



# Embedding Sustainability Across the Mechanical Engineering Curriculum: An EOP-Guided Redesign of Materials, Analytics and Capstone Courses



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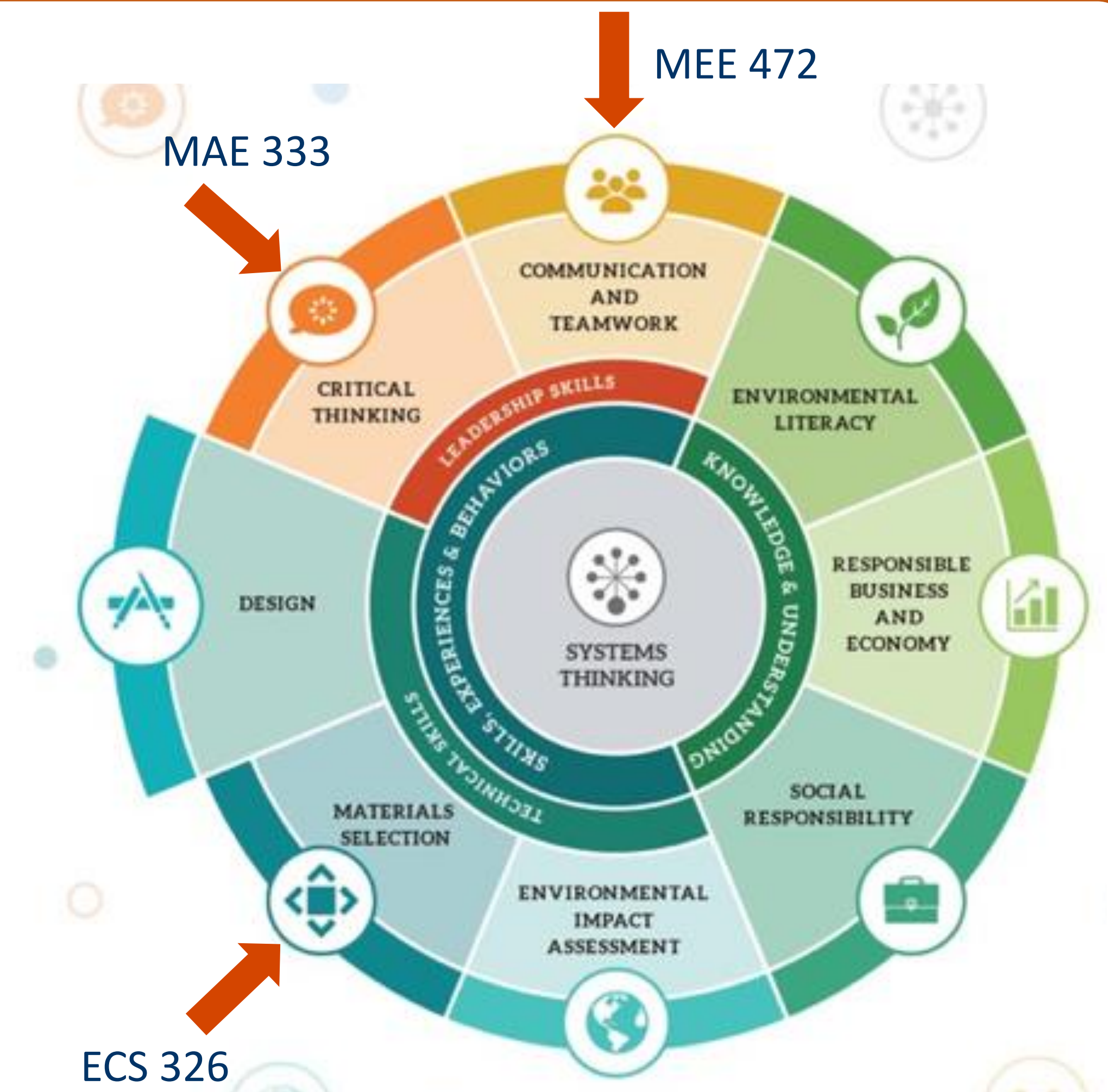
## Motivation & Need

Sustainability is increasingly central to engineering practice, yet it is often addressed inconsistently across the undergraduate curriculum. Students may encounter sustainability concepts in isolated courses without a coherent progression or common assessment framework. This project addresses that gap by embedding sustainability intentionally across multiple years of the Mechanical Engineering (ME) curriculum using the Engineering for One Planet (EOP) Framework.

## EOP-Guided Curricular Interventions

Guided by the EOP Framework, we are integrating sustainability into three required ME courses spanning sophomore through senior years:

- Sophomore Year – ECS 326: Engineering Materials, Properties, and Processing**  
 EOP Area: *Materials Selection*  
 Students evaluate material properties, performance, and environmental impacts using sustainable material selection principles in design scenarios.
- Junior Year – MAE 333: Data Analytics for Engineers**  
 EOP Area: *Topics in Critical Thinking*  
 Students analyze real-world datasets (e.g., building energy use, emissions, efficiency metrics) to assess environmental and societal impacts of engineering systems.
- Senior Year – MEE 472: Capstone Design**  
 EOP Area: *Communication and Teamwork*  
 Students integrate sustainability considerations into industry-sponsored capstone projects through collaborative, team-based design processes. Teams practice effective communication with peers, faculty, and industry partners by articulating sustainability trade-offs, documenting decision-making, and presenting environmentally and socially responsible solutions to diverse stakeholders.



## EOP Student Learning Outcomes and Assessment

EOP Topic	Assessed Learning Outcomes	Assessment Implemented	Direct Evidence Collected
Critical Thinking (MAE 333)	Core 1: Define a sustainability-related engineering problem comprehensively, identifying stakeholders, consequences, and trade-offs.	Sustainability-focused data analytics project using real-world energy datasets	Problem statement section identifying system boundaries, stakeholders, and trade-offs
	Core 6: Critique ethical and values-based choices arising from energy-efficiency trade-offs using empathy and systems thinking.	Written reflection embedded in project report	Reflection addressing ethical implications, societal impacts, and value-based trade-offs
	Advanced 3: Integrate quantitative regression results with qualitative research to support data-driven sustainability decisions.	Regression modeling + contextual interpretation in technical memo	Statistical results (models, coefficients) combined with qualitative justification and literature context
Material Selection (ECS 326)	Core 4: Compare materials properties (e.g., chemical, physical, and structural properties) and performance aligned with end-use application.	Comparative paper analyzing four consumer products using the materials science tetrahedron	Written comparison of structure, properties, processing, and application
	Core 1: Identify potential impacts of materials (e.g., embodied energy, emissions, toxicity, etc.) through the supply chain - from raw material extraction through manufacturing, use, reuse/recycling, and end of life - with a focus on minimizing negative impacts to the planet and all people (i.e., especially those who have been intentionally marginalized).	Life-cycle-based ethical analysis section of paper	Discussion of extraction, manufacturing, use, recycling, and disposal impacts
	Core 3: Critique the environmental and social impacts of designs created by others	Ethical critique of existing consumer product material choices	Evaluation of sustainability trade-offs and social/environmental consequences
Communication and Teamwork (MEE 472)	Core 1: Communicate through audience-specific written, graphic/visual, oral, and interpersonal communication skills.	Implementation in Spring.	N/A
	Core 3: Demonstrate ability to work within and function well on teams and across disciplines	Implementation in Spring.	N/A

## Future Work

- Analyze assessment data from MAE 333 and ECS 326 to evaluate student learning and inform continuous improvement.
- Implement EOP Communication and Teamwork outcomes in MEE 472 Capstone Design during the Spring semester using team-based assessments and stakeholder feedback.

## References

- The Lemelson Foundation. The Engineering for One Planet Framework
- The Lemelson Foundation. Engineering for One Planet Framework: Comprehensive Guide to Teaching Core Learning Outcomes

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