Project Name	Section	Uniqname	Uniqname	Uniqname	Uniqname	Uniqname	
Stirling	005	listc	kjcolema	jwiswall	jsethi	madamisi	
Bio-Robotic arm							
Structure							
Pillow							
Green							
Valves	05 or 04	sgallagh	slatham	bmarchen	sloanb	robertds	
Patient Simulator	002	gillb	zimmerm	parkaymas	ccadotte		
Patient Simulator	004	tunga	yht	ewidjaja	cpang		
Patient Simulator	003	adewunmi	rdewitt	avittori	mniemeye	cwinelan	
Patient Simulator							
Patient Simulator							
CNC Router tool							
Laptop Table	006	apolito	esledge	bmacfarl	yson	kmoller	
EDM							
Brain	004	rsathe	parodrig	hlandis	burrellj	cmoats	
KIDS	006	gbraziun	weberg	teichman	rdemsik		
Braille Printer							
Braille Display	004	chungak ??	ebeck ??	lelsesse ??	tongl ??		
ProCEED Arm	005	sheehanm	ccjoseph	cullenj	bpete	jlbrace	
Bushing	003	phota	rroth				
Oar	003	jfgibson	dconstan	ddouma ??			
Spinner	05 or 04	bfiedler	handj	jmtracy			
EPA HPV		glink	baldwinb	yjh	aouimet		
EPA Mix Valve							
EPA Flow	002	karlh	rwrichar				
PNF	004	fcaldero	lcelliso	tmarchio	ccary	jagreene	
Heel	005	sjjohnso ??	acombi	dcoatta	syg	cindycc	
BUGS	005	dwinterh	dbirenba	jherrity	heejungh	emorton	lcowper
Cam Profiler	005						
FSAE Exhaust	004	rileym	caratini	jtimmerm	aelgamma		
Suspension	05 or 06	hyundong	jsho	sur	yaoj	syg	
Fuel							
IROS Cross Mem							
Tendon							
Non-Contact	003	edobkin	vnewhous	mkilling	sjjohnso		
Snake							
Vascular Clamp	006	kuhln	amkoor	kabarnes	dmcgrath		
Fish	006	emoradia	kboukour	ksmehta	blamiman	draganm	
Camera							
Hand	006	zkreiner	westn	ddouma			
Tap	004	chungak ??	ebeck ??	lelsesse ??	tongl ??		
Clock	003	rmackenz	agliesma	eebrooks	enedelko		

Design & Manufacturing III
ME450 Fall 2003 Projects list
(Dennis, Kota, Kannatey-Asibu, Luntz)

DRAFT 8-28-03 RGD

This term we are emphasizing Projects that are defined by students, rather than by external sponsors. If you would like to propose a novel project (one that you or your team develops entirely by yourselves), you should follow the guidelines below for "Self-Defined Student Projects".

Sponsored Projects usually have the advantage of having a modest budget to cover the cost of supplies, whereas projects defined by students have more design freedom, but usually are not supported by a budget. Our budgetary guideline for all projects is $400 (total) for each project. Since you are not required to purchase a text book for this course, if the members of your team pay for the supplies for the project this works out to be approximately the same as the cost of text books. One difference is that, at the end of the term, if you paid for the materials in your Prototype you can keep it, whereas sponsored projects almost always go to the sponsor.

Student-Defined Design Projects:

(Code name: TBD by students)
Sponsor: Individual student teams
Contact: MUST have permission from Profs. Kota, Kannatey-Asibu, Luntz & Dennis.
Budget: NONE – students are expected to find resources to cover the costs.
Number of Design Teams (unlimited)
This project is available to students in the following sections: ANY SECTION

These projects can take one of several forms, depending upon the needs of the students.

Research Projects: These projects will usually be carried out as a part of the laboratory research of one or more of the members of the Design group.

Personal Interest or Hobby Projects: Self explanatory.

Sponsored Projects: These include, but are not limited to: Solar Car, Mini Baja, Formula 1, Moon Rover, etc. NOTE: the sponsoring group or the students themselves must provide for the materials budget.

Entrepreneurial Projects: These projects will be carried out by individuals or groups with an interest in starting their own company, or with an existing small company in which they are an involved.

General guidelines: Self-Defined Projects must be open-ended (not a "paint-by-numbers" project). Students must provide their own budget ($400.00 limit)**.** Project must not be technically trivial: it should draw from several of the basic engineering sciences and technical electives courses: strength of materials, systems control, dynamics, vibrations, thermal and fluid sciences, manufacturing, electro-mechanical design, and so forth. There is really no limit to the topic for these projects; they could include devices for environmental monitoring (e.g., a disdrometer to measure precipitation), toys, paper towel dispensers, or Rube Goldberg-esque appliances. NOTE: Students must discuss this with the instructor (Bob Dennis) during the first class period.

Stirling Cycle Heat Engine

(Code name: Stirling)
Student Originator: James Wiswall <jwiswall@engin.umich.edu>
Contact: James Wiswall <jwiswall@engin.umich.edu>
Budget: (none)
Number of Design Teams (1)
This project is available to students in the following sections: ANY
The main goal of this project is to make a Stirling cycle refrigerator that will cool a small container to very cold temperatures. Possible uses of this device include holding objects at cryogenic temperatures, and any type of portable cold space such as a small camping cooler. By adding a heat source, this device could also be used as a heat engine if power generation is desired. At www.keveney.com/Engines.html there are examples of three types of Stirling cycle engines.

Bio-Inspired Robotic Arm

(Code name: Bio-robotic Arm)
Sponsor: Bob Dennis or Sridhar Kota
Contact: Bob Dennis: yoda@umich.edu, kota@umich.edu
Budget: NONE – students are expected to scrounge materials with minimal cost.
Number of Design Teams (unlimited)
This project is available to students in the following sections: KOTA or DENNIS
Animals (and some plants) have developed a huge variety of appendages to allow them to modify their environment. Examples include tentacles which operate on a muscle – hydrostat system, like a squid; exoskeletal jointed limbs, like a crustacean or insect; internal skeleton muscle-tendon-bone mechanisms, like a vertebrate (e.g. mammal), and many others. For this project, students will be expected to develop a novel design for an appendage, inspired by nature. The general guidelines for this project are: must be very inexpensive & preferably mass producible, use common materials, remotely powered for slender end effecter design.

Structural Health Monitoring System

(Code name: Structure)
Sponsor: Prof. Bogdan Epureanu
Contact: Prof. Bogdan Epureanu: epureanu@umich.edu
Budget: NONE – students are expected to scrounge materials with minimal cost.
Number of Design Teams (1 or 2)
This project is available to students in the following sections: ANY

Physical structures can be monitored for their structural integrity by a number of means. One approach is to measure the response of the structure to dynamic loading. For example, weakened structures will often display reduced overall stiffness, and thus may have a reduced damped natural frequency of vibration when subjected to an impulse load. The students will build a simple metallic construction, attach a mechanical shaker to it, instrument it with accelerometers and strain gages, collect data, and use the measurements to make predictions about the structural integrity of the system. The students could extend this to real-life systems where they would collect data using the same sensors they use for testing the simple metallic structure.

Adjustable Pillow

(Code name: Pillow)
Sponsor: Prof. Jack Hu
Contact: Prof. Jack Hu <jackhu@umich.edu>
Budget: NONE – students are expected to scrounge materials with minimal cost.
Number of Design Teams (1)
This project is available to students in the following sections: ANY

The objective of this project is deceptively simple: design a pillow that automatically adjusts to keep the spine straight during sleep. Figure this one out, put it on QVC, and never work again.

GreenBlue Competition: Product Redesign for Environment

(Code name: Green)
Sponsor: see below
Contact: see below
Budget: TBD
Number of Design Teams (unlimited)
This project is available to students in the following sections: ANY
e-mail announcement from GreenBlue: Students would enter an exciting eDesign Idea Competition sponsored by the non-profit organization GreenBlue. The United States Environmental Protection Agency (U.S. EPA) awarded a grant to GreenBlue to conduct this competition as a forum to rethink and innovate existing computer products into more sustainable flows of services and materials. Entrants will be asked to submit their ideas for transforming the design of products, and the design of systems for recovering and recycling materials following product use. In order to realistically limit scope—desktop computers, laptop computers and displays will be the focus of the idea competition. GreenBlue will be soliciting submissions from students, faculty and researchers from diverse disciplines, as well as independent designers and consultants. We also are assembling a group of industry representatives from individual computer OEMs, component manufacturers and members of the Electronic Industries Alliance to act as sponsors, judges and the general audience for this competition. Although exact sponsors and awards have not been finalized, GreenBlue expects to offer financial awards and EPA recognition for winning entries. As a way to motivate students' participation, we are inviting you to integrate the idea competition into your semester coursework, using our call for submissions, cradle-to-cradle vision documents and assembled references as applied resources. Entries may be submitted by a group of students representing one or more university departments or by individual students. We anticipate having an entry deadline of February 28, 2004. Please see the attached document "eDesign Idea Competition" to review draft submission requirements, competition timeline, judging guidelines and other logistics. This document, along with all of the background documents will be available on the eDesign section of our website on September 2, 2003.
Please visit our current site at < http://www.greenblue.org/activities_lead.html >.

James Ewell GreenBlue P.O. Box 2001 Charlottesville, VA 22901 v: 434-817-1424 or 434-295-0204 x:227 f: 434-817-1425 <james.ewell@greenblue.org>

Electrically controlled miniature pneumatic or hydraulic valves

(Code name: Valve)
Sponsor: Bob Dennis
Contact: Bob Dennis: yoda@umich.edu
Budget: $200 limit (Bob Dennis' research account)
Number of Design Teams (1)
This project is available to students in the following sections: 005 (DENNIS)

There are a growing number of applications for miniature hydraulic and pneumatic control products. General application areas include biomedical, industrial process control, toys, and vehicles. The objective of this project is to build the most compact and inexpensive electronically-controlled valve for fluid flow control. Students have the design freedom to use new materials such as shape memory alloy (SMA), piezo ceramics or polymers, rare-earth element magnets. A variable-flow valve design will earn considerably more points than a simpler ON-OFF valve. Small size, low cost, low power consumption and ease of manufacture are paramount concerns for this design.

Human Patient Simulator

(Code name: Patient Simulator)
Sponsor: Bob Dennis & Department of Emergency Medicine
Contact: Bob Dennis: yoda@umich.edu
Thomas Deegan (tdeegan@umich.edu)
Rajani Yellamanchili (cryant@umich.edu)
Budget: TBD
Number of Design Teams (1-6)
This project is available to students in the following sections: 003, 004, 005, 006

Ever wonder how Emergency Room doctors learn to take decisive and correct action in the face of any medical emergency? By making a lot of mistakes on innocent people until they finally figure out what they are doing, that's how. Well, it's probably not that bad, but it would certainly help if there were some way to simulate an injured person, so newly trained physicians could hone their skills on plastic rather than flesh. Enter: The Human Patient Simulator concept. Students will develop subsystems to simulator physiological signals for the simulator: blood pressure & pulse, temperature, blinking eyes, etc… The system will enhance an existing system in place for training emergency medicine residents. Contact the sponsors for additional information.

Low-dust cutting tool system for CNC router

(Code name: CNC Router Tool)
Sponsor: Bob Dennis
Contact: Bob Dennis: yoda@umich.edu; Steve Emanuel: fulcrum@umich.edu
Budget: $200 limit (Bob Dennis' research account)
Number of Design Teams (1)
This project is available to students in the following sections: ANY

We have a 3-axis CNC router for cutting large objects, such as structural foam and wood planks. Objective: develop a quiet, low-dust cutting system for structural foam that will allow rapid material removal, with replaceable blades and a central vacuum to remove chips and dust during cutting.

Ultra-light adjustable-height folding laptop table

(Code name: Laptop Table)
Sponsor: Bob Dennis
Contact: Bob Dennis: yoda@umich.edu
Budget: $100 limit
Number of Design Teams (1)
This project is available to students in the following sections: ANY
The objective is to build a truly portable, adjustable height, ultra-light laptop table that can be folded into a slim carrying case (maximum folded dimensions = 1" x 1.5" x 14", in a rectangular case). When unfolded and assembled, the laptop table will be of sufficient strength and rigidity to hold a laptop at the desired height and angle for work while seated.

Electron Discharge Machining (EDM) Hole Driller

(Code Name: EDM)
Sponsor: Bob Dennis
Contact: Bob Dennis: yoda@umich.edu
Budget: $100
Number of Design Teams (1)
This project is available to students in the following sections: 005 (DENNIS)

Electron Discharge Machining (EDM) is a common industrial machining process which uses electro-chemical rather than mechanical means to remove materials during machining. The process is slow, but allows very fine details to be machined into hard metals, including hardened tool steels. The objective of this project is to develop an EDM hole driller that can be used on a Bridgeport Milling Machine, or similar standard machine shop tool.

Insertion tool for Neural Electrode Array

(Code Name: Brain)
Sponsor: Bob Dennis & Daryl Kipke
Contacts: Daryl Kipke: dkipke@umich.edu, Bob Dennis: yoda@umich.edu
KC Kong: kangchun@umich.edu
Budget: $TBD
Number of Design Teams (1)
This project is available to students in the following sections: ANY

Modern brain-machine interface electrode technology has produced increasingly fine and delicate electrodes for use in human, rat, and primate brains. These electrodes hold the promise of direct brain communication to facilitate recovery of function following trauma, and the study of basic brain function. Ironically, one serious limitation to this technology is a deceptively simple mechanical one: how to place the electrode properly into the brain. The objective is for students to design an insertion tool for use by members of the Neural Imaging Laboratory at U of M. More info: <http://www.eecs.umich.edu/NELab/index.htm

Safe Products for Infants & Children

(Code Name: KIDS)
Sponsor: Bob Dennis & Nancy Cowles, Executive Director, Kids in Danger
Contacts: Nancy Cowles: nancy@kidsindanger.org, Bob Dennis: yoda@umich.edu
Budget: $0
Number of Design Teams (unlimited)
This project is available to students in the following sections: ANY
The objective is for students to design children's products that meet safety standards. Students can select the toy or product to be designed, then they will be required to identify and follow applicable safety standards for all aspects of the design. Project Ideas from the sponsor:

-A safe, folding portable crib. If you have looked at our materials, you know that the founders of KID lost their son when a portable crib's side rails collapsed around this neck -- this type of product has killed at least 15 children. While this particular design is off the market, any portable crib that has hinged side rails has the potential to create the same hazard if the hinge fails at some point. J. Mason, another manufacturer, makes a portable crib with a continuous top rail -- eliminating the risk, but creating a rather bulky 'portable' item. Your students could look at this problem and suggest designs that won't create the hazard if they fail, but might be easier to carry around

-A warning system for strollers. A potential hazard of strollers is that if they are not fully engaged in the operative position, they can collapse when the wheels hit an obstacle, injuring the occupant. Many strollers on the market today can create a 'false' latching, because the design of the stroller makes it appear to be latched when it isn't. Could the students either design a folding mechanism that would not stay in place if it wasn't fully latched -- disallowing any 'false' latching, or some sort of warning signal to parents that the latch wasn't fully engaged.

Thousands of babies are injured each year in incidents with strollers or carriages. One of the problems is a 'false latching' situation whereby parents believe a stroller latch is fully engaged because the stroller appears to be steady, but when a bump or curb is hit, the stroller collapses, injuring the occupant. Can the students devise either an electronic alert system to alert the caregiver or eliminate the possibility of a false latching in the stroller itself.

Other Project Ideas for KIDS:

- At least 16 babies have been killed when the side rail of their portable crib collapsed, forming a v shape that entraps the child and causes suffocation. Other designs are currently made that don't allow for this hazard, but the resulting product is bulky and hard to carry. Can the students design a portable crib that doesn't allow a failure that results in a v-shape, but is more compact?
- Hard-handled baby carriers often are recalled because the handle latching system fails, causing the seat to swing down and the occupant to fall or hit an object. Can the students look at this latching mechanism and find a solution.
- Baby monitors have been recalled because of overheating. Can the students design a device that disables the device immediately on overheating and warns the user?
- Hardware failure is a major cause of injury in cribs and other children's products. Considering human factors of how a child behaves while in a crib and caregiver actions that

might strain hardware, can the students develop a test to assure hardware stability or a warning system for loose or broken screws and other hardware.

- Over 67,000 children under the age of 4 are rushed to emergency rooms each year due to injuries from children's nursery products, cribs, strollers, etc. Can students look at the incident data from one type of product and identify hazards that can be designed out of the product.
- Cribs are the one product intended to keep children safe with no supervision. Yet, between 20-30 children die each year in cribs and thousands more are injured. Can the students design a prototype of a 'failsafe' crib – one that limits hazards to a minimum?
- Many baby products sport the warning, "do not leave child unattended." What does this really mean to parents and is there a more effective way to warn about the need for supervision.
- When a product is recalled, the manufacturer issues a press release with the Consumer Product Safety Commission and notices are posted in stores. Is there a more effective way to track people who purchased the product, without sacrificing privacy, to alert them to the product dangers when recalled?
- The CPSC maintains a NEISS (National Emergency Incident Surveillance System) database of injuries presented in emergency rooms. Right now, the database can only be accessed by one person online at a time – making it virtually impossible for KID to ever log on to get needed data. Can the students write a program to query the system during non-peak hours or to continue attempting to log on until successful?
- Illinois and six other states have passed the Children's Product Safety Act that requires the states to maintain a list of recalled products on their web sites. Most often, these sites aren't updated regularly, causing delay in warning those affected. Can students write a program that automatically produces a list of recalled products from government sources when queried from another site (such as the State's)?

Braille Printer (ProCEED)

(Code Name: Braille Printer)
Sponsor: Prof. Schultz and Peter Adamczyk
Contacts: schultz@umich.edu, Peter Adamczyk: padamczy@umich.edu
Budget: $100
Number of Design Teams (1)
This project is available to students in the following sections: ANY

The objective is to develop and test a concept for an inexpensive and simple Braille printer. Braille printers do exist, but they tend to be complex and very expensive. With the advent of speech recognition and read-back software, the need for Braille printers to allow blind users to interface with a computer has diminished significantly, but there are special cases where this technology is still useful. This project would present excellent opportunities for students to develop design skills with electromechanical devices and computer interfaces

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Refreshable Braille Display (ProCEED)
(Code Name: Braille Display)
Sponsor: Prof. Schultz and Peter Adamczyk
Contacts: schultz@umich.edu, Peter Adamczyk: padamczy@umich.edu
Budget: $100
Number of Design Teams (1)
This project is available to students in the following sections: ANY

The objective of this project is to develop a Braille printer that can print ASCII text characters to normal printer paper. The students have the freedom to decide on any method for the formation of the Braille characters: deposition of thick ink dots, raised bumps, etc. This project would present excellent opportunities for students to develop design skills with electromechanical devices and computer interfaces.

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Robotic Arm for Workstation (ProCEED)
(Code Name: ProCEED Arm)
Sponsor: Prof. Schultz and Peter Adamczyk
Contacts: schultz@umich.edu, Peter Adamczyk: padamczy@umich.edu
Budget: $100
Number of Design Teams (1)
This project is available to students in the following sections: ANY

The objective of this project is to develop a robotic arm to allow adjustment of the accessible workstations in the UGLi. Jim Knox of the Adaptive Technology Computing Site has asked that we design a robotic arm to allow adjustment of the position of a flat screen display. Current versions of these adjustment arms are not powered; they are simply multi-articulated arms with springs for force biasing. The user has to adjust the arm manually. For some handicapped users, this is an impossible task. The students could adapt an existing arm to add powered motion, or they could develop an entirely new concept to solve this open-ended design problem.

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Parametric Bushing Test Tool

(Code Name: Bushing)

Sponsor: Todd Vest, General Motors
Contacts: todd.vest@gm.com

Budget: $TBD

Number of Design Teams (2)

This project is available to students in the following sections: ANY

The initial objective of this project is to develop an automated software tool which takes user specified geometry and material information for a bushing and delivers predicted bushing performance characteristics. The elastomer bushings used commonly for suspension attachments and engine mounts are carefully designed to satisfy several goals including isolation, stiffness, and load management. Oftentimes their translational and rotational rates are continually updated to find a combination which balances the often conflicting requirements as well as possible. To do this, the size and internal geometry (voids) are varied while respecting molding limitations and durability issues. This is a laborious task done in partnership with the suppliers and using UniGraphics. It is desired to develop a tool which can automatically determine the translational and rotational rates of a bushing given its geometry and material properties. A conceptual flowchart of this process automator is show in the first slide of the attached PowerPoint file. Once the UG solid geometry and material properties are provided to the tool, no other interaction should be required of the user to obtain rate information (load/deflection curves, e.g.). If the original UG solid geometry is defined parametrically, then it should be possible to extend the automated rate calculation tool into a bushing designer, with required rate information as the input and proposed geometry as the output. The optimization techniques and tools to perform this are intentionally not defined, as there are many preconceptions on how this task should be approached.

GM is looking for some new ideas. It is suggested that the simplest bushing geometry, a cylinder, be used to create a “Proof of Concept”. Given radii and length, and material properties, the tool should be able to give radial, axial, and rotational rate curves. Experimental correlation could be arranged easily. Once the automated tool is completed, extending it to more complex geometries, which will challenge the mesh generation tool as well as the robustness of the FEA solver can be tackled. Given success in this second phase of the project, running the process in reverse can be considered. It is expected that the effort could span several semesters.

Instrumentation & Analysis of Oar Mechanics

(Code Name: Oar)
Sponsor: Prof. Noel Perkins
Contacts: Prof. Perkins: ncp@umich.edu
Joe Gibson (jfgibson@engin.umich.edu)
Doug Constantine (dconstan@umich.edu).
Budget: $TBD
Number of Design Teams (1) NOTE: this team is already partially formed
This project is available to students in the following sections: ANY

Project Description: Oars used in competitive rowing and sculling transmit the forces required to propel a boat forward. This project will provide a unique capability of measuring these forces as well as the companion dynamic response of an oar. Your team will design an instrumentation module that will measure the dominant force and motion components (e.g. bending moment, acceleration and angular velocity components) needed to understand the fundamental mechanics of an oar while in use. The module will be integrated on or within an oar, be battery-powered, and will integrate with a simple data acquisition system. You will be responsible for constructing a working prototype of this module and the analysis routine (software) to reduce the data. You will also be responsible for formulating a number of key questions about oar mechanics that would be useful in coaching and diagnosing the performance of an individual crew member. Examples of what you might need to measure include the instantaneous power, the “catch” and “release” events, the stroke velocity, feathering angle, etc.

Electro-spinning machine for biocompatible fibers for tissue engineering

(Code Name: Spinner)
Sponsor: Prof. Bob Dennis
Contacts: Prof. Bob Dennis: yoda@umich.edu
Budget: $200
Number of Design Teams (1)
This project is available to students in the following sections: 005 (Dennis)

Tissue engineering is an emerging field where biologists, engineers, and clinicians try to develop new technologies to replace injured, lost, or malformed tissues. It is projected by many analysts to be the largest growth industry of the first half of the 21st century. There are several basic approaches to tissue engineering. One of these approaches involves the use of *scaffold* materials to support cell growth and to supply a mechanical support until the newly formed tissue can take over the function of the lost tissue. There are several technologies that have been employed to make scaffold materials, in fact, there are large books written about just this topic. Recently, investigators have used a very old method, called *electrospinning*, to generate very fine fibers of biological materials, such as collagen I, II, III, elastin, and fibrin. Electrospinning has been used in the textile industry for over a century to generate fine fibers. The objective of this project is to build a simple and inexpensive electrospinning machine to make scaffold materials for replacement tendons, ligaments, and blood vessels. Although there are a few companies that do this for tissue engineering, for research purposes it is necessary to have full control of this process in the laboratory.

For more information on commercially-available processes you can visit the following commercial web site: <http://www.nanomatrix.biz>

EPA: Human Powered Vehicle

(Code Name: EPA HPV)
Sponsor: EPA
Contacts: <Moskalik.Andrew@epamail.epa.gov>
<Swain.David@epamail.epa.gov> phone: 214-4377
Budget: $400
Number of Design Teams (1)
This project is available to students in the following sections: ANY
The student team will confer with the sponsor to select one of the following two ideas: a) Enhance the SAFETY and SECURITY (may need an EECS major) DETAILS: Add shielding and tethering for hydraulics. Reengineer the steering to be safer for this vehicle. Reengineer the rear wheels and drive system to be more stable around turns.   Reengineer the charging system and battery container with a safer alternative. Add seatbelts. Add centralized gauges for driver. b) Enhance the ASTHETICS and TEST the vehicle on a dynamometer. Create a skin for the vehicle, incorporating possible future enhancements for blinkers, headlights, & windshield. This is an opportunity for students to understand the chassis testing environment, critical factors during a test, and the importance of baselining the vehicle.

EPA: Mixing Valve

(Code Name: EPA Mixing Valve)
Sponsor: EPA
Contacts: Mark Stuhldreher, phone: 214-4922, <stuhldreher.mark@epa.gov>
Budget: $400
Number of Design Teams (1)
This project is available to students in the following sections: ANY
MIXING VALVE: Current stock valves used for mixing airstream flows (for example, EGR and fresh charge) have stability issues, tend to flutter, and/or seal poorly. This project would be to design a valve having two input ports, where output flow can be chosen as any combination of flow from the two input ports. Each input should be capable of being sealed to provide 100% flow from the opposite port. Valve position should be independent of flow speed. Students will be required to get instructions from their EPA contact on reporting expectations for this project.

EPA: Port Injector Flow Measurement

(Code Name: EPA Flow)
Sponsor: EPA
Contacts: <Moskalik.Andrew@epamail.epa.gov>   phone: 214-4719
Budget: $400
Number of Design Teams (1)
This project is available to students in the following sections: ANY
PORT INJECTOR FLOW MEASUREMENT: Port fuel injectors have inherent shot-to-shot variability in fuel quantity injected; this variability depends on compression pressure, engine speed, dynamics in the injection system, and other issues. For this project, design a test stand capable of measuring quantity of fuel injected with a port fuel injector. The test apparatus should be capable of detecting single shot quantities in real time at shot frequencies corresponding to real engine speeds. Students will be required to get detailed instructions from their EPA contact on reporting expectations for this project.

Upper Extremity Proprioceptive Neuromuscular Facilitation (PNF) Orthosis
(Code name: PNF)
Sponsor: UM Orthotics and Prosthetics Center
Contact: Ammanath Peethambaran: peeth@med.umich.edu
Budget: Contact Sponsor
Number of Design Teams (1)
This project is available to students in the following sections: KOTA or DENNIS

Proprioceptive Neuromuscular Facilitation (PNF) is a type of flexibility exercise, which combines muscle contraction and relaxation with passive and partner-assisted stretching. It is better known as assisted stretching. PNF utilizes an active muscle's relationship to a relaxed muscle to lengthen or stretch chronically tight muscles. A hold and relax technique is typically used to accomplish this. Therapist will stretch the muscle as far as you can comfortably go and then provide resistance while you contract the muscle. When you relax the muscle a second time, your therapist will stretch the muscle a little farther. This sequence will be repeated several times to lengthen the muscle.

Orthosis design criteria:

A typical patient after stroke (e.g. hemiplegia) may present with elbow flexion, wrist flexion and internal rotation (see Figure).

Orthosis design is to extend the elbow (manually or electrically) creating an accompanying external rotation of forearm (supination) and simultaneously extend the wrist.
Range of motion:
145 degrees Flexion –extension range of motion at elbow.
50 degrees pronation, 50 degrees supination of forearm
30 Wrist flexion, 35 Extension.
Material: Light weight Metal/ carbon composite.
Dimensions: Slim line design for human subject use.

Notes: Students will have the opportunity to work closely with the professional staff of the UM Orthotics and Prosthetics Center, and will also have the opportunity to continue with the development of the design after the term has ended.

Heel Stretching Device
(Code name: Heel)
Sponsor: UM Orthotics and Prosthetics Center
Contact: Mark Taylor: Orthotics & Prosthetics <markt@umich.edu>
Budget: Contact Sponsor
Number of Design Teams (1)
This project is available to students in the following sections: KOTA or DENNIS

Development of an orthosis that stretches out the heel cord. The system should allow for the self application of the device and then some type of self adjustment to get good stretching for a defined period of time. This would consist of a foot plate with some type of ankle joint attached to a posterior shin/thigh section. The joint could be controlled by some type of electronic motor on a worm gear or some other mechanism.

Hardware Redesign to Improve Rough Terrain Mobility and Carrying Capacity for NAVEODTECHDIV BUGS Unmanned Ground Vehicle

(Code name: BUGS)
Sponsor: Navy Explosive Ordnance Disposal Technology Division (NAVEODTECHDIV)
Contact: Winterhalter Daniel M NEOD <WinterhalterDM@eodpoe2.navsea.navy.mil>
Budget: Contact Sponsor
Number of Design Teams (1)
This project is available to students in the following sections: ANY

The Navy Explosive Ordnance Disposal Technology Division (NAVEODTECHDIV) currently has several robotics programs in progress. One of these programs is a set of autonomous mobile robots intended for co-operative use in neutralizing unexploded submunitions that have been spread over varying terrain. The Basic Unexploded ordnance Gathering System (BUGS) vehicles are currently capable of completing their mission on very limited terrain- only relatively flat and hard surfaces ranging from pavement to grass. The accessible terrain has been limited by the low ground clearance of the vehicle due to the effective range of the existing metal detector. A critical step in improving the effectiveness of the BUGS system is to increase the types of terrain that the vehicle can traverse without losing any of the mission functionality. A second important future task for NAVEODTECHDIV is the integration of the Semi-Autonomous Manipulator (SAM) with a robotic mobility platform capable of transporting it to unexploded ordnance. Objective: to examine and redesign the existing BUGS vehicles focusing on improving rough terrain mobility while maintaining effective sensor coverage and mission functionality. A secondary task is to enable transportation of the SAM. Upon completion of prototype construction, we will conduct comparison testing to determine the effectiveness of our enhancements.

Cam profiler for U-Mich Formula SAE Race Team

(Code name: CAM)
Sponsor: Bob Dennis
Contact: Bob Dennis <yoda@umich.edu>, Marvin “Bob” Riley <rileym@engin.umich.edu>
Budget: Contact Sponsor
Number of Design Teams (1)
This project is available to students in the following sections: ANY

Objective: to design a cam profiler system to automate the process of measuring a cam. The system would simultaneously record the cam angular position and the cam height. The system must accommodate cam shafts as defined by the sponsor. This project will include sensors, electronics, and data acquisition systems.

FSAE Exhaust System Design

(Code name: FSAE Exhaust)
Sponsor/Contact: FSAE: Marvin “Bob” Riley <rileym@engin.umich.edu>
Budget: Contact Sponsor
Number of Design Teams (1)
This project is available to students in the following sections: RESTRICTED BY SPONSOR
The design and manufacture of an intake and exhaust system for a 4-cylinder motorcycle engine. Design criteria are as defined by the sponsor.

Test Fixture for Primary Suspension

(Code name: SUSPENSION)
Sponsor: International Truck and Engine Corporation
Contact: Patrick G. McNally - pat.mcnally@nav-international.com – Ph. (260) 461-1125
Nolan Knight: phone: (260) 428-3195
Budget: Contact Sponsor
Number of Design Teams (1)
This project is available to students in the following sections: ANY
Objective: Design a test fixture appropriate for validating the structural aspects of the primary suspension systems for highway trucks. The primary focus of the fixture will be to provide an in-laboratory tool for validating the structural durability of the suspension system through accelerated tests.

Tasks:
Task 1 – Establish the parameters of the suspension system, while operation on a vehicle on the highway, that must be replicated on an in-lab test fixture to simulate appropriate structural loading in the suspension components. International's vehicle test engineers will assist the student in accomplishing this task.
Task 2 – Develop a geometric layout of the fixture. International engineers will provide the geometry of the vehicle components, of the electro-hydraulic actuators appropriate for the loading of the components, and of the bedplates for anchorage of the fixture. The students would need to develop the physical layout to achieve the kinematic requirements of the fixture, select appropriate bearings and other supporting commercial hardware, and size the members of the fixture for appropriate strength.
Task 3 – Evaluate and optimize (if needed) the dynamic response of the rotating and translating members of the fixture so that the system (including the hydraulic actuators) can excite the suspension system similar to the way it is excited on the vehicle.
Task 4 – Generate detailed drawings of the fixture components so International can have the fixture fabricated.

Deliverables:
International expects presentations of status and intermediate conclusions after each of the tasks. After task 3, we expect a report describing the fixture and explaining the dynamic and kinematic capabilities of the fixture. Task 4 is desirable but a CADs database of the layout could be substituted if time constraints prohibit completion of the last Task.

Public Transportation Fuel System

(Code name: FUEL)
Sponsor: International Truck and Engine Corporation
Contact: Patrick G. McNally - pat.mcnally@nav-international.com – Ph. (260) 461-1125
Mike Jones, Phone: (260) 461-1594
Budget: Contact Sponsor
Number of Design Teams (1)
This project is available to students in the following sections: ANY
Object:

Design a fuel tank system (tank and cage) that meets the FMVSS requirements for fuel tank performance on public transportation applications. The primary focus will be to provide design that takes advantage of advances in computer simulation, material selection, and manufacturing techniques.

Tasks:
Task 1 – Establish design parameter by investigating applicable federal requirements and commercial demand. Benchmark existing design. International Engineering will provide guidance.
Task 2 – Develop design envelope for fuel tank within existing parameters. Produce preliminary computer models of proposed design alternatives.
Task 3 – Evaluate and optimize response of fuel tank systems to loads expected in daily operation and in crash environment.
Task 4 – Generate detailed drawings of the components so International can have the fuel tank system fabricated.

Deliverables:
International expects presentations of status and intermediate conclusions after each of the tasks. After task 3, we expect a report describing the proposed fuel tank system (material selection, load response). Task 4 is desirable but a CADs database of the layout could be substituted if time constraints prohibit completion of the last Task.

Note: potential for two project one between the rail fuel tank and side mounted fuel tanks.

IROS Cross member Design

(Code name: IROS)
Sponsor: International Truck and Engine Corporation
Contact: Patrick G. McNally - pat.mcnally@nav-international.com – Ph. (260) 461-1125
Mike Jones, Phone: (260) 461-1594
Budget: Contact Sponsor
Number of Design Teams (1)
This project is available to students in the following sections: ANY
Object:
Design a cross member that meets performance requirements for IROS (International Ride Optimized System) cross member application. The primary focus will be to provide design that takes advantage of advances in computer simulation, material selection, and manufacturing techniques.

Tasks:
Task 1 – Establish design parameter by investigating applicable design applications and commercial demand. Benchmark existing design. International Engineering will provide guidance.
Task 2 – Develop design envelope for cross member within existing parameters. Produce preliminary computer models of proposed design alternatives.

Task 3 – Evaluate and optimize response of cross member to loads expected in service life. International to provide load information.
Task 4 – Generate detailed drawings of the components so International can have the cross member fabricated.

Deliverables:
International expects presentations of status and intermediate conclusions after each of the tasks. After task 3, we expect a report describing the proposed cross member (material selection, load response). Task 4 is desirable but a CADs database of the layout could be substituted if time constraints prohibit completion of the last Task.

Note: Project supports Technology Development program with Delphi.

Engineered Tendon Test Station

(Code name: Tendon)
Sponsor/Contact: Prof. Arruda, Bob Dennis <yoda@umich.edu>
Budget: Contact Sponsor
Number of Design Teams (1)
This project is available to students in the following sections: DENNIS

The objective is to develop laboratory instrumentation to test the function of tissue engineered tendon and ligament tissues in cell culture. This is a part of the ongoing research effort in Dr. Dennis & Dr. Arruda's laboratories.

Non-Contact Robotic Manipulation in 3-D

(Code name: Non-Contact)
Sponsor/Contact: Prof Luntz <jluntz@umich.edu>
Budget: Contact Sponsor
Number of Design Teams (1)
This project is available to students in the following sections: LUNTZ

Everyone has seen the "Bernoilli Ball", where a light ball floats stably in an upward pointing stream of air even when the stream is tilted.   A non-sperical object floats with a stable orientation (try it with a plastic easter egg and a shop-vac - it always points sideways.) This project extends this idea to the general manipulation of objects in 3-D with multiple air jets. The students will design and construct a prototype manipulator which repositions air jets to float and manipulate light objects with 4, 5, or even 6 degrees of freedom: in essence, a non-contact robot manipulator.

Pencil-thin snake-like robot

(Code name: SNAKE)
Sponsor/Contact: Prof. Luntz <jluntz@umich.edu>
Budget: $400
Number of Design Teams (1)
This project is available to students in the following sections: LUNTZ

The goal of this project is to design an extremely thin many-degree-of-freedom robotic "snake" capable of both shaping itself for insertion into tight spaces (such as in turbomachinery inspection) and of gentle grasping and manipulation of objects. The basic mechanism should be compliant and continuum-like (where the bending occurs over the length of the robot rather than at discrete joints). It is likely that the project will require the use of smart materials for actuation as the robot must be very small, although other solutions are welcomed and encouraged.

Vascular Clamp

(Code name: CLAMP)
Sponsor/Contact: Dr. Juan Arenas, Transplant Surgeon, and Prof. Kota <kota.umich.edu>
Budget: Contact Sponsor
Number of Design Teams (1)
This project is available to students in the following sections: KOTA

During a liver transplant operation, a vascular clamp is used to clamp superior vena cava. The clamp that is currently in use to clamp such thick wide structure is functionally inadequate - the force on the teeth on the clamp's toe is less than on the heel, so the vein slips out of the clamp, causing much difficulty during the operation. The goal of this project is to design and fabricate a clamp by which the force and the tension would be distributed equally across the entire length of the clamp. Additionally, it is important to avoid use of conventional joints to eliminate pinch points and for ease of sterilization. Therefore, the design team should consider a compliant mechanism to accomplish the task. The vein is approximately 20 cm from the skin edge in depth and once clamped it is approximately 5cm in length and 5 -10 mm in thickness. The clamp that is currently in use is available for study.

Robotic Fish

(Code name: FISH)
Sponsor/Contact: Prof. Kota <kota@umich.edu>
Budget: Contact Sponsor
Number of Design Teams (1)
This project is available to students in the following sections: KOTA

The idea behind submarines is stealth. Underwater warships and missiles are harder for the enemy to detect. But because they're propeller driven, subs create a wake that can be spotted, especially by satellites. So the Navy is keen to develop unmanned subs that create little or no wake, and are also more maneuverable. The best way to do that is to mimic fish, which wiggle through the water and have virtually no detectable signature. The goal of this project is to design and fabricate a foot-long robotic fish. The project entails creative design of compliant tail fins, pectoral fins, selection of small actuators, batteries and systems integration.

Quiet Camera Swivel Mount

(Code name: CAMERA)
Sponsor/Contact: Prof. Kota <kota@umich.edu>
Budget: $400
Number of Design Teams (1)
This project is available to students in the following sections: KOTA

Most surveillance-camera mounts have integral motor and kinematic joints to allow the camera to rotate approx 120 deg and swivel approx. 40 degrees to scan the space under surveillance. The noise generated by motors muffles the recorded sound and also alerts the intruder. The goal of this project is to design a new camera mount that is quiet by eliminating rotary motors and conventional joints. The goal is to design and fabricate a compliant mechanism that provides the similar function and that is integrated with compact actuators such as Shape Memory Alloy wires.

Prosthetic Hand

(Code name: HAND)
Sponsor/Contact: Prof. Kota <kota@umich.edu>
Budget: $400
Number of Design Teams (1)
This project is available to students in the following sections: KOTA

Most prosthetic hand devices available in the market are severely limited in functionality. The goal of this project is to design and fabricate a 3-fingered artificial hand that is driven by a single actuator and integrated with a novel differential mechanism to control the motion of individual fingers. The fingers themselves should be compliant and designed to exert the right amount of force as they grasp objects of different shapes and sizes.