Colorado State University

Department of Mechanical Engineering
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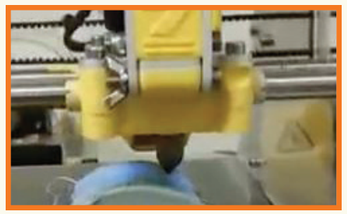


Faculty Sponsored: Drs. Arun Kota and Todd Bandhauer
Measurement of Condensation Heat-Transfer Coefficient

There is a need for a chamber that measures the heat-transfer coefficient to test various materials and surface preparations in order to find combinations that work better to remove heat. This device calculates the heat-transfer coefficient on a surface to increase efficiency and optimize materials.

Faculty Sponsored: Dr. Donald Radford
Contour 3-D Printing

This team took on a programming project, and their objective was to control the printing path using a two-step process to design more complex designs. Each layer of the 3-D model is carefully designed in such a way that each layer is created with a single, continuous path. Another objective is to be able to print paths on non-planar contours. The improvement of this process will impact other team's projects. For example, the Composite Extruder Head Development Team used contour 3-D printing to print complicated shapes.

Faculty Sponsored: Dr. Shantanu Jathar
Air Quality Monitor

In 2012, the World Health Organization reported 7 million deaths as a result of air pollution, which is 1 in 8 global deaths – particularly in children and the elderly. This staggering research motivated this team to develop an accurate, compact, and cost-effective sensor package capable of measuring the majority of the criteria pollutants, prioritized by the Environmental Protection Agency. The need for a device of this nature is crucial, as current monitoring devices are expensive and complicated to use. This easy-to-use device can be used in the industry setting, and in schools, as well as in the home. Understanding pollutants by using this device is the first step in developing a solution.

Department of Mechanical ENGINEERING Senior Design

College of ENGINEERING

2015-2016

Mechanical Engineering Advisory Board Award Picks

1st PLACE 2nd PLACE 3rd PLACE

2016 SENIOR DESIGN PROJECT RECAP

Industry Sponsored: Innovative Technologies Corporation
Wind Turbine Optimization

This team focused on refining clean-energy technologies by fitting an existing wind turbine with an optimal load controller to improve efficiency and power generation output. A wind turbine would be used for improved efficiency in any power-generating system that has more than one parameter to control.

Industry Sponsored: Boeing
Cascade Basket Additive Manufacturing

This team's goal was to design, build, and demonstrate a manufacturing process capable of producing a lighter, more durable cascade basket. Techniques included combining components of additive manufacturing with fiber placement and finding adequate fiber placement to withstand the required strength of a cascade basket. The 3-D printer designed by the group created a heated enclosure for adhesion of fiber and included dual print heads to lay plastic and fiber simultaneously. The team used materials that demonstrate strength properties, such as polymer, polymer with chopped fiber, and continuous fiber with a polymer matrix.

Industry Sponsored: Woodward
Electric Trip and Throttle Valve Actuator

Virtually all turbines today use hydraulic actuators to control trip and throttle valves. The existing problem with using these actuators is that hydraulic leaks are frequent, which cause serious fire damage to the turbines. This team designed an electric trip and throttle valve that eliminates these health and safety issues caused by hydraulic fluid leakage. This more evolved actuator is also more reliable and efficient, and could potentially save a company millions of dollars.

Industry Sponsored: John Deere
Variable-Flow Water Pump Test Stand

This group improved upon last year's design by integrating an inline torque meter capable of reading shaft speeds, and developing a control system. The control system is capable of measuring system pressure and temperature, liquid flow, main tank pressure, speed value, torque, electric power, and pump clutching. The purpose of the variable-flow water pump is to lower its speed when cooling demand is low, which, in turn, uses less horsepower and improves efficiency and performance of the pump.

Industry Sponsored: Caterpillar
Robust EGR for Natural Gas Engines

2nd PLACE

This group demonstrated the feasibility of a dedicated exhaust gas recirculation system for natural gas engines. They designed, fabricated, and installed a DEGR system into a G3304 Caterpillar engine to recirculate 25 percent of exhaust gas into intake. The purpose of this project was to reduce NOx emissions, creating an even mixing of EGR gas into air/fuel intake, maintain engine performance and efficiency, optimize engine timing, trim air/fuel flow to donor cylinder, and eliminate unreliable control systems.

Industry Sponsored: Boeing
Composite Joints

This team set out to investigate the failure modes of composite joints containing manufactured-in defects. Currently, these failure modes are not quantified using conventional modeling methods in existing software suites. With that knowledge, the team applied their research to an improved joint design to increase the damage tolerance of joint geometries investigated using composite material structures.

Industry Sponsored: Otterbox
Green & Gold Case

This group's goal was to create a durable phone case made entirely of recycled material. The case will be easy to manufacture and cost-efficient. The group evaluated recycled materials with a variety of durability, compatibility, and environmental tests and applied plastics manufacturing processes. To test durability, the group used recycled polycarbonate and thermoplastic elastomer to withstand 26 drops at various orientations from 4 feet, and against 16 different household chemicals.

Colorado State University

Industry Sponsored: Pioneer Engineering
Engine Test Cell

This device is designed to create a reciprocating load-bearing test cell to analyze the health of reciprocating machinery. It would alert users of engine fails, optimizing usage. The device can be used in every aspect of oil and gas businesses – a multibillion dollar industry, especially in Colorado. The test cell will be used to research new predictive technologies in order to prevent costly equipment failures. E.g., BP can overhaul its pipeline engines and compressors only when the machine condition warrants it rather than on a set time-based schedule.

Industry Sponsored: CZERO
High-Speed Digital Valve

1st PLACE

This team's goal was to create a high-speed valve used in a wide variety of hydraulic control applications with digital actuation, focusing on size, speed, and flow rate. This evolved valve will add efficiency and design flexibility when applied.

Industry Sponsored: Boeing
High-Temperature Fluid-Resistant Coated Fabrics

The purpose of this project was to design and evaluate a thermal-fluid barrier system using the material Nextel 312. It is flame resistant, flexible, and resistant to aviation fluids. The outcome would be a more efficient aircraft due to less air needed at the thrust for cooling purposes.

Industry Sponsored: Woodward
Triple-Function Air Valve

This group's goal was to design and validate a proof-of-concept air valve intended for use in military helicopters. Use of this valve will reduce overall system weight, improve the reliability of the helicopter turboshaft engine, and optimize air flow through the valve. It will also minimize leakage into the environment and other internal components.

Industry Sponsored: Cummins
Contaminant Filtration

This group is capitalizing on the thousands of landfills in the U.S. by creating a filtration system for the extraction of natural gas. Instead of extracting natural gas through traditional methods, drilling it from the ground, there is an opportunity for landfills to extract natural gas from waste; however, it's an expensive and complicated process. This device would simplify the process, making it easier to implement and more cost-effective. This design is an improvement to last year's Siloxane Removal System.

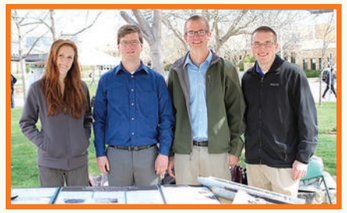
Industry Sponsored: Alden
UAV Water Temperature Measurement

3rd PLACE

The EPA requires thermal pollution to be monitored, so this team's goal was to create a cost-effective and time-efficient method to measuring subsurface water temperatures. This device acquires accurate surface and subsurface thermal measurements and images of water, and is equipped with thermal-imaging cameras and thermistors.

Challenge Project: Human-Powered Vehicle

This vehicle's purpose is to gather energy from momentum of the vehicle itself and apply it to acceleration. Features include wind fairing to reduce aerodynamic drag, three wheels for stability and comfort, and regenerative braking. The regenerative braking system includes six supercapacitors to store and release energy, a clutch system to engage and disengage motor, and display of current capacitor voltage. The most significant improvement to last year's vehicle is the regenerative braking system. It stores the energy used for braking in capacitors (like a battery). That energy can be used to propel the rider via a small onboard motor.



Challenge Project: Intercollegiate Rocket Engineering Competition

This group's mission was to design, build, and launch a sounding rocket capable of reaching 10,000 feet altitude while carrying a 10-pound payload, and being recovered in a re-flyable condition. In a modification to last year's rocket, this team increased thrust and used a student-built airframe in construction. The hybrid rocket engine operates with a liquid oxidizer being injected into a solid fuel grain, and the recovery system includes a drogue parachute deployment. At this year's competition, the team successfully launched and recovered their Aries II Hybrid Rocket on the first try. Approximately 70 teams competed, which is the largest group ever. CSU's team was one of the few that designed and built their own hybrid propulsion system and successfully launched.

Challenge Project: EcoCAR 3
Innovation Team, Composite CV Shaft

This team redesigned the CV axle shafts for the EcoCAR 3 2016 Chevy Camaro, for improved performance and manufacturing using innovative design solutions and materials. The team researched the feasibility of using composite materials for mass production manufacturing to lower weight and improve car performance. This, in turn, would reduce manufacturing time and expense.

Challenge Project: EcoCAR 3
Mechanical Team

This year, this team's goal was to convert a 2016 Chevy Camaro to a hybrid-electric vehicle, focusing on designing, manufacturing, and testing a custom carbon fiber hood. The team also worked to modify stock suspension to accommodate the change in weight post-conversion and tested multiple mounts to package new components included in conversion.

Challenge Project: EcoCAR 3
Controls Team

This team had three responsibilities – software and testing, vehicle control strategy, and vehicle integration. For software and testing, they tested Software in Loop, Hardware in Loop, and Vehicle in Loop. The team handled vehicle integration by wiring and initiating the new electric and gasoline powertrain and added three new controller area networks.

Challenge Project: EcoCAR 3
Powertrain Team

The powertrain team was successful in designing, modifying, manufacturing, and integrating the powertrain of the 2016 hybrid Chevy Camaro. Their goals were to increase vehicle fuel economy while reducing emissions, and to optimize vehicle performance, utility, and safety. They designed a lightweight fuel tank and strap, designed to withstand 20g lateral/longitudinal forces and 8g vertical forces without experiencing plastic deformation. They also integrated a clutch actuation system design to actuate clutch in under one second. Another feature this team worked on was a custom low-profile oil pan, fabricated to accommodate the tight space constraint underneath the engine.

Challenge Project: EcoCAR 3
Keysight Team

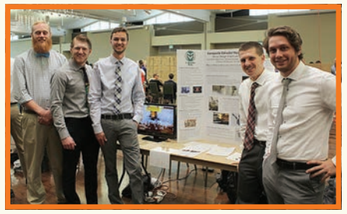
This team designed, set up, and operated a test bench to validate and optimize the performance of two power conversion systems. The first system, the auxiliary power module, functions similarly to an alternator in a conventional vehicle, but charges the low-voltage battery and powers low-voltage accessory components by converting 350 volts to 12.5 volts with up to 175 amps of current.

Challenge Project: EcoCAR 3
Energy Storage Research Team

This team's goal was to design an energy storage system to be used in the converted plug-in hybrid electric 2016 Camaro to deliver power to the high-voltage systems. They focused on designing and validating a thermal management system for the battery modules and manufacturing composite enclosure to support battery modules and components. They also finalized the design of the high-voltage junction box, installed a high-voltage wiring harness, and integrated the design into the vehicle before competition.

Challenge Project: Formula SAE Electric

Although the Formula SAE team wasn't able to compete at the Intercollegiate Design Competition, it didn't discourage this year's team from improving last year's vehicle with enthusiasm and tremendous skill. Each year, a team designs a vehicle; a formula-style racecar based off IndyCar and Formula One. This year, the team constructed a reliable test vehicle, serving as a design for next year's competition. Details of the design include: a chromoly spaceframe chassis, Emrax 207 motor with 103 ft-lbs of peak torque and 96 percent efficiency, a high-voltage system with a 300-volt battery and 72, 3.7 VDC Melasta batteries. Cooling details include composite sidepods and an air-cooled steel accumulator case.



Faculty Sponsored: Dr. Donald Radford
Composite Extruder Head Development

This group's goal was to design an extruder head to be used in conjunction with a 3-D printing system to create a new method for composite manufacturing. The previous method for creating composite materials was impractical due to its lengthy and expensive processes. Composite materials are significant to the evolution of devices in the biomedical, aerospace, and energy engineering fields, due to their low weight and strength. The uses for composite materials are endless, hence this project's goal of simplifying the process.