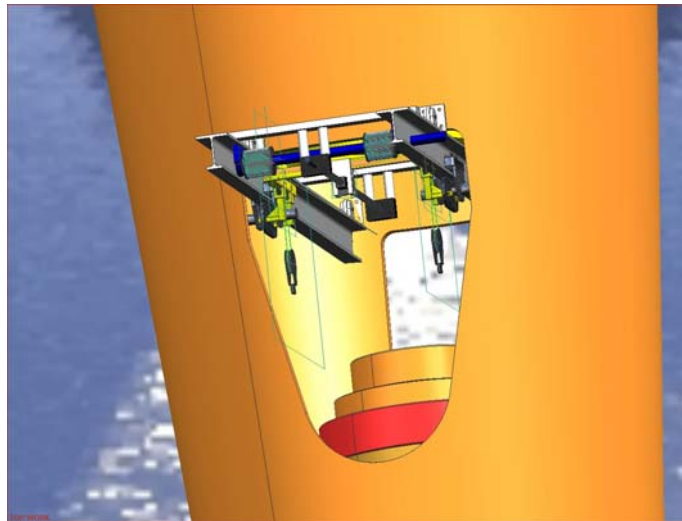




**THE UNIVERSITY OF CONNECTICUT  
DEPARTMENT OF MECHANICAL ENGINEERING**

**SENIOR DESIGN PROJECTS**

**2003-2004**



**Hand-Portable Seal Crane Hoist for Reactor Coolant Pump**

A culminating feature of the Mechanical Engineering curriculum is the two semester senior design project courses. In these courses, students tackle open-ended engineering problems whose solutions require a synthesis of design know-how, judgment, technical skills, analysis, creativity and innovation. Cost and manufacturing related issues are emphasized as an integral part of the design and development process.

Senior Design Open House and Demonstration Day will be on Wednesday, April 30, 2004. Demonstrations and presentations will be from 1:00 – 4:00 PM in the Engineering II Building. The top three projects will receive awards of \$1500, \$1000 and \$500. A panel of judges from industry will select the winning projects. Refreshments will be served.

*"Education is the best provision for old age." – Aristotle*

**Team 1**

**DEVELOPMENT OF CONTROL CONCEPTS FOR A SPLIT FLOW DUAL FAN CONCEPT**

**Sponsoring Company:** Pratt And Whitney

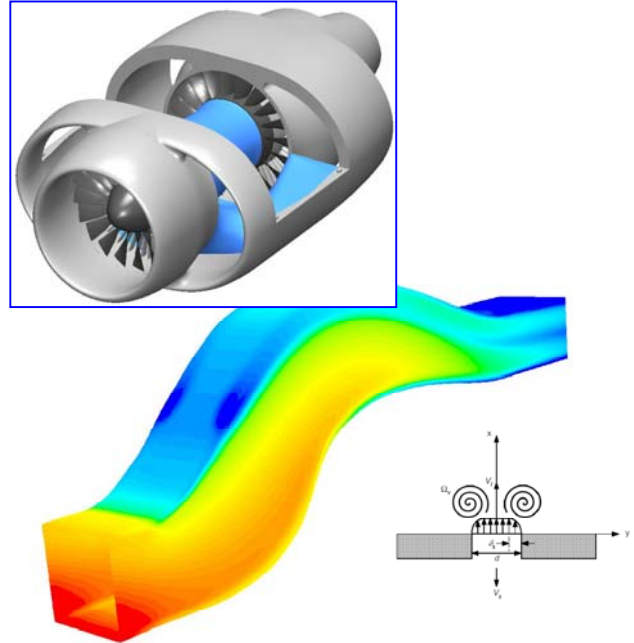
**Participating Students:** Brian Applegate, Mike Kazauskas, Jacob Virkler

**Faculty Advisor:** Professor Ranga Pitchumani

**Company Consultant:** Craig Nordeen, Gary Roberge

**Description:** Pratt and Whitney proposed a dual fan jet engine concept. The motivation behind this design is to allow an engine to use two smaller fans in tandem to produce thrust comparable to one larger fan, thereby permitting the radial envelope of the engine to be reduced. This arrangement requires a series of ducts to divert the airflow of each fan. Currently, pressure losses in the ducts are too great for the design to be practical. The purpose of this project is to study the effectiveness of flow control devices in reducing flow separation in the ducts. The ducts were analyzed using the FLUENT computational fluid dynamics software in order to pinpoint the regions in the ducts where problem flow areas occur. An experimental test section was then created based on a section created through one of the ducts. This was attached to a wind tunnel, and two different flow control schemes were used to reduce the problem flow in the section: vortex generators and synthetic jets. Vortex generators reduce flow separation along a wall by inducing swirl into the flow and adding energy to the boundary layer. Synthetic jets also energize the boundary layer by injecting fluid into the flow through the use of a speaker or other

pulsing diaphragms. The placement and configuration of these devices within the section were systematically altered until the optimal flow conditions were achieved.



**Team 2**

**DESIGN OF LOW LOSS INTERNAL FLOW DUCTS FOR TURBINE AIRFOILS**

**Sponsoring Company:** Pratt & Whitney

**Participating Students:** Alex Stepanoff, Daeseong Jo

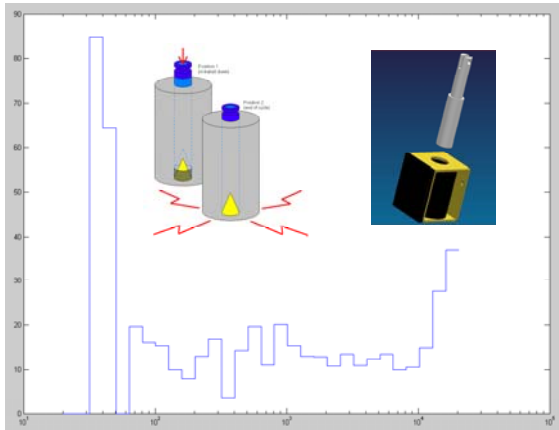
**Faculty Advisors:** Professor Thomas Barber

**Company Consultant:** Atul Kohli

**Description:** This Pratt & Whitney sponsored project aims at reducing the pressure losses in the internal cooling ducts of high-pressure turbine airfoils. These losses directly affect the efficiency of the engine, causing a higher fuel burn and lower engine efficiencies. Based on FLUENT computational fluid dynamics (CFD) calculations, five new designs were proposed and analyzed. The analyses concentrated on the highest loss region, typically located where the airflow makes an 180° turn. Based on CFD calculation, two new concepts, (1) a converging-diverging duct on the aft side of the bend and (2) a forward-facing step in the middle of the bend. Both designs produced about a 34% loss reduction over the baseline duct. A combination of these ideas yielded a 55% reduction. These designs were then examined

experimentally in a low-speed test rig provided by the United Technologies Research Center.





### Team 3

#### SOLENOID ACTUATOR OPTIMIZATION

**Sponsoring Company:** Pitney Bowes

**Participating Students:** Daniel Abaroa, Matthew Kowalski, Christopher Valva

**Faculty Advisor:** Dr. Jiong Tang

**Company Consultant:** Jim Salomon

**Description:** Noise pollution is an ever increasing concern in industry, be it jetliners or office equipment. The quality of people's work environment is very

important to most employers and can be a decision maker when it comes to purchasing new equipment. To this end, Pitney Bowes needs to make its document handling machines quieter by finding a way to make the solenoids that control the direction of paper throughout the machine less noisy. In one of the company's new machines there are about 20 of these solenoids, each of which is actuated about once a second on average. They are inexpensive devices which serve their purpose well, but tend to be much noisier than desired because of the impact that occurs at the end of the solenoid's stroke. The main idea of this design is to cushion the impact of the plunger of the solenoid before it impacts the bottom of the solenoid, or to prevent the plunger from impacting all together. However, the existing characteristics of the solenoid, such as holding force, usable work, velocity of the plunger, dimensions, etc., must not be changed as to impact the operation of the machine. Because of the difficulty in modeling an impact noise, different designs were built and tested using a microphone connected to a signal analyzer to gather data. This data was then imported into a PC running MATLAB for analysis. Also measured was the usable work of each design. These two measurements provided a way to determine the best design by finding the one with the least noise output and the most usable work.

### Team 4

#### MECHANICAL WRINKLE REMOVER

**Sponsoring Company:** Gerber Technology

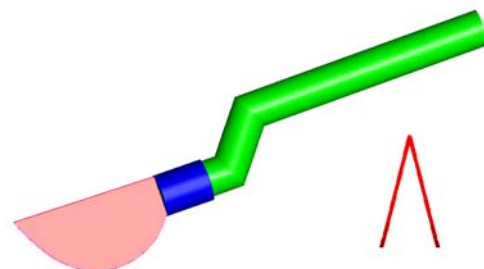
**Participating Students:** Meghan Quinn, Michelle Sadowski, Erin Williamson

**Faculty Advisor:** Professor Peng Zhang

**Company Consultant:** Bruce Plumley

**Description:** Gerber Technology designs systems for the textile industry. Their leather cutting system involves a process in which excess material that forms wrinkles in leather hides is removed, allowing the hide to lay flat on the cutting table. When the hide is flat, a scanner can pass, and then a computer program decides where to place the pattern of pieces to be cut in order to make a chair, garment, etc. The wrinkle removal processes, consisting of four steps, is very labor intensive. Currently the operator uses an ordinary rotary blade-cutting tool. Gerber would like to simplify the process with a new tool, which will remove the wrinkle in one step. The hand-held tool that was developed by the senior design team consists of a specially shaped blade with an ergonomic handle. The blade has a curved profile and is folded down the middle so that two cutting surfaces are in contact with the leather, cutting each side of the wrinkle simultaneously. The front tip of the blade at the bend is a sharp point, which starts

the cut by piercing the leather. Then the blade is rocked back to where the bend is parallel with the table. At this point the operator drags the blade to the end of the wrinkle. The wrinkle is then lifted from the leather. The design incorporates 5-inch handle with a 1-inch drop-down to allow clearance for the operator's hand above the table. A soft rubber grip is provided for comfort and to prevent slipping. A plastic guard protects the blade when not in use. The blade is attached to the handle with a clamping mechanism that allows for easy blade replacement. The tool fills the requirements with an ergonomic handle, safety features such as a blade cover and a cost of under \$25 per tool. Operators can now work more efficiently and experience less fatigue while having a reduced risk of cutting their hands.



**Team 5**

**SUBMARINE NR-1 GPS, BUOY AND TETHER MANAGEMENT SYSTEM**

**Sponsoring company:** Electric Boat Corporation

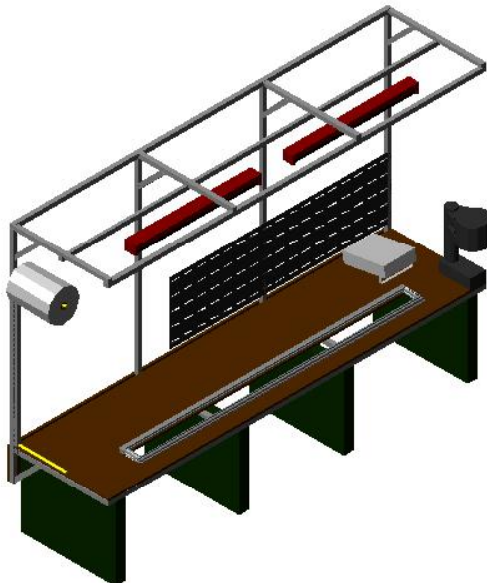
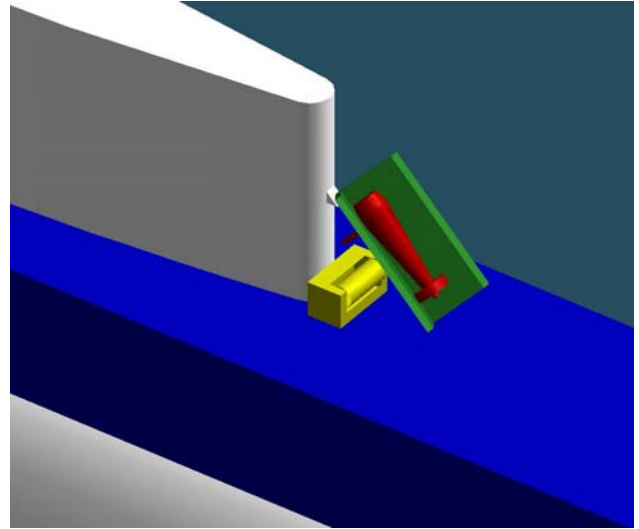
**Participating Students:** Clinton Miller, Matthew Genovese, Evan Mackenzie

**Faculty Advisor:** Professor Eric Jordan

**Company Consultant:** Ron Bashar

**Description:** The Electric Boat Corporation, based in Groton CT is The United States Navy's premier producer of nuclear powered submarines. In addition to the production of submarines, they also have a rapidly growing overhauling department. The Submarine NR-1 is a small, non nuclear, naval research vessel that Electric Boat has worked with in the past. Due to its poor surfacing characteristics, the NR-1 is required to take GPS readings while submerged. The NR-1 is therefore required to carry a GPS buoy, external of its pressure hull, which it can send to the surface to take GPS readings. The Electric Boat Corporation has approached UConn about designing a system that will send the buoy to the water surface and reel it back in to a secure position. Such a system has been designed incorporating a steel cradle mounted at a 60o angle onto the back of the submarine's sail. Underneath

the cradle will be mounted a high-powered winch. This winch will reel the buoy out to the surface as well as reel it back in via a tether that will be routed through a pulley tensioning system underneath the cradle.



**Team 6**

**TABLESOURCE MANUFACTURING METHOD**

**Sponsoring Company:** The Wiremold Company

**Participating Students:** Dennis Ljubicic, Adam Roina, Ryan Tutolo

**Faculty Advisor:** Professor Robert Jeffers

**Company Consultant:** Brian Takiff

**Description:** The Wiremold Company is the leading manufacturer of wire management systems used in industrial, commercial, and residential systems. A new product, the TableSource unit, is used to “bring power and communication access to the work surface with this compact module.” Currently, a single operator manually assembles each unit at small work cell. The current process is non-ergonomic, very time consuming and leads to worker fatigue. Several devices were designed and built to help improve the quality of the unit, decrease production time, and help reduce worker fatigue. A new work cell, complete with overhead lighting and tool balancers, was constructed to house a new clamping system that eliminated the need for workers use a free hand to steady the unit during assembly.

### Team 7

#### A DEVICE TO DAMP OUT DRIVE SYSTEM TRANSIENT RESPONSES

**Sponsoring Company:** Sikorsky Aircraft

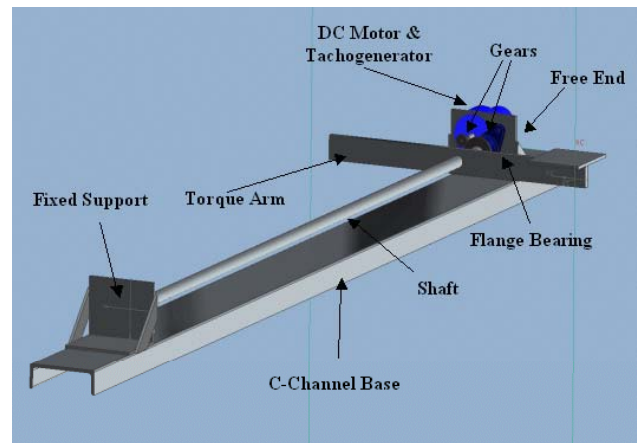
**Participating Students:** Nicholas Kattamis, Stanislav Kostka

**Faculty Advisor:** Professor Nejat Olgac

**Company Consultant:** Robert Blackwell

**Description:** A helicopter uses a tail rotor, which provides thrust to help balance the rotation of the main rotor of the helicopter. The tail rotor is driven by a drive shaft, which is connected between it and an engine. Any input of the pilot to quickly change the direction of the aircraft results in a quick pitch change of the rotor blades and also a quick change of torque through the shaft. Shaft excitations at the drive shafts natural frequency occur when a quick change in input occurs due to the rapid change in torque needed through the shaft. This project involved the creation of an electromagnetic active device, which will attenuate these oscillations. The device will prevent a large amount of torsional overshoot within the shaft and reduce the time that oscillations occur within the shaft. By reducing the overshoot and the settling time of oscillation, the shaft will not be subjected to extreme torques for and fatigue life will increase. The device consists of a tachogenerator DC motor combination, which

is mated to the shaft. The tachogenerator provides a signal proportional to the drive shaft speed. The signal is sent to a PID controller and an amplifier before it is sent to the connected DC motor to help counteract any oscillations that occur. The testing of the design is done using a shaft with one fixed end and the other susceptible to torsional vibrations. The tachogenerator and dc motor are connected to the oscillating end and will help eliminate oscillations when the shaft is subjected to step changes in torque. The PID control is performed using LabView and is done in real-time.



### Team 8

#### CLIP-ON ROTATIONAL LASH GAGE FOR STEERING SHAFTS

**Sponsoring Company:** TIMKEN

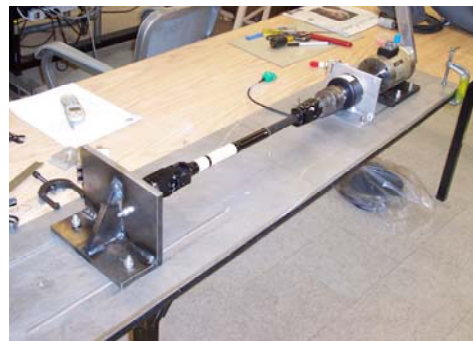
**Participating Students:** Iman Capers, Glenn Heyse, Michael Palmunen

**Faculty Advisor:** Professors Kevin Murphy and Bi Zhang

**Company Consultants:** Mike Morsches, Chris Kaswer

**Description:** The goal of this project is to measure the rotational lash between joining components of typical intermediate steering shafts. Reducing the lash of the shaft would allow for more precise and responsive steering. The sponsor of this project, Timken, is currently measuring the total lash along the entire length of the intermediate shaft. It is desired to determine how much the individual joints of the components contribute to the total lash of the entire shaft. This would allow Timken to determine where the problem areas are so they can refine their designs and/or manufacturing processes. A gauge will be designed and machined so that it is easily attachable to a wide variety of geometries of shaft

components, and adjustable along any length of the shaft. The gauge must be able to measure a rotational deflection in the magnitude 0.001 degrees. The chosen design utilizes a Linear Variable Differential Transformer (LVDT) that is rigidly attached to a base, and contacts an arm clamped to the intermediate shaft. The LVDT measures the arc displacement of the shaft from which the angle of displacement can be determined.



### Team 9

#### NO-BAK CLUTCH

**Sponsoring Company:** Carlyle Johnson Machine Company

**Participating Students:** David DeTroy and Robert Schmidt

**Faculty Advisor:** Professor Zbigniew Bzymek

**Company Consultant:** Michael Gamache

**Description:** Efficiently transmitting power for practical use is a classic engineering problem in industries such as military, medical, agricultural, aviation, and power generation. A clutch is a vital component of transmitting and regulating shaft power in applications where two shafts must spin at different speeds, provide different torque, or be locked together and spin at the same speed. The Carlyle Johnson No-bak clutch design provides an innovative locking feature where torque can only be transmitted through one shaft, the input shaft. Applying torque to the output shaft results in the locking of the clutch regardless of the direction of shaft rotation. This feature is a result of a ball bearing and cam disc geometry exclusive to the No-back clutch. However, a byproduct of the locking of the clutch is vibration. Research revealed that springs made of solid urethane have beneficial damping features in high stress applications. Urethane durometers of 85A, 90A, and 95A of various dimensions, were tested with given torque loads in measuring the vibratory response of the system and compared to the response with the prototype steel spring arrangement.

### Team 10

#### SEPARATING MOISTURE IN AN AIR STREAM FOR AN ENVIRONMENTAL CONTROL UNIT

**Sponsoring Company:** Hamilton Sundstrand

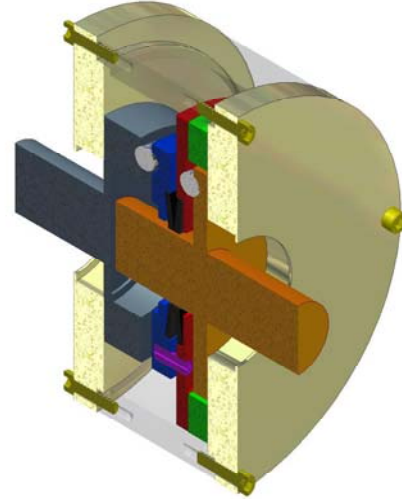
**Participating Students:** Chun Bun Chan, Eric Rogers, Michael Torchia

**Faculty Advisors:** Dr. Chiu

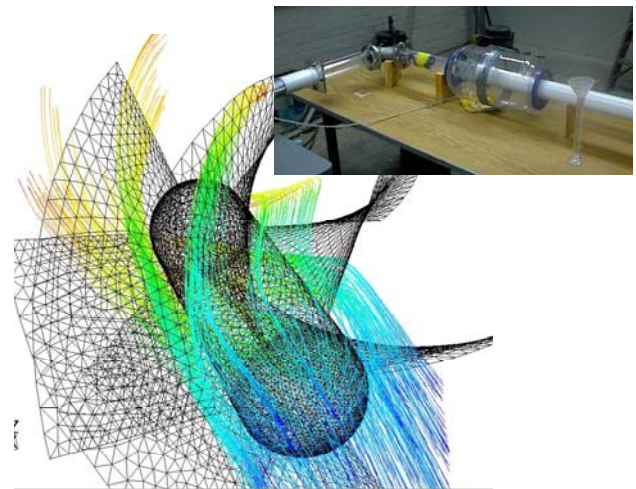
**Company Advisors:** Mark Zafetti, Ryan Hauser

**Description:** Air is bled from the compressor in an aircraft and is used for secondary purposes such as heating and cooling the cabin interior. This air is moisture laden, and needs to be removed for passenger comfort. Hamilton Sundstrand manufactures a moisture extraction system consisting of a swirl vane and water extractor. Upon testing, H-S found that for different piping configurations, different swirl vane orientations obtained different extraction efficiencies. This project aims at determining how the upstream flow affects the water extraction efficiency. First, different piping configurations with swirl vanes were modeled in using FLUENT, a computational fluid dynamics program. Various honeycomb designs were also modeled in order to determine whether or not honeycombs could eliminate secondary flow thought to be causing the discrepancy mentioned above. Next, moisture particles of 15  $\mu\text{m}$  were introduced into the FLUENT

Analysis and testing of the No-bak prototype reveals that the application of a urethane element adds a damping feature, which diminishes this vibration without adversely affecting the maintenance, performance, and applicability of this practical device.



system to determine if they would be swirled by the model. Finally, experimental test sections created out of PVC and metal piping recreated the full-scale piping configuration. Particles were introduced into the system, and the effects of various piping configurations on the collection efficiency were analyzed. An understanding of how various upstream characteristics of the system affect efficiency was achieved.



### Team 11

#### HAND PORTABLE SEAL CRANE

**Sponsoring Company:** Westinghouse (NH)

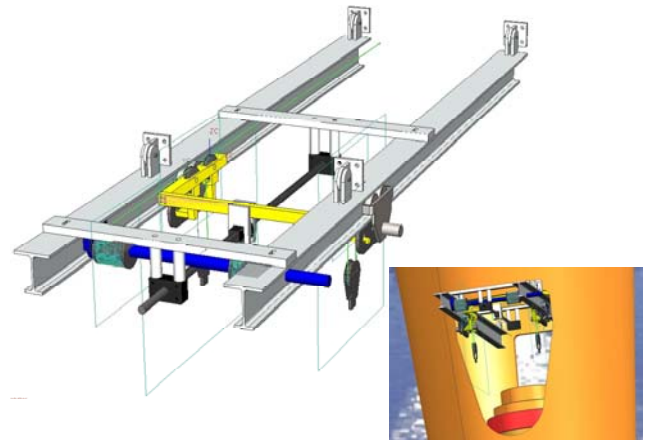
**Participating Students:** Michael Cartona, Justin Vinci, Garrett Long

**Faculty Advisor:** Professor Kazem Kazerounian

**Company Consultant:** Doug Thompson

**Description:** Westinghouse Electric Company of Newington, NH requested the design of a hand-portable hoist crane capable of lifting 1,500-lbm, which will be used to remove and install seals into the Westinghouse Reactor Coolant Pump (RCP). The weight of the "seal crane" must be such that two people can move the crane by hand from one RCP to another, while at the same time minimizing the number of modules. Furthermore, on site assembly of the crane must be quick and easy so as to limit employee exposure to hazardous radiation within the reactor housing. Once assembled, the seal crane must be capable of lifting the seal and traversing out of the reactor coolant pump where the seal will be lowered and a new seal installed. Using the ANSYS finite element analysis, an optimal and final supporting structure was determined. Two Aluminum I-beams will carry the load of the seal, and will be pinned at both ends of the coolant pump housing. For the traversing mechanism, a hand-wheel will drive a ball screw, which is connected to trolleys (one riding on each I-beam). The trolleys will serve to move

the seal horizontally into or out of the seal housing. A separate system is implemented to handle the vertical lifting of the seal. Outside the housing a hand-wheel is connected to a one-output-shaft gear reducer. This gear reducer drives a shaft on which two drums are mounted that serve to coil a wire rope. The wire rope extends from the drums, through a tether management pulley system stemming from each trolley, and ultimately attaches to a point on each respective I-beam. A minimum factor of safety of 3 was applied to all the design features as a nuclear industry standard.



### Team 12

#### THERMAL ANALYSIS OF CONTROL-ROD DRIVE MOTORS

**Sponsoring Company:** Westinghouse (CT)

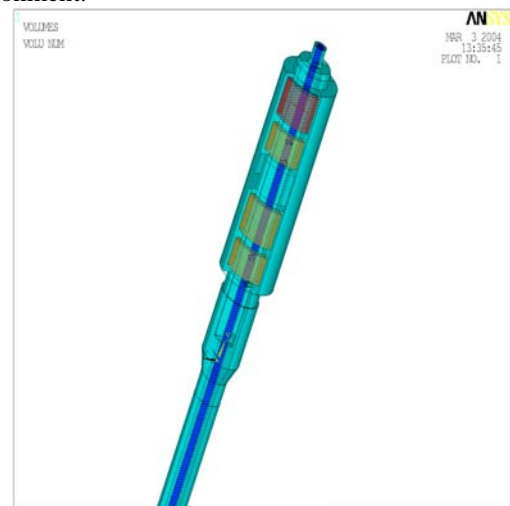
**Participating Students:** Stella Kaplinskaya, Paul Longo

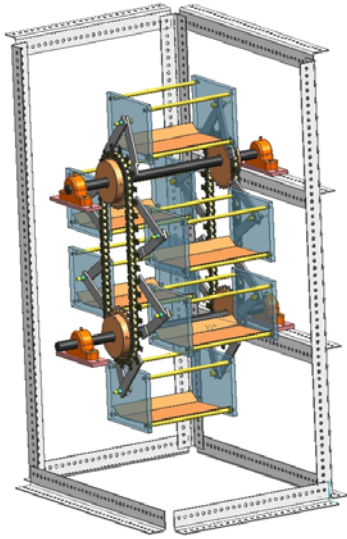
**Faculty Advisor:** Professor John Bennett

**Company Consultant:** Edward Sirica

**Description:** A magnetically actuated Control Element Drive Mechanism (CEDM) positions control rods in nuclear reactors, which is located on the top of the reactor vessel closure head assembly. The motor power is obtained from the electric, coil stack assemblies, located outside the motor pressure housing. During normal reactor operations each coil is maintained below its design temperature limits, by forced air-cooling on the exterior portions of the coil stack assembly. During abnormal conditions, such as a loss of forced air-cooling, the temperature distribution of the coil stack assembly is uncertain, due to the change in the internal buoyant flow. The buoyant flow is driven by the difference in internal wall temperatures of the CEDM, caused by the forced air-cooling. When forced air-cooling is lost, this buoyant flow diminishes and results in conduction from the reactor vessel to dominate the heat transfer mode and possibly exceed the coil design temperatures. Therefore, an uncertainty in the coil temperature results in a forced

reactor shutdown after ½ hour, by insertion of the control rods. A thermal model of the control rod has been developed, which is being used to understand the thermal environment of the coils during these types of conditions. The knowledge gained by the study of this information will facilitate assessment of design margins for the coils and evaluation of the material aging due to the thermal environment.





### Team 13

#### SELF SERVICE PHARMACY

**Sponsoring Company:** General Electric Industrial Systems

**Participating Students:** Eunsung Kim[ME], Luke Jongebloed[ME], James Durden[ECE], Madhukar Jalota [ECE], Dipika Mistry[CMPE]

### Team 14

#### VARIABLE EXHAUST BRAKE – PRESSURE REGULATOR

**Sponsoring Company:** Jacobs Vehicle Systems (JVS)

**Participating Members:** Basili Tyropolis, Adam Nogiec, Thomas Lunt

**Faculty Advisor:** Professor Baki Cetegen

**Company Consultant:** John Schwoerer

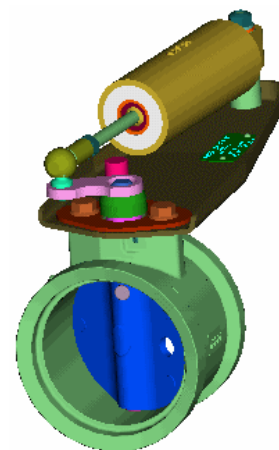
**Description:** JVS requested the design of a variable exhaust brake to drive that particular section of the company business. A durable variable exhaust brake was necessary in order to perform in a high temperature and corrosive environment at a constant backpressure of 5 bar. A rigorous patent search was used as both a learning tool and a starting point for idea generation. Several designs were brainstormed and a Pugh Analysis was used to select the wastegate design. A Pro/E model of the prototype was drawn incorporating integral parts of both of the favorable designs. FLUENT computational fluid dynamics software was used to model various sizes of obstructions in the flow field, including cones and other simple geometries. After production, the final prototype design was tested both experimentally and computationally. Experimental testing was performed using a compressor, a metering station, a

**Faculty Advisor:** Professors X. Huang and M. Fox

**Company Consultant:** John Dubeck

**Description:** The number of prescription medication used in the U.S. is increasing annually with no sign of slowing down. According to the National Association of Chain Drugstores retail pharmacies alone filled 3.14 billion prescriptions in 2002. The automated pharmaceutical dispenser can provide such a large number of people a time saving alternative to standing in long lines after work waiting for their prescriptions by applying the same convenience of 24-hour ATM banking to retail pharmaceutical distribution. The dispenser is modeled after a 11-foot tall vertical carousel which is a conveyor-like machine taking up a space efficient footprint of less than 2 sq ft and stores a 2.5in by 5.5in— 2 lb package in ¼ of a vertical foot which, for a 10 ft ceiling height, translates to over 40 packages. A 2-foot high prototype for this design has six containers, uses a key and card reader to provide secure access to the medication, has a PIC microcontroller to monitor the inventory, incorporates optical limit switches to dispense the medication accurately, and has user friendly controls are similar to that of a traditional ATM machine. To work the dispenser the customer pulls up to the drive-through swipes their card and the carousel automatically rotates and ejects their order to where it can be picked up from their car window.

straight pipe of necessary entrance length, an exhaust brake with wastegate, pressure transducers and other measurement devices, control units for calibrated brake operation, and LabView software for data collection. The exhaust brake wastegate was modeled in order to determine optimal design settings during experimentation.





**Team 15**

**FUEL CELL STACK SEALING TESTER**

**Sponsoring Company:** Rogers Corporation

**Participating Students:** Brandon Munson [ME], Christopher Virgilio [ME], Jason Lynn [ENVE]

**Faculty Advisor:** Professors Nigel Sammes and Rajeev Bansal

**Company Consultant:** John Arimond, Tim Creegan

**Description:** Fuel cells have the potential to change the way the world produces and uses electricity. Major global corporations and small enterprises throughout the world are developing fuel cell technology that would provide a cost competitive energy option for a wide variety of applications. Some applications include residential and commercial power supply, personal and public transportation, and industrial power supply. The focus of our effort was to design, build and test a fuel cell system that would provide between 100 and 200 Watts of power. The Proton Exchange Membrane (PEM) fuel cell was designed around molded bipolar plates and custom made membrane electrode assemblies (MEAs) provided by the Rogers Corporation. Air and hydrogen pumps were sized and purchased, along with all other necessary components required for assembly. Endplates and manifolds were designed and manufactured for assembly. Electrical engineers on the project designed and built the circuitry to and control system needed for the fuel cell stack. Once assembled, the fuel cell system will be tested for power output to determine the efficiency of the system. In addition, current and voltage will be measured and plotted to monitor system performance.

**Team 16**

**RAPID THAW ACCUMULATOR (RTA) DESIGN**

**Sponsoring Company:** UTC Fuel Cells

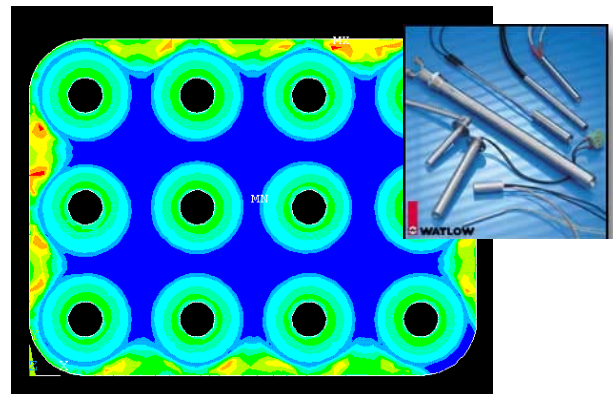
**Participating Students:** Andrew Huang, Sarah Schrupp, Michael Tammaro

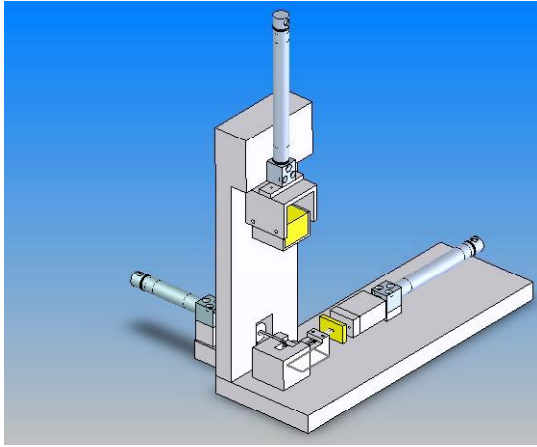
**Faculty Advisor:** Professor Ted Bergman

**Company Consultants:** Steve Kotso, Michael Yokose, Tom Clark

**Description:** The scope of this project is to design a Rapid Thaw Accumulator (RTA) that will contain and melt the process water of the cooling loop associated with a PEM fuel cell to be used in automotive applications. The vehicle will be exposed to subzero conditions in which all the process cooling water will be stored at the frozen state in the RTA. At vehicle startup, the RTA will have to melt all the process water by resistance heating and bring it up to 4°C within five minutes with a given time-power step input. The RTA will be pressurized and the liquid water will be forced into a cooling loop to be used for fuel cell operation. The geometry of the RTA is confined by a space constraint as well as angles of operation limits imposed by its function in a vehicle. The

material for the container material has corrosion resistance and strength to withstand stresses associated with the expansion of the water upon solidification and the applied pressure used to force the water into the rest of the cooling loop. Furthermore, the material is compatible with the other materials of the fuel cell. The ice is heated by 5/8"-diameter heating rods arranged in a manner such that all ice will be melted within the given time constraint. Also, a silicon surface heater will be placed around the perimeter of the RTA to assist in melting the ice from the container walls. An Ansys model of the temperature distribution in water for a given heating element arrangement (dark circles) in the RTA (top view) is shown.





**Team 17**

**RE-DESIGN OF THE PICO SURGE TESTER**

**Sponsoring Company:** Siemon Company

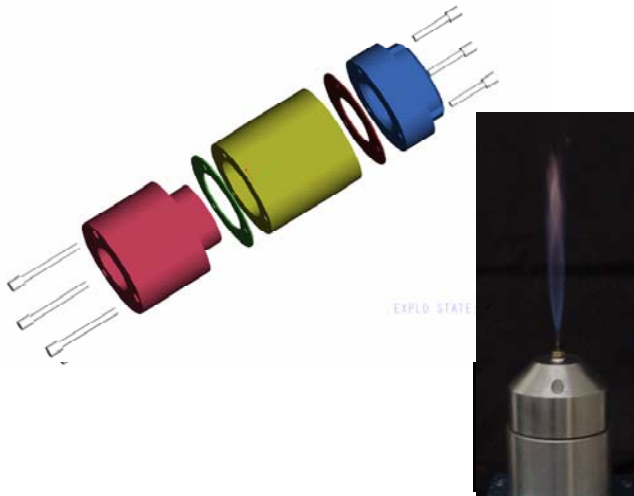
**Participating Students:** Martin Harisi(ME), Matthew Schomaker(ME), Kris Sgambato(EE), Seth Ackerman(EE)

**Faculty Advisor:** Profs. Marty Wood and John Ayers

**Company Consultants:** Randy Bielow, Juergen Matzen

**Description:** The Pico Surge module is a product manufactured by the Siemon Company. This device has seven possible configurations and provides voltage and amperage protection to electrical equipment. The task was to re-design the surge tester used for the Pico Protector module. The new machine is self-contained, combines

two production assembly procedures and corrects ergonomic complaints of the operators. Prior to the re-design, the operators were required to manually force fit the end cap and install two fuses into the Pico Surge module. After assembly, the operator was to manually test the modules for electrical compliance. This compliance test was inaccurate and required the operators to: adjust their settings for the seven configurations, read electrical voltage and resistance values, and then compare test data to the tolerated values. The new machine focuses on improving the production efficiency and providing a greater accuracy to the surge test. Through the use of Solidworks as a CAD modeling software, a machine was designed to incorporate these assembly procedures and surge test. The final design features three pneumatic cylinders combined with custom fixtures to perform assembly and test procedures. The electrical components are housed in a contaminant free and protective NEMA 12 enclosure. The re-designed surge tester features a single selector switch and a pass/fail LED configuration to display the test results.



**Participating Students:** Clayton Burns, Craig Cronin, Nathan Hemming

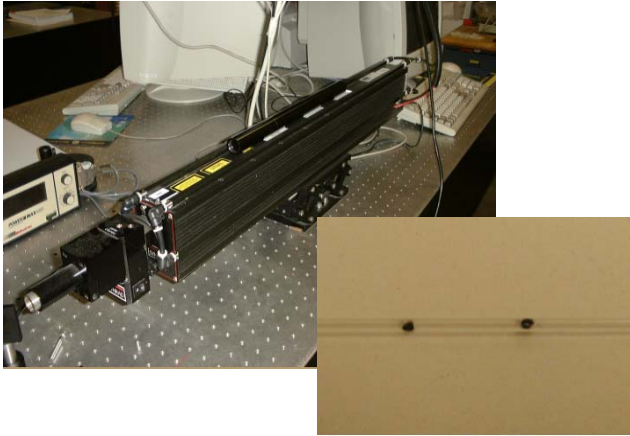
**Faculty Advisor:** Professor Mike Renfro

**Description:** Combustion is a process that is widely used in industrial applications and residential applications for heat and power generation. Many people are not familiar with the combustion process. The goal of this senior design project is to create a portable combustor that will be used for demonstration purposes in classrooms at the University of Connecticut as well as high school science classrooms. The combustor created has a modular design that allows for many different flame phenomena to be displayed easily and quickly. The design utilizes a computer controlled fuel and airflow control system via Labview and electronic pressure regulators. Fluent, computational fluid dynamics software, is being used as a qualitative tool as well as a tool to predict if the combustor will be able to create some more complex flame phenomena such as flame oscillation. Safety has been addressed in every step in the design, safety governed the amount of fuel being burned by calculating heat release, and the combustor has safety features built into such as pressure relief and check valves.

**Team 18**

**COMBUSTION DEMONSTRATOR**

**Sponsoring Company:** National Science Foundation / University of Connecticut



**Description:** Silicon Carbide (SiC) films were deposited on fused silica substrates using an open-air laser-induced chemical vapor deposition (LCVD) system. To accomplish this, the precursor gas, Trimethylsilane, was used. Therefore, a plumbing system to deliver TMS was built. In addition, a temperature model was made to ensure that sufficient laser power would be available. As it was, the temperature model indicated sufficient laser power for deposition. Varying deposition conditions were employed until the desired SiC film was obtained from deposition. These conditions included laser power and precursor gas flow rates. To ensure the film microstructure, several material characterization techniques were used. Raman spectroscopy was used to determine the stoichiometry and lattice distortion of the SiC films. Auger analysis determined the chemical composition of the film and was used to ensure that indeed Silicon and Carbon were present. Scanning White Light Interferometry was used to determine the film distribution. From the film distribution, it was concluded that the deposition was rate limited, i.e. followed the temperature distribution. And finally, Scanning Electron Microscopy (SEM) provided information such as the uniformity of growth, the average grain diameter and the thickness of the film.

**Team 19**

**CVD COATINGS ON FIBER OPTIC COMPONENTS**

**Sponsoring Company:** University of Connecticut,  
National Science Foundation

**Participating Student:** Christopher Jensen

**Faculty Advisor:** Professor Wilson Chiu

**Company Consultant:** N/A

**Additional acknowledgement:** King Hong Kwok



**Mechanical Engineering's Senior Design Class 2003-2004**

**MECHANICAL ENGINEERING FACULTY**

Thomas J. Barber  
John C. Bennett, Jr.  
Ted Bergman  
Zbigniew M. Bzymek  
Baki M. Cetegen  
Wilson Chiu  
Jim Cowart  
Ed Crow  
Amir Faghri  
Robert G. Jeffers  
Eric H. Jordan  
Kazem Kazerounian

Xinyu Huang  
Lee S. Langston  
Kevin D. Murphy  
Nejat Olgac  
Ranga Pitchumani  
Ken Reifsnider  
Mike Renfro  
Nigel Sammes  
Jiang Tang  
Marty Wood  
Bi Zhang  
Peng Zhang

#### **SUPPORTING STAFF**

Tom Mealy  
Rich Bonazza

Tom Marcellino

Jacki Veronese  
Serge Doyon

#### **GUEST LECTURERS**

Professor Robert Jeffers - Critical Path Method, PERT  
Norbert Hootsman (United Technologies Research Center - Innovation  
Mr. Ron Bashar (Electric Boat) – Project Management-Engineering Solutions  
Mr. Jim Salomon – Design of a Counterbalance Component for a Mail Stuffing Machine  
Mr. Greg Stevenson (Hamilton Sundstrand) - Patent Law & Intellectual Property  
Mr. Sam Schrager – Property Law: Liability and Negligence

#### **SPONSORING COMPANIES**

Pratt & Whitney  
Gerber Technology  
The Wiremold Company  
Timken  
Hamilton Sundstrand  
General Electric Industrial Systems  
Rogers Corporation  
Siemon Company

Pitney Bowes  
Electric Boat Corporation  
Sikorsky Aircraft  
Carlyle & Johnson  
Westinghouse  
Jacobs Vehicle Systems  
United Technologies Fuel Cells  
University of Connecticut

**For additional information or future participation and sponsorship contact:**

**Professor Thomas Barber**

**Department of Mechanical Engineering, University of Connecticut**

**U-139, 191 Auditorium Road, Storrs, Connecticut 06269-3139**

**Tel: (860) 486-5342 Fax: (860) 486-5088**

**E-mail: [barbertj@engr.uconn.edu](mailto:barbertj@engr.uconn.edu)**

