# A Multi-Disciplinary First-Year Design Project with Systems Integration, Standard Requirements, Creativity, and Impact (GIFTS)

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## Introduction

At University of Portland, we have created a first-year engineering course that uses skill-building labs to teach students to practice simplified engineering design to achieve a standard set of requirements. Then, the students can engage creatively to improve their design in any way they want. They also explore the environmental and social impact of engineering. At this stage, we are simply trying to meet the students where they are with an engaging, structured, and creative engineering design project.

## Methods

The 15-week, 2-credit course essentially completes a single course project: designing and building a table-top wind turbine by learning skills in subsystems and then integrating subsystems into the overall design.

The students complete the course project via a two-level challenge. In Level 1, they learn how to satisfy the pre-defined requirements via four skill-building labs (each with six small activities). The teams generally achieve similar designs because they have common requirements. At this stage, we intentionally sacrifice creativity to develop a shared understanding of engineering design and some common skills. As the students complete the labs, they (unbeknownst to them) learn how to design and build each subsystem.

The Mechanical Subsystem is a simple Lego machine that converts the relatively slow wind into relatively fast rotational energy (via gears) to drive an electric motor. The Circuits Subsystem combines a DC motor, breadboard, resistors, a diode, and an LED to convert wind energy into electricity, proving the system is making electricity. The Software Subsystem uses Arduino loops, logic, input/output, and variables to program (and build a corresponding circuit) to measure and display the generated voltage. The Structural Subsystem asks the students to design and build a truss structure to elevate the wind turbine to the height of the wind. During Level 1, the students also prepare a 'background research paper' to understand society's 'energy problem,' including specific attention to climate change, developing countries, and renewable energy.

In Level 2, we require them to improve their wind turbine in any way, which allows them to explore the creative side of engineering (as opposed to simply meeting requirements). There is no prerequisite knowledge for this course. Some students are learning what they need for the first time and benefit greatly from Level 1. Other students (e.g., those who already know Arduino and basic circuits) benefit greatly from Level 2, where they can lead their team in a creative engineering project.

## Conclusion and Discussion

The work scaffolds engineering design to meet first-year students 'where they are.' They are guided through a simplified design process (background research, problem definition, design development, and design finalization) to help them first complete the standard requirements (Level 1) and then be creative problem solvers (Level 2). The project leverages small, unit-sized activities to help students make each subsystem, which they combine into a working device. The project also allows them to explore creative solutions by improving the device. In parallel, the students use their newfound knowledge of energy systems and impact assessment to evaluate the positives and negatives of wind energy.

**Supplementary Materials**
If you want more information about the curriculum and course materials, please get in touch with Dr. Shaz Vijlee at vijlee@up.edu.

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