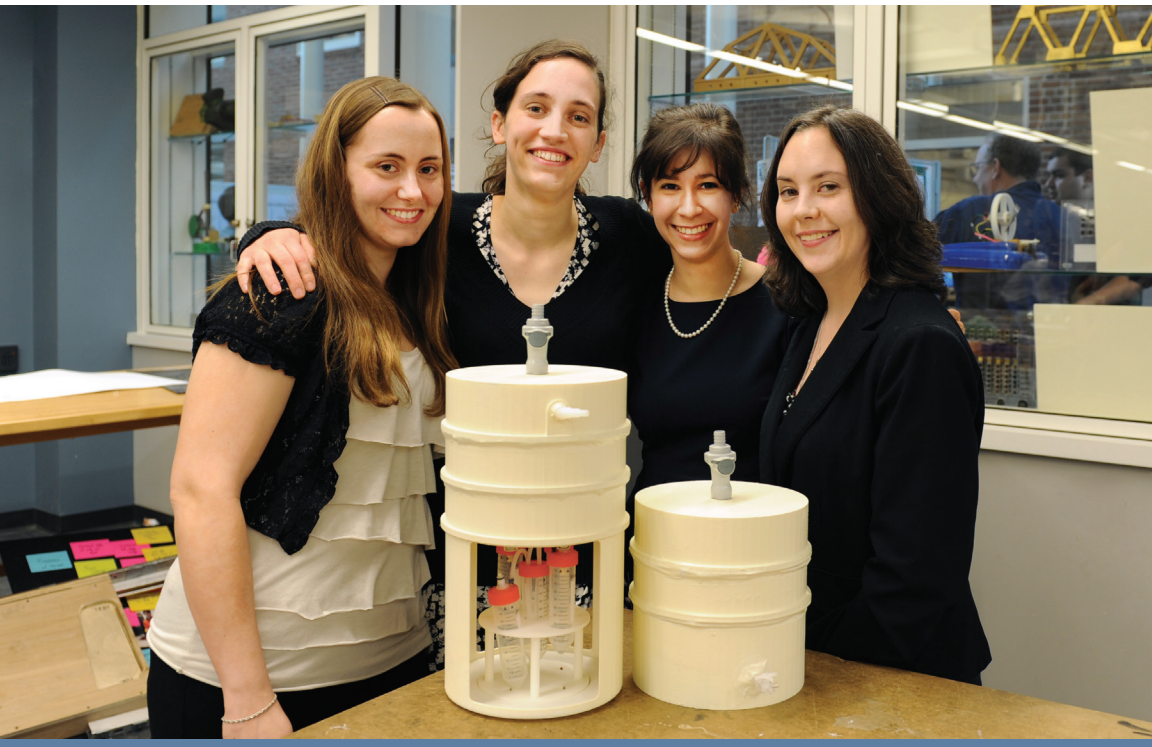
THAYER SCHOOL OF
ENGINEERING
AT DARTMOUTH

14 Engineering Drive
Hanover, NH 03755

engineering.dartmouth.edu

COOK ENGINEERING DESIGN CENTER



2012–2013

STUDENT PROJECTS

THAYER SCHOOL OF ENGINEERING AT DARTMOUTH

Cook Engineering Design Center is named for innovator and entrepreneur John Brown Cook '29, an early leader in the telephone industry and a Thayer School Overseer from 1969 to 1975. His widow, Marian Miner Cook, endowed the Cook Engineering Design Center to honor his advocacy for technological creativity in engineering education.

COVER
Left to right, Taylor Gray, Jennifer Freise, Pauline Schmit, and Alison Stace-Naughton with the Micro-flora Isolation for Fecal Microbiota Transplantation prototype they created with Sharang Biswang (missing from photo).

COOK ENGINEERING DESIGN CENTER

Industry challenges. Student solutions.

The Cook Engineering Design Center (CEDC) is Thayer School's link with the corporate world. The CEDC connects upper-level undergraduates and Bachelor of Engineering students with industry partners to solve real-world workplace challenges through CEDC projects.

For students, CEDC projects are opportunities to think like engineers, using analytical, project management, and communication skills to develop and convey efficient, inventive solutions to practical problems. For sponsors, CEDC projects are opportunities to tap the minds of talented students—and inspire them to bring their technical creativity to the marketplace.

CEDC projects form the focus of Thayer's two-term course sequence Engineering Design Methodology (ENGS 89/90). Devoting between 900 and 1,800 hours to their projects, student teams draw on the expertise of their sponsors, the CEDC staff, faculty advisors and mentors, and the technical staff of Thayer's CAD facility, machine shop, and instrument room. Project work includes professional review cycles, with teams presenting progress reports to panels of practicing engineers and experts. Students also present final written reports to their sponsors.

Project Sponsorship

The CEDC encourages all companies, large or small, to submit clearly defined workplace problems. Each fall, students select the problems they would like to solve. Sponsors contribute $5,000 to Thayer School for the project work and assign a technical liaison with practical experience in the relevant field of engineering to work with the students.

Ideal projects involve the design of a product, process, or system, with deliverables that can be achieved in 23 weeks, including:

- Design analyses, reports, and feasibility studies
- Product prototypes
- Engineering plans and drawings
- Computer programs, manuals, and data
- Manufacturing process plans
- Demonstrations, videos, and presentations
- Financial analyses

To learn more about sponsorship, visit:
engineering.dartmouth.edu/industry/cook/sponsor.html

COOK ENGINEERING DESIGN CENTER

DIRECTOR
Ronald C. Lasky, Professor of Engineering

FACULTY MENTORS
John P. Collier, Myron Tribus Professor of Engineering Innovation
William Lotko, Professor of Engineering

ADMINISTRATIVE ASSISTANT
Shay Cooper

E-MAIL: CEDC@dartmouth.edu

PHONE: 603.646.9197

engineering.dartmouth.edu/industry

2012–2013 SPONSORS

Rick Balakier and Dan Gosselin

Chroma Technology Corporation

Christopher Levey

Class of 1980 and Saint Boniface Haiti Foundation

Craftsbury Outdoor Center

Dartmouth Athletics Facilities

Dartmouth Formula Racing

Dartmouth Organic Farm

Graphicast

Maponics

Norwich Technologies

Optra Inc.

Dr. Joseph Paydarfar

Physical Sciences Inc.

PrintLess Plans LLC

Pureflora Inc.

Keith Muller

Ron Muller

Siege Technologies

Terry Smith

Solaflect Energy

Matt Strand

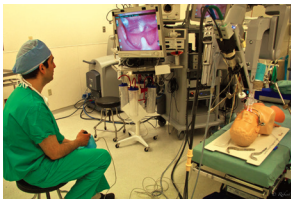
Victor Technologies

Walvisstaart B.V.

Dr. Mitchell Wolf

Dr. Peter Wright

PROJECTS



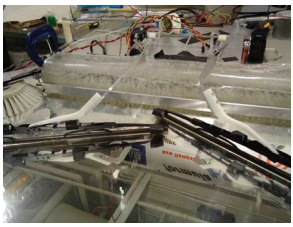
ADJUSTABLE TONGUE RETRACTOR FOR TRANS-ORAL ROBOTIC SURGERY

Robert Collier, Benjamin Cunkelman, David Reuss

Sponsor: Dr. Joseph Paydarfar, Dartmouth-Hitchcock Medical Center

Faculty Advisor: Ryan Halter

The daVinci surgical robot allows a surgeon to operate precisely and remotely where conventional instruments cannot reach. When using it to operate through a patient's mouth ('Trans-Oral Robotic Surgery' or TORS) to access the back of a patient's throat, the surgeon must be able to compress the patient's tongue along the bottom jaw and away from the surgical site. State-of-the-art tongue retractors lack freedom of motion and obstruct access to the surgical site. We concluded that the optimal solution is an automated tongue retractor that can be adjusted remotely from the surgical console. We produced three prototypes and tested them at DHMC with Dr. Paydarfar using the device on a throat mannequin. We plan to pursue this project with him and apply for a patent.



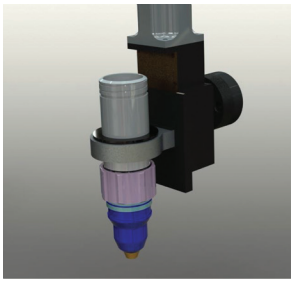
AUTOMATED CLEANING OF MIRRORS ON A SUSPENSION HELIOSTAT

Thomas Balch, Ben Blier, Alyson Pickett, Callen Votzke

Sponsor: Solaflect Energy

Faculty Advisor: Minh Phan

Solaflect Energy has designed a novel heliostat (a mirror array used in solar-thermal power) that supports the component mirrors with cables in suspension rather than using a steel truss. The current method for cleaning a suspension heliostat is by hand. Solaflect asked us to develop a proof-of-concept automated cleaning system that can navigate and clean mirrors without damaging support cables. We built a robot that can drive along a row of mirrors and navigate around poles placed where cables attach. The robot also can scrub and clean mirrors as effectively as cleaning by hand in 1/15th the time. Using our custom reflectance sensor, we showed that the robot substantially improves the reflectiveness of the mirror panels after only a single pass.



TORCH HEIGHT CONTROL FOR ROBOTIC PLASMA CUTTING

Joey Anthony, Stephanie Crocker, Wiley Dunlap-Shohl, Jacob Wolf

Sponsor: Victor Technologies

Faculty Advisor: Douglas Van Citters

The requirement that a plasma torch must be maintained at a specified distance (torch standoff height) from the work piece is problematic when the work piece is non-planar. Our sponsor wants to make torch height controlled plasma-cutting systems compatible with multi-axis robotic arms. We designed and fabricated two prototype iterations capable of producing quality cuts with a live plasma arc. Testing showed that the device meets the sponsor's requirements, and the team expects that, with minor adjustments to the design, the torch height control mechanism will be ready for manufacture.

SPINNING, HANGING KITCHEN UTENSIL RACK

Natalie Miliano, Brittany Mills, Deidra Willis

Sponsor: Keith Muller

Faculty Advisor: Peter Robbie

Our sponsor began with a proposed design and preliminary prototype for a spinning, hanging kitchen utensil rack. The focus of this project was to optimize the design of the product to best eliminate kitchen clutter, and modify the design for manufacturability to reduce production costs while retaining product quality. We completed all deliverables by developing a final optimized design for the kitchen rack, a finished prototype of the design, and a detailed manufacturing plan that minimizes production costs.

BRINGING BACK THE ICE HOUSE

Nii Tettey Addy, Matthew Heffley, Laura Kier, Akwugo Nnama, Lucas Sanford-Long, Richard Waitumbi

Sponsor: Craftsbury Outdoor Center

Faculty Advisor: Mark Laser

Craftsbury, an outdoor recreation center and athletic training facility that uses and teaches sustainable practices, wants a low-cost and energy efficient passive refrigeration system for a new walk-in cooler. We constructed an 8′ x 12′ x 8′ ice house prototype to test two heat-exchange design alternatives. The first involved an aluminum sheet with fans on either side to provide forced convection across the sheet to cool the food-room air and warm the ice-room air. The second involved direct air exchange between the food and ice rooms using automated fans. Based on testing, we recommended the second system. Due to concerns of mold growth in a direct air-exchange system, we also recommended that the client test both systems under summer conditions. Compared to a commercial cooler of comparable size, the internal rate of return obtained from costs saved by the adoption of the ice house is more than twice Craftsbury's desired 6.5 percent rate of return.

CONVERSION OF LIQUID PAINT TO DISPOSABLE WASTE PRODUCT

Isabelle Caffry, Emily Cummings, Alan Salas

Sponsor: Dartmouth Athletics Facilities

Faculty Advisor: Mark Laser

Dartmouth Athletics Facilities (DAF) repaints the lines on the grass and turf fields each week with latex paint. Washing the marking machines over a gravel pit generates 40–50 gallons of waste paint water per machine. Over time, water and paint sludge build up in the pit. Every two years the pit is dredged, allowed to dry, and replaced for approximately $3,000. The high cost and waiting time caused DAF to seek an alternative solution. Our design incorporates chemical, mechanical, and procedural changes. Washing the tank and immediately removing the water reduced wastewater to 7–8 gallons per washing. The wastewater is moved to a 60-gallon barrel, which is treated when full. Crushed moringa seeds are added to cause the paint to fall out of suspension. After 18 to 24 hours, psyllium husk powder is added to form a gel that prevents the paint particles from resuspending during water removal. The design removes up to 98 percent of the paint. The water can then be disposed down the storm drain. The solution can save $1,063 annually after an initial equipment cost of $204.

MANUFACTURING AND BUSINESS PROCESS OPTIMIZATION

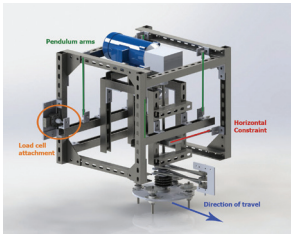
Dave Connolly, Brenden Hedblom, Shiv Kapur

Sponsor: Graphicast

Faculty Advisor: Ron Lasky

Graphicast needed a model capable of measuring its production capacity and determining when and what changes will be needed to meet future customer demand. We constructed a current-state value-stream map to quantify the path of an average part through casting, machining, and packing. We determined that machining was the constraint in part production and that the labor utilization rate had the largest impact on capacity. We concluded that standardizing cleanup at the end of each machining shift would be the most effective change. We developed and implemented a chart outlining four scenarios with unique cleanup instructions. After implementation, Graphicast collected four weeks of data and found a projected increase of 1,300 parts per year. We also developed a robust value-stream model in Excel that will allow Graphicast to easily perform similar analyses in the future.

PROJECTS



WALVISSTAART PROPULSION SYSTEM

Ethan Dreissigacker, Austin Duncanson, Bernie Roesler, Ellen Roy, Justin Samuels, Sam Williams

Sponsor: Walvisstaart B.V.

Faculty Advisor: Brenden Epps

Rising fuel prices and environmental concerns have incentivized research of efficient marine propulsion systems. Taking cues from fish and other marine life, flapping foil propulsion shows promise to significantly increase fuel efficiency. Walvisstaart's flapping foil propulsion system is designed for vessels more than 100 meters long. We investigated the viability of a Walvisstaart-style system for commercial fishing boats between 10 and 20 meters long. The primary deliverable was a functional, scale-model prototype of such a design. We developed a computer model of the Walvisstaart system and used it to design a prototype. We measured thrust and torque created by our device at various advance coefficients, and used these data to calculate the characteristic non-dimensional parameters of a Walvisstaart system. Both our theoretical and computational models agree that a Walvisstaart-style propulsion system can achieve higher hydrodynamic efficiencies than a conventional screw propeller.

HOT-WIRING OF THE FUTURE: EXPLORING CAR CAN BUSSES

Chris Hoder, Theodore Sumers, Grayson Zulauf

Sponsor: Siege Technologies

Faculty Advisor: Sergey Bratus

Cars' electrical systems have evolved into complex networks of sensors and microprocessors, referred to as Electronic Control Units (ECUs). A typical modern car contains between 50 and 70 ECUs, which communicate with each other over the car's Controller Area Network (CAN) bus using the mandated CAN protocol standard. Siege Technologies believes malicious parties could exploit these unauthenticated intra-vehicle networks, and thus sponsored our early-stage research into the security flaws present in cars' CAN busses. Our deliverables were a proof-of-concept demonstration of vulnerabilities in CAN networks by compromising one or more safety-critical car systems, a methodology for uncovering and exploiting security weaknesses in the CAN bus of any vehicle, and a software package to implement that methodology on any vehicle. We purchased a 2004 Ford Taurus, reverse-engineered the manufacturer-specific protocols used on its CAN bus, developed hacks on safety-critical ECUs, and produced a generalized methodology for characterizing and exploiting a vehicle's CAN bus. As we designed experiments, we developed the software to implement them. The final result is an intuitive interface allowing the user to view, store, and analyze raw CAN data, quickly implement our experimental methodology, and use our code base to implement their own vehicle-specific hacks.

BOTTOM BOTS MARINE BIO-FOULING REMOVAL TOOL

Kayla Davidson, Laura King, Thomas Mattimore, June Shangguan, Laura Woodman

Sponsor: Matt Strand

Faculty Advisor: Christoher Levey

Bio-fouling on submerged surfaces increases drag, reducing the speed and maneuverability of boats and increasing fuel consumption. Current cleaning methods are expensive, harm the environment, and are being banned or outlawed in an increasing number of areas. The Bottom Bots aims to fulfill the need for a less costly environmentally friendly method of preventing fouling buildup with an automated cleaning robot. The Bottom Bots adhere to the boat hull, cleaning the hull while collecting the extra algae through suction. They are remote controlled and portable. They target early, easily removed bio-fouling growth before barnacles and more mature growth can occur.

MICROFLORA ISOLATION FOR FECAL MICROBIOTA TRANSPLANTATION

Sharang Biswang, Jennifer Freise, Taylor Gray, Pauline Schmit, Alison Stace-Naughton

Sponsor: Pureflora Inc.

Faculty Advisor: Karl Griswold

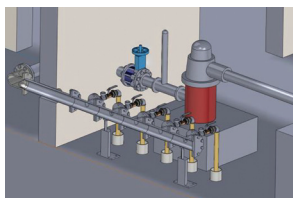
Clostridium difficile (*C. diff*) is an infectious intestinal pathogen. At its worst, it is drug resistant, highly virulent, and potentially deadly. Fecal Microbiota Transplantation (FMT), can harness the power of the body's naturally protective microbiome against the toxic effects of *C. diff*. In FMT, a healthy donor provides a stool sample, which is homogenized into a liquid and administered to the infected patient via enema or colonoscopy to bring *C. diff* under control. Our sponsor aims to bring FMT to the mainstream clinic by introducing a novel collection and isolation system that will optimize the process within a closed environment, mitigate cleaning difficulties, and reduce human exposure to fecal pathogens. Our deliverable separates viable bacteria from the insoluble waste in stool within a closed system and interfaces with last year's Engineering Sciences 89/90 homogenization device. This device will package its fluid product, which will be compatible with a multitude of delivery systems, including enema bag, colonoscopy, and gel encapsulation. We completed two works-like and looks-like prototypes. The first module is engineered for immediate use in FMT procedures, delivering the final product into a luer-lock syringe that interfaces with colonoscopy and enema delivery systems. The second module delivers the liquid into a set of standard Falcon tubes for use in centrifugal concentration and storage for use in later procedures or research.

COST-EFFECTIVE WATER PUMP FOR FOND DES BLANCS, HAITI

Robert Cholnoky, Kevin Dahms, Robert Moss, Annie Saunders

Sponsors: Class of 1980 and Saint Boniface Haiti Foundation

Faculty Advisors: Jack Wilson, Douglas Van Citters



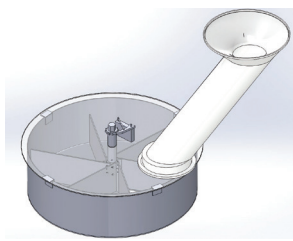
The community of Fond des Blancs, Haiti, needs a reliable and cost-effective pump system for their gravity-fed water distribution network. Through discussion with SBHF, a site assessment trip, and analysis, we identified addressing the pump as the best strategy. We designed a solar-energy-powered pump system to run in parallel with the existing diesel system. Using five solar pumps in parallel will reduce operating and maintenance costs while increasing redundancy and therefore the entire system's reliability.

REINVENT THE TOILET

Kristina Blazanovic, Jenna Hobeika, Katy Hwang, Kento Momma

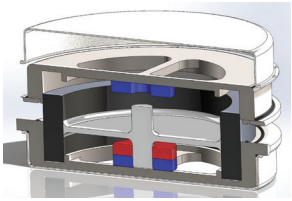
Sponsor: Dr. Peter Wright, Dartmouth-Hitchcock Medical Center

Faculty Advisor: Vicki May



Haitians need a low-cost, waterless, simple latrine that eliminates common pathogens, particularly *V. cholerae*. Specifications for the toilet include rapid on-site processing of waste (within 24 sun hours), capacity to store waste of an average family for one month, and construction utilizing locally available materials. We decided that harnessing solar energy is the optimal means to achieve rapid sterilization. We visited Haiti to collect raw solar and weather data in Cité de Dieu and interview people in Fond des Blancs. In our resultant design, urine is directed into a hole connected to a five-gallon container. A separate hole for feces leads to a PVC pipe down to a circular support plate atop a 20- or 55-gallon container. The circular support plate features six rotating flaps that move each day's waste through a cycle of exposure to sunlight before dropping it into the storage container. Our design achieved and exceeded the ideal temperature of 47°C, above which *V. cholera* is unable to grow, in under 24 sun hours. The units are inexpensive ($192.72), odorless, low maintenance, portable, and easy to use.

PROJECTS



LIGHTWEIGHT VACUUM POWER FLYWHEEL ENCLOSURE

Awais Malik, Cody Engle-Stone, Zachary Kowalski

Sponsor: Ron Muller

Faculty Advisor: Ulrike Wegst

Our deliverables were: SolidWorks models and analyses of viable flywheel and enclosure systems and an optimization and feasibility study of the flywheel and enclosure system. Based on findings regarding measures to effectively contain a flywheel's worst-case failure, our recommended design for the enclosure has two layers: an inner "burst liner"and an outer "pressure vessel." The burst liner acts as a brake in the event of a failure. The pressure vessel surrounds the burst liner and maintains the vacuum inside the enclosure. We designed this redundancy because carbon-fiber flywheels are capable of rapidly dissipating a large amount of energy when they fail, and if any oxygen enters the high-temperature enclosure, an explosive combustion reaction may occur. We developed material selection case studies to justify our choice of carbon-fiber reinforced polymer for the flywheel, low-alloy steel for the pressure vessel, and titanium alloy for the inner burst liner. We created an easily customizable Matlab program that outputs viable flywheel systems, given constraints in system energy, energy per flywheel, mass, volume, maximum rpm, number of flywheels, or specific flywheel dimensions.

NEW RECEIVER DEVELOPMENT FOR CONCENTRATING SOLAR POWER

Utkarsh Agarwal, Jeremy Brouillet, Michelle Burns, Emil Cashin, Chloe Ruiz-Funes, Scott Snyder

Sponsor: Norwich Technologies

Faculty Advisor: Jifeng Lui

Concentrating solar power (CSP) is a promising renewable energy alternative. Parabolic trough technology works by reflecting sunlight from large, parabolic mirrors to a focal line, where a receiver tube absorbs the energy and transmits it via a heat transfer fluid for use in a power cycle or industrial process. Parabolic trough CSP, however, cannot compete in levelized cost of energy with conventional energy technologies due in part to shortcomings in the efficiency and reliability of current CSP receivers. Our sponsor received a grant from the Department of Energy to design a superior receiver for parabolic trough CSP that enables higher heat capture efficiency, operation at higher temperatures, and cost reductions. Working with local engineering firms Creare and ANSYS and our sponsors, we developed a set of new high-performance receiver designs, sought out suitable materials for use in a demanding high-temperature system, and predicted receiver efficiency with optical and thermal modeling.

Image: SkyFuel Inc./U.S. Department of Energy

SPATIAL DATA EXTRACTION SYSTEM

Michael Yinghan Ding, Sofiya Taskova, Zheyang Xie

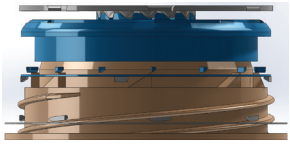
Sponsor: Maponics

Faculty Advisor: George Cybenko

Spatial data mining captures diverse but coherent spatial data from the Internet and organizes them into relevant spatial output. Currently Maponics manually collects spatial data for new products and needs an automated data collection method. We decided that developing customized automated software is the best solution. The software is a complete working prototype that allows users to specify any venue type and attributes, automatically scrapes information from the DBpedia database, and fills in missing information by a hybrid of reverse geocoding (finding city and state information from latitude and longitude) and natural language processing. The software outputs a data table with associated attributes, which could be used to create map files. In all test cases provided by our sponsor, our software achieved the specifications with considerable time saved.

BRINGING THE REDCAP TO REALITY

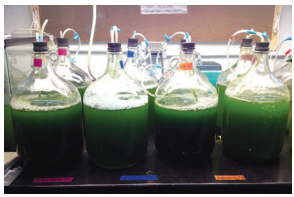
Richard Asala, Eric Hochberg, Robert Mercurio, Stephanie Wolf
Sponsors: Rick Balakier and Dan Gosselin
Faculty Advisor: Peter Robbie



A staggering $300 billion is lost annually on healthcare costs resulting from poor drug compliance, which also results in 300,000 unnecessary deaths and $100 billion spent annually on excess hospitalizations. In 2010 our sponsors and a team of Thayer students designed the RedCap to address the issue of patience adherence to prescription regimens. The RedCap is a modified pill vial cap that has a viewing window that always displays the time the patient's next dosage is due to be taken. The current design of the RedCap requires a unique vial for each type of dosage cap (1x/day, 2x/day, etc.). We worked on designing a RedCap system with a universal vial that fits all dosage cap types.

PROCESSING AND STORAGE OF ALGAL BIOFUELS

Rebecca Backer, Jorge Bahena, W. Robinson Culver, Jennifer Dyment
Sponsor: Dartmouth Organic Farm
Faculty Advisor: Mark Laser



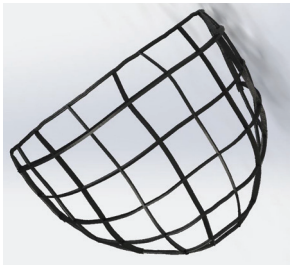
The Dartmouth Organic Farm (DOF) has unique access to an on-site algal cultivation-harvesting system: a small algae raceway that could be used to produce biofuel for the farm's motorized equipment. Algal biofuels, which do not require arable land or fresh water, have the potential to replace petroleum-based liquid transportation fuels. Scott Stokoe, the manager at the DOF, requested a concept study to assess the sustainability and economic feasibility of an educational algal biofuel production system tailored specifically for the DOF. After rigorous testing, we recommended a biofuel system that cultivates *Scenedesmus obliquus* in a raceway with hydroponic media, harvests the algae cells using sedimentation, breaks the cell walls with salt lysis to release oils, and uses the end-product, algal oil, in a modified diesel engine. Having looked at potential algae productivity as well as the energy inputs and outputs on a monthly basis, we found that DOF's biofuel production system would not be economically feasible at any time of the year (although it could be utilized as an educational tool). This is primarily due to the raceway's large energy input and could be remedied with the construction of a larger, more efficient raceway.

AN INDIVIDUAL ENERGY METERING PILOT STUDY

Rodrigo Amboss, Natasha Herring, Noah Lynd
Sponsor: Christopher Levey
Faculty Advisor: Mark Franklin

The goal of this project is to prove viability of an individual energy-metering program at Thayer School. Thayer School's current energy usage monitoring provides no feedback to individuals, and energy users may feel their everyday usage habits do not effect overall consumption at the school. Our deliverables include the installation of meters into faculty and staff offices, recommendations designed to decrease energy usage, and an analysis on the impact of these recommendations; an easy and simple user interface; an economic analysis of a larger-scale individual metering program; and recommendations for scale-up and necessary work to make this happen. We installed and successfully collected data for nine meters and provided recommendations to users on how to reduce consumption. We analyzed pre- and post-recommendation data to determine the impact of metering and measures taken to reduce consumption, compiled data to show users their individual use relative to their peers, developed a user interface to make accessing trends and recommendations easy for the user, and performed an economic analysis of a larger-scale metering program.

PROJECTS



REDUCTION OF VISUAL FIELD LOSS WITH NOVEL ICE HOCKEY MASK

Lauren Harad, Alissa Santa Maria, Cole Sulser

Sponsor: Dr. Mitchell Wolf

Faculty Advisor: Ron Lasky

A need exists for a hockey mask that reduces overall visual field loss without compromising safety and that athletes will prefer over the current full cages. We designed an improved cage with thinner bars and optimized geometry. We constructed various iterations of looks-like prototypes and performed rounds of user testing to determine an optimal design. The first round showed that the mask with the thinnest diameter bars (1/16″ bars) was optimal. The second showed that most users prefer the state-of-the-art design of square openings between bars over rectangular openings. Through modeling safety tests and performing various calculations to compare the new design with the state-of-the-art carbon steel masks, we found the minimum requirements for key material properties.

FEATURE DATA EXTRACTION FOR USE WITH SLAM

Tomohiro Berry, Joyce Chung, Vincent Dowling, Frances Wang

Sponsor: Physical Sciences Inc.

Faculty Advisors: Eugene Santos, Eric Fossum

Unmanned vehicles present the possibility of autonomous operation but are limited by their dependence on GPS. The method of Simultaneous Localization and Mapping (SLAM) is a viable solution to this problem but requires real-time feature data about the vehicle's environment. Our sponsor has developed an unmanned micro-aerial vehicle called the InstantEye that will operate autonomously with SLAM. However the SLAM algorithms do not have access to robust information about the vehicle's surroundings. Our project was to develop an integrated hardware and software solution compliant with the specifications of PSI's InstantEye. Our solution had to incorporate a robust algorithm that is capable of detecting, extracting, and tracking critical features and is computationally efficient enough to run on their limited resource microprocessor. Our project had five components: hardware, device drivers (hardware support libraries), image capture software, feature detection and extraction software, and feature tracking software.

ULTRA-PORTABLE BLUEPRINT READER

Justice Amoh, Shail Bajpai, Rachel Rothbarth, Yi-Jie Wang

Sponsor: PrintLess Plans LLC

Faculty Advisor: Kofi Odame

Architecture, engineering, and construction professionals rely on large-format drawings to view plans. Although current technology allows for viewing drawings electronically, paper blueprints are still the standard. PrintLess Plans aims to create an electronic device that retains the form factor of paper drawings through the use of flexible screen technology. Our project had three parts: hardware, software, and case design. The hardware portion featured battery selection, identification of integral parts of the evaluation board, and addition of a wireless module. Software included a smartphone app, a cross-compiler, and a daemon. Mechanical needs focused on packaging. Since sufficiently large screens do not exist, tiling multiple screens together to create a large active display area was investigated. Our sponsors requested packaging of two screens in a folder-like case, demonstrating this concept. We have a partially integrated, functioning, one-screen device and a mechanical lookslike prototype for a two-screen system. We developed a web server for uploading images from a computer into a database on the Internet. Up-to-date images can be immediately downloaded onto the phone for display on the electronic paper display, providing functionality that paper blueprints cannot offer.

SNOWBOARD BINDING MOUNT

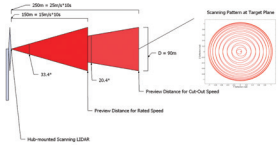
Matthew Reynolds, Scott Sottosanti, Adam Powers

Sponsor: Terry Smith

Faculty Advisor: Harold Frost

Current snowboard binding technology prevents the ideal flexing of the board needed to maximize the efficiency of a turn. This project aimed to correct the lack of control-conducive curvature in a snowboard through a centralized binding mount. We looked at various iterations of center-based prototypes, using CAD/FEM-assisted analysis, benchmark tests, and user feedback to inform each new prototype. We iterated through several designs and came to a conclusion regarding the center-based binding mount along with developing other solutions.

SCANNING DOPPLER LIDAR FOR WIND TURBINE OPTIMIZATION



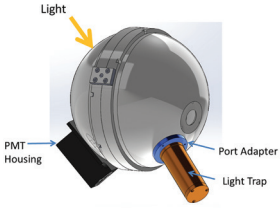
Samuel Grant, Sarah Jewett, Tianshun Miao, Russell Primeau, Nicholas Wimer

Sponsor: Optra Inc.

Faculty Advisor: Stuart Trembly

Fluctuations in wind can subject wind turbines to extreme mechanical loading. Remote sensing technologies such as Light Detection and Ranging (LIDAR) are currently used to measure average incoming wind velocities and relay them to feed-forward control systems that actuate turbine yaw and blade pitch to best make use of incoming wind while mitigating harmful stress loading. Our sponsor wanted us to investigate the merits of a scanning LIDAR system that utilizes their proprietary beam-steering device linked with a LIDAR unit and produce a value proposition to demonstrate the potential value of the spatially resolved measurements the system would produce. We produced a conceptual design of the system, ran a multi-step simulation, and provided an economic analysis.

SPECTRO-SCATTER TESTING SYSTEM FOR OPTICAL FILTERS



Dan Pennachio, Nirakar Poudel, Ruotian Wang

Sponsor: Chroma Technology Corporation

Faculty Advisor: Elsa Garmire

Chroma Technology Corporation needs a device to measure transmitted scatter through its optical filters as a function of wavelength. The system needs to obtain the spectrum within an hour. We assembled a spectro-scattermeter that can gather scatter signal even in blocking regions of the optical filter. The spectro-scattermeter also features new exit and detector port peripherals with improved background signal reduction. The project has proven the feasibility of a spectro-scattermeter that is sensitive enough to meet all the sponsor's specifications.

FRONT WHEEL / DRIVE SYSTEM

David Jensen, Scott Lacy, Luke Lee, Jose Ordonez-Coronel, Darren Reis, William Voigt

Sponsor: Dartmouth Formula Racing

Faculty Advisor: Jason Stauth

We addressed inadequacies of the 2012 race car. The deliverable was to develop the drivetrain without adjusting the suspension. This will be the first time Dartmouth Formula Racing has used electric batteries in an all-electric configuration. We analyzed and purchased a motor kit and then divided tasks by drivetrain components—throttle, battery container and housing, motor mounts, and wiring—to put it together in parallel. The mechanical side ran finite element analysis to test stress and strain put on the vehicle. The electrical side learned how the components interacted and how to safely protect both the car and the operator. We were able to get the all-electric car running by the end of the term.