



# Integrating Sustainability across Engineering Curricula

Elin Jensen, Keith Kowalkowski, Mamdouh Mohamed, Morteza Nazari-Heris, and Edmund Yuen  
Department of Civil & Architectural Engineering

## Synopsis

Pillars of sustainability are **environmental, economic, and social factors**. To **civil and architectural engineers**, sustainability applies to engineered systems such as a building, a campus or an entire city. Different metrics are used to measure and recognize the commitment by the owners and cities to sustainability. It is critical that we train the students in questioning.

- How things are **designed and constructed**?
- How are **current and possible future needs met**?
- Can **traditional or new technologies** be employed to find the most sustainable solution?
- What are **economic, environmental, and social impacts** of sustainability policies, strategies and technologies?
- Can **funds** be secured for the implementation?
- What are the **obstacles and risks**?
- Can **operational needs or user behavior** be modified to reduce resource needs?

To bring this broad topic to the students throughout the curriculum, a **focused and systematic approach** is sought that introduces concepts of **sustainability** while understanding the intersection of the 3 pillars in the planning and design of a local or global project.

## Methodology

Vertical integration of **EOP Framework** for Bachelor of Science in Civil Engineering (BSCE) and Master of Science in Architectural Engineering (MSArE). Note: MSArE is an integrated 5-year program with a traditional 4-year bachelor portion. For both programs, concepts are introduced at the FR level, reinforced at the JR level and emphasized at the SR level in either common classes or very similar classes.

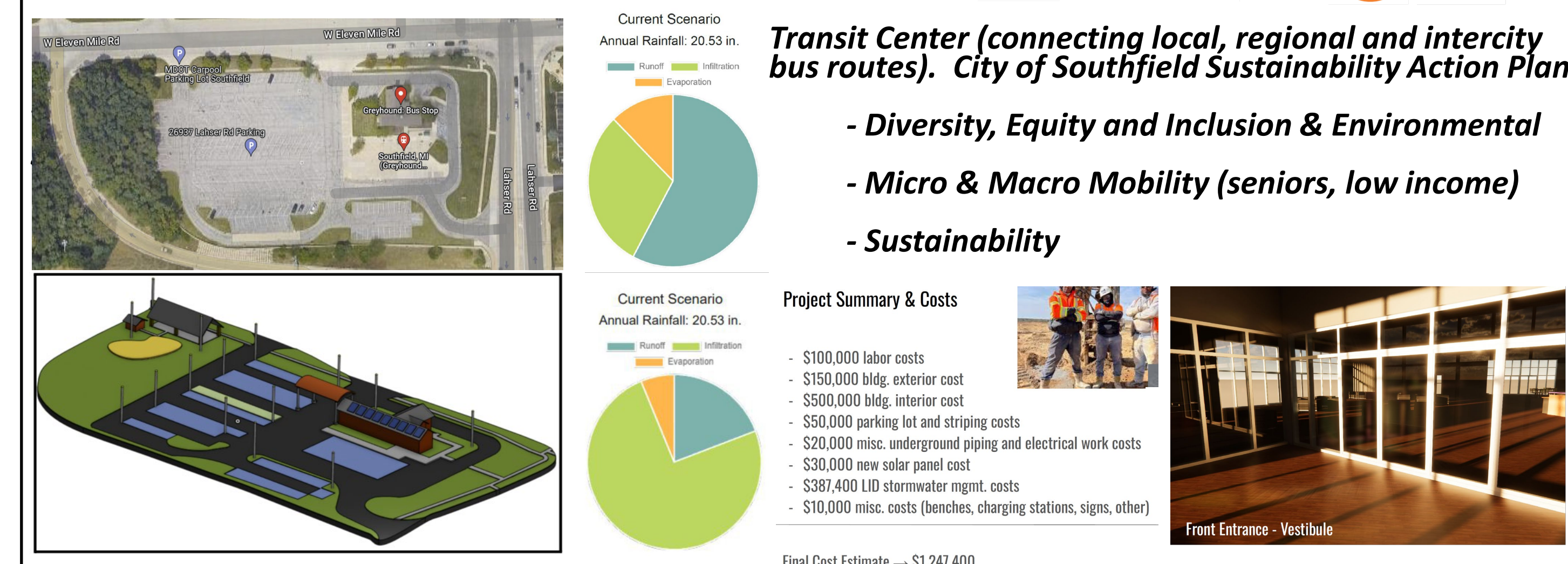
**EOP Core Student Learning Outcomes** – Some educational strategies adopted from the EOP Framework reference material and other strategies are designed to address specific program opportunities.

### Project Designed Modules -

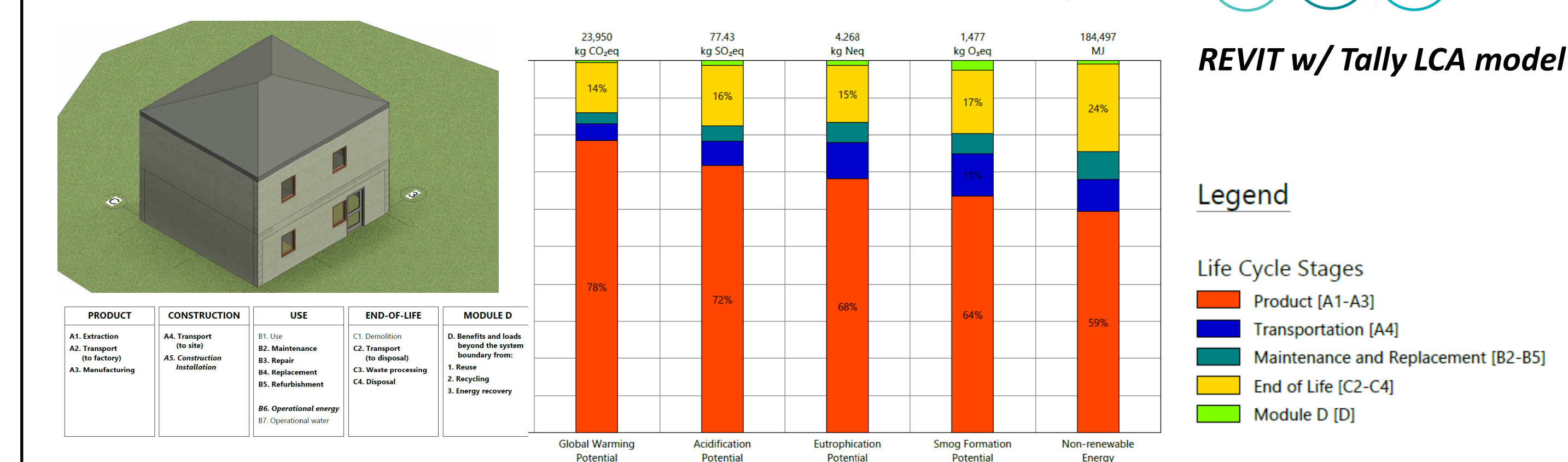
- early introduction of **systems thinking** and **social responsibilities** in projects in **Intro to Civil & Architectural Engineering**
- quantifying the **environmental impact** of construction materials throughout a project life cycle in **Construction Engineering**.
- equipping the **Senior Capstone** students and faculty with tools to effectively manage **team dynamics and communication** to better the project outcome.

## Modules

**Introduction to Civil & Architectural Engineering** (focus on **systems thinking** and **social responsibilities**)



## Construction Engineering (environmental impact)



## Senior Capstone Sequence (team dynamics and communication)

**Two 2-hour workshop**

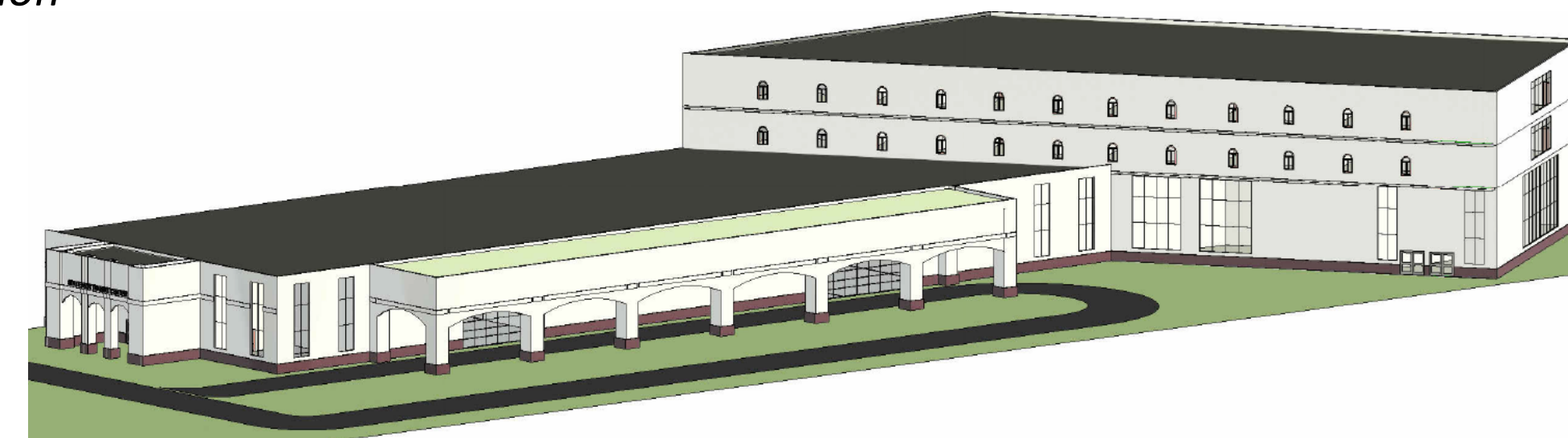
**A: Team Dynamics and Communication**  
Dr. Caryn Reed-Hendon (LTU Director of DEI)

**B: DEI, Regulations and Environmental Justice in civil & architectural engineering projects.** Dr. Caryn Reed-Hendon

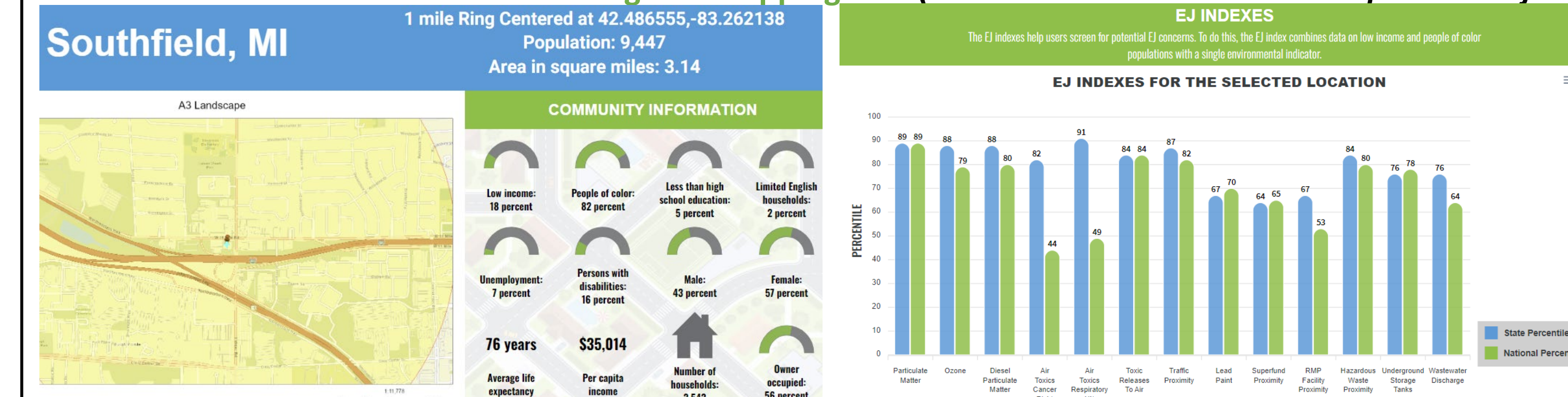
**Team Agreements**  
Biweekly check in with Team Advisor  
Self and Peer evaluations

**Social, Historical, Cultural Issues**  
Green Infrastructure Report

**State Fair Transit Center**  
(1 of 4 projects)  
Historical building preserved  
- Cattle Barn  
- Portico



## EJScreen Environmental Justice Screening and Mapping Tool (Intro to CE and AE course & Capstone Project)



## Progress and Plan for Scaling Up

Implementation: Modules developed and implemented.

Next Step: Capstone Spring '24; 2<sup>nd</sup> sem.  
- EOP Survey (Post)  
- Team Self- & Peer Evaluation  
Construction Engr S  
- EOP Survey (pre & post)  
Assessment & Follow up Focus Group

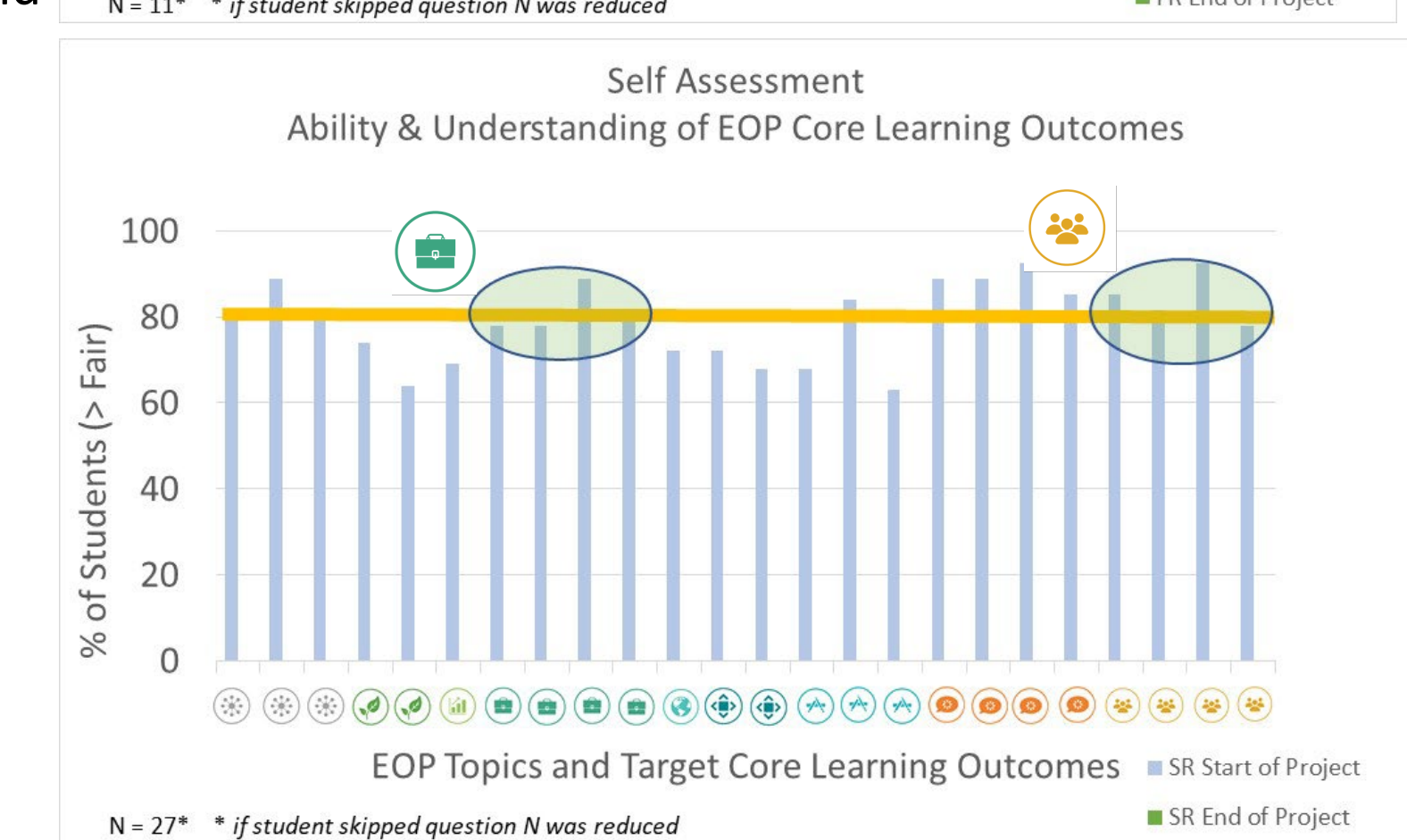
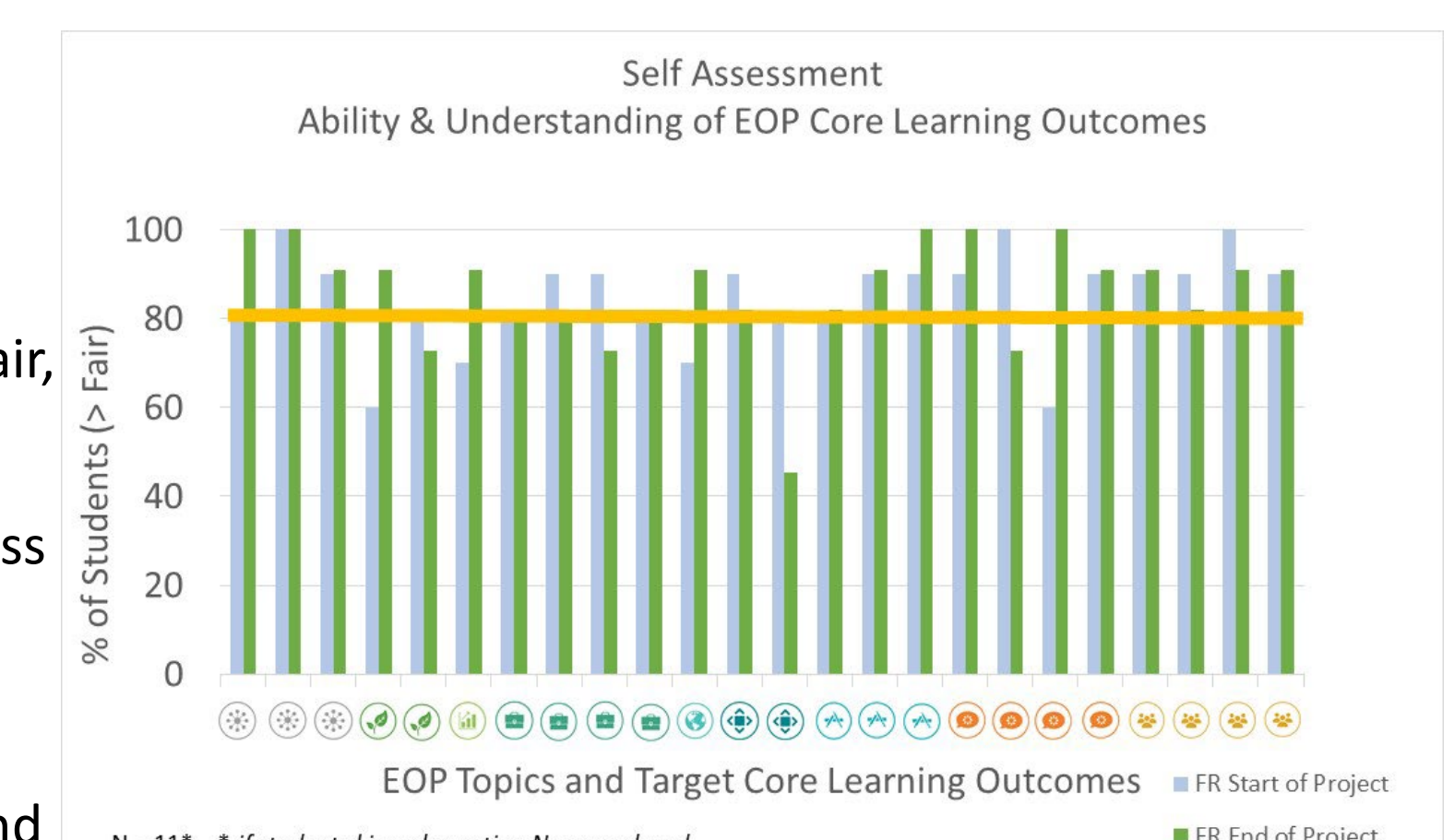
Scaling Up: Refinements of Modules  
Department level curriculum review & mapping  
Implement Team Dynamics and Communication module in other engineering programs.

Dissemination: Institutional Research Day (April 2024)  
2024 ASEE NCS Conference (abstract accepted)

## Evaluation & Impact

### Survey

- 24 EOP core learning outcomes were mapped to BSCE and MSArE program curricula.
- Survey used a 4-point scale (Very Good, Good, Fair, Poor) to measure students' level of attainment.
- Target **threshold is 80%** of the students self-assess to perform at or above "Good".
- Same survey used at each level
- Survey distributed at the beginning and at the end of the project (after general introduction to EOP Topics).



### Department Level Impact (F23)

Subject	Students	Faculty
Intro (FR)	11 + (19)	2
Construction (JR)	18 + 12	1
Capstone (Sr)	27	10 + 1

## References

The Lemelson Foundation (2022). The Engineering for One Planet Framework: Essential Sustainability-focused Learning Outcomes for Engineering Education (2022). Cynthia Anderson and Cindy Cooper (Eds). The Lemelson Foundation, Portland, Oregon, USA. 28 pages. [https://engineeringforoneplanet.org/wp-content/uploads/EOP\\_Framework\\_2023.pdf](https://engineeringforoneplanet.org/wp-content/uploads/EOP_Framework_2023.pdf) Accessed 01.09.2024

<https://www.epa.gov/ejscreen>

<https://www.epa.gov/water-research/national-stormwater-calculator>

## Acknowledgements

This project was supported by the ASEE Engineering for One Planet Mini Grant. Its contents are solely the responsibility of the authors and do not necessarily represent the official views of LTU, ASEE, or the Lemelson Foundation. We would like to thank our mentors, Dr. Shannon Parks and Dr. Adam Carberry. We also wish to thank Dr. Caryn Reed-Hendon, Director of Diversity, Equity, and Inclusion at Lawrence Technological University, for developing and delivering the workshops to the senior capstone students and faculty.