

## **GIFTS: Going Circular – Reusing a First-Year Design Project**

We developed a first-year multidisciplinary design project, which compels students to think in terms of circular economies. This project focused on introducing students to the design process and project management. We structured the project for teams of 4 or 5 first-year students, requiring 40-50 hours per student throughout the semester. The students are required to keep their vehicle battery charged with use of a photovoltaic module. The competition goal prominently features a measure of the reusability of components.

The project requires technical work in mechanics, electronics, and programming in a context of system design and sustainability. Most students find at least one area of the project that connects with their academic goals. Students must navigate an assessment objective with competing factors. A low-stakes (3% of final grade) competition includes several conflicting factors: project cost, vehicle speed, trajectory accuracy (straight-line travel), load-carrying capacity, and percentage of reusable parts. Students record and reflect on the struggle of balancing cost and reusability against performance goals. Should the car be light and fast, or focus on carrying a larger mass and reliably following a straight line? Should they invest in expensive remote-control car wheels or use old CDs?

The higher the percent of the reusable cost (ratio of cost of reusable parts to total cost), the better their performance score. Faculty assess reusability: which components, after the students disassemble their projects following competition day, will be marketable to future project teams. Generally, parts need to be un-modified from off-the-shelf condition. Custom parts: any part fabricated or modified in our fabrication lab, do not qualify. Teams design their vehicles to avoid having to customize off-the-shelf components and for easy disassembly. Such design decisions form the foundation of circular economies. Students weigh the trade-off between an easier low-cost design and one featuring reusability (more removable fasteners and less epoxy).

Closing the loop on the circular economy in our course, early in each new semester while teams are finalizing their conceptual designs, we hold a parts auction. Teams competitively bid on the reusable components from year's past. Students from previous years enjoy connecting to the current groups using "their" motors or wheels.

Teams budget parts purchased at auction in the same manner as purchased new components. Students gain insight into design for reuse, recycling, and the circular economy connecting our study of ethics and sustainability to an applied project. Following the competition, students disassemble their vehicles and complete a reusability report tabulating the percentage of the overall vehicle cost that is reusable. Students were intentional with their incorporation of reusable parts with one team having 92.2% reusability and the overall winner of the competition having 89.5% reusability. The average car had 73.9% of its cost assessed as reusable.

Administratively, we have significantly reduced our budget for the first-year project. Teams work hard to minimize their project cost and keep components in like-new condition. Expenditures on this project have been reduced substantially since implementing the reusability component in the scoring algorithm.