

# CAPSTONE

## DESIGN PROGRAM



2006-07

## About Capstone Design

### About the Michigan Tech Capstone Program

Michigan Technological University's Capstone program is a two-semester experience in which senior undergraduate engineering students, working in nominally sized teams of 5-6 people, solve engineering design problems posed by sponsoring industrial firms. Projects are 2 semesters (1 academic year) in length, with new projects beginning twice each year (January and September). These projects encompass the entire design process — ideation through functional prototype build and evaluation.

The first semester ends with a formal project review, reflective of a typical stage-gate process, in which each team demonstrates their design progress to date and gain approval for their plan to complete the project during the second semester. The second semester concludes with a project-ending full presentation before industry representatives, faculty members, and their peers.

This is truly a Capstone experience for these students, bringing their analytical skills to bear in the context of a team working toward a common goal. The experience is further enhanced through inter-disciplinary makeup of the teams normally formed to solve these engineering tasks. Students from various engineering curricula including Mechanical, Electrical, Computer, Biomedical, and Chemical Engineering can leverage their diverse perspectives in producing innovative solutions to their design issues.

Typical projects are design-intensive, where the team may be asked to develop a new product, design and build a portion of a new manufacturing process cell, or fabricate a special machine designed for a specific task. Each team operates autonomously with an advisor from MTU's faculty and is responsible for managing their own operating budget. Regular contact with each sponsor's project champion is maintained throughout the project via telephone or video conferencing. The projects are highly interactive with the sponsor. On-site visits by the team to the sponsoring unit are usual, and frequency will vary from project to project.

Systems are in place to accommodate IP protection issues as well as allowing for an open model conducive to foundation/non-profit funding.

I welcome you to have a look at some recently completed projects outlined in this booklet, and to consider experiencing this program for yourself. Our Capstone program continues to excel and our thanks go to the firms who continue to support the development of these young engineers through our Capstone Program.

Bob De Jonge, Project Director  
*Michigan Technological University*



Photo: Michigan Tech Photographers

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- 23 Projects Completed December 2006 (orange section)
- 33 Projects Completed April 2007\* (green section)

\*These projects were yet to be completed at time of printing

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*Research Engineer*

# UNIVERSAL LAUNCHER

## DESIGNING WITH MICHIGAN TECH UNIVERSITY

By Dave Heatherington

Last year, Shape was approached by a representative from Michigan Technological University (MTU) and asked to participate in sponsorship of a Senior Design Project. Senior design projects are common in engineering schools and are used to emphasize and employ theoretical teachings in real world applications.



The seniors are expected to work in teams to tackle real world problems that are defined by an actual company. The company becomes the sponsor and works throughout the year providing guidance and support to the senior design team.

Shape's Advanced Product Development (APD) Team was asked to evaluate this opportunity and identify potential projects that could be defined and completed in one year by a team of up to six engineering seniors from different curriculums. The APD Team identified a handful of ideas and eventually settled on a Universal Launcher—a flexible piece of test hardware that can be used to propel various shapes at intended targets. The Universal Launcher represents another piece of test equipment that can be used to evaluate new energy management products. As energy management companies, Shape and our sister company, Netshape, are continually looking at ways to apply our energy management knowledge and experience to additional products that can be used to reduce vehicle damage and better protect the vehicle occupants.

Initial use of the Universal Launcher will focus on pedestrian protection and the

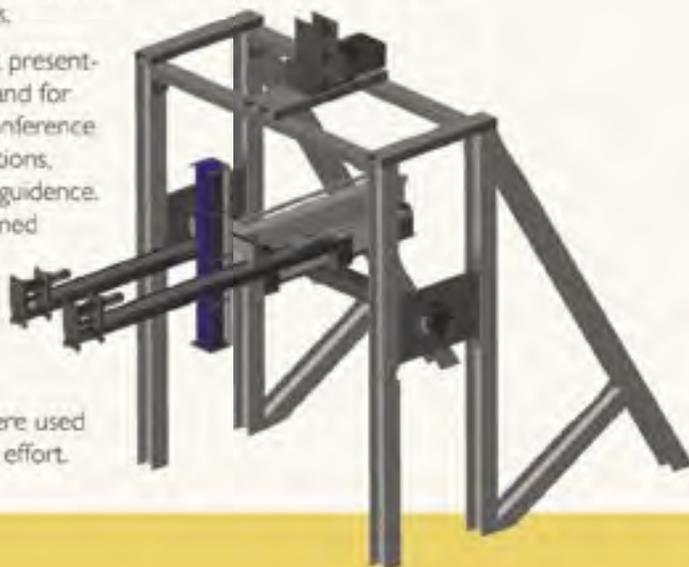
new, stricter European legislation associated with this protection. This legislation opened the door for new products that efficiently manage the impact energy when pedestrians and vehicles collide. The launcher is able to launch all of the fixtures associated with this new legislation: lower leg form, upper leg form, adult head and child head. Netshape recently developed a vacuum-formed energy absorber that is positioned in front of Shape's bumper beams, providing the absorption characteristics necessary to protect pedestrians who are struck by vehicles. The launcher will help to better quantify the performance of these types of energy absorbers.

The MTU senior design project presented challenges for the students and for the Shape team. Weekly teleconference calls were held to answer questions, monitor progress, and provide guidance. The senior design team performed numerous calculations for design and safety to verify the structural integrity of the launcher. Common industry software tools for computer aided engineering were used to assist the team in the design effort.

The team struggled with procuring all of the components necessary to construct the launcher in a timely manner, and thus the team had limited test launches before final presentation to the staff, faculty, students and sponsors at MTU.

The team sent a detailed final report that included design criteria, CAD files/data, operating instructions, bill of materials, and parts list that included cost. The launcher was disassembled and sent to Shape where the staff of the Shape Technical Center went to work immediately assembling and modifying certain elements of the launcher to make it more flexible and robust.

The staff of the Technical Center did an excellent job receiving an academic project and turning it into a functioning and safe real world piece of test equipment. The Universal Launcher can now be used to test new products that continue to reduce vehicle damage and protect vehicle passengers.





## Projects Completed April 2006

april 2006

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## Universal Launcher for Automotive Testing

### PROJECT DESCRIPTION

Guided and free flight launchers are used in a wide range of automotive testing to certify component/system performance for various federal and international testing standards. Federal Motor Vehicle Safety Standards 201 "Occupant Protection in Interior Impacts" and 208 "Occupant Crash Protection" deals with head forms and full Hybrid III dummies where impact forces are measured with respect to various body parts. The European Commission recently adopted Pedestrian Protection regulations that require free flight launching of lower leg, upper leg, and head form test fixtures.

### OBJECTIVE

The project objective is to design and develop a universal launcher that is capable of guided and free flight launch of various automotive test protocols (head forms, body blocks, leg forms, knee forms, etc...). The launcher should be capable of launching test fixtures up to a maximum weight of 40kg and at maximum speeds of 16m/s. It is anticipated that the launcher will contain no instrumentation capable of measuring forces and deformation on the components/systems that are to be tested. The instrumentation will be built into the impact test fixtures.

A second phase of this effort is to investigate non contact displacement or deformation measurement of component/system that is being tested. Displacement or deformation measurements have typically been done with contact instrumentation that would include LVDT and string pods attached to reference rods. Non contact measurement of displacement or deformation is more desirable due to packaging space restrictions, improved mounting flexibility and more accurate measurements.

### PROJECT SCOPE

The student design team working on this project will be comprised of students from the Mechanical Engineering Department at MTU.

This project includes design and build of a universal launcher as outlined above, and as defined by Shape Corp. specifications. A functional system should be completed along with functional design qualification test results.

### ProjectGoals

- Identification of underlying theoretical principles
- Numerical modeling with experimental confirmation
- Detailed build prints for the Universal Launcher
- Prototype Build and demonstration of functional Launcher



**Company:** Shape Corp.

**Advisor:** Mahesh Gupta

**Team Members:**

Ray Francis

Steven Janssens

William Marcinak

Greg Niedzwiecki

Joshua Olearnick

Jonathan Palmreuter



# Acoustic Panel Design with Compressive Durability

This project team will be cross functional in nature and comprised of students from both Mechanical Engineering & Materials Science Departments.

## PROJECT DESCRIPTION

With increased demand for multi-floor commercial and residential construction, there is a substantial demand for improved impact sound reduction through concrete sub-floors. There are numerous products and systems available to reduce these sound pressure levels. However, little data is available that demonstrates the value of specific raw materials acoustical value as it relates to impact sound.

Also, design optimization for improved isolation or transmissibility values often is at odds with design optimization for compressive durability. Achieving an optimum design taking both acoustic properties and durability into account is a challenge.

## OBJECTIVE

To achieve a cost competitive construction that will achieve a delta improvement of 20-25 using ASTM 2179 (acoustic) and have a complete 8 cycles of ASTM C627 (compressive durability).

Evaluate available data to determine what types of composite constructions will yield optimum benefit in impact sound reduction. These constructions must also meet ASTM standards for compressive load durability when used with ceramic tile or natural stone flooring.

## PROJECT SCOPE

This project includes research and analysis of acoustic properties, and design optimization of construction of acoustic panels meeting the constraints as outlined above. Functional units should be completed for demonstration for project completion, along with test results supporting or disproving initial design predictions.

**Company:** The Noble Company

**Advisor:** Mahesh Gupta

**Team Members:**

Jennifer Harjer

David Johnson

Fred Terwilliger

Paul Reider

Jon Walter

Robert Vitton



## Casting Design Optimization

### PROJECT DESCRIPTION

Kurdziel Iron produces a number of large castings in grey & ductile iron such as machine bases, counterweights, and support structures. Castings of this type can typically take up to 72 hours to cool to the point where they can be removed from their molds. During this cooling time the castings are using large amounts of floor space within Kurdziel's foundry which dictates the entire process flow rate. If castings of this type could be cooled faster, production facility usage could be improved, as floor space would be made available sooner allowing a higher rate of production without additional capitalization.

This cooling rate is not totally free from restrictions, however. Proper microstructure must be created in the iron, dictating specific rates of cooling through certain temperature regimes. There are a large number of variables that can be analyzed and evaluated for impact on this process. Some are process related (i.e. ambient temp, casting surroundings, process fixturing/racking, etc.) while others are design-related (casting design, flask/mold design).

### OBJECTIVE

The project objective is focused on optimizing the process of cooling large castings produced by Kurdziel within the constraints imposed. This project presents a multi-variable constrained optimization problem at its core, and also requires understanding of metallurgy and involves various transport phenomena.

### PROJECT SCOPE

This project team will consist of students from the Mechanical Engineering and Materials Science Departments at MTU.



**Company:** Kurdziel Industries

**Advisor:** Mahesh Gupta

**Team Members:**

Martin Kamensky

Daniel Mayo

Christopher McNalley

Timothy Reeves

Jillian Rothe

Adam Thielsen

# HVAC Duct Insertion Loss

**Company:** Caterpillar

**Advisor:** Mohan Rao

**Team Members:**

Kevin Christian

Derek Fultz

Joseph Hernandez

Jessica Strickland

Matthew Walsh

## PROJECT DESCRIPTION

As operator noise sound levels decrease within the cab to meet market pressures, the HVAC system is becoming a more dominant noise source. As part of a program to develop methods and technologies for low-noise HVAC systems, Caterpillar requests Senior Design teams to test HVAC duct elements for sound Insertion Loss (IL). This project will involve Mechanical Engineering Senior Design Team's project entitled CAT HVAC Noise Project to design and build a test apparatus and conduct duct IL tests in accordance with ISO7235. The Student Team will design the test apparatus with the intent that it can be used at Caterpillar's Sound Research Lab after its use at MTU. This project includes design and build of certain generic duct elements as prescribed by Caterpillar. Caterpillar may also provide some actual duct elements for testing. Approximately 25 different duct elements will be tested.

The scope of testing will cover IL for static conditions (no flow). However, if the Student Team should consider feasibility to design the apparatus to accommodate flow for some future testing. Caterpillar would certainly welcome that. Future design teams will undertake dynamic condition testing using this same apparatus.

While Caterpillar desires the methods outlined in ISO7235 to be followed, it is recognized that certain allowances or deviations may be necessary. Along these lines, Caterpillar does not wish to specify every little detail of this project – rather it is expected that MTU students and their advisors will use their engineering judgment in consultation with Caterpillar. Caterpillar expects to have regular contact with MTU throughout the project.

## OBJECTIVE

Determine Insertion Loss (IL) of cab HVAC duct elements in accordance with ISO7235.

## Project Outcomes

Anticipated technical outcomes include:

- Duct test fixture and designs
- Insertion Loss results for HVAC duct elements



## Micro Fluidic Liquid Delivery Apparatus

### PROJECT DESCRIPTION

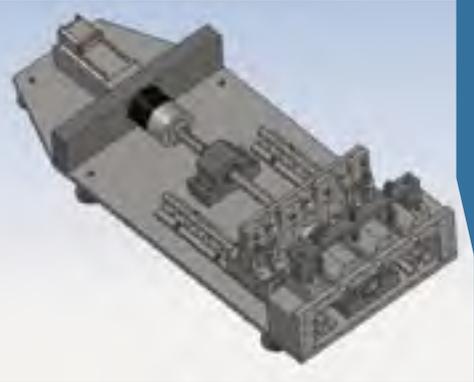
A need exists to develop a super smooth fluid delivery system for many microfluidic experiments. Current and obsolete syringe pumps are positive displacement pumps so the average flow rate is known. These pumps are ideally suited to biological applications where a known flow rate is maintained over a long period of time. In old syringe pump designs, the runout on the lead screw shows up in the experiment data. While the average flow rate is known, there is a sinusoidal oscillation in the flow rate and pressure which may affect the results; particularly the two-phase flow in microsystems experiments. The newer syringe pumps provide additional flexibility in operation through the use of a stepper motor, but current research has revealed that an advancing meniscus will “jump” at every step of the motor. In other words, each step can be observed (even quarter step) of the motor by watching the advancing contact line. This is extremely detrimental to research studying moving contact lines.

### OBJECTIVE

Design and build a type of fluid delivery apparatus which will provide a known flow rate (as opposed to a known pressure drop) without small flow oscillations or pulses as found on traditional syringe pumps. The apparatus may be a modified syringe pump (using syringes is convenient) or something completely new.

### Project Outcomes

- Proposals, designs, and prototype of fluidic delivery system as outlined
- Initial design qualification testing



**Company:** ME-EM Dept.

**Advisor:** Donna Michalek

**Team Members:**

David Hanes

Christopher Harwood

Erik Pepin

Russell Stacy

Lisa Stringham



# Water Pump Design Optimization

**Company:** Ford Motor Company

**Advisor:** Donna Michalek

**Team Members:**

Grace Eaton

Michael Graziano

Travis Marti

Christopher Paiva

Melissa Ulstad

## PROJECT DESCRIPTION

A previous in-house six sigma project at Ford has resulted in the introduction of some design changes in the Duratec 35 water pump housing. Feed slots and flow interruption ribs introduced as a result of that study have improved seal performance and eliminated coolant leakage problems. The size/shape of these features may not be fully optimized, however, so Ford is interested in further work in this area to optimize the design of the pump. This project will be directed towards investigating feed slot geometric definition and the relationship between feed slots and interrupting ribs.

## OBJECTIVE

The objective of this project will be to optimize the seal cavity environment in the Ford Duratec 35 water pump housing. The goal will be to obtain the highest average coolant pressure level around the seal faces for a given flow rate through this pump.

## PROJECT SCOPE

The student design team working on this project will be comprised of Mechanical Engineering students at MTU. Specialization in computational fluid dynamics was a criteria for selection to this team.

This project includes analysis of flow properties of the Ford Duratec 35 water pump, and design and prototype of an optimized design as outlined above, and as defined by Ford specifications. A functional system should be completed for demonstration for project completion, along with design qualification test results and empirical correlation with numerical data.

Testing will be functional in nature, and intended to qualify the design. Lessons learned during initial build-up and testing should be documented with recommended corrective actions defined.

## Project Outcomes

Anticipated technical outcomes include:

- Design and fabrication of prototype water pump which would include proposed design optimization
- Complete numerical analysis of specific areas involved in study
- Functional test results and correlation studies



## Driver Interface Module

The design team working on this project will be comprised of students from both Mechanical & Electrical Engineering. This will represent a fully cross functional engineering team aimed at optimization of specific components within the system described.

### PROJECT DESCRIPTION

Concept, design, & build 2 driver control modules. These should be interchangeable and of different designs, should incorporate the interior design cues appropriate to the Equinox Challenge-X team vehicle, and include controls supporting that team's direction.

The electronic shift control portion of these modules will also incorporate MMS 'Multi-Mode Shifting' technology, and non-contact position sensing design generated by the GHSP Non-Contact Sensor team. Human factors appropriate to the operating environment should be incorporated into these modules.

GHSP will be on campus to meet with the capstone design team & Challenge-X team. The purpose of this visit would be to familiarize the students with FMVSS requirements specific to driver controls, provide an overview of the driver control problem domain, and to show previous work done in this area.

### OBJECTIVE

Concept, design and build functional electronic driver interface modules suitable for pass-car applications, and packaged specifically for the GM Equinox Challenge-X competition vehicle.

### PROJECT SCOPE

Project will include:

- 2 interchangeable electronic driver interface modules
- Electronic shift control
- Multi-Mode Shifting
- Non-contact position sensor command input
- Human factors appropriate to environment
- Complete bibliography of intellectual property and emerging technologies related to design work
- Recommendations for future work/development based on discoveries made during project



**Company:** GHSP

**Advisor:** William Endres

**Team Members:**

Nathan Anderson

Adam Benes

Stephen Blair

Andrew Denis

Ryan Rosinski

Jonathan Sloane



## Non Contact Position Sensor Module

**Company:** GHSP

**Advisor:** William Endres

**Team Members:**

Matthew Barkley

Joel Feenstra

Vedat Kayapinar

Yuta Shokinji

This team will be comprised of students from both Mechanical and Electrical Engineering departments, and will focus on research of non-contact position sensing technologies, determine their maturity, and select one for incorporation into a position sensing module. The team will design and build these modules for specific applications, and be able to show design flexibility in adaptation to multiple applications.

### PROJECT DESCRIPTION

Non contact position sensing has become more or less mandatory for all forward-looking automotive applications. Among these applications are the newly-emerging electronic gearshift control systems. These sensor systems must be linear/analog in nature as opposed to a simple binary on/off (i.e. digital hall-effect) type.

The module would be used in both the shift control unit & for the transmission control feedback in electronic gearshift systems. The immediate applications would be for the Challenge-X Equinox competition vehicle, and for GHSP's current product designs.

### OBJECTIVE

The thrust of this sensor team is to evaluate the next generation of position sensing technologies and determine their readiness for a production application. State of the art non-contact technologies appropriate for automotive applications should be researched. The team will establish selection criteria, select the best technology based on those criteria, and design and build a functional sensor module incorporating this technology. This module should be designed and built for two specific applications:

- The driver control modules concurrently designed and built by the GHSP Driver Interface Team
- The design should be modular in nature, and shown to be easily adaptable to a variety of other applications.



## Door/Hatch Closure Optimization



### PROJECT DESCRIPTION

General Motors (GM) Corporation is building the new Lansing Delta Township Assembly (LDT) facility in Lansing, Michigan with a planned opening in 2006. LDT brings together GM's latest technology in both process and product design and will implement GM's lean manufacturing system known as GM Global Manufacturing System (GMS). The LDT team is currently working to develop the process controls and problem solving tools in key areas that will successfully enable a high quality / high volume start of the facility.

### OBJECTIVE

This project consists of competitive analysis, design modeling and assembly plant process tooling design proposal (manual) to assure that LDT can accurately monitor and control closure performance to optimize wind noise, water leak and closing efforts.

### KEY CHALLENGES

Analyze the current closure system design to define the amount of variation allowed in the plant closure process. Does the current design of the door headers, door hardware, seal shape and thickness allow for a 'sweet' spot where each closure can be set to meet all customer satisfaction requirements?

- Closure efforts (as measure dynamically at LDT)
- wind noise (as measure in GM wind tunnel)
- No water leaks

### Project Outcomes

Anticipated technical outcomes include:

- Proposals, designs, and models directed toward improving situation outlined herein
- Synopsis of competitive analysis results
- Complete BOM of proposed design refinements

**Company:** General Motors Lansing Delta Township Assembly

**Advisor:** Bernie Bettig

**Team Members:**

Gregory Arens

Andrew Cieslinski

Kristopher Kreh

Kean Shiang Ng

Christine Maloney

# Rear Suspension Module Alignment



**Company:** General Motors Lansing Delta Township Assembly

**Advisor:** Bernie Bettig

**Team Members:**

Andrew Adrian

Robert Dillion

John Juckette

Adrian Little

Amanda Marks

## PROJECT DESCRIPTION

The project consists of working with LDT and its Tier 1 supplier for the rear suspension to review the current design (product and processing tools), collect data from prototype builds and verify supplier preset capability to guarantee that all tooling is capable and repeatable (passes R&R).

## OBJECTIVE

Analyze current situation with the rear suspension module, and propose design changes which would improve upon the current situation.

- Proposals, designs, and prototypes of refinements to process and/or components which would improve upon the current situation as outlined
- Implementation of design refinements into production process at LDT

## KEY CHALLENGES

- Situation required high attention and weekly mean shifts (mainly rear toe)
- Vehicle specifications adjusted to not control individual toe and allow up to .40 rear sum and .15 thrust angle
- Double inspection process implemented at Supplier
- Module set, tooling removed then separate verification cycle measures module 2nd time
- Repair person in Assembly Plant pit to manually adjust if supplier set characteristics out of specification
- Rear Toe & Camber—Tier II/Tier I
- Front Camber & Caster—Tier I
- Front Toe--LGR.





## Dynamic Test Stand



### PROJECT DESCRIPTION

Whirlpool Corporation's products, such as washers and dryers, are highly dynamic in nature, and operate in many different types of environments. Increasing customer demand for larger capacities, shorter cycle times, and higher operating speeds are accentuating the need for specific product designs with this dynamic operation in mind. At the same time, they must operate up to customers' expectations in all expected installation scenarios.

Previous research has been done on various types of residential construction, and their behavior when exposed to the dynamic input offered by an operating washer. The range of expected operational environments is known, and now needs to be simulated in Whirlpool's product validation test protocols.

### OBJECTIVE

The objective of this project is to design and build a test stand able to reproduce the various feedback profiles exhibited by identified constructions. Dynamic response behavior is known through previously accumulated data. This test stand will be able to reproduce any known profile as needed to complete product validation of Whirlpool products.

The test stand will be built so that, in its static fundamental state, it reproduces the minimum stiffness configuration in the known profile set. Alternate profiles will be reproduced through the use of active elements which will be procured through Whirlpool and incorporated into the test stand at a later date.

### SPECIAL NOTE

Following completion of this project, representatives of the team attended the second annual International Student Capstone Design Fair at the Seoul National University of Technology (SNUT), Korea, in November 2006. The team was recognized for its superior work through being awarded first place in the International category at the Design Fair.

Jeff Van Karsen and Dr. John Gershenson represented the team and department at the competition. Both met briefly with the Minister of Industry, Commerce and Energy and Jeff was interviewed for Korean television. The faculty advisor for the senior design project was Dr. Nels Christopherson. The fair had 313 entries with 10 international universities invited from the U.S., Singapore, China, and Japan. Dr. Gershenson was asked to organize and select most of the U.S. entries and his role will expand at next year's competition. Dr. Peck Cho, who is on leave at SNUT, did much of the original liaison work for the event. This is the second straight year that a MEEM Senior Design team has been asked to exhibit at the Fair.

**Company:** Whirlpool

**Advisor:** Nels Christopherson

**Team Members:**

Richard Bellenbaum

Karen Hauch

Bradley Rush

Jeffrey Van Karsen

Kelly Willett

# Modular Adjustment Mechanism for Office Chair Arm Support

**Company:** Herman Miller  
**Advisor:** Nels Christopherson  
**Team Members:**  
 Greg Anderson  
 Andrew Bruce  
 Matt Hanks  
 Erik Lehmann

## PROJECT DESCRIPTION

Herman Miller helps create great places to work, heal, learn, and live by researching, designing, manufacturing, and distributing innovative interior solutions that support companies, organizations, and individuals all over the world. Herman Miller is widely recognized both for its innovative products and business practices.

Among its products, Herman Miller designs and manufactures a full range of office seating solutions. Their task chairs incorporate a wide range of adjustability to suit individual needs and unique situations. Adjustability of the arm supports for ergonomic fit is a key element in the design of these chairs. As Herman Miller works on its next new chair line to follow their 3 existing lines, Aeron, Mirra, & Cella, the design of the mechanism for adjusting the arm support is critical. A new modular approach is desired. A family of mechanisms that allow the industrial designer the freedom to specify the form and function of the arm support and also allow the engineer and manufacturer to fit each model with the desired adjustment options while not requiring new development, re-engineering and new processes for each chair line.

## OBJECTIVE

Design a new family of arm support mechanisms, which can be incorporated into Herman Miller's existing and future office task chair products, which provides for specified degrees of freedom and user controls, and is based upon a modular structure where adjustment options can be matched with individual models.

## PROJECT SCOPE

- Summary of current state of the art and outline of intellectual property in the field of chair arm mechanisms
- Summary of competitive benchmarking
- Feasibility analysis of all designs considered
- Summary of theoretical principles involved, and factors considered in final design
- Design and development of arm support mechanisms for each of the four chair lines which would provide the desired functions (i.e. fore-aft, lateral, rotational adjustment)
- Basic CAD models and drawings that identify critical features and dimensions
- Engineering analysis to demonstrate structural performance and dimensional variation of critical interfaces
- Design FMEA•• Functional prototypes
- Complete BOM of system including estimate of production cost (ann. volume to be provided) and material selections



## Mobile Power Solution

### PROJECT DESCRIPTION

Our customers are found in the growing interactive workspace and small office segment, as well as the growing home office environment. It's all about campers and campsites – people in flexible work groups who need tools and environments that foster New Workstyles. Izzy's objective is to equip these high performing Campers with fresh, inviting personal workspaces – Campsites – that promote and create productive collaboration.

### OBJECTIVE

Develop a mobile power solution, which is small & lightweight; an almost backpack style unit that can plug into a central power station for recharging. The recharging unit must utilize the current post from the Edison product line. These units must be portable (?20 lbs.) and provide power and wireless communication for 8 hours of work with laptop.

Considerations of cutting-edge power storage technologies are encouraged, such as micro fuel cell technology. In these cases, the recharging/refueling scheme can depart from the present paradigm (i.e. 120VAC power source / battery recharge).

### PROJECT SCOPE

The student design team working on this project will be comprised of students from Mechanical, Electrical, and Computer Engineering Departments at MTU. They will represent a fully cross functional engineering team, encouraging inter-disciplinary collaboration in design optimization.

### Project Outcomes

- Functional prototype of the 'power pack' w/carrying case
- Complete BOM of proposed design with production cost estimates (ann. vol. tbd) and supplier information
- UL compliance documentation
- CAD model of proposed design
- Value analysis of design and considered alternatives/features
- Research results on current state of the art and intellectual property in this field
- Recommendations for further development based on discoveries during project



**Company:** izzy design

**Advisor:** Jaime Camelio

**Team Members:**

Stephen Anthony

Bryan Friedsberg

Justin McLeod

Mark Peaslee

Mitchell Stump



# Venturi Eductors

**Company:** Kimberly Clark Corp.

**Advisor:** Donna Michalek

**Team Members:**

Kelsey Fors

Matthew Gagner

Michael Lahti

Evan Nelson

Jason Pettengill

## PROJECT DESCRIPTION

Venturi eductors are used throughout industry to perform many different functions – from cooling objects on mass production lines to evacuating toxic gases from industrial processes.

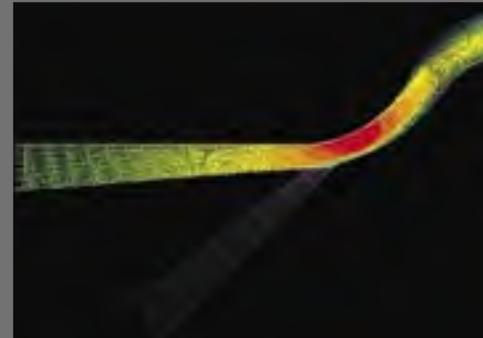
Despite the widespread use, current knowledge in this field is limited to this point. Reliable information is generally confined to very specific equipment supplier databases. Because high aspect ratio or slot type eductors are not as popular as the circular type very little information is available

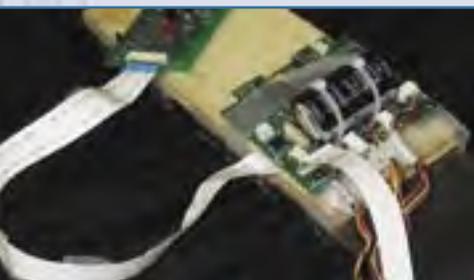
## OBJECTIVE

The project objective is focused on extending the technical understanding of high aspect ratio eductors. These eductors have a wide range of uses and are typically purpose built for each application without the benefit of a basic technical understanding.

## Project Outcomes

- Identification of underlying theoretical principles
- At least one example of numerical modeling with experimental conformation
- Sufficient conclusions and recommendations that performance of the experimental eductor may be reliably revised
- A complete bibliography of available publications
- Lab scale prototypes built using simple materials to generate/verify/correlate all findings and provide ample empirical data to confirm analytical predictions.





## Grade Level Control System

### PROJECT DESCRIPTION

Leica Geosystems' Grade Lasers are the most accurate and reliable lasers for machine control applications that require precise grade. They can be used wherever level, single or dual grades are required, and are compatible with Leica Geosystems' 2D and 3D Machine Control Systems for ultimate grade control. As development of this family of products continues, a new type of control system is desired - one which focuses on cost effective design while maintaining Leica Geosystems' standard of performance. System content will need to be scrutinized, as well as manufacturing tolerances of critical components and their materials.

### OBJECTIVE

To design an accurate and cost-effective precision optics mounting platform control system.

- Summary of current state of the art and outline of intellectual property in the field of this type of system
- Proposal, design, and prototype of control system, including 3-D models, drawings, FEA and other analysis results
- Initial DQ test data
- Complete BOM of system including estimate of production cost (annual volume to be provided)
- Fabrication of full-scale prototype system. Conduct physical testing to validate performance achievement. Document test results.



**Company:** Leica Geosystems GR LLC

**Advisor:** Nels Christopherson

**Team Members:**

Sarah Bradley

William Dehlin

Matthew Holmes

Patrick McCabe

Mark Salisbury



# Noise Emission Analysis & Reduction

**Company:** Terex Handlers

**Advisor:** Jaime Camelio

**Team Members:**

Peter Bryson

Matthew Kero

Christopher Lockwood

Stephen Polzien

Christopher Rokke

## PROJECT DESCRIPTION

Terex produces material handlers in 3 sizes: 6000 pound, 8000 pound, and 10,000 pound. These sizes are given in terms of each model's lifting capacity. Each size has two models, yielding 6 distinct products Terex produces at their Baraga facility. These handlers are used in residential environments, and quieter operation is always desirable. Noise emission during operation can be traced to a number of sources. Identifying these sources in terms of magnitude of noise produced would be valuable information as Terex continuously improves their product line. The largest contributors to any noise generation profile will be addressed first as design work proceeds on future models.

## OBJECTIVE

The project objective is focused on analyzing the current Terex telehandler and its noise emissions. The team will then design and build a cost effective solution to reduce/attenuate noise generation of the largest contributor in the system. This design proposal must be shown to be easily adaptable across the entire product line.

## PROJECT SCOPE

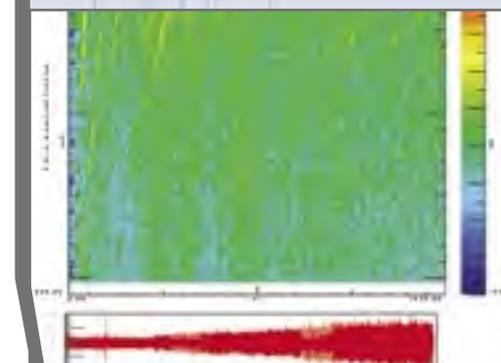
The student design team working on this project will be comprised of students from the Mechanical Engineering Department at MTU.

This project includes noise emission analysis of an operational handler as outlined above, and design and build of attenuation solutions. A functional system should be completed along with operational test results.

The scope of testing will be functional in nature, and intended to qualify the design. Test data should be shown to support design predictions. Lessons learned during initial build-up and testing should be documented with recommended corrective actions defined.

## ProjectGoals

- Noise emission test data identifying sources of operating noise of the handler (model-TBD) and quantifying these sources in terms of their sound pressure levels
- Proposal, design, prototype, and implementation of a solution to the largest contributor(s) identified in earlier analysis
- Test data of prototyped system vs. baseline
- Design proposals incorporating solution into all 6 Terex models
- Special note – this team was awarded first place at the April 2006 Design Expo at MTU



# Independent Rear Suspension Module

## PROJECT DESCRIPTION

General Motors and Magna are evaluating a unique hybrid rear suspension for a unique hybrid rear suspension. Using a prototype mule, Magna has fitted a type of bolt-in module in an effort to prove out the design. The design has several attractive points, foremost of which is the ability to fit this module to the chassis with no need for complete tear-ups of other systems in the vehicle (fuel, exhaust, frame, etc.). While the initial prototype is functional and proves the concept, further refinement is desired.

## OBJECTIVE

The basic objective of this project was to analyze, refine, and provide competitive benchmarking information to assist in optimizing the module design developed by Magna.

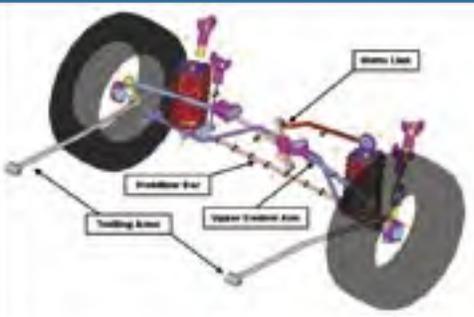
This project is very broad in nature, given the vehicle dynamics elements involved in re-designing a rear suspension system. The design space is also relatively constricted given the constraints imposed in this particular case. The project as a whole will be broken into seven main areas:

- |                               |                          |
|-------------------------------|--------------------------|
| 1. Kinematics optimization    | 5. Bushing rate analysis |
| 2. NVH optimization           | 6. Serviceability        |
| 3. Mass/strength optimization | 7. Cost analysis         |
| 4. Competitive benchmarking   |                          |

The project team will be subdivided into three groups, each of which will focus on one of these main design areas. The team will operate as a unit, and will develop a cohesive design direction comprehending all focus points. The existing system will be analyzed, and design proposals generated which would offer specific performance improvements in these main areas of focus.

## Project Outcomes

- Proposals, designs, and prototypes of refinements to independent rear suspension module, including 3-D models, drawings, FEA and other analysis results (i.e. ADAMS, ANSYS, etc.)
- Implementation of design refinements into existing buck
- Initial design qualification testing
- Complete BOM of proposed design refinements including production cost impact estimates



**Company:** General Motors & Magna

**Advisor:** William Endres

**Team Members:**

Adam Abraham

Matthew Debo

Eric Elberling

Andrew Fenton

Timothy Flynn

Timothy Gibbs

Chelsey MacNeill

Daniel Maher

Lakmini Wimalasena

Nathan Zambon

# Automatically Indexing Inserted Cutting Toolholder

**Company:** Endres Machining Innovations, LLC

**Advisor:** Jaime Camelio

**Team Members:**

John Armstead

Casey Coolich

Andrew Fenderbosch

Jonathan Granstrom

Jeremy Rickli

## PROJECT DESCRIPTION

Inserted tool holders are used routinely in metal cutting applications, including turning, face milling, boring, and even end milling and drilling processes. The “insert” is clamped or screwed into a pocket in the toolholder that has the same size and shape as the insert. The insert is made of a hard cutting tool material, such as tungsten carbide, and typically has multiple corners that can be used to cut. For instance, a triangular insert has three usable corners, a square insert has four usable corners, and a round insert has many “corners”, how many depending on process conditions, but often as many as twelve or more.

When machining difficult to machine materials, such as hardened steel, titanium and nickel-based alloys, even advanced insert materials wear very quickly. Manually indexing an insert, including shutting down the machine’s cycle, loosening, rotating, tightening, and getting back into cycle, can take as much as five minutes and much longer for multi-tooth cutters like face mills. A toolholder that can index the insert via a control signal sent to it can improve productivity, in one case study by as much as 14%.

## OBJECTIVE

The objective of this project is to conceive, design and fabricate a prototype turning tool holder that has built-in actuation that indexes a round cutting insert upon delivery of a control signal. The design may include two variants, one for lower volume and one for higher volume production.

- Patent search report
- Functional design to address cost, ease of manufacture, repeatability, and durability.
- A fabricated prototype with control signal coming from low-voltage push-button switch.
- Prototype test data supporting repeatability and strength of physical prototype.
- Full final Pro/E CAD model and production drawings, including any recommended prototype refinements.



## **Upper Michigan's Smartzone Welcomes GHSP Innovation Center To Business Incubator**

*Reprinted with permission from the Daily Mining Gazette, May 15, 2006*

HOUGHTON, MI – GHSP, Inc. becomes the fourth company to open a satellite innovation center in the MTEC SmartZone business incubator. The company's engineers in the Houghton office will lead new initiatives in product innovation and development taking place at the company's headquarters in Grand Haven, MI.

According to Bob De Jonge, who is helping manage this initiative for GHSP, the SmartZone offers an ideal point of presence for the company. "The SmartZone helped us to pull resources together in a manner that helped us move quickly. This was especially important so that we could offer positions to the graduating engineers we sought from Michigan Tech University." De Jonge, presently a Senior Research Engineer at Michigan Tech, developed the innovation center from a model used by other SmartZone companies. "We're looking carefully at how other companies are fostering innovation, trying to encourage open collaboration, and rolling in some of our own unique ideas. GHSP is taking early critical steps in this process by starting with recent graduates working full time, and following on from their highly successful senior design projects sponsored by GHSP. Continuity and creative thinking are key elements we want to capture & nurture. The supportive network offered by Michigan Tech and the SmartZone's infrastructure are nearly an ideal combination; a 'perfect storm', in a good sense!" Two of this year's graduates from Michigan Tech started working at the innovation center last week.

Jonathan Leinonen, Program Manager for MTEC SmartZone is not surprised by the growing interest that companies are taking in the SmartZone. "Nearly half of the people working in our SmartZone incubators are employed by companies headquartered outside the Upper Peninsula. We're seeing more companies coming forward that want to engage students and alumni from Michigan Tech without having to relocate them. By having an office here, companies can quickly set up an office, attract professional engineers and develop joint projects with MTU and enhance innovation for a lower cost while local employees enjoy the community and lifestyle that have grown to love."

GHSP is a leading global supplier of transmission shift systems and electronic throttle controls. The company serves customers around the world in the automotive industry as well as in other surface transportation industries. Founded in 1924 and headquartered in Grand Haven, Michigan, GHSP operates 12 sales, engineering, and manufacturing facilities in North America, Europe and Asia.

For further information please visit them at <http://www.ghsp.com>

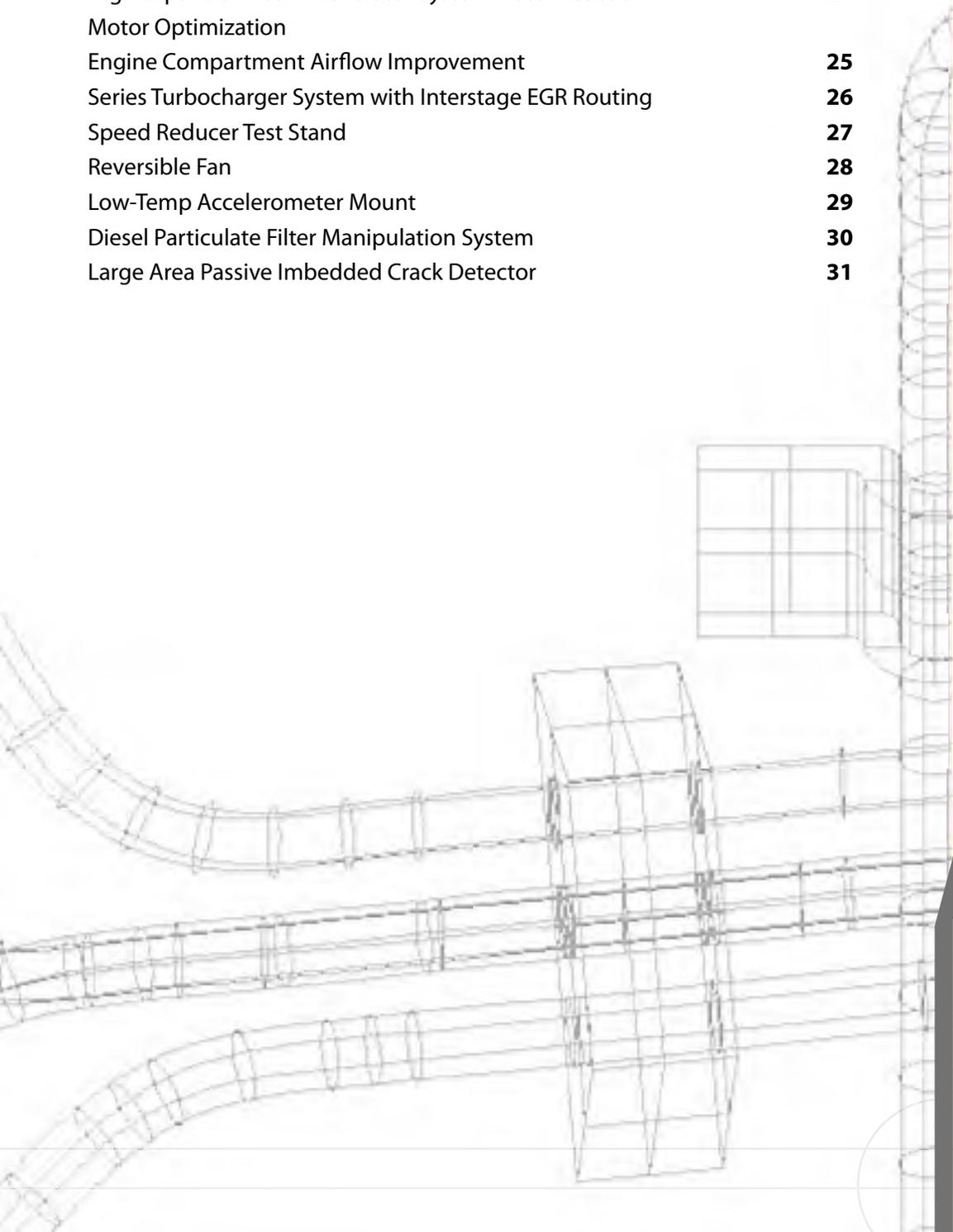
The Michigan Tech Enterprise SmartZone is a 501 (c) (3) private non-profit corporation and has as its mission the growth of the high-tech job base in the Upper Peninsula by commercializing technology, supporting and mentoring the growth of technology companies currently located in the region, and attracting technology companies to the area ([www.mtecsmart.com](http://www.mtecsmart.com)). SmartZone is a registered service mark of the Michigan Economic Development Corporation.



## Projects Completed December 2006

dec. 2006

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## High Expansion Foam Generator System Water Reaction Motor Optimization



### PROJECT DESCRIPTION

The project objective is focused on analyzing a current ANSUL High-Expansion Foam Generator, and proposing design changes that would improve the output efficiency of the system.

### PROJECT SCOPE

The overall project will be broken into two complementary project teams. Team one will be comprised of ME senior undergraduate students and will commence work on 9 January 2006. This team will focus on optimizing the design of the water reaction motor portion of the High-Expansion system. Team 2 will follow team one, and will be formed at the beginning of the fall 2006 term (~28 August 2006). This team is planned to be cross-functional in nature, and made up of senior undergraduate students from the mechanical and chemical engineering departments. Team two will focus on optimization of the foam screen and foam solution itself. Together, these two teams will have the task of proposing design solutions which will improve the output of the system as a whole. The ‘overlap’ term (fall 2006) in which both teams will be working concurrently will be key in many ways.

Team one will focus on optimization of the water reaction motor portion of the High-Expansion system. The objective of this optimization effort will be to improve output of the motor.

There are a number of design variables in the water reaction motor portion of the foam generator system, allowing for a large design space in which to work. Known key variables in the objective function are:

- Fan blade design & configuration and airflow
- Foam solution spray optimization
- Nozzle refinement and inlet pressure

**Special Note:** The accomplishments of this team were recognized by Tyco Fire Suppression Group at a special dinner following completion of their portion of the project.

*“This team has laid the groundwork for achieving a fundamental design improvement for Tyco. If team #2 maintains the level of performance of team #1, Tyco will have leapfrogged their competition in this market, and will have achieved a significant competitive advantage.”*

Mark Van Dover, President, Fire Suppression Group

*“...The overlapping team model has allowed us to feasibly work on an engineering task of such scope that it would not have been possible with a single team. The benefit to the project in particular and to Ansul/Tyco in general of having one team member at our Marinette facility as a summer intern in the midst of this project proved to be very effective...”*

Jay Thomas, Director of Research & Development, Fire Suppression Group

**Company:** ANSUL/Tyco

**Advisor:** Madhukar Vable

**Team Members:**

Aaron J. Ditty

Seth R. Parker

Richard G. Smith

Soon Siong Tan

David B. Voshol

# Engine Compartment Airflow Improvement

## PROJECT DESCRIPTION

The project objective is focused on improving performance of Caterpillar's current strategy of extracting engine compartment air using existing exhaust gas flow or other means.

## PROJECT SCOPE

Thermal management can be improved if airflow can be increased into, through, and out of the engine compartment. Introducing a specific active ventilation system involving fans or the like is not cost effective, as this type of solution would introduce additional complexity & cost to the overall system. Rather, using existing dynamics in these vehicles and optimizing their effectiveness would potentially improve the performance of the vehicle while not introducing any substantial added cost/content. This approach has been used in the past, and continues to be used, as air extraction systems using the high velocity exhaust gas flow are known. Improvement and/or optimization of this type of system is desired here.

Caterpillar currently designs exhaust ejectors following the practices of SAE AIR1191 'Performance of Low Pressure Ratio Ejectors for Engine Nacelle Cooling'. Current designs of exhaust extractors provide between 0.2 and 0.4 kg of underhood air per kg of exhaust gas flow. The goal of this project is to provide at least 1 kg of underhood air flow per kg of exhaust gas flow, while limiting the pressure loss at the exhaust pipe outlet to a maximum of 2.5 kPa. The current exhaust extractor system consists of a pipe from the muffler mounted concentrically inside a second, larger, exhaust pipe. The team will be free to revise the design of pipes and their mounting configurations, while meeting the pressure loss criteria. A team comprised of 5 senior undergraduate engineering students will work on this project under with guidance from a ME-EM faculty advisor. The students will be from the mechanical engineering curriculum, as this project deals with phenomena particular to the mechanical engineering discipline.

## Project Goals

- Basic computational model(s) used in analysis of system
- Design FMEA
- Functional prototype(s) demonstrating improvements potentially offered by design proposal(s)
- Complete BOM of proposed design(s) including estimate of production cost (ann. volume to be provided) and material selections
- Design qualification test data demonstrating level of correlation between computational model and functional prototype, and system performance relative to SAE AIR1191
- Roadmap for future product development based on team's design work and test results -- i.e. a process for Caterpillar designers to use to design an ejector that will provide performance better than a system designed by SAE AIR1191s

**Company:** Caterpillar

**Advisor:** Dr. Ibrahim Miskioglu

**Team Members:**

Sean A. Deffendall

Jason M. Podleski

Joshua J. Pryor

Justin L. Stuckmann

Nicholas B. Tarzwell



## Series Turbocharger System with Interstage EGR Routing



### PROJECT DESCRIPTION

A variety of concepts have been proposed to achieve the goal of delivering high rates of exhaust gases back to the intake manifold of high output diesel engines. This proposed system involves the application of series turbocharging and ‘interstage routing’ of the EGR gases to accomplish this goal.

A significant proposed advantage of the system is the fact that a two stage system is believed to offer the best potential engine fuel economy as the efficiencies of each of the compressor and turbine stages are not subject to the high pressure ratio levels that a single stage unit must achieve. On the other hand, the two stage system obviously suffers the significant drawback of added cost and packaging challenges.

### PROJECT SCOPE

Given the magnitude and complex nature of the work envisioned, the overall project will be broken into two complementary project teams. Team one will be comprised of ME senior undergraduate students and will commence work on 9 January 2006. This team will focus on modeling, analysis, and design of the proposed system. A second team will begin in the fall term of 2006, working concurrently with team one during that semester. The second team will finish their portion of the project in April 2007.

Together, these two teams will have the task of proposing design solutions which will achieve the objectives outlined above. The ‘overlap’ term (fall 2006) in which both teams will be working concurrently will be key in many ways.

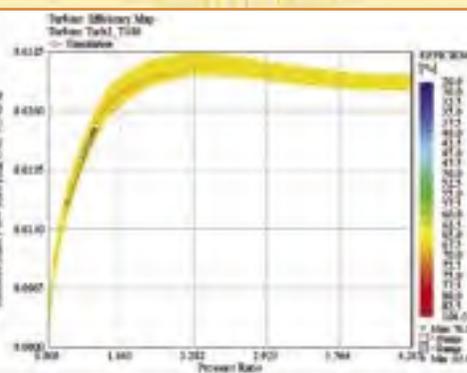
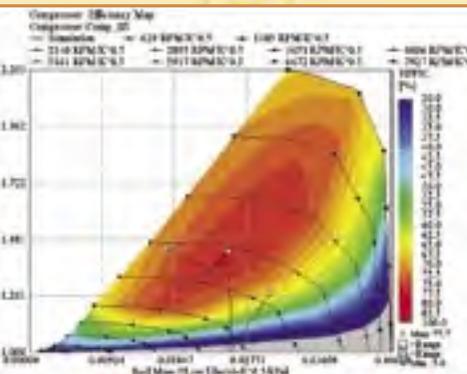
#### Team #1 Focus

Team one will focus on modeling and analysis of the system. This team will perform an overall system analysis, size all components, design the needed hardware for the final build and test. They will be concerned with becoming fluent with current computational tools, and with system modeling.

During the fall semester, with both teams working jointly, team 1 continue their work with system analysis & design while team two is brought up to speed very quickly with details of the project. Team 2 will then pick up responsibility for implementation of the system design, and ultimately test and measurement activities.

### Project Goals

- Use a cycle simulation program to identify the turbocharger candidates for each stage (this task is composed of a number of sub-tasks, for example, waste-gating can be a factor for either turbo)
- Design study regarding best approach for an EGR cooler – sizing, shape, placement
- Design study regarding best approach for packaging the two turbos
- Incorporation of one or more after treatment devices



**Company:** John Deere Product Engineering Center

**Advisor:** Dr. Jeffrey Naber

#### Team Members:

Jeremy J. Allan

Andrew P. Davidson

Yong E. Guan

Peter J. Hesselroth

Kyle D. Norwood

Douglas H. Sage

# Speed Reducer Test Stand

**Company:** Textron Fluid & Power  
Cone Drive Operations

**Advisor:** Dr. Ibrahim Miskioglu

**Team Members:**

Beau E. Crandell

Kyle A. Holihan

Thomas P. Sandor

Joshua J. Swathell

Steven G. Watkins

## PROJECT DESCRIPTION

This project will focus on design and build of a self-contained test stand that can be used to test key operating parameters of a range of sizes and configurations of industrial speed reducers manufactured by Cone Drive.

## PROJECT SCOPE

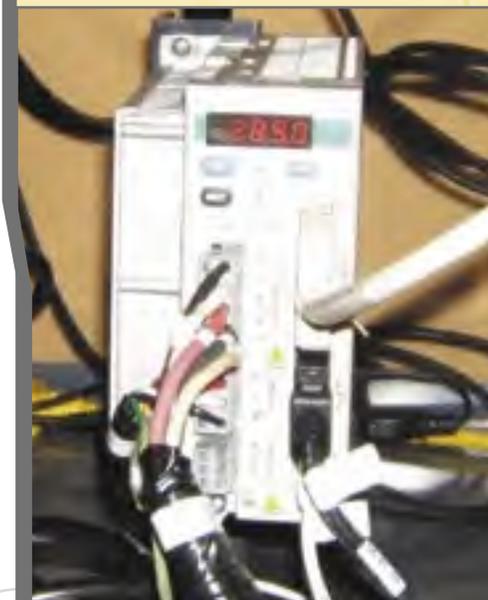
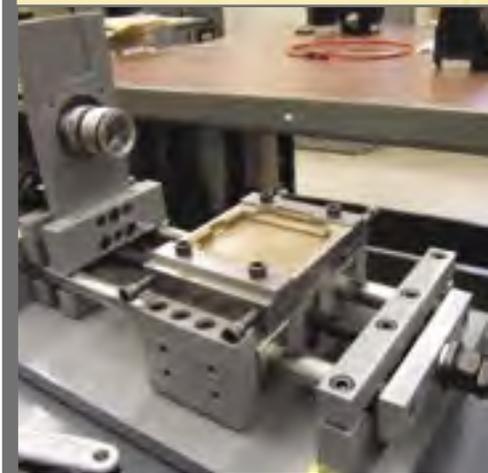
This test stand would be used to quantify product performance and investigate related warranty claims. The test stand would consist of a drive motor, fixture(s), coupling device(s), loading devices and data acquisition devices capable of supporting the goals detailed below.

## Project Goals

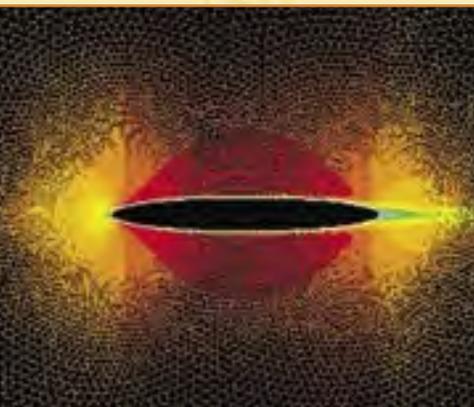
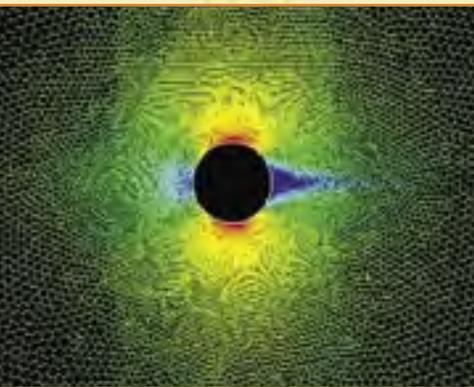
- Powered by a 120v motor capable of speeds between 600 and 3000 RPM. Motor to include torque and thermal overload protection. Motor and controls must be capable of both CW and CCW operating directions and output of at least 1500 in.-lbs.
- Test stand must be adjustable to accommodate reducers with between 75mm and 200mm from the bottom of the mounting feet to the centerline of the reducer input shaft.
- The motor output shaft coupling must be of a type that would allow Cone Drive to adapt the drive motor to a variety of reducer input shaft diameters and lengths. Typical shaft diameters would range between 14 and 28mm.
- Controls must allow for manual adjustment of input speed, motor direction (CW/CCW), zero to full speed ramp-up time, and adjustment of the output load. Controls must also allow for programming of standard test cycles including speed, duration, direction, load, and data sample points.
- Capable of measuring reducer input torque in the range of 2 – 100 in.-lbs.
- Test stand to be equipped to be able to perform contact/non-contact surface temperature and contact reducer sump/internal temperature measurements Temperature range up to approximately 200 F.
- Test stand to be equipped to perform sound/vibration testing per agreement with Cone Drive. Typical values would be below .1 in/sec. RMS vibration as measured using a three axis accelerometer.

*“I have been in the manufacturing industry for 25 years, and this was one of the best managed and executed projects I’ve ever been a part of.”*

Dave Zempel, Quality Assurance Manager, Cone Drive Operations, Inc. 7 December 2006



## Reversible Fan



### PROJECT DESCRIPTION

The project is focused on optimization of a reversible fan design. This design would be incorporated into ventilation systems for tunnels constructed for rail and highway applications.

### PROJECT SCOPE

Greenheck, America's leading manufacturer of ventilation equipment, has come a long way since 1947 when it opened for business as a tiny sheet metal shop in Schofield, Wisconsin. Today, Greenheck designs, manufactures and ships fans and ventilators, centrifugal and vane axial units, make-up air units, energy recovery ventilators, dampers, louvers, kitchen ventilation systems, and laboratory exhaust systems around the world. No other company offers a wider selection of these products. The company has sales in excess of \$400 million annually, employs more than 2,500 and has over a million square feet of manufacturing space.

This project entailed design optimization of a reversible fan intended for use in rail/highway tunnels. The fan in this project was 36" in diameter, and incorporated a unique blade design in die cast aluminum. The team was encouraged to investigate various physical blade parameters during the course of their design optimization work. The project included design of the blades only, and did not consider optimization of various enclosures (i.e. fan housing, motor, etc.). The objective was to optimize fan efficiency with at least 90% airflow in the reverse direction.

A team comprised of 5 senior undergraduate mechanical engineering students worked on this project under guidance from a ME-EM faculty advisor.

### PROJECT RESULTS

Methods were developed to simplify the flow through the blades into a 2-Dimensional CFD model in order to compare design iterations. Many designs were analyzed through this process and profiles with poor lift-to-drag ratios were eliminated. A method for machining patterns and casting prototype blades was established. Four different designs were developed and manufactured as prototypes. These prototype blade castings were installed in existing Greenheck fans and run through full fan performance testing. Performance results met or exceeded existing blade designs for reversible flow.

**Company:** Greenheck Fan Corp.

**Advisor:** Dr. Thomas Grimm

**Team Members:**

Philip M. Benes

Adam C. Brown

Daniel R. Charais

Benjamin W. Johnson

Catherine L. Rogers

# Low-Temp Accelerometer Mount

## PROJECT DESCRIPTION

This project team will design and build a cool (i.e. low temperature) mounting system for accelerometers used in engine tests. The intent of this mounting system is to maintain local temperature at the accelerometer(s) within their reliable operating range.

## PROJECT SCOPE

When performing dynamic testing on engines, Caterpillar frequently faces the need to measure vibration of hot objects (turbochargers, exhaust manifolds, etc.). Accelerometers are cheaper and easier to use than non-contact methods such as lasers, but no accelerometer can withstand the temperatures of these hot components without some help. A system that would maintain 3 PCB J0953B17 accelerometer case temperatures below 135° C when mounted on hot (i.e. exhaust) components with surface temperatures of up to 700°C - 800° C and significant radiant heat would be of great value to Caterpillar by reducing costs and ultimately increasing operating efficiency.

Additional desires/constraints:

- No modes below 10kHz
- Small size and low mass
- Mounting locations for 3 orthogonal accelerometers
- Safe and easy to set up and use/reuse
- Low cost (hopefully < a few hundred \$ each?)

## Project Goals

- Benchmark of similar systems (background research)
- Complete BOM, schematics and detail drawings of design with outline for future use
- Completed Machine as outlined above with the following additional constraints:
- No modes below 10kHz
- Small size and low mass
- Mounting locations for 3 orthogonal accelerometers
- Safe and easy to set up and use/reuse
- Low cost (hopefully < a few hundred \$ each?)

**Company:** Caterpillar

**Advisor:** Madhukar Vable

**Team Members:**

Matthew A. Bluhm

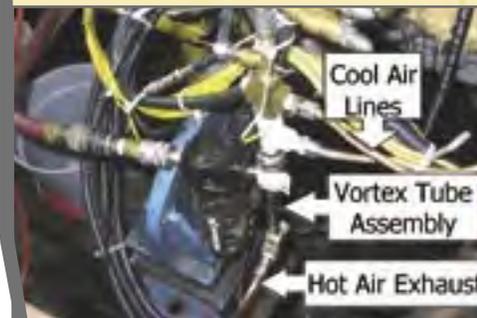
Alan D. Crawford

Gary A. Figi

Adam J. Lawniczak

Thomas M. Peterson

Christopher Sebastian



## Diesel Particulate Filter Manipulation System



### PROJECT DESCRIPTION

Benchmark, design, and build an automated machine to safely and repeatably remove a hot Diesel Particulate Filter (DPF) from an engine test stand, place it onto a scale (in order to take a weight measurement), and return the filter back to the test stand.

### OBJECTIVE

Obtain accurate DPF weight measurements in a cycle time of less than 5 minutes.

### PROJECT SCOPE

Diesel Particulate Filters (DPFs) are becoming a fundamental component in many diesel engine systems. As a result significant development time and expense go into testing DPFs for robustness against a variety of failure modes that could potentially be exasperated by customer use of the system. The DPFs primary function is to filter (trap) soot particles out of the diesel exhaust stream in order to reduce engine out PM (particulate mater) by 90-99%. As a result DPFs increase in mass as they filter soot out of the exhaust.

Eventually the amount of soot in the DPF (or filter) reaches a critical level where it must be regenerated. Essentially this process entails oxidizing the soot (which can be roughly modeled as solid carbon) into CO<sub>2</sub>, which passes harmlessly out the exhaust side of the filter. Soot oxidation is an exothermic process and can potentially damage the DPF if too much soot is in the DPF during regeneration (the temperatures increase extremely quickly leading to material failures). Therefore having an accurate measurement of the amount of soot actually trapped inside the DPF is critical to the development process.

### ProjectGoals

The goal of this project is to benchmark existing systems and to design and build a machine that meets the following constraints:

- Easy to operate and maneuver by one operator
- Able to adjust to DPF installations of varying heights
- Removes and weighs a DPF in less than 5 minutes
- Assume DPF max potential weight is 50 kg
- Filter systems dimensions range between 10-15" OD and 10-30" lg
- Assume DPF surface temperature of 200 C
- Robust in somewhat abusive environments (including fuel, oil, soot, water (low potential))

**Company:** Caterpillar, Inc.

**Advisor:** Thomas Grimm

**Team Members:**

Samuel J. Miller

Eric D. Olson

Adam F. Tittman

Eric D. Welch

Tyler Z. Wenzel

Timothy J. Woelfel

## Large Area Passive Imbedded Crack Detector

This team will be comprised of students from both ME & EE curricula. The cross-functional nature of this team will be ideal for generating original designs from which future research programs could take their direction.

### PROJECT DESCRIPTION

The goal of this project is to assess, design, evaluate, predict the performance, and design the manufacturing method of a new type of passive crack sensor that uses no power or wiring, introduces no geometric or structural discontinuity, and can be inexpensively integrated with the composite material in large numbers.

### PROJECT SCOPE

The goal of this project is to assess, design, evaluate, predict the performance, and design the manufacturing method of a new type of passive crack sensor that uses no power or wiring, introduces no geometric or structural discontinuity, and can be inexpensively integrated with the composite material in large numbers.

The ME challenges of this project are to:

- Select or design a material system to serve as the EAS tag in conjunction with EE requirements
- Develop a method for rapid, inexpensive, and repeatable deposition the EAS strips over large sheets of fiber fabrics
- Determine where strips should be placed to best detect the smallest cracks in typical composite structural shapes and uses, such as fastener holes and stress concentrations

The EE challenges of this project are to:

- Evaluate the design of current EAS tags and modify the design, if required, to provide a method for detecting if the EAS tag is cracked
- Determine the minimum size and minimum spacing between multiple tags to provide a reliable determination if local cracking is present, and how manufacturing variability may affect accuracy of detection
- Determine the spatial resolution of crack detection given off-the-shelf transceivers and if needed, modify those devices to increase spatial resolution of crack detection.

**Company:** MTU – MEEM Dept.

**Advisor:** Ibrahim Miskioglu

**Team Members:**

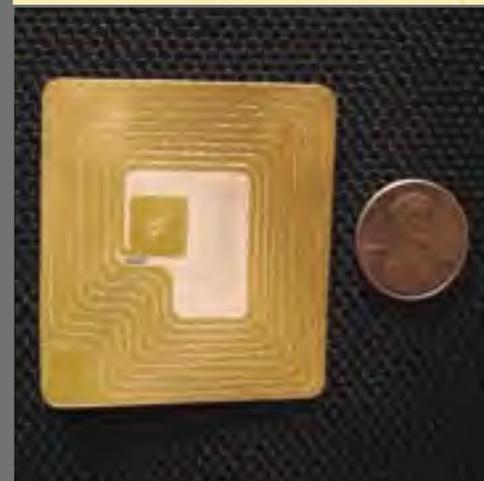
Michael L. Barnaby

Joel B. Chitwood

Matthew D. Mittag

Stefanus K. Rumawas

Casey J. Wierich





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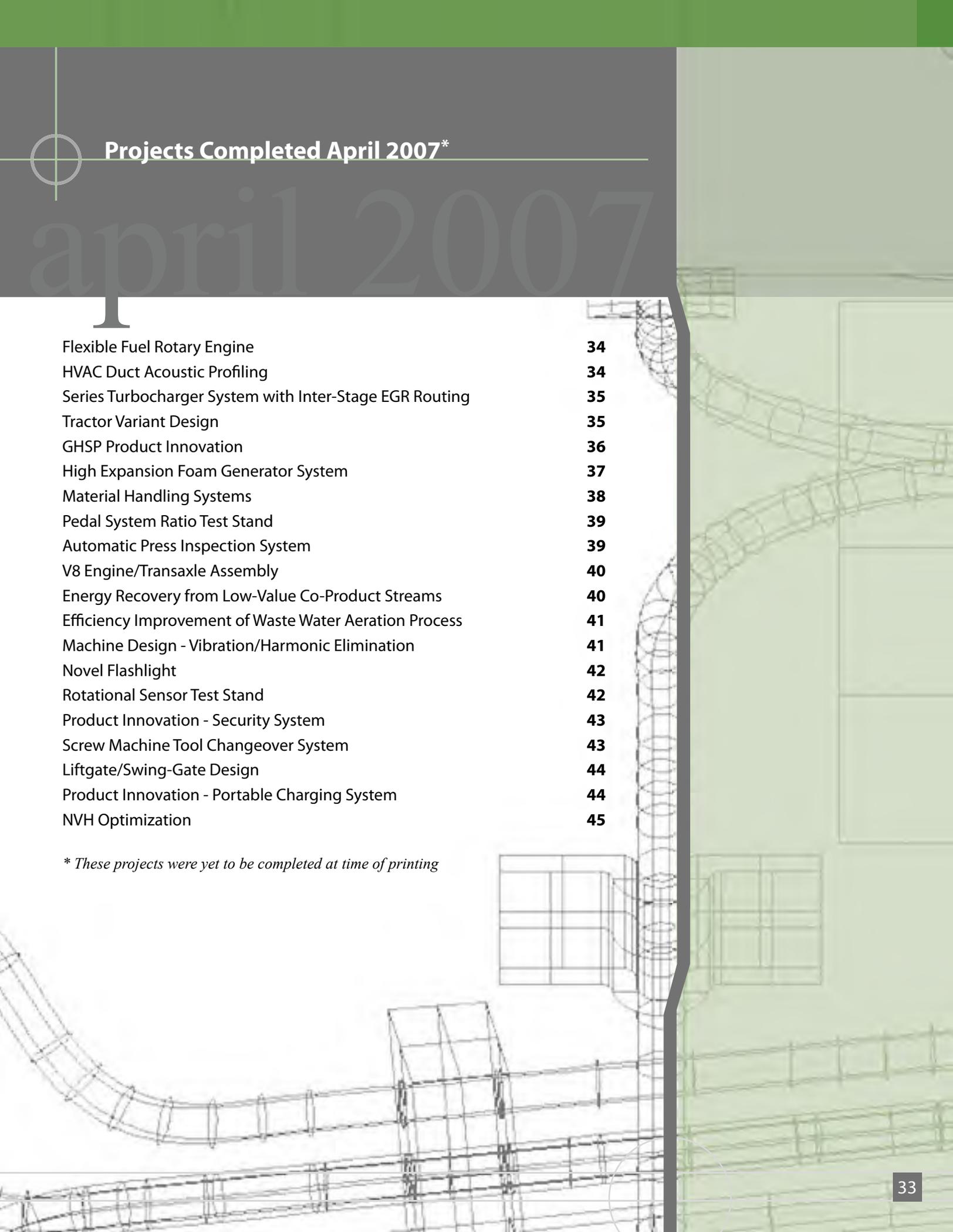
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*\* These projects were yet to be completed at time of printing*



**Company:** Alex Van Holstyn

**Advisor:** Thomas Grimm

**Team Members:**

Jacob Stine

Christopher Kero

Kiel Vanderhovel

Derrick Kendziorski

John Cox

## Flexible Fuel Rotary Engine

### PROJECT DESCRIPTION

Design and build a functional prototype of flex-fuel rotary engine suitable for use in further research and performance evaluation.

### OBJECTIVE

The mechanical engineering students on this team will be tasked with comprehending the principles of operation as will be described by the inventor himself, designing specific components, systems integration, and creating a functional prototype. It is contemplated that issues unknown or unforeseen at this point will be uncovered by this team. Design alternatives and/or workarounds for such issues will be an integral part of this project. Identifying these unknown issues will be a huge value in substantiating the analytically predicted engine performance parameters or discovering where these may have been flawed.

### PROJECT SCOPE

Given the sheer scope and complexity of the overall project, it will be broken into two complementary project teams. Team one will be comprised of ME senior undergraduate students and will commence work on 7 September 2006. This team will focus on identifying critical components & subsystems, design of engine components, and initial build. A second team will work in conjunction with team one, and will be formed at the beginning of the spring 2007 semester (8 January 2007).

This project includes design and build of a universal launcher as outlined above, and as defined by Shape Corp. specifications. A functional system should be completed along with functional design qualification test results.

## HVAC Duct Acoustic Profiling



### PROJECT DESCRIPTION

Noise heard by the operator inside the cabs of heavy machinery is a dominating factor in the marketing and the operation of such products. Caterpillar's current goal is to decrease noise levels within their line of operator cabs. HVAC systems are a dominant source of this noise within the operator cabs due to factors including blower noise and air turbulence. Therefore, there is a need to quantify this noise to improve duct designs and lower overall interior cab noise.

### OBJECTIVE

Design and evaluate duct geometries and environments with the common goal of reducing HVAC-generated cab noise in Caterpillar's heavy machinery.

### PROJECT SCOPE

This project will extend the work done by a previous senior design team. This project will begin with the hardware built and information generated by that team, and enhance their usefulness by adapting for use in a more realistic situation involving airflow through ductwork. Re-assess the insertion loss of the ductwork with the addition of airflow in the system. Develop a standardized design for coupling all types of cross-sectional areas. Test and evaluate ductwork with different foam materials in relationship to initial test results. Conduct further insertion loss tests with the application of foam, using a certified anechoic chamber and actual operator cab while following the proper testing procedures (ISO 7325).



**Company:** Caterpillar

**Advisor:** Mohan Rao

**Team Members:**

Brian Kargela

Kyle J. Marsh

Justin P. Metsa

Jeffrey E. Pruetz

## Series Turbocharger System with Inter-Stage EGR Routing



### PROJECT DESCRIPTION

Beginning in 2011, John Deere's 9.0 L engine must meet the new Tier 4 emission standards. This engine is capable of producing between 225 hp and 400 hp and will be expected to reduce its particulate matter production by 90% while maintaining the current emission standard of 0.015 g/bhp\*h of carbon monoxide (CO). Between 2011 and 2013, 50% of all engines must reduce their production of nitrous oxides (NOx) and hydrocarbons (HC) by 96% and 86%, respectively. To meet these new emission standards, John Deere plans to use large percentage exhaust gas recirculation (EGR) to achieve compliance. The proposed intake design includes using a dual series turbocharging system with cooled EGR being delivered interstage after the charge air cooler.

### PROJECT SCOPE

This large-scale project is being addressed by two complementary project teams. An initial senior design team began work on this project in January 2006, with a focus on creation of a refined intake model within GT-Power combustion simulation suite (*see page 26*). This team, team #2, will begin their work in September 2006 and conclude the project in April 2007.

### PROJECT GOALS

- Use a cycle simulation program to identify the turbocharger candidates for each stage (this task is composed of a number of sub-tasks, for example, wastegating can be a factor for either turbo)
- Deliver completed engine for testing to Deere, to include all hardware

## Tractor Variant Design

### OBJECTIVE

Design and Build of upsized Du-More Tractor prototype

The project will be supported by two overlapping senior design teams. Team one will begin in the fall semester of 2006, and complete its portion of the overall project in April of 2007. A second team will begin work on this project in January 2007, and complete the overall project at the end of its second semester in December of that year. Note that both teams will be working simultaneously on this project during the spring semester (January-April 2007).

### PROJECT GOALS

1. Increase size of machine from 1.5 yd<sup>3</sup> to 4 yd<sup>3</sup> bucket capacity
2. Horsepower increase
3. Optimize the operator's station in terms of improving human factors considerations
4. Maneuverability must not be compromised with larger design



**Company:** John Deere Product Engineering

**Advisor:** Jeffrey Naber

#### Team Members:

Varun Kaushik

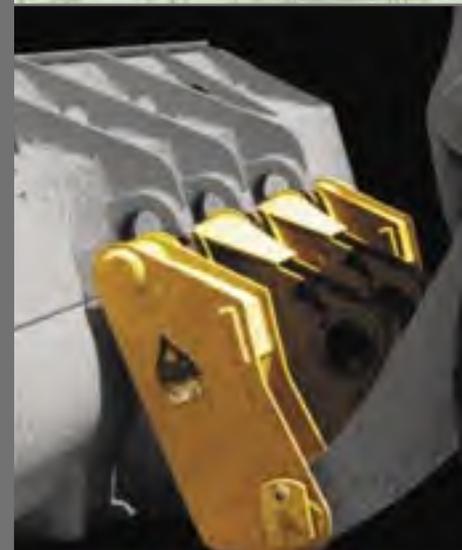
Chad Brunet

Ryan Windgassen

Jacob Loiselle

Aaron Skelnar

Michael Coppinger



**Company:** Elmer's Crane & Dozer

**Advisor:** Nels Christopherson

#### Team Members:

Andrew Rajala

Sean Williams

Jeffrey Haber

Joseph Bartell

Clinton Pernack

Mike Aho



**Company:** GHSP

**Advisor:** W.J. Endres

**Team Members:**

Jacquelyn Wilson

Samuel Johnson

Rachel Canepa

Jonathan Davis

Tenasia Hatch

### PRODUCT INNOVATION

Innovation – in a word, it is the heart of this project. This project will provide a nearly one-of-a-kind opportunity for select senior engineering and business students. The experience here is unique in that the team will be in a position to create, design, prototype, test, produce, and market a new and innovative product based on its own decision-making processes.

This project team will consist of Electrical, Computer, and Mechanical Engineering students, and students from MTU's school of Business and Economics. The team represents a fully cross-functional design/marketing team, encouraging inter-disciplinary collaboration in design optimization. It will be the assignment of this project team to identify products that could be made using the company's existing infrastructure, build business a case around each proposed product, and propose these to company representatives. The product(s) with the strongest business case(s) will be chosen through this process, and the project will proceed through design, prototype, and test phases; finally concluding with manufacture, sale & marketing of this product.

### OBJECTIVE

The objective of this project will be to create a new and innovative product using the core competencies of the sponsoring company. In essence, the project teams will have the capabilities of the company at their disposal to put to their greatest effect in producing their product design. Product proposals will, of course, be expected to be supported with related market research, design details, and manufacturing & marketing plans.

The team will be able to profile the company, getting an understanding of the capabilities within (i.e. manufacturing processes, existing customer base, in-house engineering & design skills, logistics, etc.). Based on those strengths, the team will present various product ideas to the company, with the ultimate goal of presenting a strong enough business case to be given the go-ahead for prototyping, validation testing, manufacturing and marketing.

### PROJECT GOALS

- Establish process for innovation through situation/problem analysis, ideation, market research, product design studies, experimentation, etc.

#### 1st semester

- Company analysis/evaluation
- Ideation
- Market/product analysis
- Building business case and preliminary design work
- Presentation of 3-6 most promising product choices with supporting data

#### 2nd semester

- Design freeze for 'alpha' phase prototype for product chosen from those presented at end of 1st semester
- Prototype build and functionality testing
- Presentation of results of testing, and refined business cases reflecting latest market research

# High Expansion Foam Generator System



This team will be comprised of students from both Mechanical & Chemical Engineering. The team represents a fully cross-functional engineering team, encouraging inter-disciplinary collaboration in design optimization.

## PROJECT DESCRIPTION

ANSUL™ JET-X™ delivers a mass of uniform bubbles in which the foam solution is expanded in volume to a range of 200:1 to approximately 1000:1. This high expansion foam is achieved by coating a perforated screen with a foam solution comprised of water and JET-X high expansion foam concentrate, while a high volume of air is blown on the screen to produce the expanded foam.

## OBJECTIVE

The project objective is focused on analyzing a current Ansul high expansion foam generator, proposing design changes that would improve the output efficiency of the system, and build a functional prototype to demonstrate design improvements.

## PROJECT SCOPE

The overall project has been broken into two complementary project teams. An initial senior design team began work on this project in January 2006, with a focus on optimization of the water reaction motor. The team being formed here, beginning work in the fall 2006 semester, will complement the other and will focus on overall system integration, expanded foam delivery, and performance of the foam solution itself.

The team represents a fully cross-functional engineering team, encouraging inter-disciplinary collaboration in design optimization. Together, these two teams will have the task of proposing design solutions intended to improve the performance & efficiency of the system as a whole.

## Team #2 Focus

Team two will focus on optimization of the foam output of the high expansion foam generator. The optimized output from the water reaction motor as designed by team #1 will be integrated into the overall system with the screen/housing as completed by this team.

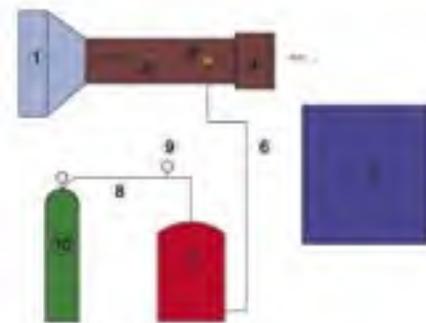
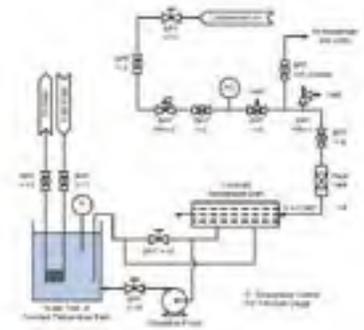
## Mechanical Focus

- Screen configuration – hole size/pattern
- System integration & optimization -- relating key components and sub-systems (i.e. water reaction motor, nozzles, size/shape of screen, packaging, etc.)
- Optimization of flow through entire system – forced convection, multi-phase flow, foam generation

## Chemical Focus

- Bubble structure – chemistry of foam concentrate
- Chemical properties of various agents i.e. stiffer foam vs. more easily flowing foam
- Investigation into agent improvement - increased bubble elasticity
- Comparison of Ansul vs. competitor agents - research to determine if other technologies exist
- Optimize bubble size with surfactant

**Company:** ANSUL/Tyco  
**Advisor:** Madhukar Vable  
**Team Members:**  
Neal Frantti  
Julie Motz  
Jason Tougas  
Micheal Fleck  
Michael Coppinger





**Company:** Winsert, Inc.

**Advisor:** William Endres

**Team Members:**

Nicole Drexler

Joseph Lechnyr

Michael O'Shaughnessy

Tyler Pagel

Martin Strande

Neil Sanders



**Company:** Winsert, Inc.

**Advisor:** William Endres

**Team Members:**

George Gramas

Stephanie Walton

Michael Heavener

Jeff Lachapell

Dan Morgan

## Material Handling Systems

### PROJECT DESCRIPTION

Winsert's current process includes a large amount of manual loading/unloading/orientation of valve seat inserts as they proceed through their machining processes. The basic machining sequence of these valve seat inserts is:

1. Gate removal, manual load onto centerless grind; every part handled manually
2. Both faces ground
3. Centerless OD grind; most OD stock off; ~.003" stock remaining; roundness; no orientation at this point; ID has feature for top/bottom distinguish
4. Manual load onto rod; top/bottom orientation; load from basket onto rod, then into lathe

### OBJECTIVE

Given the large scope of the work involved, and the nature of the current process, the overall project is proposed as being taken on by two senior design teams working in parallel. Team one will focus on material input – loading workpieces into each machining operation through the plant. Team two will focus on output – receiving each workpiece from a machining operation and handling it prior to the next operation. The teams will work together in creating a system for efficient inter-stage transport of product. In this way, each team is cooperatively associated in that the input team will need to work with the output team in designing a system that flows effectively from output to the next stage's input. Also, given the nature of the current machining processes using quite similar handling procedures at this point, it would seem logical to divide the engineering tasks as above. Each team can have a micro and macro focus, designing systems that can be integrated into each stage across the current operation, rather than focusing on one stage and trying to adapt to other stages at a later point.

### PROJECT GOALS

- Design & prototype machine/system which can be integrated into Winsert's current processes which would optimize material handling through existing machining operations
- Eliminate manual re-orientation of valve seat inserts during processing
- Integration of QC system into material handling scheme
- Any design adopted must comprehend easy adaptation to new machines anticipated being purchased in coming years (i.e. designs must not be strictly limited to machines currently in use)



## Pedal System Ratio Test Stand

### PROJECT DESCRIPTION

Dura Automotive Systems produces various automotive control systems. Among these are brake, clutch, and accelerator pedals, both fixed and adjustable. Because of the large volume and wide variation in these products and their types, a dedicated test stand is needed to perform design qualification and product validation testing. The team will be tasked with designing and building a test machine that will include the following features:

- Load input perpendicular to pedal pad throughout stroke (note: can possibly design system with moving anchor point programmed to remain perpendicular to pedal bean throughout stroke)
- Filtering – this needs to be defined – there was discussion during our initial meeting in May that some signal filtering may be required
- Device must measure input load as well as output throughout test sequence
- Device must be able to accept any fixed or adjustable pedal system for testing
- Pedals must be mounted in vehicle position for testing
- Machine must include functionality to enable printing of graphic output (pedal force ratio/pedal travel ratio vs. pedal travel)
- Designed test stand must be able to save all raw data in .xls format for later review/evaluation
- Test stand should use National Instruments Labview software & hardware for both machine control and data acquisition



**Company:** Dura Automotive Systems

**Advisor:** Roshan D'Souza

**Team Members:**

Ronald Knoebel

Matthew Kempeinen

Ben Riutta

Thanh Pham

Matthew Pavlovich

## Automatic Press Inspection System

### OBJECTIVE

Develop a flexible system to inspect critical dimensions of complex metal stampings as they come off a metal stamping press at rates up to 60 parts per minute to eliminate gaging.

### PROJECT GOALS

- Utilize current or emerging technology (i.e. laser, vision system, back lighting)
- Operator interface / front end software will be developed to provide easy to use software for programming of parts into system from CAD data
- Programming should be able to be done on a remote computer and downloaded into the system via Ethernet
- Machine / system software must interface front end/user interface with the hardware and stamping press.
- Environment – metal stamping environment, oily parts, noise & vibration, variable sizes and types of press equipment.
- No operator involvement at the press (i.e. moving, orienting, etc).
- Allow for easy change over by set-up personnel via HMI interface on system at the press
- API system should run and work independent of the stamping press.
- Must interface with press in order to meet all Michigan and national safety requirements.



**Company:** Gill Industries, Inc.

**Advisor:** Thomas Grimm

**Team Members:**

Jason D. Crockett

Benjamin J. Kolhagen

Timothy W. Lau

Jennifer L. Martin

Travis D. Pietsch

## V8 Engine/Transaxle Assembly



### PROJECT DESCRIPTION

GM is in the early stages of starting up their new Lansing Delta Township vehicle assembly plant. The vehicles being assembled have begun production with a V-6 engine as the only power plant option. Early in 2007, however, a V-8 engine will be offered and integration of this engine with the proper transaxle will be required. The task of this project team will be to analyze the current assembly process, design and build proper hardware necessary to optimize this integration, and to implement solution into new V-8 engine line. Clearance issues unique to the UV-8 build sequence, must allow the transaxle and PTU to be assembled prior to marrying to the engine. This sequence drives the sub-assembly of the transaxle and the PTU on the UV-8. To process this variation, a tooling change and change in the assembly process need to be implemented.

### OBJECTIVE

Develop a sub-assembly fixture to accommodate the assembly of the transaxle to the PTU (Power Transfer Unit) for the UV-8 engine. This fixture needs to be integrated into the current engine build process using minimal space and no additional manpower.

### GM-LDT WILL PROVIDE

- Access to LDT assy plant as needed
- CAD data / drawings of current V6 fixturing
- Definition of design constraints and related process equipment

## Energy Recovery from Low-Value Co-Product Streams



### PROJECT OBJECTIVE

Design, prototype, and demonstrate a high potential energy recovery system which could be integrated into Grain Processing Corporation's existing processes. Recent economic dynamics within the corn milling industry (both wet & dry milling) have unfavorably affected revenue streams on various co-product streams. At the same time, energy costs continue to escalate. Consequently, there is strong interest in quantifying inherent energy values in various lower-value co-product streams as well as internal waste streams.

### PROJECT SCOPE

Two phases are envisioned for this project:

1. Phase one would involve determining inherent energy value potentials for at least four streams from the Muscatine, IA plant and at least three streams from the Washington, IN plant. Stream samples will be supplied for analytical analyses. Using that empirical data, the team will develop both mass and energy balances and energy recovery potentials vs. cost for each of four technology categories GPC has identified whereby the lower-value/waste process streams may be converted to energy sources: combustion, gasification, anaerobic digestion, cellulosic fermentation
2. Using the data generated throughout phase one, the team will pursue the highest value product streams, and propose designs that would capture inherent energy in them. These newly proposed processes should be designed allowing flexible integration with GPC's existing facilities to provide optimum return.



**Company:** General Motors Corp.  
Lansing Delta Township

**Advisor:** Thomas Grimm

**Team Members:**

Jeffrey Taylor

Roderick deNijs

Dave DeVormer

Rachel Sherzer

Benjamin Deyo



**Company:** Grain Processing Corp.

**Advisor:** R.L. Whipple

**Team Members:**

Andrew Volmering

Jesse Manthei

Luke Donovan

Joshua Arthur

Jason Frazier

## Efficiency Improvement of Waste Water Aeration Process



### OBJECTIVE

Design & prototype an improved aeration method intended for integration into wastewater treatment processes.

### PROJECT DESCRIPTION

Existing wastewater treatment processes involve a high degree of aeration. The aeration is integral to the process and the separation of constituents of a waste stream. Current methods of aeration are quite power-intensive and diminish the overall efficiency of any treatment system. Another method of aerating the wastewater has been considered as an alternate to the traditional compressed air approach. Such a system promises much better power efficiency than the conventional compressed air version. Implications of a more efficient aeration method are quite substantial considering widespread use if these systems. A project focused on designing and prototyping such a system is being sponsored by Van Aire, Inc.

### PROJECT GOALS

- Design & build functional prototype of improved efficiency aeration system
- Test prototype in regards to power consumption and compare to current systems(s)
- Power/energy balance of newly proposed design v. existing system

## Machine Design – Vibration/ Harmonic Elimination



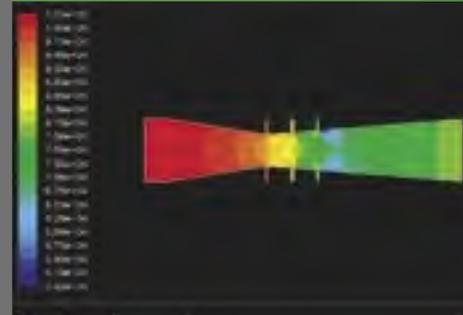
### PROJECT DESCRIPTION

Thilmany Papers in Kaukauna, WI produces a wide range of paper products. Among their processes is what is known as a calendar. It comprises, in basic terms, two parallel-axis rotating cylinders which are in contact under a given pressure. Paper is fed through the contact 'line' of the rotating cylinders with the intent of imparting a desired surface finish or improving the properties of the paper being produced. A problem has existed in this machine, in that the surface of the upper cylinder becomes 'barred' over a relatively short period of operation. What is meant by this term is that the surface is permanently deformed over time. The cylinder's cross section changes from a true circle to a non-round condition. A series of depressions become permanently formed along the length of the upper cylinder's surface. The end result of this phenomenon is the machine can no longer produce product of adequate quality, and requires the surface of the upper cylinder to be replaced/reworked.

### OBJECTIVE

Engineering solution to current barring issue on Thilmany's #13 calendar top roll

- Design proposal outlining solution to current barring issue
- Proof of concept through prototype build and correlation to engineering analysis results
- Synopsis of numerical models and analysis tools used



**Company:** Van Aire, Inc.

**Advisor:** Nels Christopherson

#### Team Members:

Alan Pieniadz

Andrew Daavettila

Thomas Halt

Kassie Monick

Christopher Thoms



**Company:** Thilmany Paper

**Advisor:** Nels Christopherson

#### Team Members:

Gregory Ehlert

Gregory Montie

Edgar Leonard

Seung Hyun Moon

Aaron Meyer

## Novel Flashlight

### PROJECT DESCRIPTION

This project will provide an opportunity for select senior engineering and business students to develop a product which can be commercialized. The team will be in a position to create, design, prototype, test, produce, and market a novel battery-less LED flashlight, which can project a variety of images.

### OBJECTIVE

The objective of this project is to create a new and innovative product using components and technologies already available. To accomplish this, members of the team must do the following:

- Intellectual property search, customer surveys, and benchmarking
- Develop value chain
- Develop a prototype and initial test
- Investigate manufacturing costs and modification possibilities.
- Develop a business plan to commercialize the product.

### PROJECT SCOPE

This project team will consist of Electrical, Computer, and Mechanical Engineering students and students from MTU's school of Business and Economics. The team represents a fully cross-functional engineering team, encouraging inter-disciplinary collaboration in design optimization. The project is being sponsored jointly through the National Collegiate Inventors and Innovators Alliance and the National Science Foundation through Dr. Lumsdaine and Dr. Nelson.

## Rotational Sensor Test Stand



### PROJECT DESCRIPTION

Rotational position speed sensors are used in automotive engines and transmissions to provide critical rotational position information, relative speed information and as the primary detection method of misfire in engines. The sensors used for this purpose typically are Variable Reluctance (VR), Hall and Magneto-Resistive (MR) devices. These sensors detect the rotation and position of a rotating metallic target wheel and provide voltage signals back to the computer control module for the powertrain. Ford Motor company is planning to transition its engines from one sensor technology to another over the next few years. One critical need is a method to evaluate various sensor and wheel designs early in a program to assist in optimizing the design.

### OBJECTIVE

Design and Build Rotational Speed and Position Sensor Test Stand

### PROJECT SCOPE

Develop a rotational sensor test stand. This would be to develop a universal test stand to primarily evaluate various crankshaft position sensors. This stand would be used to verify supplier claims and to evaluate competing designs. This stand would include a motor and target wheel rotational setup, sensor fixtures, data acquisition system and post processing software. The students would be expected to demonstrate gage repeatability and reproducibility at the end of the project.



**Company:** ME-EM Dept

**Advisor:** Thomas Grimm

**Team Members:**

Christopher Sherman

Matthew Rossman

Johathan Moran

Joshua Olsen

Nitim Yadav

Owen Seltz



**Company:** Ford Motor Company

**Advisor:** Robert Whipple

**Team Members:**

Derek Botero

Jeff Bowman

Dasol Kim

Aik How Tan

Nurudeen Balogun

## Product Innovation - Security System

### PROJECT DESCRIPTION

This project will provide an opportunity for select senior engineering and business students to develop a product which can be commercialized. The team will be in a position to create, design, prototype, test, produce, and market a product which improves security in homes, offices, business establishments, cabs, and private vehicles. The project is being sponsored jointly through the National Collegiate Inventors and Innovators Alliance and the National Science Foundation through Dr. Lumsdaine and Dr. Nelson. The product is a clock or imitation “fuzzbuster” or dashboard ornament which actually contains a camera, microphone, motion detector, infrared light, memory chip, and wireless transmitter. Content: flexible mounting, autoerase feature, wireless transmitter and record capability.

### PROJECT GOALS

- Intellectual property search
- Conduct a survey of selected local businesses and businesses owned and/or operated by MTU alumni to see if such a system would be desired, and to identify additional features which might enhance the product.
- Examine a collection of electronic gadgets to study the relevant mechanisms and determine what improvements could be made.
- Determine what power requirements would be needed to operate the several components of the project.
- Develop a prototype.
- Test the prototype in a variety of settings
- Investigate manufacturing costs and modification possibilities.
- Develop a business plan to commercialize the product.

## Screw Machine Tool Changeover System

### PROJECT DESCRIPTION

Existing machine at Anchor Coupling is inefficient with regards to tool changeover. Present practice requires upwards of 12 unique wrenches & tools to be used during a tool change. An environment not ideally suited to the task, high torque values for clamping bolts, and tight spaces all contribute to less than acceptable safety metrics. The tool changeover is also complex, requiring approximately 5 hours to complete.

### OBJECTIVE

Design & prototype safe & efficient tool changeover device/system for current family of screw machines. A successful solution will eliminate the risk of injury to the operator while decreasing the amount of time and tools necessary to complete this process. Goals include: optimized tool change process for screw machine; identify a realistic design upgrade that achieves; enhanced safety; reduced machine downtime; reduction of unique tool usage; simple operation; universal adaptability within present facility; detailed BOM and engineering documentation for proposed system; fabrication of functional prototype; design validation testing and demonstration on current machines.



**Company:** ME-EM Department

**Advisor:** Nels Christopherson

#### Team Members:

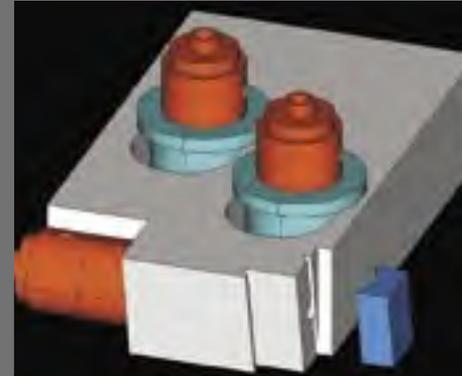
Kenny Ng

Michael Marantis

Jeffrey O'Brien

Elise Vertin

Mark Dehlinger



**Company:** Anchor Coupling

**Advisor:** Roshan D'Souza

#### Team Members:

David Siegfried

Nitin Yadav

David Grunlund

Lee Woelmer

Jeremy Heidbrier



**Company:** General Motors Corporation

**Advisor:** William Endres

**Team Members:**

Patrick McGee

Aaron McCabe

Christina Hall

Micah Bowron

Sarah Pearson



**Company:** ME-EM Department

**Advisor:** Thomas Grimm

**Team Members:**

Darald Chao

David Henderson

Mark Burgener

Catherine Rottier

James Stitt

Lisa Deschaine



## Liftgate/Swing-Gate Design

### PROJECT DESCRIPTION

GM North America Engineering is planning a new vehicle platform which will involve an updated design of a rear swing / drop / lift gate.

### PROJECT OBJECTIVE

Design and develop Swing / Drop / Liftgate for new vehicle platform and demonstrate functionality through prototype build. Project will involve design, analysis, prototype development and validation of designs.

### PROJECT GOALS

This team will be tasked with design of new swing / drop / lift gate and integration into new vehicle platform. There are various design constraints and requirements of this new design which should be fully defined (and potentially re-defined as the designs develop). Students will work with GM engineers who are working on the actual vehicle program. Designs will, hopefully, be implemented into the actual vehicle design when it goes into production.

## Product Innovation – Portable Charging System



### PROJECT SCOPE

This project team will consist of Electrical, Computer, and Mechanical Engineering students and students from MTU's school of Business and Economics. The team represents a fully cross-functional engineering team, encouraging inter-disciplinary collaboration in design optimization. The team is further enhanced through the integration of students from MTU's school of Business and Economics.

### PROJECT SCOPE

This project will provide an opportunity for select senior engineering and business students to develop a product which can be commercialized. The team will be in a position to create, design, prototype, test, produce, and market a product which is sorely needed by millions of cell phone users and lab top/notebook computer users.

The product is a battery powered cell phone that has crank style charging device and an umbilical cord that can be used to provide an emergency charge to the batteries in other electronic devices such as iPods, and lap top/notebook computers. The product should have the capability to provide an extra ten to fifteen minutes of service on a lap top or notebook computer.

The project is being sponsored jointly through the National Collegiate Inventors and Innovators Alliance and the National Science Foundation through Dr. Lumsdaine and Dr. Nelson.

## NVH Optimization



### OBJECTIVE

Design and prototype an improved muffler system for the current range of Terex handlers.

### PROJECT DESCRIPTION

Terex produces material handlers in 3 sizes: 6000, 8000, and 10,000 pounds. These sizes are given in terms of lifting capacity. Each size has two models, yielding 6 distinct products Terex produces at their Baraga facility. These handlers are used in residential environments, and quieter operation is always desirable. Noise emission during operation can be traced to a number of sources.

A previous senior design team (fall '05—spring '06) analyzed the current Terex product and identified a number of contributors to its overall noise profile. That team focused on optimization of the hydraulic pump, it being a major contributor to the overall noise profile of the handler. Terex remains concerned about the contribution of the muffler to this profile, and is interested in exploring design alternatives aimed at reducing its noise emissions while maintaining performance of the powertrain. Another primary goal for Terex is to be able to economically manufacture any such newly designed system at their Baraga facility.

Goals include: functional prototype of improved muffler system for current line of Terex handlers, which would be manufacturable at the Terex Baraga facility; test data correlating predicted to actual noise emission of new design(s); comparison of new design to current system showing amount of noise reduction realized; trade-off study showing costs of various design possibilities vs. performance; proposed manufacturing plan of design.



**Company:** Terex Handlers

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