Department of
Mechanical ENGINEERING

College of | ENGINEERING

Senior Design

2014-2015


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FACULTY-SPONSORED DESIGNS:

1. Fiber-Reinforced Composites with 3-D Printing – Dr. Don Radford

3-D composites formed with plastics often destroy easily, decreasing functionality and versatility. This group's goal was to significantly improve upon the manufacturing and design flexibility in the field of fiber-reinforced composites by utilizing filament winding to add significant strength to the composites. This 3-D machine is capable of locally varying the amount and type of matrix material used. It also incorporates local reinforcement features and varies the in-plane fiber path, overcoming the limitation of geodesic patterning. The machine is also capable of automating the process for a more inexpensive result.

2. Aortic Heart Valve Remover – Dr. Prasad Dasi

Roughly 1.5 million people in the U.S. suffer from calcific aortic valve disease. For 500,000 of these cases, the lesion is severe, and 30 percent of these patients cannot undergo open-heart surgery due to advanced age or other co-morbidity. To avoid open-heart surgery, this group utilizes a device they have created called the Aortic Heart Valve Remover, which enters the body through an incision under the rib to perform the valve replacement. The device creates a minimally invasive opportunity to remove 90 percent of the aortic heart valve leaflets, creating a better surface for the replacement valve to reside on. The group also focused on improving the cutting mechanism and sharpness of the blades previously used to remove the valve. Using this method would prevent clotting and other complications.

3. Biomass Combustion Human Exposure Facility – Dr. John Volckens

Nearly 3 billion people, primarily the world's poorest, are using traditional, inefficient, and poorly ventilated indoor cookstoves. The National Institutes of Health recognized this issue and granted mechanical engineering Professor John Volckens, a $2.8 million grant to study the emissions and health effects of air pollution from these cookstoves. In order to carry out his research, a senior design group conceptualized and constructed a human exposure facility, which is basically a walk-in cooler with a variety of safeguards in place. Volunteers will be exposed to wood smoke within this facility, and Dr. Volckens and his team will measure the cardiorespiratory health just hours after exposure.

4. Continuous Electric Field-Assisted Sintering Device – Dr. Troy Holland

This group's task was to evolve the current Spark Plasma Sintering Device into a novel continuous device to increase productivity and efficiency. The overall goals were to decrease production time, to increase sample size, and to demonstrate that CEFAS is a revolutionary concept in the field of metal-ceramic manufacturing with zinc oxide as the target material.

5. Engine Dynamometer Relocation – Dr. Patrick Fitzhorn

For the purpose of improving the MECH 338 Thermosciences Lab, this group replaced an old engine and dynamometer with a larger engine and more updated dynamometer. The overall objectives were to use LabVIEW to evaluate the torque and speed of engine and interfacing measurements, utilize a cooling system to prevent overheating, and apply the proper mounting of components to prioritize safety and operation.

6. Film Advance Mechanism – Dr. Michael Lefsky

Millions of aerial photographs of the Earth will one day decay unless they are preserved through digitization, and that was this group's mission. They created a low-cost, open-source film advancement solution for film-scanning technology. The utilization of this mechanism will support projects that rely on the studies of long-term, large-scale changes to the world. Along with the objective of preserving photographs, the group also focused on producing an automated process for large-scale projects.

CHALLENGE PROJECTS:

7. EcoCAR 3: Battery Team

The overall objective of this team was to transform a 2016 Chevrolet Camaro, donated by General Motors, into a hybrid electric vehicle and compete against 16 other North American universities at EcoCAR competitions organized by the U.S. Department of Energy. CSU students are split into subgroups based on their interests, each group being responsible for a different portion of the vehicle. The battery team was responsible for building the high-voltage battery system. Objectives were increasing the efficiency of the vehicle, improving upon the vehicle's baseline performance capabilities, and adding consumer appeal to not only the HEV industry, but also the Chevrolet Camaro.

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8. EcoCAR 3: Controls Team

This group's main objective was to design the supervisory controller architecture for the 2016 Chevrolet Camaro HEV. The controls team focused on implementing safety controls for the user inputs, choosing a supervisory controller capable of handling all communications, and developing a Simulink model for Software in the Loop and Hardware in the Loop testing of the controls strategy.

9. EcoCar 3: Emissions Team

The largest objective for this group was to reduce carbon dioxide emissions from the vehicle tailpipe, as well as, design, build, and test a Series Bosch Reactor; use DOE to simulate various user conditions; determine optimum conditions for highest rate of carbon capture; and prove scalability from bench-top prototype to a 2016 Chevrolet Camaro HEV.

10. EcoCAR 3: Mechanical Team

The goal of this team was to integrate EcoCAR 3 hybrid systems into the 2016 Chevrolet Camaro HEV structure. To do this, they integrated the hybrid powertrain and battery systems and ensured that the weight, performance, and safety of the vehicle were upheld. This team also maintained relationships with all other EcoCAR subgroups to facilitate the overall assembly of the entire vehicle. Design details included battery mounts, powertrain mounts, and suspension.

11. EcoCAR 3: Powertrain Team

This team built the architecture for the powertrain of the 2016 Chevrolet Camaro HEV. To uphold the ecological initiatives of the vehicle while maintaining performance, the group aimed to increase fuel efficiency, lower vehicle greenhouse gas emissions, lower the consumption of petroleum, and maintain safety, power, and drivability of a high-performance vehicle. With the assistance of the mechanical team, this group selected and installed the electric motor, transmission, and auxiliary engine.

12. Formula SAE

This group's objective was to build and test CSU's first all-electric race car for the Formula SAE – Ram Racing team, within a one-year timespan to compete in the national Intercollegiate Design Competition in Nebraska and present at CSU's Engineering Days. Utilizing previous years' strategies to maintain a fast-tracked design, fabrication, and assembly process was an important step. It was also important to adhere to FSAE's strict guidelines in order to pass technical inspections at the annual competition. The electric motor is powered by a 144 lithium cobalt oxide battery with a max 300 volt DC. It operates at 80 kilowatts max power, has about 236 lb-ft of torque at the crank and a 4:1 gear reduction through the chain drive. 944 lb-ft of torque is available at the wheels, and the total weight of the vehicle is 625 pounds.

13. Hybrid Rocket Flight – Colorado State University International Rocket Engineering Competition Team

This group's mission was to design, build, and launch a sounding rocket capable of reaching 10,000 feet altitude and being recovered in re-flyable condition. The group also developed a payload to collect scientific data during flight. Data captured were atmospheric carbon dioxide measurements, rocket orientation logging through video analysis, and fuel-vibration analysis. The group competed in the Intercollegiate Rocket Engineering Competition in June 2015.

14. Air Force Research Laboratory Challenge – Heat Stress Prevention Kits (Rocky Mountain Cooler)

The purpose of this wearable device is to extract heat from the body in a hot and humid atmosphere. The Rocky Mountain Cooler is four pounds, reusable, one-size-fits-most; was designed from a deconstructed backpack; has eight cooling units on the back; and has an exhaust system to reject heat from the system. The cooling units are thermoelectric on the inside, and users can wear this lightweight device under their clothing/gear. The device was tested at room temperature on volunteers who ran on an elliptical or treadmill to raise their body temperatures and resulted in a minimal body temperature increase of .5 degrees Fahrenheit in test subjects, and a 2-degree Fahrenheit increase in the control subject.

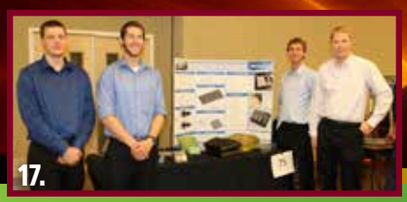
INDUSTRY-SPONSORED PROJECTS:

15. Aerowings: Autonomous Drag Reduction Device for Semi-Trucks

The concept of this project was to improve the aerodynamics of a semi-truck by developing a system for air dam panels to automatically deploy based on vehicle speed, wind speed, and wind direction to direct airflow around the trailer. The device was tested to ensure endurance of vibrations and forces from road perturbations. A control system utilized vehicle speed, wind speed, and wind direction sensors, so the device can autonomously change configuration. This device has the potential of improving fuel efficiency in semi-trucks.

16. The Boeing Company: Ceramic Matrix Composite

This group was tasked with improving the interlaminar properties of ceramic matrix composites in aircrafts for the Boeing Company. The group focused on high-temperature applications, design stitching jig to allow for a consistent stitching angle of 45 degrees, manufacturability on a large scale, and maintaining the tensile properties of the CMC. The goal of this project is to increase fuel efficiency within the aircraft.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17. The Boeing Company: Development of a Thrust-Reversing Cascade

When an aircraft lands, cascades are deployed to redirect engine bypass air in order to reverse thrust or reduce the speed of the aircraft. This group focused on creating a manufacturing process to assess scalability, cost-effectiveness, and potential for automating the process. Currently, thrust-reversing cascades are designed by a limited number of vendors, and the process is extremely labor intensive.

18. British Petroleum: Active Noise-Cancellation Team

Natural gas compressors in the San Juan Basin produce unwanted noise affecting nearby residents. Current industry solutions are expensive, intrusive, and potentially hazardous. This group's goal was to design a noise-cancellation solution capable of mitigating the noise of the compressors by 12dB. A two-stage active noise-cancellation system, consisting of feedback and feedforward control systems, has the potential to replace current solutions. Each system has demonstrated up to a 10dB reduction of noise on the largest contributing tones of a natural gas compressor.

19. Colorado Corn: Fuel Optimization of Ethanol

This group's mission was to increase awareness for the viability of ethanol-based fuel for use in internal combustion engines. Ethanol-based fuels have a lower energy density than petroleum-based fuels and therefore generate lower fuel economies in cars. Since ethanol-based fuels also have significantly higher octane ratings and multiple engine modifications, engine control unit variable changes can be made to extract more energy into useful work without damaging the engine.

20. Cummins: Siloxane Removal System

This group created a test apparatus to simulate landfill gas for the purposes of measuring siloxane levels within the gas and using a filtering method to remove it from landfill gas. Siloxane is a highly corrosive gas, and, by eliminating it, landfill gas has the potential to be utilized as an energy source. The test apparatus used compressed air in place of landfill gas, includes gas-sampling ports to accommodate sample collection, and has a heat exchanger in combination with a heated water loop to allow changes in air temperature.

21. John Deere: Variable-Flow Water Pump Test Stand

This group designed and built a variable-flow water pump test stand for John Deere. The test stand focused on flexibility, high performance, and simulating engine operating conditions for optimal results. The purpose of the variable-flow water pump is to lower its speed when cooling demand is low, which uses less horsepower and improves efficiency and performance of the pump.

22. Schneider Electric: Electric Vehicle Support Equipment

This group utilized 3-D printing to create a set of level two electric vehicle supply equipment chargers with the goal of reducing cost to $250 each. Along with being less expensive, the chargers had to be able to tolerate impacts, for example being dropped or being driven over. The group designed and produced eight functional units to demonstrate ease of mass production, and the final cost comparison per unit showed that the average competitor's chargers were $362.71 more than this group's design.

23. Spendrup Fan Company: Explosion-Proof Variable Frequency Drive

This group designed a system to cool a variable frequency drive and other internal components inside an explosion-proof enclosure for two 50HP, 480VAC, 3600PM fan motors on a mobile coal mine face fan. The VFD needed to fit inside Spendrup Fan Company's XP enclosure while maintaining the VFD's air intake at 50C when the system is under full load.

24. Woodward Inc.: Dual-Function Air Valve

The purpose of this project was to design an air valve that integrates two metering airflow functions into a single flow body while utilizing only one actuator. The group focused on maximizing effective area while minimizing weight and the device's ability to handle extreme pressures and temperatures. The air valve consists of four major parts: The Butterball to split up the flow, the Flow Body to contain and direct flow, the Shoe to seal and direct flow, and the Shaft to open and handle loads.

25. Woodward Inc.: Electric Rotary Valve with Harmonic Drive

This group was tasked with the challenge of developing the GS16DR Third-Generation Fuel Valve for use in Industrial Aero-Derivative Natural Gas Turbines, which will be a vital component in the Woodward fuel-metering skid that meters fuel for energy production. The group adhered to a variety of requirements: utilized a Harmonic Drive Gear Reduction, overcame increased fuel pressure due to lower heating value of natural gas, and redesigned the actuator to accommodate the new drive.

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26. Woodward Inc.: Gas-Admission Valve

This group designed a rotary-actuated natural gas admission valve as an alternative to the Woodward Solenoid Operated Gas-Admission Valve. The SOGAV is an electrically actuated, high-response gas-admission valve for in-manifold (port) fuel admission on large natural gas engines. This group worked in partnership with the group that developed the pressure regulator.

27. Woodward Inc.: Pressure Regulator

This group developed a gas-admission system composed of a new rotary valve concept and an electronic pressure regulator that meets the overall engine system gas-injection requirements. The system was designed to adjust to rapid changes in operating conditions, program the regulator to accept varying set points, and enable communication with the gas-admission valve to optimize flow. This group worked in partnership with the group that developed the gas-admission valve.

28. Woodward Inc.: Liquid Cooling System

Woodward would utilize the Liquid Cooling System when valve-testing in their facility. The 2500 psi pump used to test valves generates considerable heat in the working fluid, which needs to be removed. The group designed a heat-exchanging system to maintain the process temperature while testing to ensure protection of personnel. It's a fully automated design that doesn't require human intervention and has a small enough footprint to fit within allowable space at the facility.

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