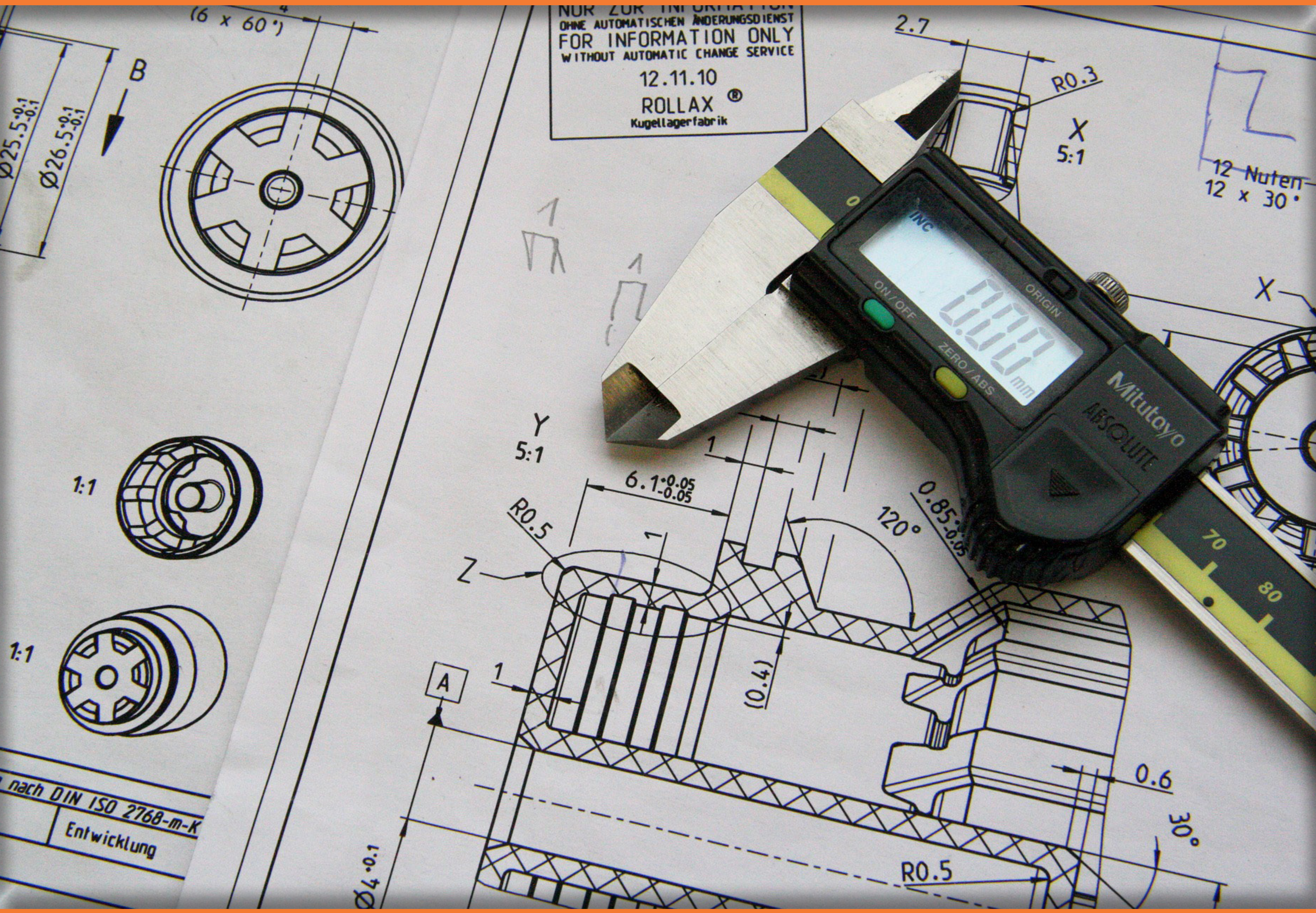
SENIOR DESIGN
FALL 2018
TEAM & PROJECTS DATABASE



Electrical and Computer Engineering
+
Mechanical and Aerospace Engineering

Welcome

The College of Engineering, Architecture and Technology at Oklahoma State launches a new future this year.

Our new strategic plan integrates new pre-college standards and freshman advising, retention initiatives to provide more pathways to degree completion in four years, accelerated research and development, and a large step forward in interdisciplinary hands-on learning and entrepreneurial opportunities.

In the area of research, we are utilizing the new 72,000-square-foot ENDEAVOR platform to showcase this year's fall senior design projects. ENDEAVOR allows undergraduates to be involved in an interdisciplinary education and houses nearly $5 million in state-of-the-art equipment to train engineering, architecture and technology students. These students will be equipped with advanced knowledge and experiences that they will use to create industry inspired and innovative senior design projects like you will see displayed in ENDEAVOR today.

The college's future is about the pedagogy and experiences that graduate world-class engineers and professionals with strong technical knowledge, interdisciplinary training, business acumen and articulate communication skills.

We have engaged industry, alumni, faculty, students and university leaders in our strategic plan that elevates the impact of our research and reputation with leading employers and peers.

None of this would be possible without the generous support of donors and industry partners who are providing the financial support of scholarships, internships, equipment and faculty support. We are truly a Cowboy Family that will endure for generations to come.

I hope you will enjoy getting a look into the bright young minds of these Oklahoma State seniors today. They are preparing to solve the grand challenges that face us and to become valuable contributors to their respective industries. Take some time to get to know them; you won't be disappointed.

Go Pokes!

Paul J. Tikalsky
Dean
College of Engineering, Architecture and Technology

Schedule

MAE

12:15 PM: Lunch

1:30 PM-2:00 PM: Group 1 Project Presentations

2:00 PM-2:30 PM: Group 2 Project Presentations

2:30 PM-3:00 PM: Group 3 Project Presentations

3:00 PM-3:30 PM: Open question and answer session between judges and teams. Complete evaluation forms.

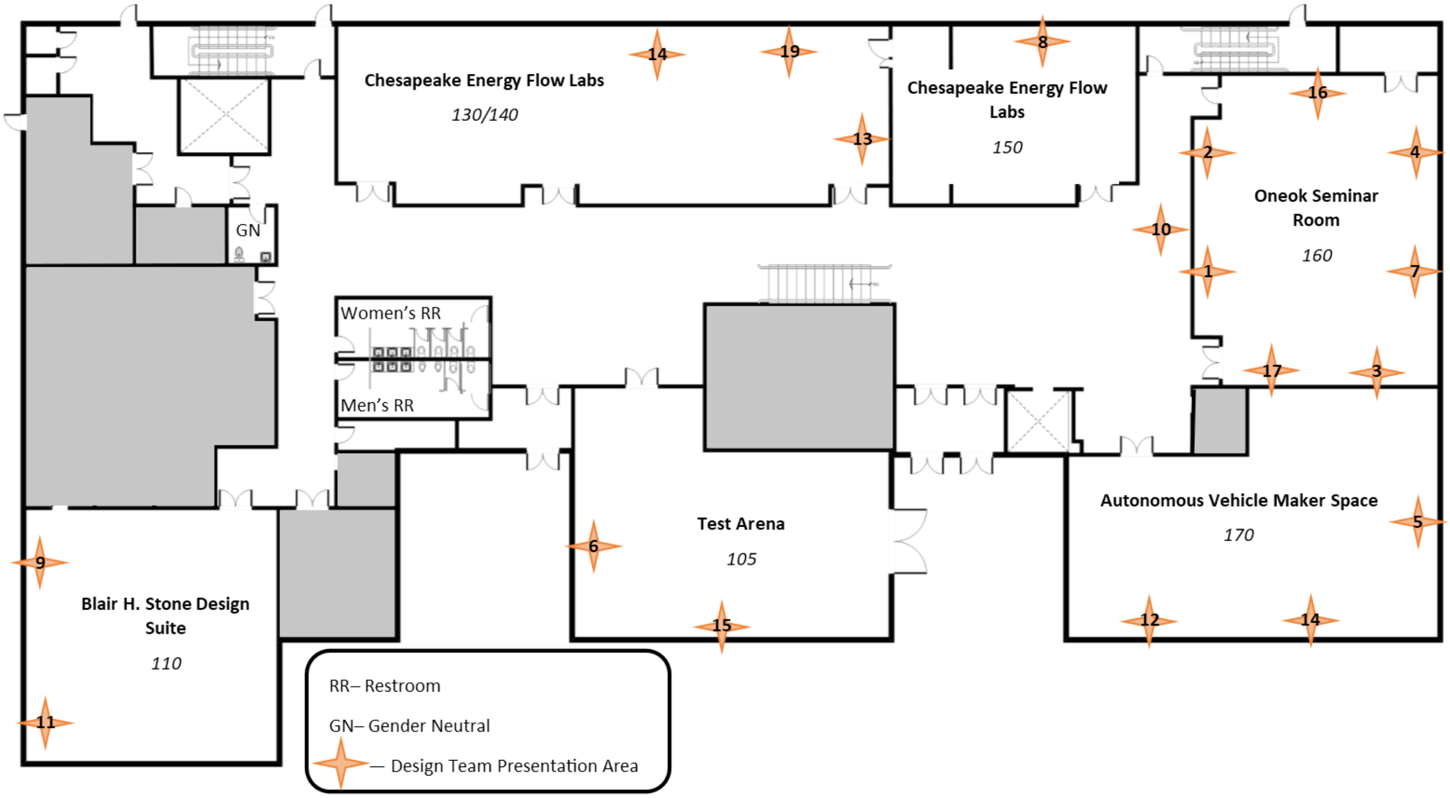
3:30 PM-4:00 PM: Judging complete. Social networking time.

4:00 PM: Awards ceremony and adjournment.

ECE

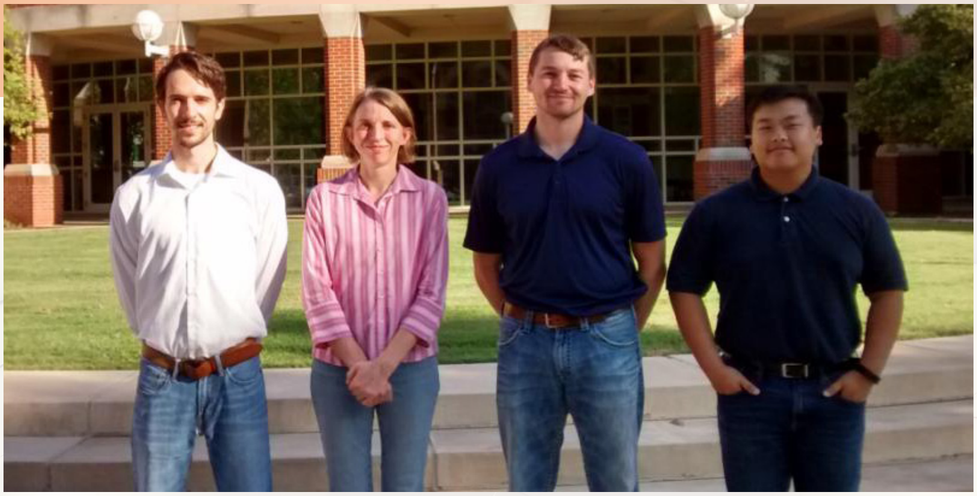
1:30 PM-3:00 PM: Project Presentations

Project Location Map



1. **Scanned Frequency Ground Wall Penetrating Radar** (ECE)
2. **Time Domain Single Pulse Ground Wall Penetrating Radar** (ECE)
3. **Time Domain Reflectometer** (ECE)
4. **Scintillation Detector Radiation Counter** (ECE)
5. **Mercury Car** (ECE)
6. **Model Car Rodeo** (ECE)
7. **Thermal Bonder** (ECE,MAE)
8. **An Organic Rankine Cycle Learning Environment Using HVAC&R Components** (ECE,MAE)
9. **Dual-Use High Efficiency Variable Speed Dehumidifer** (ECE,MAE)
10. **Improved Small Turbojet Engine, Thrust-to-Weight Ratio** (MAE)
11. **Advanced Air Mixers for High Accuracy Measurements** (MAE)
12. **Hypogravity Simulator: How Would We Walk On Mars?** (MAE)
13. **Hydrocyclone Manufacturing Process** (MAE)
14. **Cup Orienting System** (MAE)
15. **Fiberglass Composite Post Analysis and Testing** (MAE)
16. **Safe Heat Exchanger Rotation Device** (MAE)
17. **Bumper Receiver Mounted Ranching Tools** (MAE)
18. **Rod Straightening Machine** (MAE)
19. **Michelin Drivetrain Redesign** (MAE)

PROJECT 1: Scanned Frequency Ground Wall Penetrating Radar (ECE)
TEAM 1: (Pictured from left to right) Sam Smith, Kisa Fors-Francis, Stewart Long, Cheemeng Xiong
ADVISOR: Dr. James West

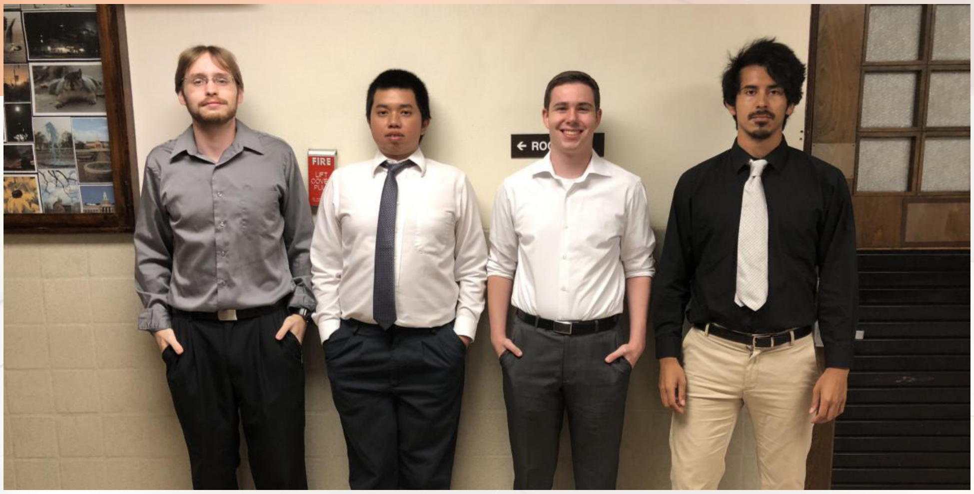


The purpose of a ground penetrating radar is to use radio waves to detect objects below the ground. The range of such a radar is limited by the strong attenuation of the radio frequency signal in wet soil (i.e., a few meter range is achievable in a wet soil). The radar frequency source should scan greater than the 100 MHz to 1 GHz range. The antenna must be correctly designed to assure radiation across the whole frequency band. The scanned transmitter signal propagates into the ground and is reflected by the underground structures. The received reflected signal is combined in the receiver with the transmitted signal, which due to continuous scanning has a different frequency then the reflected signal, thus producing a beat frequency dependent on the time delay (i.e., dependent on the depth of the reflecting element). After processing, the received signals are displayed on a computer driven display. The display must be calibrated in distance or propagation time units.

PROJECT 2: Time Domain Single Pulse Ground Wall Penetrating Radar (ECE)
TEAM 2: (Pictured from left to right) Juan Salinas, Bassam Qoutah, Woodrow Daniel, Alexander Perry
ADVISOR: Dr. Weili Zhang

The purpose of a ground penetrating radar is to use radio waves to detect objects below the ground. The range of such a radar is limited by the strong attenuation of the radio frequency signal in wet soil (i.e., a few meter range is achievable in a wet soil). A sub-nanosecond pulse can be generated using an avalanche transistor. Shorter pulses can be made using a step recovery diode pulse sharpener. The transmitter power is fed into a transmitting antenna, which must be correctly designed to assure radiation of the whole frequency band. There are inexpensive, fast logarithmic detectors on the market that are suitable for receivers. The signal can be observed on a fast oscilloscope. The display must be calibrated in distance or propagation time units.

PROJECT 3: Time Domain Reflectometer (ECE)
TEAM 3: (Pictured from left to right) Sean Goad, Alan Chim, Alec Smith, Irvin Hinojosa
ADVISOR: Dr. Weili Zhang



Checking the integrity of cables and transmission lines is an important task in electronic systems. One method of doing that is by sending a short, sub-nanosecond pulse into the cable and observing reflected signals due to discontinuity and possible damage of the cable. A short rise time signal can be generated by many methods including avalanche transistors, tunnel diodes, or fast transistor oscillators followed by a step recovery diode pulse sharpener. The reflected signal can be sampled with sub-nanosecond resolution using a fast sampling circuit based on an ultrafast comparator and a few transistors, and displayed on a computer controller. The output signal from the sampler is to be fed into a flash, analog-to-digital converter (eight-bit resolution or better) and then fed into a microcontroller able to control a display with a resolution matching the A/D. The display must be calibrated in distance or propagation time units.

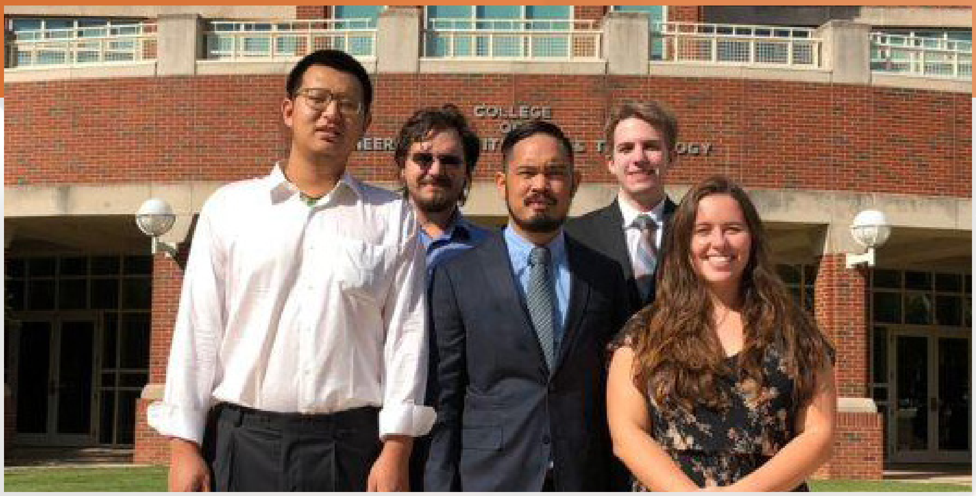
PROJECT 4: Scintillation Detector, Radiation Counter (ECE)
TEAM 4: (Pictured from left to right) Conor Henry, Anh Than Quynh, Haley Welch, Stephen Ivanusic
ADVISOR: Dr. Sabit Ekin

The purpose of this project is to design, construct and test a radiation counter using scintillation detection. A scintillator excited by a gamma photon emits a visible light flash that is detected by a photomultiplier. Intensity of the flash is proportional to energy of the photon, which makes it possible and desirable to analyze the energy spectrum of the radiation. Output pulses from the photomultiplier are in the range of several hundred milli-volts. Photomultipliers are powered by a high voltage source (i.e., about one kilovolt). The detector should display a number of detected photons per second, and it should have a bar graph with its length being scaled logarithmically with intensity of the gamma radiation. It should also show the spectrum of energies of the detected gamma photons. The main problem in this project is calibrating the detector.

PROJECT 5: Mercury Car (ECE)
TEAM 5: (Pictured from left to right) Nathan Memmott, Adam Clair, Tony Zeuch, Brent Palacios
ADVISOR: Dr. Carl Latino

The purpose of this project is to construct a distance-controlled car for the Mercury Competition. The competition is a predefined obstacle course the car must traverse while being driven remotely over an internet connection. This project requires both hardware and software design for control, communications and actuation. The car can be outfitted with additional intelligence resulting in capabilities to utilize data coming from sensors like LIDAR, gyros, etc. to make certain decisions autonomously.

PROJECT 6: Model Car Rodeo (ECE)
TEAM 6: (Pictured from left to right) Back Row: Dustin Riddick, Jon Shuck
Front Row: Wei Zihang, Nino Ilidan, Madison Mrla
ADVISOR: Dr. Richard Guo



The objective of this project is to make an autonomous learning car for a race in one of the ECE hallways. The controller will have only two control signals - START and STOP. The rest of the vehicle control must come from the autonomous system. After receiving a START signal, the car begins the race driving as fast as it can down the hallway, then slows down to a manageable speed to make a 180 degree turn around a barrel at the end of the hallway, and finally setting a direction at maximum speed to the finish line. Deep learning techniques are required to tune the software to navigate and control the car. The STOP signal is used to stop the vehicle after crossing the finish line. To save construction time, the racing vehicle should be based on an existing remote controlled toy car. Speed is the number one issue while stability of controls is the second. The objective is to win the race. It is important to note the sensors should look ahead of the vehicle.

PROJECT 7: Thermal Bonder (ECE, MAE)
TEAM 7: (Pictured from left to right) Hunter Hixon, Sayre McDaniel, Matthew Myers, Mikhail Bliskavka
ADVISOR: Dr. Nishantha Ekneligoda

The purpose of this project is to construct a thermal bonder that can be used in the ECE machine shop. Thermal bonding is a procedure where two pieces of metal are fused together by means of solid electrodes. After contact and proper pressure are established, an adjustable short current pulse of a few hundred amps is transmitted between the electrodes. That current melts the metal between the electrodes and fuses the pieces making a connection similar to a rivet with much less effort than that required for riveting. Power is usually provided by a transformer of approximately 1kW with output voltage of a couple of volts. One can use transformers from microwave ovens. The first choice for metal of the electrodes seems to be copper, but that design decision should be investigated. The current pulse length must be adjustable. Switching the current on the output side would be extremely difficult due to huge currents. Switching of the current on the primary side is preferred.

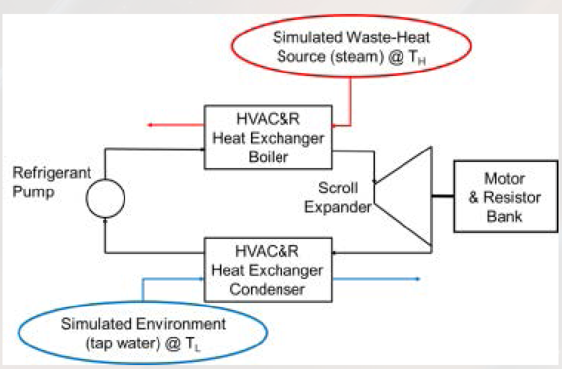
PROJECT 8: An Organic Rankine Cycle Learning Environment Using HVAC&R Components (ECE, MAE)
TEAM 8: (Pictured left to right) Seth Yarborough, Kangfeng Hong, Gharabet Torossian, Chris Rodriguez, Travis Higgins
ADVISORS: Dr. C. R. Bradshaw

The Rankine Cowboys team has been tasked with delivering an operational Organic Rankine Cycle environment that will be used to teach the basics of Rankine cycle operation to students in thermodynamics. The project differs from a normal Rankine in that is uses an organic fluid such as a refrigerant as the working fluid rather than water.

The Rankine cycle is a power generation cycle that heats and cools water to produce shaft power through a turbine. It's the most common power generation cycle and is a strong focus in thermodynamics courses.

Our Project design will showcase an operational ORC that will allow users to measure temperature and pressure in the cycle to calculate net power, thermal efficiency, and collect that data using a LabView GUI. The unit will be using a scroll expander to produce shaft power coupled with a motor, variable frequency drive and braking resistor to use the shaft power.

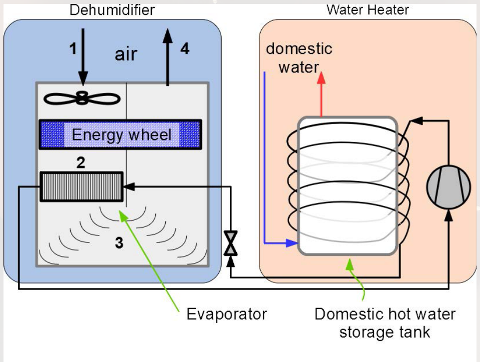
RANKINE COWBOYS 2018



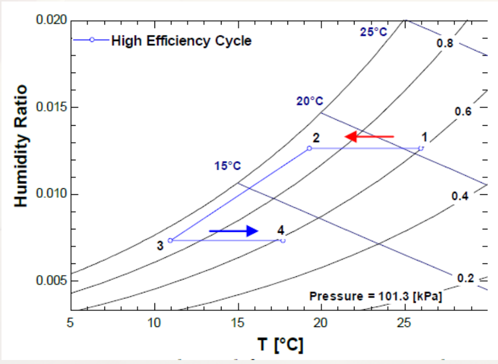
An Organic Rankine Cycle schematic (left) and proposed 1 kW Air Squared scroll expander (right).

PROJECT 9: Dual-Use High Efficiency Variable Speed Dehumidifier (ECE, MAE)
TEAM 9: (Pictured left to right) Nolan Wilson, Kyle Bennett, Patrick Johnson, Drake DeWitt, Hannah Wiese, Nick Ingraham, Caleb Koch, Xun Chen
ADVISORS: Dr. C. K. Bach

Dehumidification requirements in mixed-humid and hot-humid climate zones (IECC zones one- four) are high, especially in aging structures with limited air tightness. Ironically, some older buildings may be better for their occupants due to "inbuilt" fresh air ventilation that reduces buildup of hazardous airborne pollutants. However, this non-conditioned ventilation comes at the expense of increased humidity transfer to the occupied space. Heating, ventilation and air conditioning cooling set points are then often lowered for humidity removal, increasing building energy consumption. This project will provide high efficiency dehumidification by incorporating the ideas behind separating sensible and latent cooling with the dehumidification benefits of heat pump water heaters. The proposed system consists of a conventional refrigeration cycle that uses a domestic water tank for heat rejection purposes. The air passes through a pre-cooling energy wheel prior to entering the evaporator for dehumidification. After the air passes through the evaporator, the now cold air once more passes through the energy wheel. A conventional heat pump water heater would use the evaporator for the full process, thus requiring more than 20 percent more energy for the process of dehumidifying the air.



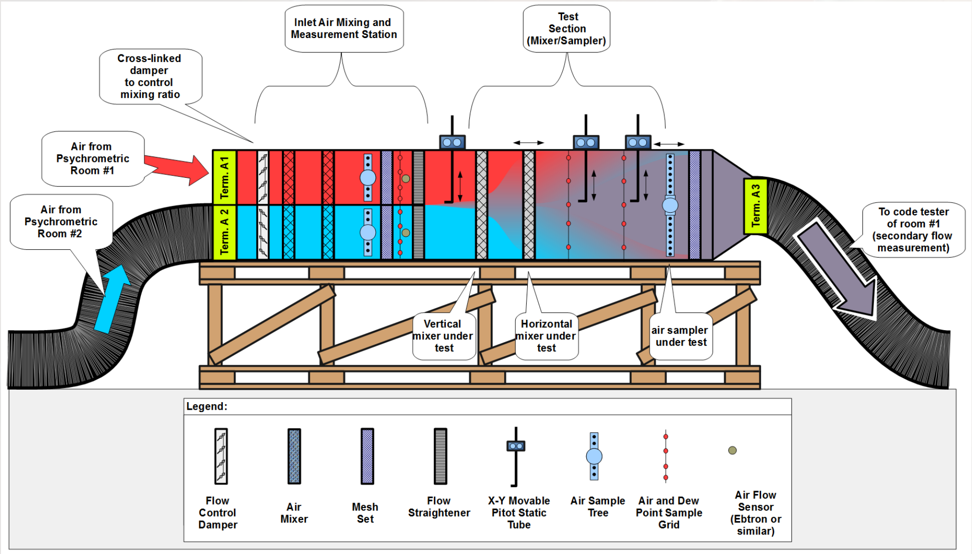
A system schematic. High efficiency dehumidification and domestic hot water pre-heating unit.



Dehumidification process with precooling by energy wheel.

PROJECT 10: Advanced Air Mixers for High Accuracy Measurements (MAE)
TEAM 10: (Pictured left to right) David Plain, Jeremy Kilbride, Dominic Richert, Zac Pasco, Bradly Blevins, Christian Negratti, Casey Ivanoff, August Frank, Andrew Herndon, Bryan Heng, Hyunjin Park (graduate assistant)
ADVISOR: Dr. C. K. Bach

Psychrometric performance testing of HVAC&R equipment requires accurate measurement of the air flowrate as well as the inlet and outlet air conditions. This project will develop a testing environment to evaluate air mixer's effectiveness, develop new air mixer designs, and compare their performance in the testing environment to the standard air mixer designs suggested in ASHRAE standard 37.

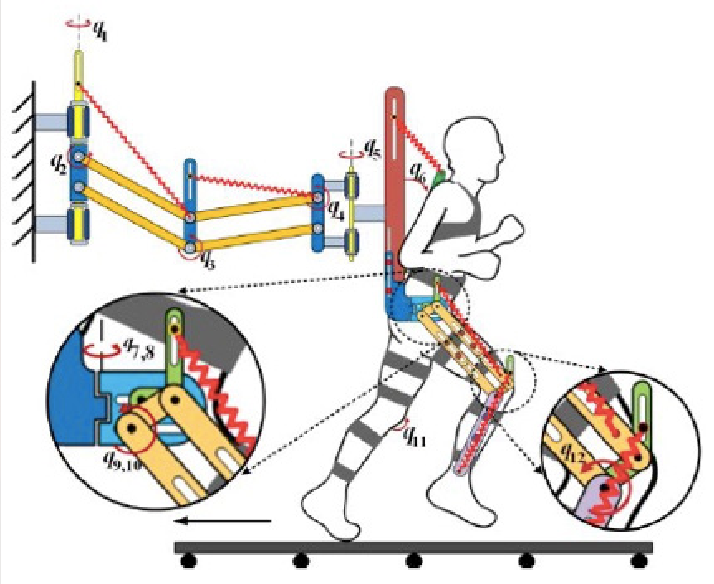


Conceptual design of the proposed air mixer test apparatus.

PROJECT 11: Hypogravity Simulator: How Would We Walk On Mars? (MAE)
TEAM 11: (Pictured left to right) Anna Hutnik, Nikyla Hatfield, Nick Ortiz, Taigh Goggin, Brandon Reynolds
ADVISOR: Dr. Hausselle

With the renewal of space exploration and the goal to colonize Mars, new health issues will arise. Although we have extensive knowledge of the forces acting on the body on earth during walking, we do not know the preferred mode of locomotion that astronauts will adopt on Mars. Although computational models have been shown that skipping may be the preferred locomotion strategy, it has not been validated experimentally. More importantly, there is no information about the effect of the locomotion strategy on bone remodeling and related long-term health issues. Hypogravity will likely reduce the amount of loading on the bones, which in turn will lead to bone mass loss and an increased risk of fracture.

The proposed project will develop a passive hypogravity harness to be mounted on top of a treadmill to simulate the effect of hypogravity on human gait.



Conceptual design of the passive harness. **(Xiu et al., 2014 IEEE International Conference on Robotics & Automation (ICRA), Hong Kong Convention and Exhibition Center, May 31 - June 7, 2014. Hong Kong, China)**

PROJECT 12: Hydrocyclone Manufacturing Process (MAE)
TEAM 12: (Pictured left to right) Joe Brands, Alexander Svetgoff, Morgan Taylor
ADVISOR: Dr. R. Taylor

Neptune has contracted the New Product Development Center to design a commercial grease separating unit for use in restaurant kitchens. The grease separating unit is based on the performance of two hydro cyclone units developed by Neptune. Neptune desires to have a manufacturing process developed that will produce hydro cyclone units with tight tolerances around the design provided. One of the two existing hydro cyclone unit provided by Neptune is shown below.

The goal of this project is to design a manufacturing process that will produce hydro cyclones meeting the specifications for the Neptune design. A characteristic unit from the process developed should be tested in the Neptune system to measure grease separation capability.

Deliverables:
- A hydro cyclone manufacturing process and all required support hardware.
- Instructions for using the process.
- System test data for a unit characteristic of the manufacturing process.

PROJECT 13: Improved Small Turbojet Engine, Thrust-to-Weight Ratio (MAE)
TEAM 13: (Pictured left to right) Michael Wilton, Justin Kattchee, David Mena, Indah Merkel, Derek Tucker
ADVISOR: Dr. K. Rouser

Continually and rapidly evolving small unmanned aircraft system (UAS) requirements drive the need for increased engine performance in terms of speed, range, endurance and payload weight. Thus, there is a critical need to increase engine thrust-to-weight. The 2018-2019 Aerospace Propulsion Outreach Program (APOP) research activity, sponsored by the Air Force Research Laboratory, requires undergraduate students, working as a team, to research and develop an engine with increased thrust-to-weight compared to a stock P-90 or P-100 JetCat gas turbine engine, shown in the image below. Presently there are various components of these engines which are unnecessarily heavy and inefficient. Research teams are responsible for modifying the engine and demonstrating increased thrust-to-weight of the entire system (engine and starter).

Thrust:	22.5 lbf (100 N) at 152,000 RPM
Weight:	2.38 lbs (1080g)
Diameter:	97 mm
Total length:	245 mm
Shaft speed:	44000-154000 RPM
Max exhaust gas temperature:	730° C
Fuel consumption:	350 ml / min
Fuel:	Jet A1 fuel, kerosene

Stock JetCat P100-RX and specifications
(http://www.chiefaircraft.com/jc-p100-rx.html)

PROJECT 14: Cup Orienting System (MAE)
TEAM 14: (Pictured left to right) Aaron Davis, Micah Dobrinski, Mohammed Bagais
ADVISOR: Dr. R. Taylor

Your objective is to create a system that finds the seams of disposable cups and orients them so the seams all face the same way (i.e. all to the left).

The system should be built in a way that is easily adjustable should we find later that the seams need to be a certain direction.

The cups will come into the system bottom first, alternating from two lines and exit bottom first, alternating from two lines. These lines are offset, and a drawing is included showing where the centerlines of the cups are. These locations however are not set so your system should allow for an inch adjustability in any direction. The cups will be passing through the system at a minimum of 100 cups per minute. Your system will need to be able to orient cups of a range of sizes from 3.25 in. diameter to 4.5 in. and 4 in. to 7 in. in height as well as a variety of substrates.

Samples of the cups will be provided. The system must be able to run 24/7 and must not cause damage to the cups. It is also vital that it not contaminate the cups or create excess static charge.

Parts should either be purchased or be made in house on a 10in. x 30in. x 8in. 3-axis CNC Mill and 14 in. x 40 in. manual lathe. Keep the design as simple as possible while still having it be reliable and cost effective.

Project Deliverables:

- Design for a cup orienting system
- Functional prototype
- Supporting engineering analysis

PROJECT 15: Fiberglass Composite Post Analysis and Testing (MAE)
TEAM 15: (Pictured left to right) Clay Stubblefield, Aidan Woods, Alex Tliemat
ADVISOR: Dr. R. Taylor

Fibaroot currently manufactures and sells fiberglass composite poles that are popular in applications where the poles are loaded in compression along the primary axis. They have found significant utility in applications like supporting shade nets over fruit tree orchards. Fibaroot is currently looking to expand their markets to include fencing applications such as standard barbed wire fencing. To complete this expansion the poles need to be analyzed and tested for loading in bending. A typical fiberglass composite pole structure is shown below including an HDPE core, structural fiberglass shell and a UV protective outer gelcoat.

This project will support the analysis and testing of Fibaroot poles targeting use as a corner post for a barbed wire fence. Loading conditions should be typical for 5 or 6 wire fencing as recommended by the wire manufacturer. The team should also consider changes in the poles' construction or dimensions that would improve performance for this application.

Project Deliverables:

- Structural analysis for the Fibaroot composite poles.
- Load testing data for the poles with comparison back to the analysis.
- Results of compositional or dimensional analysis to improve pole performance.

PROJECT 16: Bumper Receiver Mounted Ranching Tools (MAE)
TEAM 16: (Pictured left to right) Brayden Knocke, Odai Al Lali
ADVISOR: Dr. R. Taylor

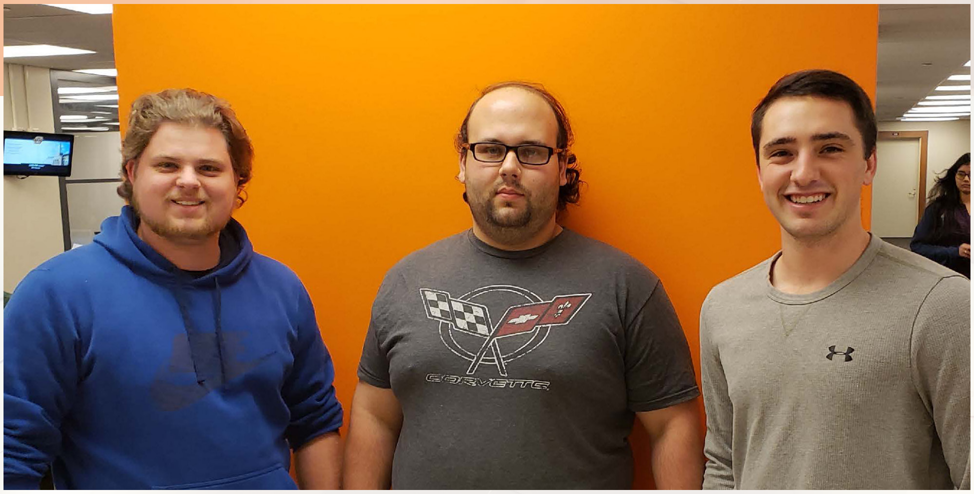
Moving large round hay bales to cattle in the field is a common operation on the ranch during the winter months. This operation is generally carried out with expensive specialized equipment. A need exists to allow the small operation rancher to deliver hay with cost effective solutions or tools.

The goal of this project is to design a manually operated round bale transport tool that is carried by a typical bumper receiver. A picture of the client's prototype is given below. The bale moving tool should be designed for minimal cost while safely transporting bales up to 1,500 pounds. The design team should also consider the acceleration often induced by bad road conditions.

Project Deliverables:

- Design of a bumper mounted bale moving tool.
- All engineering calculations supporting the tool development.
- A fully functional prototype of the bale moving tool.

PROJECT 17: Rod Straightening Machine (MAE)
TEAM 17: (Pictured left to right) Tanner Crawford, Dillon Harrison, Austin Gigoux
ADVISOR: Dr. R. Taylor



Tulsa Centerless manufactures a wide variety of very high precision cylindrical rods and bars. The manufacturing process requires that raw steel stock coming into the facility be straightened as the first step in the manufacturing process. The facility has a need for an automated straightening system for rod stock in a variety of diameters. The goal of this project is to design and demonstrate a straightening process that will meet the needs at the Tulsa Centerless facility.

Project Deliverables:

- Design of a steel rod straightening system.
- All engineering calculations supporting the system development.
- A fully functional prototype of the rod straightening system

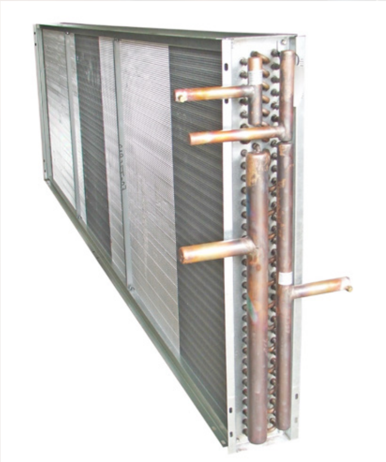
PROJECT 18: Safe Heat Exchanger Rotation Device (MAE)
TEAM 18: (Pictured left to right) John Ruggeri, Carter Files, Austin Beaver
ADVISOR: Dr. R. Taylor

The RAE Corporation manufactures a wide variety of HVAC systems at their facility in Pryor Oklahoma. Much of the work done in the facility is focused on large industrial systems with coil sizes up to 280 inches long by 98 inches tall and 24 inches wide. Coil weight can be as high as 2200 pounds. Most of the coil placement and assembly is carried out by hand. This is a difficult job leading to the possibility of injury.

The goal of this project is to develop a safe coil rotation device. The device should be capable of lifting the coil and rotating it to facilitate placement in the housing with minimal manual labor. The device should be capable of handling all sizes, shapes and weights for the coils manufactured in the Pryor facility. The device should be safe for use by all manufacturing floor employees.

Project Deliverables:

- Design for a safe heat exchanger rotation device.
- All engineering calculations supporting the device development.
- A fully functional prototype.

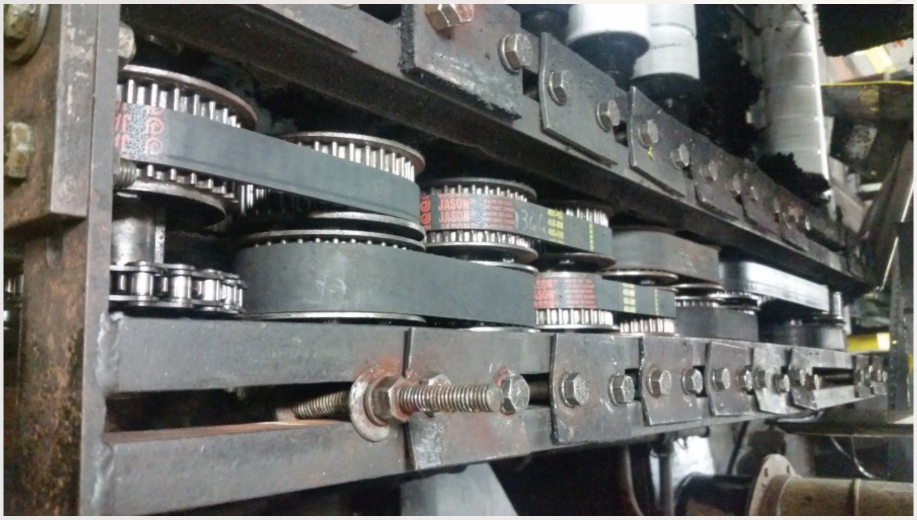


PROJECT 19: Michelin Drivetrain Redesign (MAE)
TEAM 19: (Pictured left to right) Ryan Hill, Michelin Employee, Taylor Vazquez, Maddie Linam
ADVISOR: Dr. R. Taylor

The picture below shows a multi-gear drive system that currently operates in one of the tire manufacturing lines in the Michelin facility in Ardmore Oklahoma. The drive system shown is responsible for a significant portion of the down time on its line. Michelin has requested assistance with the redesign of this drive system to eliminate or minimize the current down time.

Project Deliverables;

- Analysis of the existing drive system and identification of the failure modes.
- Design of an alternative drive system.
- All engineering calculations supporting the new drive design.
- A demonstration of the drive system utility.



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