# 2024 Undergraduate Summer Research Project Descriptions

**Application Link:** bit.ly/2024research
**Applications Due:** February 16, 2024
**Program Period:** May 6 – July 26, 2024

**Phytoremediation of environmental pollutants**
Human activities are releasing pollutants into the environment impacting ecosystems and human health. Phytoremediation is a sustainable method to clean up environmental pollutants such as excess fertilizers and heavy metals from agroindustry and urban runoff. A small floating plant, duckweed, has emerged as a promising species for management of pollutants as well as a transition to a more circular bioeconomy. The student will conduct experiments to evaluate various natural and synthetic duckweed strains for bioremediation of targeted compounds from naturally occurring waste waters in the region.
**Advisor:** Tia-Lynn Ashman, Biological Sciences

**Solar-Powered Nanotechnology and Origami Engineering**
This project aims to leverage solar energy to directly drive chemical conversion of solid precursors to form functional nanomaterials, such as graphene, carbon nanotubes, and other porous nanocarbons. Moreover, solar energy can enable creating local thermal gradients across shape memory polymer films, which leads to self-folding toward origami-inspired 3D manufacturing of polymer structures.
**Advisor:** Mostafa Bedewy, Mechanical Engineering and Materials Science

**Urban Permaculture**
Student will learn the concepts of permaculture at an urban community farm in Garfield. Tasks will include land restoration design and implementation, food distribution at the Valley View Church Food Pantry, community garden participant management, and assisting with educational tours and project leadership.
**Advisors:** Kevin Bell, Bioengineering
Corey Flynn, Physical Therapy

**Reducing Embodied Carbon Emissions in the Built Environment through Innovation Construction Waste Assessment**
Minimizing construction waste and facilitating opportunities to reduce embedded carbon within construction materials is an early-stage activity for many civil construction companies. S&B USA, an infrastructure development and construction company based in Pittsburgh, PA is seeking research-based solutions to develop baseline assessments for its material consumption, opportunities for waste minimization, landfill diversion, and supply chain enhancements that can reduce emissions and encourage the use of reduced carbon materials.
Advisor: Melissa Bilec, Civil and Environmental Engineering

**Testing of Laboratory-scale Binder Jet Printer with reduced metal powder waste**
Commercial 3D Printers often target large build volumes for the production of big parts. However, this requires excessive amount of powder to start even the smallest prints and results in increased wasted material. A custom-built 3D printer for small powder quantities that reduces initial powder amount, waste, and cost is currently being built but requires further improvements, validation, and testing before being fully operational.
**Advisor:** Markus Chmielus, Mechanical Engineering and Materials Science

**The Effect of In-Solution Particles on Reusable, Additive Manufactured Metal Filters**
Many gas and liquid filters are non-reusable, go to waste and pollute the environment as seen with many N95 masks during the pandemic. We developed an additive manufacturing process that will result in highly porous, tunable metal structures that can be reused, cleaned, and if needed sterilized. In this research project, we would like to learn more about how filtration of particles is affected by the amount of porosity and porosity characteristic in the additive manufactured metal filters.
**Advisor:** Markus Chmielus, Mechanical Engineering and Materials Science

**Storm chasing to understand nutrient cycling in the urban tree canopy**
Urban trees in parks and along streets act as sponges for stormwater, pollutants, nutrients, and many other particles and there has been recent attention on biogeochemical cycling within the tree canopy. The summer fellow would lead a project investigating canopy biogeochemical cycling and the contribution to soil and stream nitrogen fluxes during precipitation events. This project will involve fieldwork, lab work, and data analysis while working in an interdisciplinary lab with opportunities to participate in a broad range of projects.
**Advisor:** Emily Elliott, Geology and Environmental Science

**Microplastics transport in waves**
This project will use an experimental method to study microplastic transport tumbling in waves. We will use a high-speed camera to image the flow as well as the microplastic in the lab.
**Advisor:** Lei Fang, Civil and Environmental Engineering

**Zooplankton and phytoplankton transport in waves**
This project will use an experimental method to study how planktonic life navigates in waves. We will use a high-speed camera to image the flow as well as the plankton.
**Advisor:** Lei Fang, Civil and Environmental Engineering

**Energy-efficient processors, sensors, and systems for space-based sensing and computing**
The focus of this research opportunity is to study and contribute to a topic in advanced computer architectures, apps, sensors, networks, systems, and/or services, often in the context of resource constraints and environmental hazards, with the goal of maximizing performance, energy-efficiency, and resilience. Students will learn and employ selected concepts, methods, and technologies in parallel, reconfigurable, dependable, and/or distributed computing, by working on a research task for next-generation spacecraft, autonomous systems, or supercomputers, in the NSF Center for Space, High-performance, and Resilient Computing (SHREC) headquartered in the ECE Department at Pitt.
**Advisor:** Alan George, Electrical and Computer Engineering

**Environmental Sustainability and Market Competition**
In this project I would like to explore the interaction between market competition and environmental sustainability. Namely, by going green companies can obtain a competitive edge in the market as well as favorable treatment from government and regulatory policies. In this theoretical project we will study the structure of government subsidy that best incentives firms to transition towards truly green production.
**Advisor:** Michael Hamilton, Business Analytics and Operations

**Avoiding numerical issues in optimal power flow problems**
Software for managing the modern power grid can in rare cases run into numerical issues where arithmetic errors in the computer can cause failures to produce a viable solution to the problem. This project will attempt to develop some techniques to avoid these issues and therefore make this software more robust. Students for this project should have taken a course in operations research or optimization, and should be strong programmers. Knowledge of how the power grid functions is not needed for this project.
**Advisor:** Oliver Hinder, Industrial Engineering

**Energy Harvesting Powered Sensors and Machine Learning**
Enable energy harvesting (solar panel, RF) powered sensors and running tiny machine learning models on these sensors for different objectives.
**Advisor:** Jingtong Hu, Electrical and Computer Engineering

**Future Proof Software Development**
We are aiming to develop software for embedded systems that are extensible such that they can be used as long as possible such that we can reduce e-waste generation from retired electronic devices.
**Advisor:** Jingtong Hu, Electrical and Computer Engineering

**Using Machine Learning Models to Identify Wildlife Species in Field Recordings**
Our lab uses small, inexpensive acoustic recorders to record soundscapes at field sites across the United States. We are interested in hosting a summer fellow who will work with us on this research. The main tasks will be developing and testing machine learning models to identify species of birds, bats, frogs, and/or insects within long field recordings, but tasks may also include deploying recorders in the field, managing incoming data, and testing new hardware designs. Several of our previous summer fellows have been co-authors on manuscripts describing their work.
**Advisor:** Justin Kitzes, Biological Sciences

**Tracking migration of monarch butterflies with the world's smallest computer**
This project will investigate the carbon footprint of deep learning models and how we account for device heterogeneity. Students will develop simulation models and explore various energy and carbon models to measure energy consumption and carbon emissions. Furthermore, the study will explore techniques that use dynamic voltage and frequency scaling (DVFS) on performance and energy.
**Advisor:** Inhee Lee, Electrical and Computer Engineering

**Solar Recycling**
This project focuses on addressing the sustainability of solar panels, as approximately 90% of them are discarded in landfills when they reach the end of their lifecycle. Our aim is to explore and assess various methods for recycling solar panels, with a particular emphasis on developing efficient processes to separate the different materials they contain.
**Advisor:** Paul Leu, Industrial Engineering

**Antireflection Glass for Solar**
This project is dedicated to enhancing the power conversion efficiency of solar panels by mitigating the light loss caused by reflection from the top glass layer. We are investigating innovative antireflection technologies with the goal of diminishing the amount of light that is lost and, consequently, improving the overall performance of solar panels.
**Advisor:** Paul Leu, Industrial Engineering

**CyberWater2 -- A sustainable data/model integration framework**
Natural hazards, such as coastal and inland flooding caused by Hurricanes and severe drought and its associated wildfire, have been occurring with unprecedented frequency induced by climate changes. To mitigate these potential disasters, CyberWater2, to be built on top of CyberWater, will develop a collaboration-centric cyberinfrastructure for scientific and engineering communities to solve complex scientific modeling problems efficiently, accurately and in-depth and to facilitate collaboration across disciplines, platforms, organizations, and geographic boundaries.
**Advisor:** Xu Liang, Civil and Environmental Engineering

**Manufacturing 3D biomimetic fibrous scaffold**
Biological tissues are structurally supported by complex 3D nanofibrous scaffolds with spatially varying fiber arrangement. Due to the small diameter and extreme total length of such fibrous structures, manufacturing 3D biomimetic fibrous scaffolds has been challenging. We are working on a novel technology that combines airflow and electric field to realize unprecedented precision and throughput to tackle this challenge.
**Advisor:** Qihan Liu, Mechanical Engineering and Materials Science

**Environmental life-cycle assessment of natural gas energy systems**
Natural gas (NG) is an emerging commodity in low-carbon transitional scenarios towards sustainable economy that can be utilized for diverse downstream power, alternative energy, and chemical applications. Hence, it is vital to have a system-level energetic and environmental understanding of NG production and processing, as well as its downstream usage in different energy and chemical sectors. Here you find a great opportunity to learn about industry-wide-use life-cycle assessment methodologies by conducting a NG related summer project.
**Advisor:** Mohammad Masnadi, Chemical and Petroleum Engineering

**Enabling biofuels circular economy via liquid metal catalysis**
Ethical concerns about use of food crops for energy and fuels production and their significant climate impact due to land-use change have led bioenergy research to shift from food-based biomass (e.g., corn, sugar cane) to lignocellulosic resources (e.g., forestry woody residues, agriculture wastes) for energy and fuels production. Despite decades of research & development, solid catalyst (nano particles) deactivation via feedstock carbonaceous compounds is one of the key challenges that has prevented commercialization of second generation biofuels (i.e., biofuels generation via cellulosic material). Here we transform the previous research approach by utilizing liquid-phase metallic systems - which are resilient against deactivation - to convert cellulosic biomass to valuable bio-fuels.
**Advisor:** Mohammad Masnadi, Chemical and Petroleum Engineering

**Resolving contradictions and finding counterfactuals from multimodal data**
This project will use artificial intelligence methods such as natural language processing, knowledge representation learning, causality and reasoning on knowledge, as well as stochastic simulation and statistical hypothesis testing and estimation to infer explanations or suggest resolution for contradictions in multimodal data. In particular, we will explore contradictions between interaction networks inferred from biological data and the knowledge available in published literature.
**Advisor:** Natasa Miskov-Zivanov, Electrical and Computer Engineering

**Addressing combinatorial complexity of data-driven methods with knowledge graphs**
This project will focus on using artificial intelligence methods for knowledge representation learning, causality and reasoning on knowledge to reduce the combinatorial complexity faced by machine learning methods and neural network-based methods. The scope of applications for the methods that will be developed is broad, from medicine to economy, agriculture, or power systems. We will first test the developed methods in systems and synthetic biology.
**Advisor:** Natasa Miskov-Zivanov, Electrical and Computer Engineering

**LoRa-ambient: a low power, low-cost sensing platform for sustainable and energy-efficiency for Pitt buildings.**
LoRa-ambient will be a cost-effective and energy-efficient sensing platform that promotes sustainability and raises building occupant awareness of energy-related behavior. The platform is based on the new LoRa (Long Range) communication technology, a new standard for IoT (Internet of Things), that offers low energy consumption but has low bandwidth. We will build a building monitoring platform by (i) studying and selecting appropriate sensors (e.g., (temperature, humidity, air quality, lighting, occupant detection, counting), (ii) building LoRa devices and deploying a LoRa network; and iii) collecting and analyzing data to display.
**Advisor:** Daniel Mosse, Computer Science

**LoRa-control: context-aware and occupant-centric building control strategies for sustainability**
LoRa-control will create algorithms to optimize Pitts and CCACs HVAC and lighting based on building occupancy and environmental conditions. The system will be designed to reduce energy consumption, carbon emissions, and associated costs, while providing comfort for occupants. The student will investigate building occupantsâ€™ preferences/requirements and energy consumption characteristics, and then develop a real-time response to occupancy, as well as remote and multi-zone control.
**Advisor:** Daniel Mosse, Computer Science

**Adaptation and Resiliency to Historical Climate Change**
The student working on this project will collaborate in developing an annotated bibliography about global responses to historical changes in climate with a focus on the pre-industrial era (pre-1800), especially the Late Antique Little Ice Age, the Medieval Climate Anomaly, and the early modern Little Ice Age. The ability to conduct research in a language other than English is a plus.
**Advisor:** Ruth Mostern, History

**The Cost of Complexity: Uncovering determinants of the Environmental Burden for Remediating Contaminant Mixtures**
"Persistent Organic Pollutants, Forever Chemicals, The Dirty Dozen." Why do some chemical classes cause so much environmental damage, and why does it so often come as a surprise? Will we have the resources needed to sustainably clean up environments contaminated by complex mixtures of persistent contaminants? This project seeks to define a fundamental metrics that links the chemical fingerprints of complex mixtures with the environmental cost of remediation and conversely, seek to define the cost of inaction for contaminated sites.
We seek student(s) interested in data extraction, organization, and analysis. Coding experience in Python or similar programming language are desirable.
**Advisors:** Carla Ng, Civil and Environmental Engineering
Vikas Khanna, Civil and Environmental Engineering

**Experimental and Theoretical Grain Growth Studies of Nanocrystalline Soft Magnetic Alloys for Sustainable Aviation and Space Electric Power Applications**
Soft magnetic alloys play a critical role in energy efficient and power dense electrical power conversion systems, a critical requirement for sustainable aviation and space vehicles with increased reliance on electrical power conversion as compared to traditional thermal propulsion-based technology. The student will pursue a combination of experimental and simulation studies to investigate grain growth kinetics of nanocrystalline soft magnetic alloys being investigated and developed for high temperature applications including aviation and space electric power. X-ray diffraction and microscopy will be combined with thermodynamic and kinetic modeling to understand what factors influence grain size and how alloys can be optimally designed to maintain high energy efficiency under extreme operational conditions.
**Advisor:** Paul Ohodnicki, Mechanical Engineering and Materials Science

**Novel Ferrite Nanocomposite Soft Magnetic Material Loss Investigations for Electric Vehicle Applications**
Widespread deployment of electric vehicles requires improved energy efficiency to enable maximum range of charge to realize a user experience that can compete with traditional gasoline power vehicles in use today. Electric power conversion plays a critical role in the overall size, weight and efficiency of the electric vehicle drive train with advanced soft magnetic materials required to optimize performance. In this project newly developed nanocomposite ferrite soft magnetic materials will be characterized in detail to understand both their energy efficiency (i.e. loss) and saturation flux density (i.e. capacity to handle large quantities of electrical power with small size) performance using a combination of analytical models and electrical testing instrumentation.
**Advisor:** Paul Ohodnicki, Mechanical Engineering and Materials Science

**Exploring Sustainable Design**
Students research assistants working on this project during the summer of 2024 will form partnerships with local organizations, develop curriculum, assist in facilitating workshops, and gather data. Primarily, students research assistants will work to expand project curricula and program offerings in partnership with Pitt's Community Engagement Centers in Homewood and the Hill District. This will involve coordinating with CEC leadership and community partners to organize programming, identify sustainable design projects or environmental concerns in those neighborhoods, plan walking tours, help to facilitate instruction on the designated dates, and gather relevant data.
**Advisor:** Stephen Quigley, English

**Election systems in the election year: study of democratic resilience in the (mis)information age**
Spread of election conspiracies, doxxing and online harassment paired with physical, offline threats lead to extremely difficult work conditions for election administrators; and the unprecedented turnover of election officials across the US has raised concerns about the integrity of future elections and democratic resilience. The undergraduate researcher will contribute to ongoing work to map the election infrastructure in Pennsylvania, developing simulation models to stress-test the election infrastructure and identify vulnerabilities.
**Advisor:** Amin Rahimian, Industrial Engineering

**Mapping sustainable consumption behavior across PA**
We will use network diffusion models to study complex contagions in adoption of new sustainable technologies, by accounting for high-order network interactions. Building on ongoing work, the undergraduate researcher will contribute to data collection on adoption of solar roofs in PA and combine that with the existing data on residential properties, neighborhood facilities and demographics of residents to map a landscape of solar roof adoption. The data together with the simulation model will help inform interventions to increase adoption of innovations in sustainability technology.
**Advisor:** Amin Rahimian, Industrial Engineering

**Bridge Asset Management: Data analysis to prioritize intervention.**
The project consists of: (1) learning the different approaches U.S. State DOTs use to prioritize bridge intervention; (2) applying three of those approaches to the National Bridge Inventory (NBI) relative to the state of Pennsylvania; (3) identifying the top ten bridges in Pennsylvania and in Allegheny County that should be considered for immediate repair.
**Advisor:** Piervincenzo Rizzo, Civil and Environmental Engineering

**Sustainability research on a selected topic**
This project aims to advance sustainability learnings and commitments based on research on a selected topic of studentâ€™s interest. The project will cover fundamental knowledge on sustainability, guiding principles, and basic approaches for sustainable development. It will explore scientific literature on the selected topic and provide an analysis to highlight the most promising opportunities for further development. The project will elaborate on the report of the most active research centers in the field, sources of publication, and tools for analysis. It is aimed to approach a life cycle analysis of the material or process.
**Advisor:** Joaquin Rodriguez, Chemical and Petroleum Engineering

**Protocol for renewable energy laboratory experiments**
Two available lab equipment are in the process to be commissioned for supporting the learning of undergraduate students on sustainability. A solar powered electrochemical cell and a hydrogen fuel cell units are to be used to illustrate and provide basic analysis of the competitive use of alternative energy based on renewable sources. The project consists of testing the equipment, developing lab protocols, and structuring undergraduate lab practices.
**Advisor:** Joaquin Rodriguez, Chemical and Petroleum Engineering

**Designing modules for experiential learning: Understanding the formation of food deserts**
Help design an experiential learning model for understanding the formation and persistence of food deserts. This position requires multidisciplinary work in food security, political history and digital education. Seeking students interested in sustainable development broadly defined, food systems, economic development, and education.
**Advisor:** Kay Shimizu, Graduate School of Public and International Affairs

**Stream Restoration Monitoring in the Churchill Valley Greenway**
This is an opportunity to collect stream and wetland monitoring data in the Churchill Valley Greenway, a 151 acre former golf course that is being restored via Acid Mine Drainage remediation and reconnecting of the stream to floodplain wetlands. The Allegheny Land Trust is developing a master plan for the greenway, and our project will provide necessary information on stream and air temperatures, water quality, and the fish and macroinvertebrate community in Chalfant Run, which flows through Environmental Justice communities. The data collected through a Before-After-Control-Impact (BACI) design will help inform future stream restoration efforts in Chalfant Run and Thompson Run watersheds east of Pittsburgh.
**Advisor:** Patrick Shirey, Geology and Environmental Science

**Using diatoms to reconstruct environmental change in central Chile during the Common Era**
The major objective of the proposed research is to use previously obtained sediment cores from lakes in south central Chile to reconstruct climate and environmental change over the Common Era along a latitudinal transect in central Chile. The student will sample diatoms from sediment cores and identify diatoms to species to indicate past environmental conditions. Hydroclimate variability as indicated by diatoms will be compared with planktonic (water column) diatoms dominating relative abundance during warmer conditions and periphytic (attached) diatoms dominating relative abundance during cooler conditions in Patagonia. Diatoms will be used to indicate changes in water quality conditions as others in Patagonia have been able to track changes in tropic status and lake level.
**Advisor:** Patrick Shirey, Geology and Environmental Science

**Supporting Human Rights in Urban Policies: Racial Equity, Housing, and Environmental Justice**
This project supports work with Pittsburghs Human Rights City Alliance doing research related to policy advocacy around the application of international human rights law in Pittsburgh and other cities. Summer fellows/interns may support one or more of the following tasks: implementation of UN human rights recommendations for remedying systemic racism, addressing racial discrimination in policing, promoting environmental justice, and improving the Cityâ€™s process for monitoring compliance with human rights laws and standards. Students engage in research, communication/ journalism and other public education and outreach work and learn skills in community organizing, policy, and public communication.
**Advisor:** Jackie Smith, Sociology

**Practical optimization of traffic signals to reduce fuel consumption and vehicular emissions**
This project will give students an opportunity to investigate impact of various stop penalties (e.g. how many seconds of delay is each vehicular stop worth, from the perspective of consumed fuel) on optimization of traffic signals. Students will use one of the contemporary practical signal optimization tools to test how various stop penalties affect the quality of signal timing plans, which will be measured through associated fuel consumption based on outputs of highly calibrated and validated microsimulation model. The study and results are intended to be submitted for presentation at the 2023 Transportation Research Board conference and the associated journal.
**Advisor:** Aleksandar Stevanovic, Civil and Environmental Engineering

**Validation of Google Eco-friendly routing method**
This project will give students an opportunity to validate Google's, recently introduced, Eco-friendly method where drivers are given the best route not in terms of shortest time to their destination but in terms of the lowest impact on the environment (by suggesting a route which leads to lowest fuel/energy consumption). Students will compare Google's results, for a selected number of routes, to data from a set of highly calibrated and validated microsimulation models to test validity of the proposed routing method. The study and results are intended to be submitted for presentation at the 2023 Transportation Research Board conference and the associated journal.
**Advisor:** Aleksandar Stevanovic, Civil and Environmental Engineering

**Environmental Inequality and Disasters Research**
This project examines the social, economic, and political determinants and outcomes of disaster responsiveness in the United States. We seek to understand how disasters and disaster recoveries affect people's lives, opinions, and behaviors. Centrally, we examine the underlying processes of disaster resource allocations, the means by which disaster recoveries can be more equitable, and how communities can better prepare for disasters and mitigate their complex impacts.
**Advisor:** Fernando Tormos-Aponte, Sociology

**Depolymerizing Plastics Waste with Liquid Metals Catalysis**
The burgeoning amounts of plastics waste are creating an ever-increasing global environmental problem, while at the same time constituting an unused resource that could replace fossil feedstocks. In this project, we are exploring a novel approach towards circular reuse of plastics waste via chemical recycling enabled by catalytic depolymerization in molten metals.
**Advisor:** Götz Veser, Chemical and Petroleum Engineering

**Hydrogen Purification and Utilization via Chemical Looping**
Hydrogen plays a critical role both as an emerging energy carrier and as a key reactant across many segments of the chemical industry. However, in all of these applications, very high purity hydrogen is required, adding costly and energy-intensive separation steps. In this project, we aim to circumvent this problem by exploring the direct use of low-purity hydrogen streams for chemical hydrogenations enabled by a dynamic reactor operation mode ("chemical looping").
**Advisor:** Götz Veser, Chemical and Petroleum Engineering

**Design spinel ferrite magnetic adsorbents for water purification**
In this project, advanced computational methods will be used to predict the capability of a series of spinel ferrites for removing heavy metal ions (such as Pb, Cu, As) from industrial wastewater. The outcome of the project is to identify the optimal composition and morphology of spinel ferrite particles to chemically adsorb and remove metal ions from the water.
**Advisor:** Guofeng Wang, Mechanical Engineering and Materials Science

**Laccase-Mimicking Bionanozyme for Sustainable Removal of Water Contaminants**
Bionanozymes are nanomaterials with enzyme-like activities. They present a significant opportunity to overcome the high-cost and low-stability challenges associated with natural enzymes, and hold immense promise for sustainable water treatment. This project aims to evaluate a laccase-mimicking bionanozyme for degrading emerging water contaminants.
**Advisor:** Meng Wang, Civil and Environmental Engineering

**Biological Recovery of Critical Metals from Electronic Waste**
Recovering high-quality metals from waste is of great importance to improve the metal circular economy and ensure a robust and sustainable metal supply. This project aims to engineer microorganisms to selectively concentrate and recover metals from electronic waste leachate.
**Advisor:** Meng Wang, Civil and Environmental Engineering

**Life cycle analysis of metered dose inhalers in the UPMC system**

Metered dose inhalers (MDIs) are common medical delivery devices used by patients with lung diseases such asthma and chronic obstructive pulmonary disease (COPD). However, despite their ubiquity, they have tremendous detrimental climate impact. MDIs contain hydrofluorocarbon (HFC) propellants that cause have an extreme effect in trapping heat in the atmosphere and have severe global warming potential. HFCs from MDIs are a sizable contribution to healthcare's greenhouse gas emissions. MDI devices when used in the hospital are also go unused or are often wasted, contributing to plastic waste. While there have been recent calls for the pharmaceutical industry to develop lower-emitting options, those new technologies are years away from mainstream patient use. However, some MDIs are less polluting than others, and in some cases there are reasonable alternatives for medication delivery than MDIs (such as nebulizers, dry powder inhalers, and soft mist inhalers) that do not have the same deleterious climate impact. By performing life cycle analysis (LCA) and characterizing the specific greenhouse gas emissions of individual MDI devices used in different settings throughout the UPMC system, we may better elucidate the locally derived climate impact of these devices which will help us identify which MDIs to prioritize on inpatient and outpatient formularies with the goal of reducing our UPMC healthcare system's scope 3 emissions while still adhering to clinical guidelines and important patient-specific needs.

**Advisor:** Noe Copley Woods, Obstetrics and Gynecology
Stephanie Maximous, Internal Medicine

**Metals 3D printing of Functionally Graded Alloys for Resource Constrained Environments**

Additive manufacturing has emerged as a highly effective approach for fabricating intricate structures with enhanced design flexibility. However, the feedstock materials can be wasted significantly after the printing process. This study not only addresses the demands of resource-constrained environments but also caters to the requirements of location-specific design objectives. The recycled powder will be used to generate a powder mixture for a high-quality printing design. Experimental verification and design modeling will be combined for the summer internship study.

**Advisor:** Wei Xiong, Mechanical Engineering and Materials Science

**Materials Design for Advanced Manufacturing of Co-free Cemented Carbides**

This project aims to reduce the environmental impact and cost of cemented carbide production by developing a new Cobalt-free alloy binder for binder jet additive manufacturing and powder metallurgy techniques. Due to their high strength and wear resistance, cemented carbides are widely used as cutting tools, wear parts, and structural components in various industries. However, the conventional cemented carbides are based on the WC-Co system, which poses environmental and health risks due to the toxicity and scarcity of Cobalt. Therefore, there is a need for alternative binder alloys that can provide comparable or superior mechanical performance without using Cobalt.

**Advisor:** Wei Xiong, Mechanical Engineering and Materials Science

**Integrated photonic accelerator for efficient machine learning**

Machine learning consumes a significant portion of the energy in data centers--a challenge which could be addressed with highly efficient photonic computing hardware. This project involves working with graduate students to build and automate a test setup which will be used to characterize photonic computing hardware developed in the PI's lab at Pitt. Experience in Python is highly beneficial.

**Advisor:** Nathan Youngblood, Electrical and Computer Engineering

**Alternative Energy Opportunities**

Assist in new technology research and renewable energy projects at UPMC, including solar installations and energy storage pilots. Maximize utility rebates and federal incentives for energy efficiency and sustainability projects.

**Advisor:** Kate Zettl, UPMC Center for Sustainability

**Climate Inventory and Targets**
Gather energy, water and greenhouse gas emissions data associated with the top UPMC hospitals to help track progress to meeting ambitious environmental targets. Assist in the evaluation of top energy-consuming buildings and opportunities to reduce energy across the portfolio, including utilizing smart building technologies and data analysis tools.
**Advisor:** Kate Zettl, UPMC Center for Sustainability

**Novel 3D Printing for Efficient Composites Manufacturing**
Ceramic matrix composites (CMCs) have broad applications in critical industries such as aerospace and automobile. Traditional CMCs manufacturing processes involve multiple sequential steps and processes which are time-consuming and energy-consuming. The objective of this project is to develop a novel 3D printing system that can streamline the fiber deposition and matrix printing processes to print high-performance CMCs.
**Advisor:** Xiayun Zhao, Mechanical Engineering and Materials Science

**Lean Additive Manufacturing of Multi-material Photopolymers for Soft Robotics Applications**
Photopolymerization-based additive manufacturing technologies would typically adopt material switch-over mechanisms to fabricate complex multi-material components. This, however, requires tedious re-alignment and cleaning between each change of material, leading to excessive consumption of time, energy and material and disposal of wastes. In this project, we will harness the wavelength selective photopolymerization (WSP) mechanisms to realize rapid, continuous multi-material photopolymer based lean additive manufacturing of multi-material polymeric parts and demonstrate it by printing soft robotics for interesting applications.
**Advisor:** Xiayun Zhao, Mechanical Engineering and Materials Science