Undergraduate Research Fellowship Competition

The Engine Research Center (ERC) at the University of Wisconsin-Madison is a world-class research facility dedicated to furthering the knowledge of the thermofluid aspects of internal combustion engines. The ERC is internationally recognized for both experimental and computational research.

A fellowship competition is being offered to allow undergraduates to be involved in the research activities of the ERC. If desired this can be incorporated into your degree program as an independent study project. It is anticipated that the successful applicant will be paired with a current graduate student (to help facilitate day-to-day needs) and a faculty advisor.

The ERC undergraduate research fellowship (URF) provides **a stipend of $500 to the student**, and makes available up to $500 for research supplies. A list of projects suggested by the ERC faculty can be found below, or acquired from Prof. Ghandhi (rm. 125 ERB, *ghandhi@engr.wisc.edu*). Additionally, the ERC faculty are interested in hearing your project ideas.

Application Procedure:

1. Applications will be due **November 4, 2009** and winners will be announced by November 13, 2009.
2. The application consists of:
   a) A 3 page (maximum) research proposal that clearly identifies the area of study, includes relevant background material, and provides details of the proposed investigation.
   b) A current resume
   c) A transcript.
   d) Submission to Prof. Ghandhi in room 125 ERB.

It is expected that the work will be performed either during the semester break, or during the spring semester. The culmination of the work will be a short presentation made at an Engine Research Center seminar.

How to get started?
The first step in the process is to contact the faculty member in charge of projects that you are interested in (the most efficient method would be to email them to set up a meeting time). Based on these discussions, choose the project of greatest interest and work with the faculty member on the development of the proposal.

ERC Faculty and Staff

Prof. Foster	Room 113 ERB	foster@engr.wisc.edu	263-1617
Prof. Ghandhi	Room 125 ERB	ghandhi@engr.wisc.edu	263-1684
Prof. Rutland	Room 1018 ERB	rutland@engr.wisc.edu	262-5853
Prof. Reitz	Room 1018 ERB	reitz@engr.wisc.edu	262-0145
Prof. Rothamer	Room 127 ERB	rothamer@wisc.edu	890-2271
Prof. Sanders	Room 109 ERB	ssanders@engr.wisc.edu	262-3540
Prof. Shedd	Room 123 ERB	shedd@engr.wisc.edu	265-2930
Prof. Trujillo	Room 2043 ME	mtrujillo@wisc.edu	262-0944
Mike Andrie	Room 120 ERB	mandrie@wisc.edu	263-1615

ERC Undergraduate Research Fellowship Project List

Heater development for high temperature gas cell use (Prof. Ghandhi)
A high temperature, high pressure gas cell has been built in the ERC for testing the optical (absorption and fluorescence) properties of gases at elevated temperature and pressure. In this project, a constant wall temperature heater will be designed and constructed. The constant wall temperature will prevent local hot spots that can lead to chemical reaction.

Fiber FTIR spectrometer (Prof. Sanders)
In this project, two spools of optical fiber, each ~ 5 km long, will be alternatively temperature cycled between 10 and 80 degrees C. Owing to the linear coefficient of thermal expansion, an effective fiber length change of 7 m can be realized during the temperature cycling. This length change can replace that induced by the moving mirror in a Fourier-transform infrared (FTIR) spectrometer. The student will design and build such a fiber FTIR, and demonstrate its utility in absorption spectroscopy.

Hydrodynamic breakup (Prof. Trujillo)
Implementation of numerical models for hydrodynamic breakup within the Volume-of-Fluid context are currently being developed. The student in this project will help analyze a small part of the problem consisting of the breakup of liquid droplets exposed to a constant shear stress environment.

Nano-particle phosphorescence for temperature measurement (Prof. Rothamer)
Development of a diagnostic used to image temperature in combusting flows is currently under development. The technique requires seeding of ceramic nano-particle phosphors into the fuel and air mixture prior to combustion. To test whether the high temperatures present in the flame alter the luminescence properties of the particles, a method for capturing or sampling the particles exiting the flame is desired. This project would involve designing and building the test apparatus to sample particles and helping to take data using the apparatus on the luminescence spectrum of the particles before and after exiting the flame.

Swirl meter development and testing (Prof. Ghandhi)
Engines found in commercial cars to race cars use swirl of the intake air to promote combustion stability. The student will take a torque sensor already acquired and design and build an impulse-type swirl meter. The student will then test two custom engine heads using this swirl meter along with a paddle-style swirl meter and compare the results.

Design of a portable optical engine (Prof. Sanders)
Former ERC undergraduate researchers have fitted a portable generator with sapphire windows so that laser sensors can be easily tested. In this project, the student will review that work, and design a next-generation optically accessible portable generator.

Cavitation inception (Prof. Trujillo)
Prior to full scale cavitation, small bubble nuclei suffer violent collapses stemming from the Rayleigh-Plesset dynamics. The primary drivers for this behavior are pressure fluctuations originating from the fluid turbulence. Based on an approximated pressure spectrum corresponding to the flow inside an injector nozzle, a Rayleigh-Plesset analysis will be performed to examine the susceptibility of bubbles to this type of violent collapse.

Measurements of H_2O spectra in a ribbon burner (Prof. Sanders)
By directing one or more infrared laser beams through an engine, one can measure in-cylinder gas temperatures. However, the performance of such thermometry is often limited by our understanding of H_2O vapor spectra (the absorption signature of H_2O vapor as a function of laser wavelength). Therefore, we are working on improving our understanding of H_2O vapor spectra, particularly at high temperatures and high pressures. In this project, the student will work with senior graduate students to use laser equipment to record H_2O spectra in a 3-ft-long flame. The resulting spectra will look roughly like the ones shown at the very top of http://www.engr.wisc.edu/me/faculty/sanders_scott/2008_RA_ad.pdf and will ultimately improve the accuracy of gas thermometry performed in the ERC.

Assembly and testing of a fiber-coupled RGB laser system (Prof. Sanders)
RGB laser systems are currently used for laser light shows and are likely to see widespread use in next-generation televisions / displays. This project will make use of an RGB system build by previous undergraduate researchers in the ERC. The student will purchase parts needed to control that system using a personal data assistant (PDA) or similar. Also, a transparent rod containing light-scattering particles will be designed, obtained, and used to visualize the RGB laser beam. The entire system will then be placed in the ERC display case, where ERC researchers will use it to explain to others the peculiarities of experiments involving swept-wavelength lasers and combustion.