ReMaDe

Multiple PhD Positions with Professor Dan Cooper in the Resourceful Manufacturing & Design (ReMaDe) group (https://remade.engin.umich.edu/), part of the Mechanical Engineering Department at the University of Michigan, are available.

Note that the deadline for PhD applications at the University of Michigan is **December 1st, 2022**. See here for more details: https://me.engin.umich.edu/admissions/graduate/

We are looking for dedicated students to contribute to projects in any of the areas below. Ideal students will have majored in either environmental/sustainability science, mechanical engineering, materials science, or a related discipline. Please contact Dan Cooper (drcooper@umich.edu) for informal enquires.

- **Project A: A Technical Evaluation Framework for Recycling Technologies** Increased high-quality recycling could propel U.S. industry towards a circular economy with reduced greenhouse gas (GHG) emissions. This project focusses on generating a rigorous framework for prioritizing interventions and a consistent method for evaluating emerging (polymer and metal) recycling technologies in open and closed-loop recycling systems. This project is in collaboration with multiple industry stakeholders and the National Renewable Energy Laboratory (NREL).

  Skill sets to be developed: Optimization, Recycling system process and system modeling, (Dynamic) material flow analysis, Life Cycle Analysis.

- **Project B: Robust & Adaptable Decisions for Manufacturing & Product Sustainability.** Engineers make decisions based on predicted performance and conditions. Planning for industrial decarbonization is riddled with deep uncertainties about the future eco-system. PhDs in this project will focus on developing sustainable design and manufacturing roadmaps that are robust to the uncertainties.

  Skill sets to be developed: Decision-making for environmental sustainability under deep uncertainty

- **Project C: Creating rapid, transparent, and updateable material flow analyses** MFAs are critical tools in the transition towards a circular economy. They reveal opportunities for material efficiency and symbiosis, as well as the system-level impacts of localized changes to the supply chain (e.g., the effect of increased electric vehicle deployment on lithium extraction and manufacturing emissions). The goal of this project is to improve the speed at which material flow analysis (MFA) is performed and to transparently communicate and reduce the uncertainty in the results, thus enabling a routine and updatable process to make MFAs at any scale (from factories to supply chains). The objective is to quantify the uncertainty of MFA parameters and network structures, and to conceive intelligent data collection strategies early in the MFA, thus decreasing the cost for high-confidence MFA results.

  Skill sets to be developed: Bayesian inference, Optimal Experimental Design, (Dynamic) Material Flow Analysis, Unit Manufacturing Process Modeling

- **Project D: Ultra high efficiency utilization of materials in automotive manufacturing** There are significant opportunities to improve the material utilization of material along metals processing supply chains by both developing mass production technologies for lightweighting and improving the process yield of mass production technologies; e.g., around 40% of all aluminum is scrapped between material production and the final aluminum products. PhDs in this project will focus on evaluation of the environmental impacts of metal processing supply chains and/or lab-based development of novel manufacturing tools for high material utilization in metals processing.

  Skill sets to be developed (depending on the specific PhD topic): Solid mechanics, Metal forming plasticity, Heat flow analysis, Finite Element Modeling, Machine Design, Life Cycle Analysis and Material Flow Analysis.

- **Project E: Pathways for Electric Power System Decarbonization under a Sustainable Manufacturing Future** Constructing renewable electric power sector (EPS) technologies requires much more emissions-intensive material than traditional fossil-fuel based systems. This material intensity poses a serious problem since industry must both rapidly produce low-carbon EPS technologies and decarbonize to keep the emissions targets viable. This project will focus on answering: How can U.S. industry & the U.S. electric power sector (EPS) achieve absolute decarbonization given the material intensity of renewable energy?

  Skill sets to be developed: Supply chain analysis, Material flow analysis, Life Cycle Assessment, Operation and expansion of electricity investment capacity expansion models, such as NREL's ReEDS model

- **Other projects in both Industrial Ecology and Metals Processing may also be of interest**