnectivity of global challenges and engineering solutions.
- **Activity:** Student-led presentations that identify and model an engineering solution and connect that solution back to relevant SDGs.

Moving Forward

We aim to make these curriculum materials **available beyond the EDSGN 100 course** and to **make them accessible to people across disciplines, means, and educational backgrounds.**

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References

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*See addendum on table for additional sources.