2010 Senior Design Clinic

Engineering @ St. Thomas

Welcome to the 2010 Senior Design Clinic! What you see here today are 18 working prototypes which 8 months ago were nothing more than ideas. Fourteen companies and non-profits have engaged our students with the real life experience of asking, "is it possible?" then letting the teams go to work. The teams will all tell you that at times it got tough and they themselves weren't sure how it was all going to unfold. And that is exactly what we are trying to capture in the St. Thomas Senior Design Clinic. Where the comforts of well-defined textbook problems are abandoned, real engineering emerges. What you see here today is the manifestation of that uncertain process of translating ideas into reality. In short, what you see here today *is* engineering.

On behalf of the School of Engineering faculty, I would like to thank you for coming today. We are grateful for the support of the sponsoring companies and non-profits who have committed the funds, equipment, and time to truly make this a great experience for our students. And lastly, we are especially grateful for the support of the family and friends that each one of our seniors has relied upon to make it this far in their incredible life journey.

Again, thank you and enjoy!

Don Weinkauf - Dean of Engineering

Metamodix, Inc.

Future Force

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MINNESOTA

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(651) 962-5750

or email: dhweinkauf@stthomas.edu

Three Phase Flow Meter for Oil Well Monitoring

Team:

Kelli Lais, Isaac Remer, Brian Sames, and Morgan Impola

Clinic Advisor:

Dr. Ranjan Charkravarty

Industry Representative:

Dave Wehrs - Emerson

Project Summary:

There are many 1000's of oil wells which produce large amounts of water, natural gas, and oil. These components form three phases in the pipeline. The measurement of oil flow in this multiphase mixture at the well head is difficult and costly. Currently, there are multi-phase flowmeter devices on the market; however, these flow meters can range in cost up to $100,000. The Emerson senior design team is expected to deliver a device capable of taking measurements from fluid flowing through.

Project Mission:

Create a low cost device that can accurately measure volumetric flowrates of oil, water, and natural gas in multiphase mixtures under standard oil well process conditions.

Solution:

After extracting the mixture through valve manipulation the sample naturally settles on its own in a collection chamber. A microwave probe then measures the levels of the three liquids to determine each percentage (oil, gas, water).

Retro-Viewer Redesign for Retro-Reflective Film Authentication

Team:

Brian Schmitt, Michael Boston, Nathan Drude, Jed Jenkins, and Clarence Schaack

Clinic Advisor:

Dr. Ranjan Charkravarty

Industry Representative:

Jim Mitchell – 3M

Project Summary:

The purpose of this year-long project was to use material and optical properties to design a new and improved retroviewer for the 3M Company. The retroviewer is a handheld device used to visually authenticate official documents, ranging from packaging labels to government passports. These documents incorporate 3M's retro-reflective technologies.

The new retroviewer features a wide range of improvements over the current Retroviewer. The new retroviewer performs over a large range of lighting conditions and under all seasonal conditions; while removing glare experienced with its predecessor. The new retroviewer provides an increase in viewing hole size, light intensity, and battery life resulting in a better viewing experience for the user.

Project Mission:

To use material and optical properties to design a new and improved retroviewer for the 3M Company.

Biggest Challenge:

The biggest challenge our group faced was trying to determine how big of a viewing hole we could create while maintaining the visibility of the Confirm technology. We had to approach this experimentally because the technical specifications provided for the previous Retroviewer did not match with our experimental results.

Optical testing of the retro-reflective films in the labs at St. Thomas indicated that the angle of incident light could be much broader than originally thought. The data led us to design a much more user friendly device with a convenient viewing window.

Pediatric Vein Transilluminator

designwise medical

Team:

Ryan Markwardt, Thomas Hillebrand, Daniel McNamer, David Timm, Daniel Wadell

Clinic Advisor:

Dr. Surya Iyer

Industry Representative:

Brad Slaker – DesignWise Medical

Project Summary:

One of the top unmet needs in neonate and infant medical care involves the lack of appropriately designed and effective vein transilluminators. Current products attempt to illuminate veins with red and orange light emitting diodes (LED). Many of these products are difficult to use and most simply do not work. This deficiency leads to clinician abandonment of transilluminators and a return to traditional, non-assisted methods for locating and accessing veins. Using this traditional approach frequently causes additional needle sticks – leading to increased pain and infection risk as well as greater discomfort and trauma for the patient and the patient's parents. Our objective is to design a highly effective transilluminator to replace the devices currently being used in pediatric hospitals.

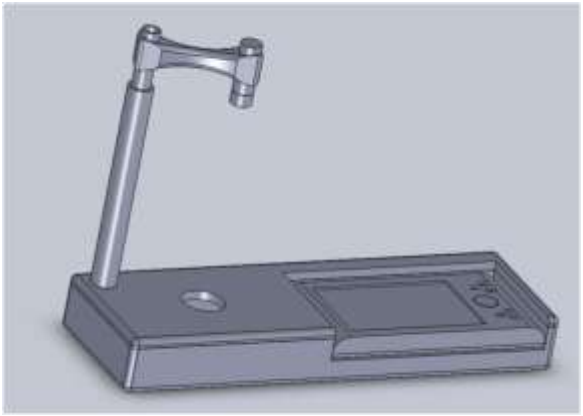
Our team will use a new approach to solve this problem, engineering a creative solution that gives clinicians confidence in their actions and provides patients with a more pleasant, safe experience. This solution allows clinicians to accurately assess the location of veins without needing to handle bulky or awkward devices and has the potential to become a standard of care in the field of infant IV insertion.

Project Mission:

Our team has engineered a creative solution that gives clinicians confidence in their actions and provides patients with a more pleasant, safe experience. This solution allows clinicians to accurately assess the location of veins.

Biggest Challenge:

One of the biggest challenges our team faced was acquiring the necessary background knowledge in the field of optics to successfully complete the project.



Introducer Sheath for Femoral Artery Surgery

Team:

Benjamin Haselman, Sara Lais, Matthew Olson, Robert Schulzetenberg, Benedict Skemp

Clinic Advisor:

Dr. John Wentz

Industry Representative:

Rob Kohler – Cardiovascular Systems Inc.

Project Summary:

When performing procedures related to peripheral artery disease, doctors must often navigate a small tube, or sheath, through the arteries of the legs and over the "arch". The arch, also known as the iliac bifurcation, is the location where the femoral arteries of the two legs meet to form the single aorta which continues up to the heart. At times, this bifurcation can reach extreme angles which can cause the sheath to either kink or curve to a very small radius. Both of these cases make it difficult for doctors to pass devices through the sheath to the point of treatment.

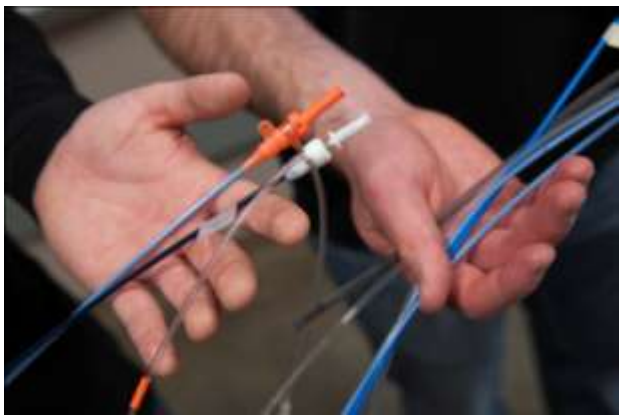
The CobraSheath team was given the task of designing a new introducer sheath to reduce the likelihood of this event. The team settled on two methods of accomplishing the goal: making the sheath stiff enough that it will not kink, or designing a radically-expandable introducer. The first design involved a flexible distal portion of introducer to navigate around bends, and a stiff proximal section so that the sheath will naturally rest at a larger radius. The second design allowed doctors to insert a sheath into the body, and increase the diameter of the sheath over the arch section once the sheath was in place.

Project Mission:

Develop an introducer sheath to effectively allow insertion of an orbital atherectomy device into human vasculature to treat peripheral arterial disease (PAD).

Biggest Challenge:

Due to the unique requirements of materials and the scale of the project, we were not able to go into the machine shop and build prototypes from scratch. Prototyping involved extensive communication with manufactures to produce the desired products.



Electrical Generator Heat Pipe System

LOCKHEED MARTIN

Team:

Timothy Flesch, Jacob McAlpine, Craig Spande, Andrew Snedden, Brandon Turek-Krengel

Clinic Advisor:

Dr. Chris Haas

Industry Representative:

Dr. Bob Monson – Lockheed Martin

Project Summary:

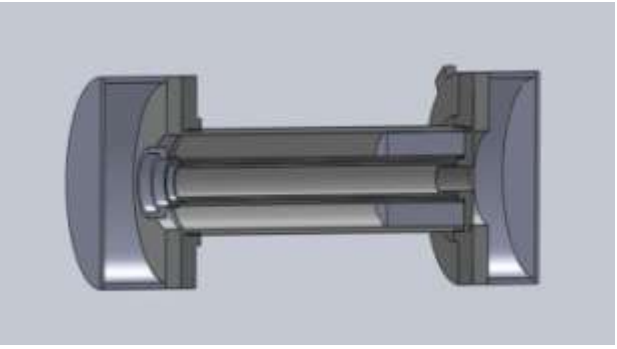
Natural Thermal Electric Engineering (NTEG) is a heat pipe application that would convert energy from any thermal gradient into electricity. The Heat Pipe system team will create a thermal heating unit to demonstrate the concept that power can be generated from such a device. It will harness the heat in for use in a building and also to create electricity. Using heat from the ground, the heat source creates vapor from a liquid solution, the vapor will rise and drive a fan in the heat pipe. This fan will in then turn a turbine, creating electricity.

Project Mission:

The mission of the NTEG project is to design and create a working prototype that demonstrates the capability and functionality of a Natural Thermal Electricity Generator in simulated real-world conditions. Analysis of the system's functions and efficiencies will be conducted and utilized to produce a final prototype capable of producing sufficient electricity to illuminate an LED, approximately 50mW.

Biggest Challenge:

The crux of the NTEG project is that it must rely on sustainable energy. The Team was forced to find a generator, motor, and blade orientation capable of extracting the maximum amount of energy from the system. The challenge of locating this ideal generator challenged us constantly in the later part of the NTEG design and fabrication.



Gastro-Intestinal Implant

Metamodix, Inc.

Team:

Joseph Edison, Scott Plooster, William Johnson, Karl Ganske

Clinic Advisor:

Dr. Don Weinkauf

Industry Representative:

Dr. Kedar Belhe - Metamodix

Project Summary:

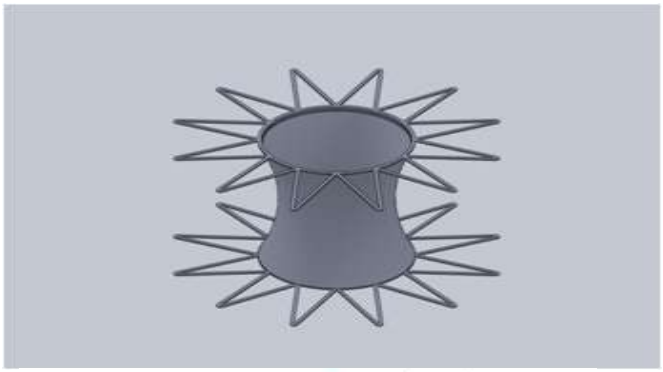
Type 2 diabetes is a disease that affects 17 million people in the United States alone. Studies have shown that limiting food absorption in the initial 9 to 14 inches of the small intestine will reduce the symptoms of type 2 diabetes. The challenge of this project is to create an anchoring system that will support an intestinal liner which will effectively stop food-intestine interaction. The anchoring devices will be placed in the pyloric region, just after the stomach, which will allow for the greatest stability and minimal interference with normal bodily function. Three designs have been chosen to be prototyped based on design advantages and novelty.

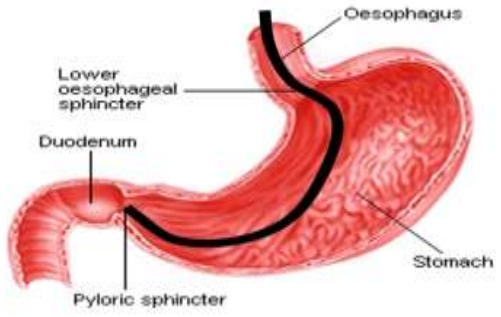
Project Mission:

To create a working prototype of a device that can be implanted into the region immediately after the stomach. The device will be an anchoring system for a larger assembly which will actively inhibit the absorption of nutrients, food, and digestive fluids in the first nine to fourteen inches of the small intestine.

Design Requirements:

1. The device must be deliverable and removable in a noninvasive delivery method.
2. The device must not inhibit the function of the stomach or intestines, nor cause blockage.
3. The device must not migrate from the point of anchoring.





Retractable Windscreen for Touring Motorcycle

Team:

Bryan Edlund, Eric Crosby, Matthew Hudson, Anthony Kanozik, Joseph Summarbor

Clinic Advisor:

Roy Jenson

Industry Representative:

Joshua Katt - Polaris

Project Summary:

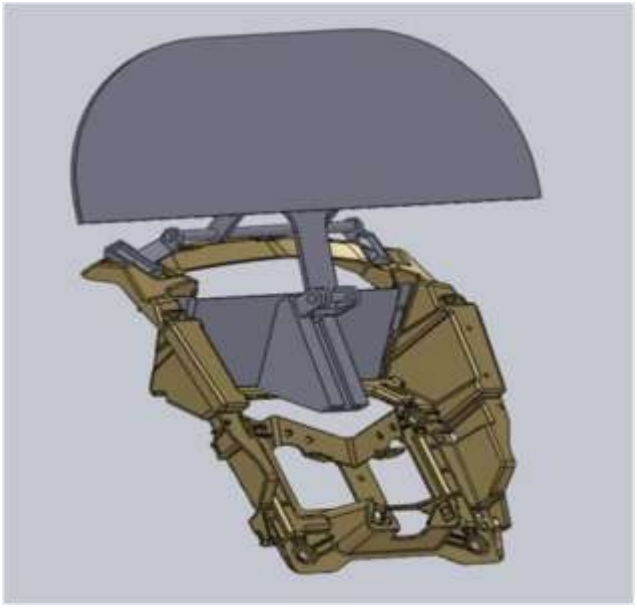
The Polaris adjustable windscreen design team's goal is to develop a mechanism that can adjust a windscreen during the operation of the Victory Cross County ™ motorcycle. The reason adjustability is demanded in the touring market is to accommodate for varying riding conditions such as temperature or rain. The design team's solution was to use a power screw in a four-bar linkage to move the windscreen to the appropriate position. Complex brackets were built to package the system.

Project Mission:

Design an adjustable windscreen for a touring motorcycle.

Biggest Challenge:

Package and mount a mechanism in an extremely limited space without modifying the existing fairing or aluminum substructure.



Pavement Marking Road Groove Depth Sensor & Coordinate-Logger

Team:

Timothy Tursich, Hans Drabek, Christopher Davis, Olivia Smith

Clinic Advisor:

Dr. Chris Haas

Industry Representative:

Padraic McGuire – 3M

Project Summary:

The goal of 3M Pavement Groove Sensor's project was to create a device that will aid in groove depth inspection. Team 3M Pavement Groove Sensor's solution is a small cart-like device reminiscent of a push lawnmower. Using electronic sensors and small rollers attached to the cart, the device is able to roll along the groove taking measurements at a continuous rate. Depth information and GPS position along the road surface is displayed on a touch screen for instant access to measurements. Data is also stored on removable SD cards which can be transferred to any computer for later analysis.

Project Mission:

Mount a sensor on a cart to be pushed along groove trench. Sensor will relay and relay information to a computer and will be stored on an SD card for easy mobility.

Design Requirements:

1. Measure the depth of a groove to within +/- 0.002" to 0.005".
2. Contain a user interface that displays data, includes warning indicators, and accepts and stores data.
3. Store data on Secure Digital (SD) card.

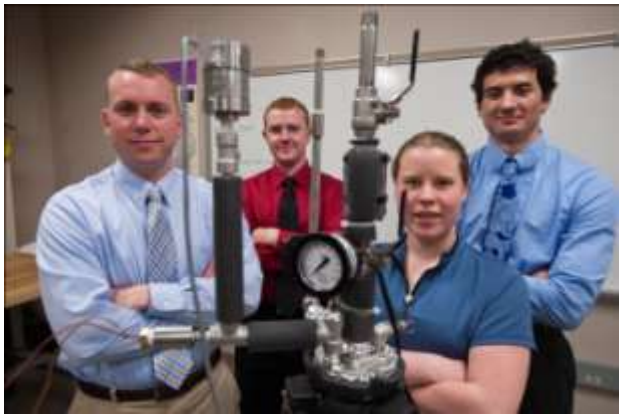
Hydrogen Peroxide Decomposition Chamber for Power Generation

Future Force, LLC

Team:
Kylie Bennett, Jacob Dahle, Brian Johnson, William Schwalbach

Clinic Advisor:
Dr. Camille George

Industry Representative:
Mike Tkadlek & Jim Rau – Future Force



Project Summary:

To develop a hydrogen peroxide decomposition chamber that utilizes pressure rather than thrust to operate a prototype steam engine. The H2O2 propellant concentration must be less than 50%. We need a minimum of 50 PSI at 1.35 CFM. The catalyst must be inexpensive and non-toxic. The system should be virtually maintenance free and minimize the amount of propellant necessary to operate the unit.

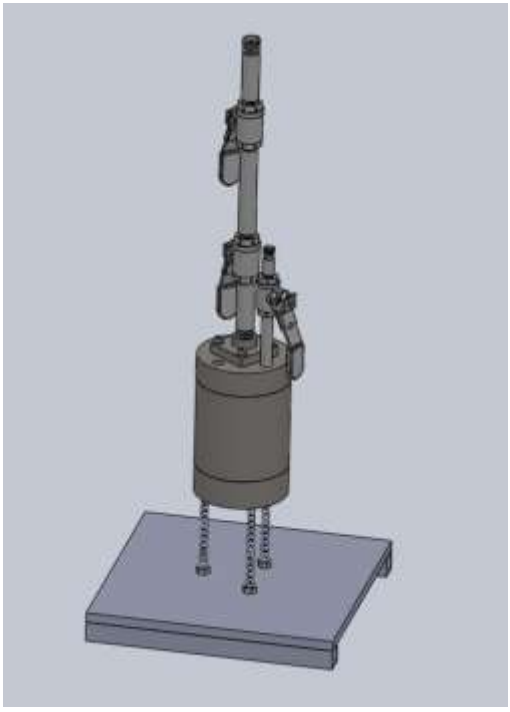
To achieve this purpose, a four part system was developed. The four components of the system are: the delivery of hydrogen peroxide, the catalyst, the reaction chamber, and a data acquisition system. When operating, the hydrogen peroxide is first passed through a silver screen catalyst where a reaction occurs. This reaction is then harbored in the reaction chamber where the byproducts, steam and gaseous oxygen, are bled through a regulator to operate the steam engine, generating mechanical power.

Project Mission:

The basis of this project, a hydrogen peroxide decomposition system, is to efficiently decompose hydrogen peroxide to a gaseous state at a specific pressure and flow rate in order to operate a steam engine.

Biggest Challenge:

Creating a system that runs off a concentration of 50% hydrogen peroxide or lower.



Machine Vision System for Laser Cutting

Team:

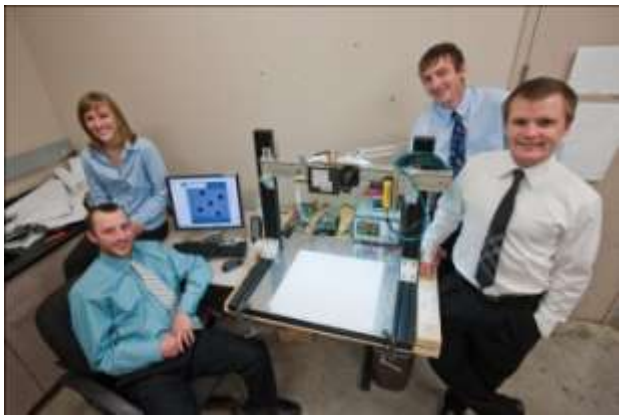
Stephanie Behrns, Alexander Gabriel, Andrew Gikling, William Neve

Clinic Advisor:

Dr. Ramesh Rajagopalan

Industry Representative:

Tom Weigman - LasX



Project Summary:

Machine vision systems are a used in a variety of industries worldwide. In recent years significant advancements in machine vision systems have lead to their proliferation, specifically in manufacturing. LasX Industries uses machine vision systems to find part locations and then accurately laser cut the parts. Their current machine vision scheme uses a stationary camera which locates fiducial marks only under the camera's field of view. If a fiducial mark falls out of the camera's field of view, the machine vision is rendered useless. A more sophisticated system would allow the camera to see the entire laser cutting field to eliminate this problem.

The senior design group's challenge is to develop this new, dynamic machine vision system. The goal is to locate the position of the fiducial mark to within 120 micron accuracy over the entire laser cutting field. The system's design includes calibrated custom optics, mathematical perspective transformations, search algorithms, and custom software. All these technologies have been integrated to achieve a robust, cost effective machine vision solution.

Project Mission:

To design and develop a high precision, dynamic machine vision system.

Design Requirements:

1. Mount and optically calibrate the camera, lens, and scanhead system.
2. Develop scan algorithm to locate fiducial marks.
3. Develop transform to map camera image of fiducial mark to the field location of the fiducial mark.
4. Assemble working prototype to find world locations within 130 microns.

Control Panel Assembly Cart

Team:

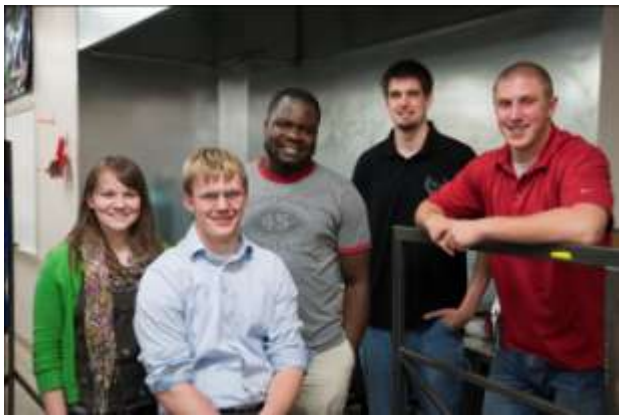
Ndefru Formuluh, Thomas Garske, Kelly Coss, Garrett Nelson, David Lymburn

Clinic Advisor:

Dr. James Ellingson

Industry Representative:

Dr. Mitchell DeJong - DRC



Project Summary:

The DRC Control Panel Carrier and Paperless Tracking System is a unique project because it presents two different challenges each with its own end product: a mechanical cart and an electronic tracking system. Design Ready Controls (DRC) is a local company that produces electronic control panels. The current manufacturing process requires DRC to use multiple tables and stations to place the panel in various positions and orientations. Each new position or orientation requires the technician(s) to manually transfer the panel. As the panels can weigh up to 1000 lbs. and be roughly the size of a picnic table. DRC has asked the team to provide a single cart that can carry the control panels throughout the entire manufacturing and shipping process.

Project Mission:

Facilitate the population, Wiring and Delivery (Shipping) of DRC control panels on a single cart. Track the cart and panel through all stages of production.

Solution:

Design a cart that can rotate a control panel similar to a sheetrock panel to aid in component installation of panel. Design a passive system to track the panel and cart through all stages of production.

Fast Retraction Metal Punch

MATE PRECISION TOOLING

Team:

Katherine Bensen, Nathan Beaudry, Michael Frodl

Clinic Advisor:

Roy Jenson

Industry Representative:

Ron Windingstad – Mate Precision Tooling

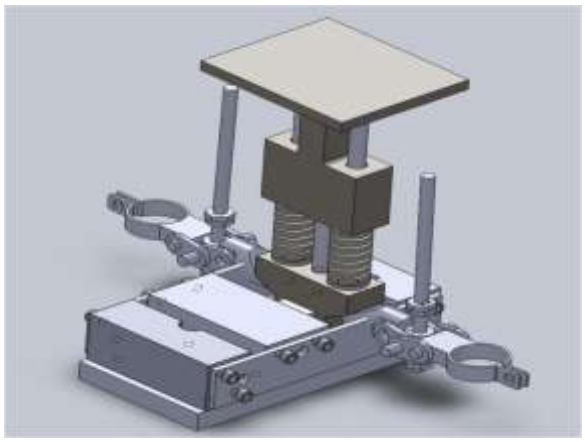
Project Summary:

The importance of efficient punch press tools cannot be underestimated in the field of manufacturing. Many manufacturing processes utilize punches and a well constructed tool is essential for cost-effectiveness. In order to help ensure a certain tool's effectiveness, a thorough test of the forces it might encounter should be applied. It is for this reason that Mate Precision Tooling sponsored a project for students at the University of St. Thomas to design an apparatus that can be retrofitted to an existing punch press assembly and also simulates the force of strip-miss, which occurs when a punch unexpectedly becomes caught in the sheet metal before being violently released. Strip-miss is a top concern in relation to tool failure.

In order to achieve an effective strip-miss simulation, the tip of the punch must be grabbed at the machine's bottom dead center and quickly released. This requires high forces in a small, contained space. Our proposed solution will use a toggle mechanism to transmit and amplify the power of the punch press. Research, calculations, and machining are among the things being done by the team to bring a solution that will satisfy the client's needs on time and within budget.

Design Requirements:

1. Simulate strip-miss.
2. Withstand tool forces exceeding 10,500 lbs
3. Retrofitted to an existing punch press assembly at Mate's facility in Anoka, MN.
4. Budget of $10,000.
5. Run 10,000 cycles before needing to replace components.



Reduced Effort Motorcycle Clutch

Team:

William Cooke, Isaac Jensen, Andrew Carlson, Alexander Peterson

Clinic Advisor:

Roy Jenson & Don Weinkauf

Industry Representative:

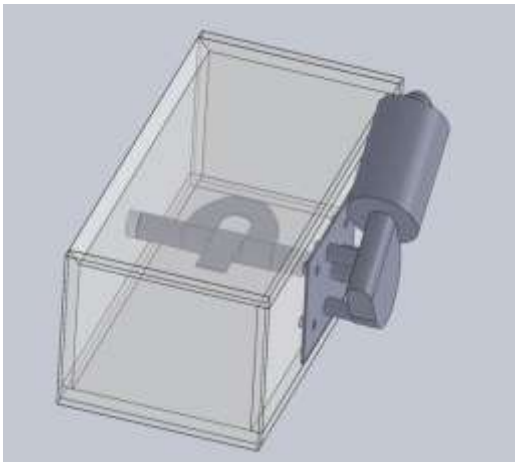
Joshua Katt - Polaris

Project Summary:

Team Polaris reduced effort clutch chose to go with a novel, yet simple, design as illustrated by this simplified example: A string wrapped loosely around the shaft of an operating motor will sit still. Once tension is applied to the string, the friction between the rotating shaft and the string will provide a boost to the applied tension. In the same manner, we will attach a flexible member to the existing cable between the clutch lever and the clutch pinion that is pulled when the lever is pulled. This flexible member, or belt, is wrapped around a drum that is attached to a motor shaft. Before the clutch lever is pulled, the belt will be wrapped loosely around the drum. The belt will be tightened as the lever is pulled in and the motor will apply a corresponding boost to assist the rider in the clutch pull. The motor will be turned on when needed by using a limit switch that is activated as soon as the clutch lever moves.

Project Mission:

Create a clutch that is power by a component outside the engine, to assist the rider in less force to squeeze clutch lever.



Shea Butter Mixer

Team:

Kevin Barr, John Stark, Nathan Sherrill, Jennifer Nielsen

Clinic Advisor:

Dr. Mike Hennessey

Industry Representative:

Dr. Camille George

Project Summary:

Shea butter production in Mali is very labor intensive. The process consists of over a dozen steps and the mixing portion alone can take several hours. In 2004 a senior design team produced a mixer that was implemented in Mali. Since then, user feedback has been collected, and a new engineering challenge presented to this 2010 team. New materials, drive system, bucket design, and many other changes were made to optimize the process with this manually operated mixer.

Project Mission:

Design and create a manual shea butter mixer that improves upon the previous UST 2004 design, which will consistently produce shea butter of high quality, and can be manufactured locally in Mali.

Design Requirements:

1. Reduce labor needed in shea butter production process.
2. Each unit can be built at an attainable cost, maximum of $200.
3. Works in rural sub-Saharan environment.

Vortex Wind Energy System

LOCKHEED MARTIN

Team:

David Erstad, David Riley, Nicholas Greczyna, Thomas McCulloch, Kyle Rogers

Clinic Advisor:

Dr. Chris Greene

Industry Representative:

Dr. Bob Monson – Lockheed Martin

Project Summary:

The senior design project sponsored by Lockheed Martin is a new way to look at wind energy. This project's purpose is to find an alternative to the traditional wind turbine. The concept to which the team was first introduced involved using the vortex shedding from a flag flapping in the wind where the changing shape of the flag would produce a force which could then be transformed into useable electricity.

The concept that the team is pursuing involves a belted generator which drives a magnet in front of copper wire coils to produce a current. The device consists of a small, rectangular frame, roughly a foot long and 5 inches tall which has a thin film stretched between its two ends. The film then has magnets affixed to it which are then arranged in front of the coils. When wind moves across the belt, its force causes the belt to oscillate up and down, causing the magnets' magnetic field to move across the coil which draws a current.

Project Mission:

This project's mission is to find an alternative to the traditional wind turbine for remote location power generation.

Design Requirements:

1. Produce 40mW per module (multiple modules to produce more energy).
2. 99.9999% Reliability and Single User setup.
3. Small enough to fit into an 85 Liter backpack while collapsed and 10 lbs. or less. Backpack transportable.
4. Must withstand a maximum wind speed of 50 MPH.

Design of Z-Axis Scan Head for 5 kW Laser

Team:

Timothy Marrs, Nicholas Leininger, Kayla Pocquette, Philip Brick

Clinic Advisor:

Dr. Greg Mowry

Industry Representative:

Kevin Klingbeil – Las X

Project Summary:

The purpose of this project is to both enhance the current capability in 3D processing and increase the maximum power level of the 3D scanner system. The current systems are capable of only limited z-axis motion and only capable of handling 2.5kW of laser power. There are at least 2 different approaches that can be taken to achieve the desired results. One would be to design a new totally reflective system the other would be to use the current reflective scanning technology for x-y movement but design a transmissive optic z-axis that is capable of achieving the desired outcome.

Project Mission:

To research and design a Z-axis scan head for a 5kW CO2 laser.

Design Requirements:

1. Overall size no more than 760mm x 760mm x 760mm
2. No more than a 20° angle
3. Up to 250 Z-axis from table
4. X-Y table size up to 1,000²mm
5. X-Y scanning speed up to 10^4mm/second
6. Diffraction limited optics
7. 150 microns tolerance in beam location

Seed Potato Cooling Structure for Rural Mali

Team:

Ryan Chapman, Nicholas Shannon, Brett Mernin, Milo Oien-Rochat, Nicholas Peterson

Clinic Advisor:

Dr. David Gasperino

Industry Representative:

Dr. Camille George

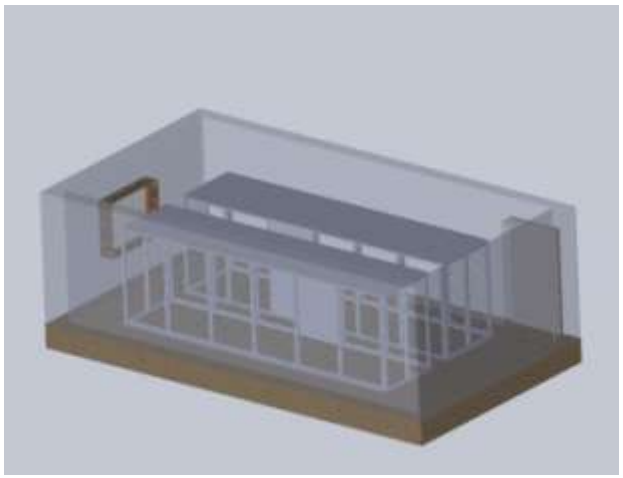
Project Summary:

A creative cooling structure was be designed to hold 5 tons of seed potatoes. Students learned about cooling and humidity conditions required for the storage of agricultural products and designed an evaporative cooling structure that has a practical and reliable water distribution system which is coupled with an economical mechanical cooling supplement. The final design has combined both traditional and innovative solutions. The team's final solution for the problem was to create a drip system fed from an old water tower to increase humidity within a shed that provides shade for cooler temperatures with fans to keep air moving. This designl creates optimum conditions for food storage in order to reduce spoilage.

Three students were sent to Mali in January to select a construction site and perform preliminary feasibility experiments. The cooling structure will enable the formation of a seed potato industry in Borko, Mali.

Biggest Challenge:

Challenge: Create a storage area to keep potatoes at an optimum humidity and temperature for storage where conditions are harsh and electricity is scarce.



Magnetic Car Top Bike Rack System

Four peaks ^^^^ tm

Team:

Peter Douglass, Luis Maya, Paul Knowles

Clinic Advisor:

Dr. Surya Iyer

Industry Representative:

Patrick Hager – Four Peaks

Project Summary:

Four Peaks needs a bike rack that can be magnetized to a car and have a device that can make it very user friendly to detach. Additionally, the company is seeking unique and patentable technology. Therefore the team must come up with a design that incorporates a powerful magnet or magnets that have 75 lbs of pull force or more. Furthermore, there must be a lever or control arm to engage the mechanism of detaching the rack safely and effectively.

Project Mission:

By placing 4 -8 opposite polarity magnets in a reticular tube, the tube could be rotated to magnetize on one side and demagnetize on the next. The magnets are rated at 75 lbs. of pull force.

Design Requirements:

1. Capable of withstanding forces under normal use for 2-4 bikes.
2. Cost-competitive including ease of manufacture and assembly.
3. Visually appealing and must not damage car or underlying sheet metal.
4. Fits and is transferrable to essentially all vehicles and bike rack systems.


Dec 2
Cust
Revie
Dec 9
Early Feb
Mid Feb
Hynix
Auto CAD Design
Write Product Standard
Order Materials
Develop Test Methods
Build Prototype
Selection of Concepts
Design Computing/ Sensing System
Select materials
April
Write Report
Prepare

Thank you.


GALWAY