FROM THE LAB

Current Research at Cooper

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SUSTAINABILITY

In-stream Kinetic Hydropower Generation from Slow-moving Waters

Catherine Wolfe CE'17

ADVISOR: PROFESSOR JAMEEL AHMAD

This project describes ongoing research on a system patented by Professor Jameel Ahmad relating to a power generation flume for use with water flow channels that include an acceleration zone where a turbine system can be used to generate power in a cost-efficient manner. The flume can have a variety of dimensions and can be used at multiple locations along or across the flow channel without affecting upstream flow conditions. The in-stream, kinetic hydropower system can be used to generate power from slow- moving waters such as irrigation canals or tailraces, a water channel leading away from a dam or mill.

Energy-efficient Propulsion of Robotic Boats in Oceanic Flows

Samuel Cavas ME'17, Sai Chikine ME'17, John Donnellan ME'17, Ryan Yun ME'17, Nikhil Iyengar ME'18, Cristian Lacey ME'18, David Shekhtman ME'16/MME'18

ADVISORS: PROFESSOR DIRK M. LUCHTENBURG, PROFESSOR PHIL YECKO

The goal of this project is to develop robotic boats that use flow sensors to efficiently navigate the ocean using a minimum amount of energy. To this end, an experimental infrastructure is being developed including a flow tank, flow visualization system, model boats and a control system. A set of pumps has been adapted to create realistic currents, which are visualized by tracer particles and recorded by an overhead camera. Currently, small autonomous boats are designed and tested.

Distributed Algorithms for Reducing Traffic Congestion Using Social Network Data

Ihsan Gunay EE'18

ADVISOR: PROFESSOR ANITA RAJA

"Selfish routing" is a mathematical model used by transportation scientists to estimate routes that self-interested drivers take through traffic. Selfish routing decisions are known to cause congestion in transportation networks. We have developed a novel distributed- traffic coordination framework to alleviate traffic congestion that leverages real-time traffic data from a social network. We have performed an extensive experimental study of the effectiveness of our algorithm and utility computation mechanism for route choice to reduce traffic congestion for various road network structures including those that have been shown to result in classic traffic flow paradoxes.

Reinventing Household Refrigeration

Greg Loibl ChE'94, Mike Gutierrez ChE'09
ADVISOR: PROFESSOR GEORGE SIDEBOTHAM
Conventional household refrigerators are ubiquitous, yet they are "energy stupid." They act as electric heaters in the summer and require electricity to maintain the cold space during winter. They switch on and off several times an hour. Finally, the cold spaces are constrained to be in one of two compartments (freezer and refrigerator). The long-term goal of this project is to develop engineering systems that address these energy-related characteristics, with full recognition that acceptance of a fundamentally different approach to refrigeration will require a paradigm shift.

Life Cycle Assessment of Menstrual Products

Chae Jeong ChE'16, Josephine Chen ChE'16
ADVISOR: PROFESSOR BENJAMIN DAVIS
To mitigate waste generated by disposable feminine hygiene products, women have opted for more viable alternatives such as menstrual cups and sea sponges. A life cycle assessment (LCA) can be used to verify the claimed environmental friendliness and economic attractiveness of such products by tracking the manufacturing process from the raw materials to packaging stage ("cradle to gate"). In this LCA, the environmental impact and economic burden of tampons and menstrual cups were evaluated over three time periods: five days (menstruation), one year, and five years. The menstrual cup proved to be a significantly more environmentally and economically responsible alternative.

Synthesis of a Separation System for OCM Reactor Effluent

Kenneth O'Neill ChE'16
ADVISOR: PROFESSOR BENJAMIN DAVIS
This project proposes one method for separating ethylene from oxidative coupling of methane (OCM) reactor effluent. The proposed system consists of two flash tanks and four distillation columns that serve to purify polymer-grade ethylene and reactor recycle. Using this method, a large percentage of the methane enters the separation train and results in an ethylene distillate that is 99.481% pure with a bare module cost of approximately $3.3 million.

Measuring Elevator Efficiency

Anthony Assal MME'17
ADVISORS: PROFESSOR ROBERT DELL, PROFESSOR C. S. WEI
There has been substantial recent research in elevator efficiency and regeneration technology. The Center for Innovation and Applied Technology (CIAT) has been researching and writing conference papers on this subject for several years. In order to accurately measure elevator efficiency there must be a direct link between the energy consumption metering devices and the elevator positioning systems. This project is developing a standalone unit that can be located by the elevator motor and determine what floor the elevator is on without interfering with the elevator system's integrity. This saves substantial regulatory compliance while ensuring data accuracy needed for precise measurements.

Modal Analysis of a Mysticete Tympanic Bulla (Balaenoptera physalus) Using Finite Element Methods

Jay Dalal MME'17
ADVISORS: PROFESSOR ROBERT DELL, PROFESSOR C. S. WEI
It is well established that whales can navigate with their own internal sonar system. Their ears can be significantly damaged by modern sonar. By completing an analysis of the tympanic bone and by creating mathematical models of the geometry, there is the potential to increase the efficiency of sonar technology while acquiring a better understanding of the whale's navigation system. Finite element analysis, enhanced CT scans, 3D printing, and vibration analysis techniques will be used in this research.

Patented Thermoelectric Generator

Iceland Study Abroad students
ADVISORS: PROFESSOR ROBERT DELL, PROFESSOR C. S. WEI, NICHOLAS MITCHELL
The Center for Innovation and Applied Technology (CIAT) is continuing to develop its patented thermoelectric-based point of use generator with no moving parts that produces more than 6W of steady state power when attached to the outside of a steam pipe. The system has powered LED lights and a web interfaced video surveillance system while simultaneously trickle charging 12 V 7000 mAh batteries. The generator is now powering robots. NASA has filed a notice of interest in this invention because it appears to "have significant utility in the conduct of aeronautical and space activities."

Heated Gardens

Iceland Study Abroad students
ADVISORS: PROFESSOR ROBERT DELL, PROFESSOR C. S. WEI, NICHOLAS MITCHELL
The Center for Innovation and Applied Technology (CIAT) has developed a thermally enhanced open field heating agricultural system using waste geothermal hot water in Iceland and waste steam in New York City. Plant growth is enhanced by up to 30% and out-of-region cultivars are able to grow outside in climates that are normally too cold. Our students have grown banana plants in the Icelandic summer and produced a small cotton harvest in New York City. The Center has written numerous award-winning papers about this ongoing research.

Optimizing Cogeneration Heat Recovery

Soyoung Moon ME'17, Joseph Viola ME'16
ADVISOR: PROFESSOR MELODY BAGLIONE
Cogeneration or combined heat and power (CHP) is the use of a heat engine to simultaneously generate electricity and useful heat. Power plants produce electricity but reject waste heat to the atmosphere and have grid losses. By using on-site cogeneration instead of buying electricity from the utility, efficiency is increased from around 40% to 80%. The 250 kW and 150 kW cogeneration plants at 41 Cooper Square and the Foundation Building save The Cooper Union around $130,000 annually. By analyzing sensor data and developing analysis tools, students have identified ways that CHP may save an additional $200,000 annually. The goal is to work with facilities and vendors to implement changes and optimize the cogeneration systems.

Laboratory Ventilation Energy Conservation Measures

Tony Zhao ME'17, John Han MME'16

ADVISOR: PROFESSOR MELODY BAGLIONE

One of the largest sources of energy consumption in an academic research building is the laboratory ventilation systems. Laboratories require extra ventilation compared to classrooms and offices to maintain a safe environment. This project analyzes the laboratory ventilation system of 41 Cooper Square and investigates opportunities for reducing energy usage and costs. Computational fluid dynamics is applied to study the effects of reducing laboratory air change rates and fume hood face velocities on safety. Additional energy savings could come from monitoring fume hood usage and decommissioning unused fume hoods as well as optimizing laboratory exhaust fan operation.

Building Energy Analytics

Zhengqi Xi ME'17

ADVISOR: PROFESSOR MELODY BAGLIONE

Buildings consume about 40% of total U.S. energy usage. Modern buildings utilize building management systems to control and monitor mechanical and electrical equipment, such as ventilation, lighting, and heating and cooling systems. Over time these systems do not always work as intended due to unforeseen factors such as human intervention and maintenance related issues. The goal of this project is to design a system at 41 Cooper Square that gathers building data, such as occupancy, hourly energy consumption, and lighting usage for comparison against an energy model to highlight energy saving opportunities.