UNIVERSITY OF PITTSBURGH

Mascaro Center for Sustainable Innovation

2019 Undergraduate Summer Research Projects

Reducing Emissions - Fuel Consumption Reduction Technologies for Pittsburgh Port Authority Buses
This projects involves the parametric study, using ANSYS CFX, of various integrated thermoelectric generator designs, to maximize the capture of waste heat from exhaust gas, and subsequent conversion to electrical power of Pittsburgh Port Authority buses, to minimize fuel consumption and emissions.
Advisor: Matthew Barry, mechanical engineering & materials science

Silk-based flexible/wearable electronics: towards sustainable fabrication and materials engineering
In this project, silkworm cocoons are processed in order to produce regenerated silk fibroins, which are cast into thin flexible, transparent and degradable films. These films are then treated chemically and/or thermally in order to control the protein secondary structure of regenerated fibroins as a means of tailoring their properties for use in flexible and transient electronics. Carbon nanotube-silk composites are also created by adding nanotubes to silk fibroins in order to create flexible films with improved mechanical and chemical properties.
Advisor: Mostafa Bedewy, industrial engineering

Energy-efficient synthesis of carbon nanotubes by rapid thermal chemical vapor deposition
In this project, carbon nanotubes are synthesized by a unique rapid thermal chemical vapor deposition reactor that is custom-designed to enable real-time monitoring of the height kinetics of the growing nanotube structures. Combining automated image processing with 3D microscopy enables studying the successive stages of growth and paves the way for optimization of process parameters such as temperature and gas flow rates in the reactor.
Advisor: Mostafa Bedewy, industrial engineering

Laser-induced graphene: towards understanding proximity effects in patterned graphitization of polymers
In this project, a fast and energy efficient process for creating patterned graphene-based materials is studied. This process is based on using laser rastering on commercial polymers such as polyimide in a direct-write fashion. A mechanistic understanding of limitations to feature size, spacing, and pattern geometry will be studying through a combination of experiments and mathematical models.
Advisor: Mostafa Bedewy, industrial engineering

Developing energy audit features of smart phones
This project tests the capability of existing smart phone sensors to provide first-order estimates of building envelop efficiencies.
Advisor: Mike Blackhurst, university center for urban and social research

Validating citizen science tools used to identify lead water lines
This project will collect and test data complied using *Leaducated*, a web-based app that helps users determine if they have a lead water line.
Advisor: Mike Blackhurst, university center for urban and social research

Additively manufacturing layered structures and characterizing magnetocaloric properties of for high efficient magnetic refrigeration
By using advanced additive manufacturing, this project will be focused on advancing magnetic refrigeration via layered structures with high delta T.
Advisor: Markus Chmielus, mechanical engineering & materials science

Ni-Mn-Ga magnetic shape memory alloys for power generation applications
Magnetic shape memory alloys can be deformed to produce a changing magnetic field that could then be used to produce power for self-powering building monitoring in locations where vibrations are present.
Advisor: Markus Chmielus, mechanical engineering & materials science

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 & computer engineering

Chemical semantics and its implications on environmental transport, fate, and toxicity
When is a chemical considered a material, and when is a material considered a chemical? The answers to these questions are more than just semantics, they have implications for how we model and determine the transport, fate and toxicity of substances in the environment and in living organisms. This project will begin to tackle these questions by (i) identifying candidate chemical-material classes (e.g., monomers ↔ polymer ↔ plastic), (ii) establish critical properties (e.g., size/molecular weight, solubility, bioavailability), and (iii) conduct preliminary experiments to validate parameters and quantify transition points for the identified candidate classes.
Advisors: Leanne Gilbertson and Carla Ng, civil & environmental engineering

The rise of diversity in academia: How did it emerge and how do we promote future growth in STEM fields?
This project will draw on cutting edge network science to analyze the emergence and current state of diversity within the network of higher education, focusing initially on gender and ethnic diversity and the engineering field within STEM. This project is ideal for someone interested in gaining a transferable skillset, someone who enjoys learning about other people, has good communication skills, and is interested in learning more about diversity in higher education.
Advisors: Leanne Gilbertson and Carla Ng, civil & environmental engineering

Small & Mighty: Exploring nature to identify bacteria capable of degrading a new generation of environmental contaminants
This project will involve identifying and isolating bacteria from the environment capable of degrading emerging contaminants that will inspire future bioremediation strategies.
Advisor: Sarah Haig, civil & environmental engineering

Structural Design with Bamboo
Dr. Harries is presently leading the effort to develop an international standard for design with bamboo (ISO 22156). As a result, there are multiple opportunities for self-contained research studies which will have a direct and immediate benefit on this standard! Projects include study of test methods for shear, bamboo connection methods, creep, and durability. Architecture students or those taking the Architecture Minor would have the opportunity to design bamboo structures.
Advisor: Kent Harries, civil & environmental engineering

Capturing and storing energy from hurricane waves with a piezoelectric device
This project will involve ordering materials and constructing a piezoelectric + battery prototype, then performing experiments with the prototype in a small wave pool to check for electrical conversion. I'm looking for a student in mechanical or civil engineering who enjoys prototyping and performing experiments.
Advisor: Katherine Hornbostel, mechanical engineering & materials science

Capturing carbon dioxide from the ocean with a membrane device
This project will involve performing experiments with small capsules in fake ocean water to test their rate of carbon dioxide absorption. I'm looking for a student in mechanical or chemical engineering who enjoys performing experiments and analyzing data.

Advisor: Katherine Hornbostel, mechanical engineering & materials science

Reducing frictional energy losses in transportation and industry: Surface coatings and the effect of surface roughness on friction

Because roughly 8% of all energy used in the US is wasted overcoming friction and wear; this project helps to remedy this by experimentally investigating friction and surface topography in advanced diamond-based surface coatings for commercial and industrial equipment.

Advisor: Tevis Jacobs, mechanical engineering & materials science

Using acoustic sensors and machine learning to locate birds and bats in the field

We're looking for assistants to help us with our ongoing field research, which uses acoustic recording devices to record bird and bat calls throughout western Pennsylvania. We'll be deploying and retrieving the recording devices, using machine learning models to identify what species are present in the recordings, and analyzing the data to determine what environmental factors determine which species are found in the recordings.

Advisor: Justin Kitzes, Department of Biological Sciences

Durable Antireflective, Anti-Soiling and Self-Cleaning Solar Glass

Students will create new glass surfaces that may help improve the efficiencies of solar panels. Students will create new surfaces that are antireflective across a wide variety of wavelengths and incidence angles. Students will also create new glass surfaces that prevent particulates from accumulate and remove those particulates easily. https://www.youtube.com/watch?v=F4PPetsqRxg&t=1s

Advisor: Paul Leu, industrial engineering

Simulating First Solar Cadmium Telluride Solar Cells

Student will simulate Cadmium Telluride thin film solar cells that are currently being manufactured by First Solar. Students will have an opportunity to work with First Solar, the largest manufacturer and recycler of solar panels in the United States. Students will attempt to reproduce reported solar efficiencies by the company and then explore new concepts that may offer improvements to efficiency.

Advisor: Paul Leu, industrial engineering

New materials to enable radical electrification of the commodity chemical industry

This project centers on the use of electrochemistry to supply renewable electricity as the energy input for industrially relevant hydrogenation reactions. The student working on this project will be tasked with synthesizing and measuring the chemical properties of metal oxide compounds that we plan to use as catalysts in this brand new type of electrochemical hydrogenation reactor.

Advisor: James McKone, chemical & petroleum engineering

Designing new ways to test the performance of large-scale battery technologies

We are developing new experimental methods that can be used to understand the performance characteristics of a potentially revolutionary new type of energy storage technology called the redox flow battery. Work on this project will involve the design and construction of an electrochemical flow reactor that can be used to measure reaction kinetics of these batteries under real-world operating conditions.

Advisor: James McKone, chemical & petroleum engineering

Smarter Riversheds – real-time sensor networks

Advisor: David Sanchez, civil & environmental engineering

Combined sewer overflows result in over 9 billion gallons of sewer/storm water flowing into Pittsburgh's rivers each year. Identifying water-quality trends in real-time is essential to solving this problem projected to cost over $3billion for Pittsburgh. With many cities across the US facing this challenge, this project focuses on triangulating historical, historical, and grab sample water quality data to understand water quality dynamics in real-time and to evaluate Green infrastructure. Student will gain experience in environmental sampling, analytical chemistry techniques, and data analysis using unsupervised learning techniques.

Recirculating Aquaculture – managing water quality in Land-based containment system to grow fish.
Advisor: David Sanchez, civil & environmental engineering
In Recirculating Aquaculture systems there are various factors that govern the health of the fish and the sustainability of its process. This project will focus on identifying governing design parameters (water quality, species, lighting, feed conversion ratio, recirculation rate, treatment process etc.) to identify strategies that optimize fish quality and reduce environmental and economic impacts.

Wind Prediction over Complex Terrain
Perdigao Field Experiment was conducted in 2017 to provide extensive data to validate and assess the accuracy of computational fluid dynamics based wind models for complex terrain. A complex terrain wind solver with a large-eddy simulation technique will be applied for various atmospheric stability conditions and wind directions to assess its predictive capability in capturing flow recirculation.
Advisor: Inanc Senocak, mechanical engineering & materials science

Campus-Wide Sustainability Dashboard
Investigations, recommendations, and analyses across equity, environment, and economic facets related to the University of Pittsburgh's Oakland campus (at both the building and campus scales) and considering communications and behavior change opportunities.
Advisor: Aurora Sharrard, Director, University Office of Sustainability
Faculty collaborators: Drs. Melissa Bilec & Michael Blackhurst, plus interactions with Pitt Facilities Management

Increasing the Structural Resilience of Reinforced Concrete through Bio-Remediation
Reinforced concrete is susceptible to a range of damage from long-term environmental exposure including corrosion and spalling resulting from chloride attack and/or carbonation and cracking resulting from repeated freeze/thaw cycles and/or shrinkage. This research will focus on increasing the long-term durability and resiliency of reinforced concrete through the use of bio-remediation. Of specific interest here is evaluating the feasibility of using bacteria, fungi, and/or archea to metabolize unwanted substances which result in the corrosion of reinforcing (e.g. Cl^- and CO_2), and to provide self-healing properties to prevent water ingress through temperature, shrinkage and/or structural cracking.
Advisor: Max Stephens, civil & environmental engineering

Making more with less: "Greening" the process industry via process intensification
Almost a hundred years after its inception, the specialty chemicals industry is still almost exclusively using large-scale batch reactors for manufacture of their products. However, an increasing awareness of the multitude of advantages of using continuous processing – including less energy consumption, reduced waste production, improved process safety, and drastically reduced footprint – is starting to change minds in this industry. In close collaboration with an industry partner, we are exploring the batch-to-continuous transition for the production of a dispersant product. The project involves a broad scope of efforts, including experimental and computational studies of mixing, reaction, and separation steps.
Advisor: Goetz Veser, chemical & petroleum engineering

Going with a Bang: Cavitation reactors as highly efficient concept for production of specialty chemicals
Cavitation reactors (CR) are a potentially highly efficient, but to-date much underutilized reactor concept. In a CR, a localized pressure gradient is created (typically through hydrodynamic shear forces) which results in the formation and eventual collapse of small bubbles throughout the liquid. The implosion of these bubbles results in very efficient localized heating and mixing and hence promises strong improvements in the efficiency of liquids processing. In this project, we are exploring CR for reactive processing of highly viscous mixtures with the aim of reducing energy intensity and improving product quality (hence reducing waste).
Advisor: Goetz Veser, chemical & petroleum engineering

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What the Frack: Designing nanocatalysts for responsible use of natural gas
Shale gas is both an economic opportunity and an environmental threat. In order to assure a resurgence of a cleaner, more efficient and environmentally responsible domestic chemical industry, novel concepts for natural gas utilization (beyond combustion and the use of "crackers") are needed. Specifically, we are exploring the use of microwave-based processes to upgrade methane to aromatics in a drastically more efficient way. As a critical step in that direction, we are investigating the design of nanostructured catalysts to enable such microwave based processes, i.e. how careful "nano-design" of catalysts can render a material a good candidate for microwave catalysis.
Advisor: Goetz Veser, chemical & petroleum engineering

3D printing of graded alloys for sustainability improvement in fossil fuel engineering
The project will apply additive manufacturing technique to build graded alloys for steel and Ni superalloys, which will improve the functionality of the structural materials. The application is for the fossil fuel power plant. However, such a technique is of the highest interest in the aerospace industry. This project aims to design a strategy of the additive manufacturing process for the graded structure alloys through the Materials by Design technology. Experiments will be focused on studying process-structure-property relationships of the 3D printed alloys. The expected results would contribute to an existing funded project through DOE-NETL (Department of Energy-National Energy Technology Laboratory), and will further push the technology boundary of additive manufacturing. Through this project, students will learn more about the practical application of materials science in advanced manufacturing design.
Advisor: Wei Xiong, mechanical engineering & materials science

Post-processing design on superalloys by additive manufacturing for NASA space technology missions.
It is not that easy to print everything in Mars or Moon. Therefore, NASA is looking for a chance accelerating the insertion of additive manufacturing alloys for the space missions. The project will consider NASA as the client designing post-processing of Inconel 718 superalloys after additive manufacturing. This requires a good understanding of process-structure-property-performance relationships in additive manufacturing 718 alloys. The project aims to develop the optimized post-processing for Inconel 718 alloys after laser melting. The expected results would contribute to an existing funded NASA project, which will lead to standard processing of Inconel 718 for NASA space technology missions. Through this project, students will learn more about the practical application of materials science in advanced manufacturing design.
Advisor: Wei Xiong, mechanical engineering & materials science

Graphene-based composite materials for high performance thermoelectric devices
The goal of this project is to develop composite materials in order to enhance thermoelectric effects.
Advisor: Minhee Yun, electrical and computer engineering

Developing a novel photopolymer based additive manufacturing machine (3D Printer) for high-resolution applications
The goal of this project is to develop a novel precision mask projection vat photo-polymerization additive manufacturing process which can print high-resolution micro structures with super dimensional accuracy that cannot be achieved with existing commercial vat photopolymreization AM machines.
Advisor: Xiayun Zhao, mechanical engineering & materials science

Real time measurement and control for directed energy deposition (DED) based metal additive manufacturing
The goal of this project is to develop an in-situ sensing and measurement system on a commercial metal additive manufacturing (3D Printing) machine for monitoring part dimensions online, and to explore the approach of feedback control to adjust the process parameters on the fly for correcting the printed parts dimensions in real time fashion.
Advisor: Xiayun Zhao, mechanical engineering & materials science