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Introduction

Sustainability in engineering is highly complex problem that cannot be achieved with a single approach. It relies on agility in many knowledge domains for us to make equitable improvements for humanity and for the natural world.

In a pilot project to address a sustainability knowledge gap and lack space in the engineering curriculum for new courses, we experimented with a co-teaching approach to deliver Engineering for one Planet (EOP) framework topics *within* three courses. These course were selected because of their project-centric approach and course-based research methodologies, faculty willingness to co-teach and the opportunity to interact with 1st year to graduate level students. Our approach was to reinforce learning through application of knowledge in physical prototype building.

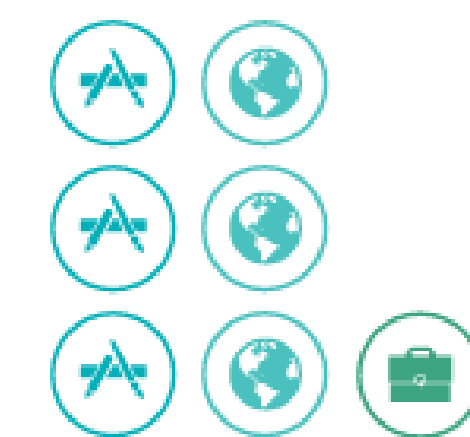
Approach

EOP framework focus for our teaching intervention

- Design
- Social Responsibility
- Environmental Impact Assessment

The three courses

- ENGN 0032 Introduction to Design Engineering 1cr
- ENGN 1735 Vibration in Mechanical Systems 2cr
- ENGN 2171 Iteration with Intention 2cr



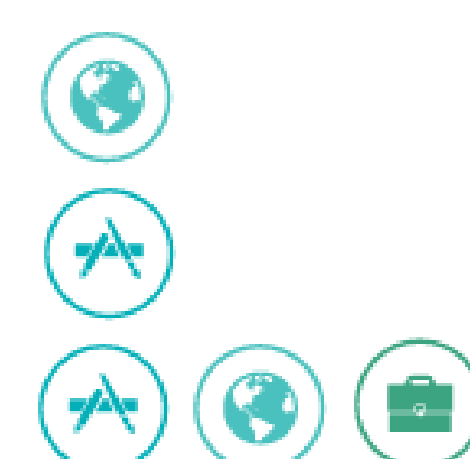
All courses used the same prototyping facility, the Brown Design Workshop (BDW) to develop and build project solutions. All projects were *group-work focused* where students self-selected which topic they were to pursue for the semester.

Content delivery and support

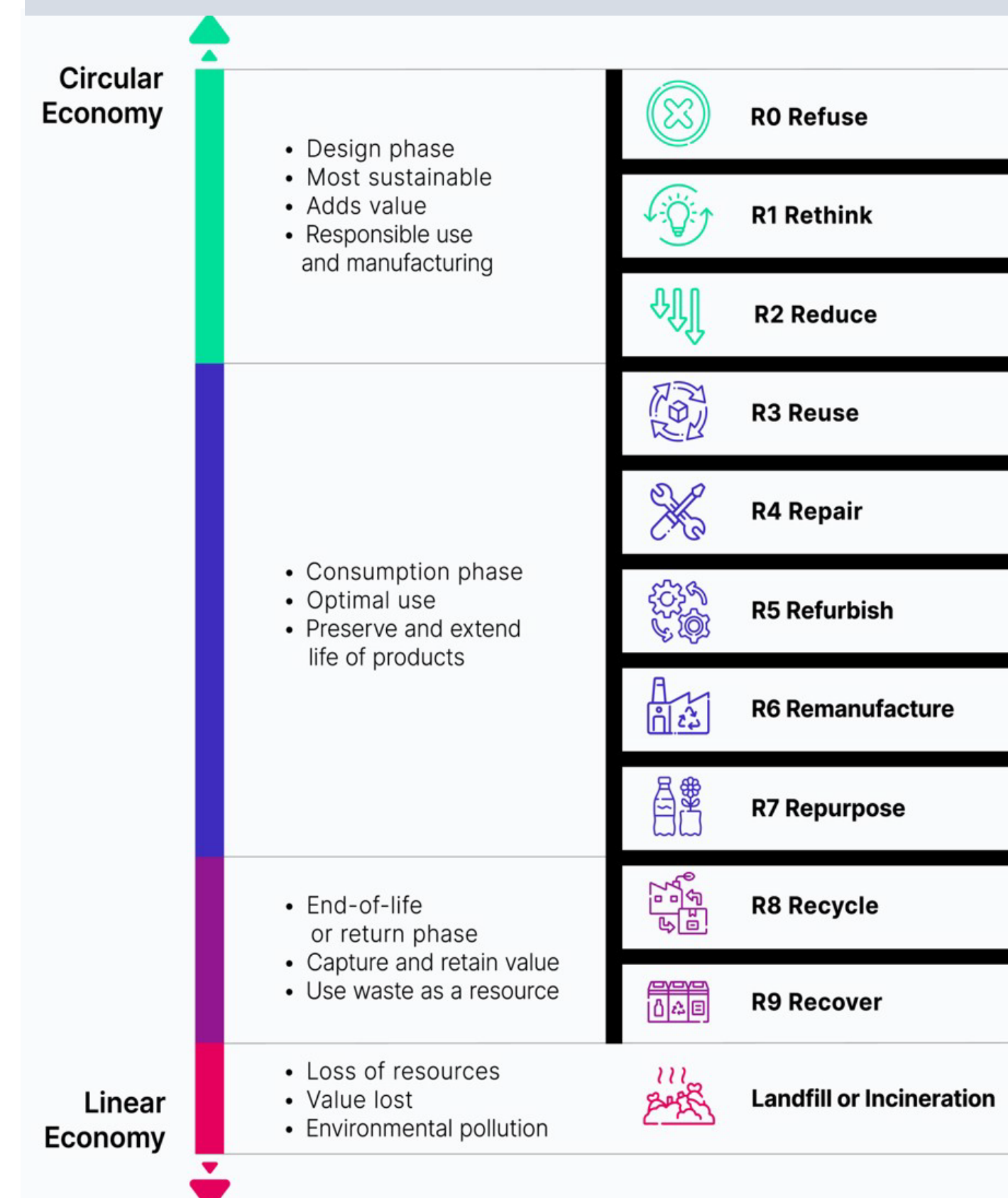
- 1.5hr interactive lecture on 10R, Circular Economy, Fast Track LCA
- Additional reading and video tutorials added to Canvas
- Access to salvaged materials and virgin material impact scores
- 3hr Positive Sum workshop (ENGN 2171 only)

Augmented deliverables to assess EOP learning

- Gate to gate spreadsheet of prototype materials
- 10R and user research used guide the design process
- Group reflection on EOP learning objectives



Frameworks for 10R and circular economy design



Guiding framework for Design EOP (left). This gave students a hierarchy of more circular to a linear economy.

The group's approach was captured in final presentations specifically for the prototype. Future direction R10 was discussed in the report.

- ENGN 0032
- ENGN 1735
- ENGN 2171

Progress: Student work examples

ENGN 1735 Vibration in Mechanical Systems

EOP Deliverables: Length of project: 12 weeks

Client-based projects centered on vibration (mostly lab instrumentation development or improvement) that required a 10R prototyping strategy.



Wearable kinetic energy harvesting device. R4 Repair focus. PLA shredder dampening using standard components to isolate vibration. R4 Repair focus; R7 repurpose emphasis. Flapparoo fluid mechanics instrument. R3 Reuse of standard items focus.

ENGN 2171 Iteration with Intention

EOP Deliverables: Length of project: 7 weeks

Group-directed project scoping and delivery that needed to address 10R and Positive Sum Design principles.



Compostable to-go food container and cutlery. R1 Rethink focus. Compostable menstrual products. R1 Rethink focus. Customizable modular retro-styled games controller system. R4 Repair focus.

Evaluation plan (work in progress)

43 student project gate-to-gate material data.

Evaluation goals:

- Visualize material movements within and across courses
- Identify opportunities for less waste and greater flow to BDW.
- LCA of environmental impact

		Component Details				Material Destination (%)						Fully Accounted For?		certainty of % allocation accuracy	
Iteration round #	Component Name	Monomaterial?	Primary material composition	Material Mass (g)	Source	Material Circulation	MADE library	Recycling Stream	Course Inventory	Landfill	Fully Accounted For?	certainty of % allocation accuracy			
1	Cardboard	Yes	Paper/card stock	250	MADE Library	90%		10%			TRUE	mostly (70%)			
1	Raspberry Pi 5	No	Electronic	60	MADE Library	50%	20%		30%		TRUE	mostly (70%)			
1	Keyboard	No	Hardware	1200	MADE Library	100%					TRUE	yes (100%)			
1	Mouse	No	Hardware	450	MADE Library	100%					TRUE	yes (100%)			
1	2.3 PLA	Yes	3D print filament	3000	Purchased New	90%				10%	TRUE	mostly not (30%)			
1	Plastic wrap	Yes	Polymer	5	In group inventory	5%	95%				TRUE	mostly not (30%)			
1	Super glue	Yes	Polymer	2	MADE Library	90%	10%				TRUE	mostly not (30%)			

Reflections from ENGN 1735 and ENGN 2171. Qualitative evaluation of:

- how the students experienced the teaching intervention/challenges
- likelihood of pursuing deeper knowledge beyond this course

Impact and scaling up

In this pilot study we taught:

- 168 students
- 148 undergraduates
- 20 graduate (non doctoral)

EOP course	Student impacted (non-eng)	Additional notes
ENGN 0030 Intro	118 (17)	~42% of intro course cohort (2 courses offered)
ENGN 1735 Vibr.	30	Mostly ME concentrators
ENGN 2171 Iter.	20	Core course for 11 month masters

Plans for scaling and opportunity to broaden impact

- Dissemination of impact and recommendation so mini-module execution to School of Engineering Faculty with a proposal to embed EOP framework ENGN 0030 (sister introductory course)
- EOP framework infusion to ENGN 0620 Design Brief (Manfredi & Harris course in spring 2025).
- Using assessment materials from this pilot, make incremental improvements to courses and EOP material delivery.
- Exploration of informal EOP framework learning in the BDW which serves 100's students each year.

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References:

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