COLLEGE OF ENGINEERING

2024 SENIOR DESIGN SHOWCASE

Friday, May 3, 2024 | Kiewit Hall

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sds.unl.edu

WELCOME

Welcome to the University of Nebraska – Lincoln College of Engineering's premier undergraduate senior engineering design showcase, featuring the work of 30-plus teams and more than 100 seniors. These capstone projects are the culmination of many hours of research, creativity and effort and are designed to make a positive and lasting impact.

VOTE: PEOPLE'S CHOICE AWARD

Using your own criteria, vote for your favorite senior design project. Only one vote per guest, please. Pick up and drop off your ballot at the People's Choice Award Table.

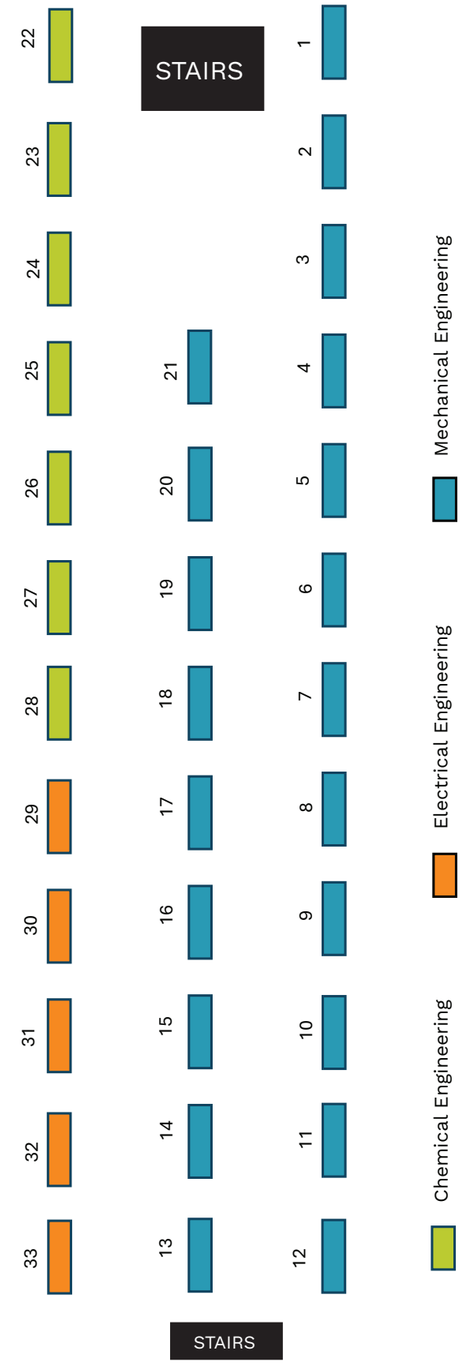
SCHOOL OF COMPUTING SENIOR DESIGN SHOWCASE

Thursday, May 9, 2024 | 1-4:30 p.m. | Nebraska Union

Student teams partner with sponsoring organizations to develop innovative software and systems engineered solutions. The School of Computing teams will present and demo their projects for members of the university and local community.

BOOTHS

KIEWIT HALL
LOWER LEVEL



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DEPARTMENT OF CHEMICAL AND BIOMOLECULAR ENGINEERING

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DEPARTMENT OF MECHANICAL AND MATERIALS ENGINEERING

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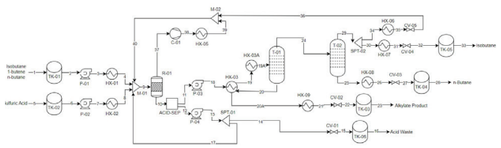
CHEMICAL ENGINEERING

DEPARTMENT OF CHEMICAL AND BIOMOLECULAR ENGINEERING

#22 Alkylation Process

Thomas Hope | Benjamin Ebel

Faculty Supervisor: Kevin Van Cott



This project consists of simulating, designing, and economically evaluating an alkylation unit. Specifically, we simulated a 100KTA hydrofluoric acid catalyzed (HAC) alkylation process. This process is widely used around the United States for alkylation production.

#23 Dimethyl Ether Production from Methanol

Taylor Adams | Jack Mettin | Leo Pruhs | Jacob Voigt

Faculty Supervisor: Kevin Van Cott

Dimethyl ether (DME) is a promising clean fuel alternative that offers versatility and eco-friendliness in various applications like transportation and the chemical industry. To meet the escalating demand for sustainable energy sources, there's a critical need to devise efficient methods for DME production. A prominent approach involves converting methanol, a widely available feedstock, into DME. Our project focuses on establishing a cost-effective and environmentally friendly process for DME synthesis from methanol. This entails designing, implementing, and optimizing a production facility equipped with catalytic technologies for methanol-to-DME conversion. Our key objectives include the catalytic conversion of methanol to DME, optimizing reaction conditions to maximize DME yield while minimizing cost and energy consumption, conducting an environmental evaluation of the process to ensure compliance with regulatory standards, and assessing the economic viability of DME production factoring in capital costs, operational costs, and potential revenue. Upon project completion, we envision a robust and sustainable DME production process from methanol, offering a cleaner alternative to fuel.

SENIOR DESIGN PROJECTS

#24 Dehydrogenation of Isopropyl Alcohol to Produce Acetone

Connor Hartigan | Alexander Thomas | Meng Fong Wan

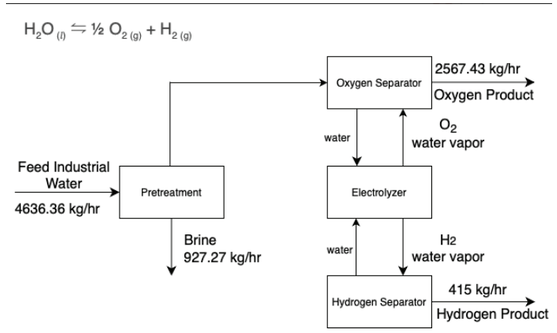
Faculty Supervisor: Kevin Van Cott

Taking a sample procedure, the group designed, coded and optimized the engineering aspects of a chemical production plant. Proper engineering standards were applied to create a more profitable process. The designed plant uses isopropanol as a precursor to produce bulk food and pharmaceutical grade acetone.

#25 Alkaline Electrolysis of Water

Justin Powers | Kenneth Reese | Wendell Li | Brennan Palmer

Faculty Supervisor: Kevin Van Cott

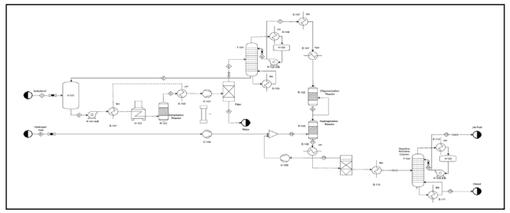


This process creates H2 and O2 gas from filtered tap water using electrolysis. The trace amounts of gas are separated downstream. H2 and O2 are stored in tanks.

#26 Production of Jet Fuel from Iso-Butanol

Franklin Thomas | Wade Slepicka | Jordan Schlautman-Sudik | Jarod Harris

Faculty Supervisor: Kevin Van Cott



This project outlines the theoretical modeling and construction of a jet fuel production plant using a renewable source of iso-butanol.

#27 The Liquefication of Natural Gas With Mixed Refrigerant Loops

Jacob Konecky | Helen Philbrick | Keegan Nitsch | Matt Koenig

Faculty Supervisor: Kevin Van Cott

Natural gas is a mixture of methane and other hydrocarbons that is used in power generation and a variety of chemical processes. Global usage of natural gas as a fuel source is increasing as it emits less pollutants than other fossil fuels, such as coal. The United States is the world's largest exporter of natural gas, but current global demand exceeds existing domestic infrastructure capacity. All overseas exports of natural gas are in the form of liquid natural gas (LNG). In order to meet the growing demand, new LNG facilities need to be built. This project analyzes two different methods of producing LNG on an industrial scale, both of which utilize multicomponent refrigerant (MR) loops. Mixed refrigerants allow for a highly optimizable cryogenic process but react poorly to disturbances added to the system. A facility consisting of a single MR loop is compared to a facility using a combination of single-component and multicomponent refrigeration cycles. Both facilities are sized for a production rate of 5 million tonnes of LNG per annum and compared on a basis of profitability, sustainability and flexibility.

SENIOR DESIGN PROJECTS

#28 Cryogenic Distillation of Air

Kaitlin McKenzie | Cassidy Jackson | Zach Alderson | Jack Doherty

Faculty Supervisor: Kevin Van Cott

Oxygen, nitrogen and argon are used in both gaseous and liquid forms across many industries, with all of these components being found in the atmosphere. Cryogenic distillation can be used to separate the components using cryogenic temperatures to liquify the air and distillation to separate the components based on relative volatilities. This process allows for the scaled-up production of liquefied products. The goal of the project is to design a cryogenic distillation of air plant that will produce a target of 3,000 metric tons of oxygen per day while minimizing energy and utility usage throughout the plant.

ELECTRICAL ENGINEERING

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

#29 The Gig Starter Pack

Preston Sorensen | Spencer Latimer | Josh Whittenburg | Charlie Sims

Faculty Supervisor: Mark Bauer

When moving from home playing to a stage environment, a musician's rig must change. Introducing The Gig Starter Pack, a hybrid digital/analog effects unit, amplifier head, and 1x12 speaker cabinet. Multiple algorithms on the digital side of the effects unit, coupled with the analog gain stage in front of it, add delay, modulation or volume. The provided amplifier can keep up with loud drum kits, all while having flexible transient and frequency response. The amplified signal is then sent out to the speaker cabinet, which sports an inventive cavity design to allow high frequencies to propagate outwards while being a Helmholtz resonator for low frequencies.

#30 Weed Terminator

Jacob Landegren | Pete Tungtweegait | Hein Htet Win | Logan Glynn

Faculty Supervisor: Mark Bauer

The Weed Terminator is a robot that autonomously patrols fields using AI and cameras to identify weeds. Once detected, its drilling mechanism eliminates the unwanted plants at the root, offering a sustainable, eco-friendly alternative to herbicides.

#31 NeuroPong

Austin Bubak | Jenny Olander | Jacob Dalton | Jacob Stewart

Faculty Supervisor: Mark Bauer

The purpose of this project is to create a Brain Computer Interface (BCI) using Electroencephalography (EEG) to allow a user to play Pong with their mind. Using custom-made hardware - including an electrode cap, signal amplifiers, and embedded system design - as well as developing software for Fourier analysis and data processing, anyone can sit down and interact with the computer with nothing but their thoughts.

SENIOR DESIGN PROJECTS

#32 Soil Sensor Network for Greenhouse Application

Jessica Campagnuolo | Matthew Neville | Kyle Linnell | Emerson Puatu

Faculty Supervisor: Mark Bauer

The goal of our project was the development a network of sensors for monitoring soil qualities using wireless communication capabilities. The main body of the sensor contains all necessary electronics, including a printed circuit board with an MSP430F5522, a custom moisture sensor, temperature sensor, batteries, and the long range (LoRa) radio transceiver. The circuity within the 3D printed housing has connections to external probes which will be inserted into the soil. The user can interact with the probe readings from the main hub, which is powered by a Raspberry Pi with a touch screen. This hub also contains an air quality sensor to detect any impurities in the area. All of these components come together in a low power network to monitor the conditions of a plant environment.

#33 Radar Based Fall Detection

Bekah Nelson | Cole Long | Silas Perry | Edoe Houndjoe

Faculty Supervisor: Herbert Detloff

Falling poses significant health risks, emphasizing the critical need for effective response mechanisms. Traditional solutions, such as wearable devices or monitoring systems, suffer from limitations, including user discomfort, forgetfulness or dependence on external devices. Addressing these shortcomings, this report proposes an autonomous fall detection system integrated with self-contained hardware and software. By embedding a neural network model, the system processes radar data to automatically detect fall events. Upon detection, an emergency response protocol is initiated to notify pre-selected contacts. The radar neural network is trained on one subject and is put in place as a proof of concept for such a system. Accuracy and robustness are critical for a device which will be in the business of saving lives. Results show the feasibility of further implementation. Recommendations include improving accuracy by training the network with broader data sets and condensing the package size for consumer usage.

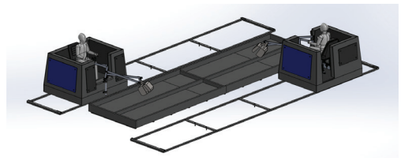
MECHANICAL ENGINEERING

DEPARTMENT OF MECHANICAL AND MATERIALS ENGINEERING

#1 Lunar Lander Rover

Noell Whitaker | Luke Landkamer | Andrew Koranda | Reid Wortman | Zac Voss

Faculty Supervisor: Kurt Palik

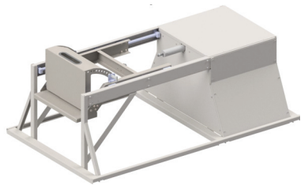


Strategic Air Command (SAC) and Aerospace Museum have recently acquired a model of the Dynetics Lunar Lander, sparking the initiative to create an exhibit that is STEM-based, interactive and educational, aimed at capturing the interest of a younger demographic. In response, the senior design team developed an exhibit inspired by the Artemis Rover. This exhibit showcases various mechanical components, including a linkage system, a gear system and other build elements, all of which are identifiable within its design.

#2 Pneumatic Leg Press for MS Patients

Noah Hoffschneider | Levi Schulze | Tanner Brandl | Isaiah Spahn | James Admiraal

Faculty Supervisor: Kurt Palik



We have designed a leg press/hip sled machine for patients with multiple sclerosis or similar conditions. Our project sponsor is MSForward, a gym for patients with neurological diseases. The design implements pneumatics for resistance so it can be quickly and safely shut down if a patient experiences muscle spasms.

SENIOR DESIGN PROJECTS

#3 Lunar Flagpole

Matthew Brown | Sam Raabe | Connor Birkholz | Sam Peterson | Connor Herridge

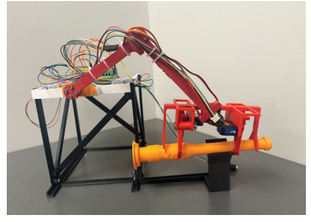
Faculty Supervisor: Carl Nelson

Artemis will return astronauts to the moon, and with that the symbolic gesture of a flag deployment. NASA is looking to innovate upon the Apollo designs with a taller, more stable and easily deployable flagpole. The Tape Measure Actuated Rigid Moon Flag Support (TARMS) integrates a pole consisting of tape measures constrained in a boom orientation by a series of vertebrae spaced intermittently up the pole. The flagpole assembly includes an anchor comprised of laser-cut aluminum and 3D auger, a 3D printed base to spool the tape measures and attach the pole to the anchor, and a carbon fiber flag connecting rod that keeps the flag unfurled in the absence of wind. To mitigate the sharp edge and finger entrapment concerns with the tape measures, a nylon shroud will encompass the fully extended pole. The flagpole assembly must meet certain mission requirements, most notably; be structurally stable when a 10 lbf is applied vertically and laterally to the top of the pole, be dust tolerant, weigh less than 10 pounds in Earth gravity, fit within a defined stowable configuration, stand between 96 and 120 inches tall, and be EVA friendly throughout all phases of deployment. The assembly is designed to be testable in the NASA Neutral Buoyancy Laboratory (NBL) pool at Johnson Space Center in Houston, Texas.

#4 Robotic Arm for Mars Helicopter

Samuel Harvey | Jonah Bricker | Matthew Dohmen | Charles McCoy Jr.

Faculty Supervisor: Shane Farritor



The goal of the Robotic Arm for Mars Helicopter project is to create an easily manufacturable version of NASA JPL's Mars helicopter sample return arm. The Mars Sample Return mission is an upcoming mission to retrieve sample tubes left by the Perseverance rover and bring them back to Earth. As part of the mission, two helicopters will ferry sample tubes from the surface to the return vehicle. The robotic arm will grab a sample tube, stow it during flight, and place it into the return vehicle. The replica arm is constructed entirely from 3D-printed and off-the-shelf components. It is packaged as an outreach kit for high school robotics groups.

#5 Hospital Chair for Patients with Dwarfism

Isaac Cade | Magdalene Peklo | McCaylee Dempcy | Jack Miller | Jackson Taylor

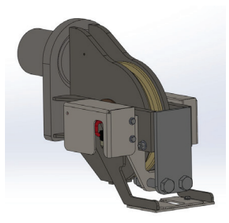
Faculty Supervisor: Kurt Palik

The team is creating a hospital chair specifically designed for individuals with dwarfism, a genetic condition that causes disproportionate limb growth. Individuals with this condition require special furniture accommodations. A typical hospital chair is a reclining chair for impatient use that is easy to clean and has mobile capabilities to be maneuvered to required rooms. UNMC has seen an increase in patients with dwarfism, thus increasing the demand for more permanent accommodations, such as hospital chairs with adjusted dimensions for individuals with dwarfism.

#6 Altec Fairlead Redesign

Kirk Hanson | Ghazwan Haskan | Luke Lanik

Faculty Supervisor: Li Tan



The fairlead system is a cable payout system attached to the end of a utility truck. The cable is either pulled or dispensed by a large winch on the truck. The fairlead head maintains alignment of the cable in whichever direction it may be pulling from. The fairlead has a limit switch that is utilized when the cable is fully retracted and will cut power to the winch to prevent damage to components or the truck. This project's objective was to redesign a cable payout fairlead to accommodate a larger sheave bearing, a more reliable limit sensor, and updated clearances for interacting components. Various analysis methods were used to verify function and integrity of parts like bearing fatigue life, shear analysis, and a SolidWorks Finite Element Analysis.

SENIOR DESIGN PROJECTS

#7 NASA MicroG Next – Lunar Tool Carrier

Simon Thengvall | Elijah Crittenden | Conner Rainforth | Mason Rivera | Joseph Mueller

Faculty Supervisor: Carl Nelson

As part of the Artemis III mission to the moon, NASA astronauts will be collecting geological samples using a variety of different tools. Some sampling sites will not be easy to access and may require astronauts to approach solely on foot. To transport geology tools to these difficult areas, a hand carrier that astronauts can pick up and deploy to multiple heights is needed. The ideal carrier will allow astronauts to transport the tools and then quickly and easily set up a station that the tools can be accessed from during sampling operations. Our device fulfills these requirements by using a ratcheting tool rack and folding legs, providing an effective and portable tool-holding solution for astronauts. We plan to test our device in NASA's neutral buoyancy laboratory in June.

#8 3D Printed Pressure Vessel

Seth Higginbotham | Sullivan Sandridge | Riley Schilz | Adam Roth | Bakir Al-Ameri

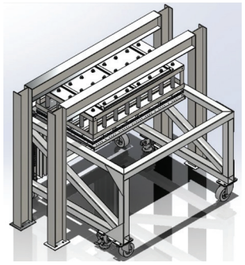
Faculty Supervisor: Jeffrey Shield

A two-piece, 3D-printed pressure vessel has been designed to be compatible with various measurement devices to determine the mechanical and material properties of the material used to create the vessel. The design of the vessel was created in such a way that the pressure will concentrate on a specific point, leading to the failure always happening in that area. Pressure calculations were done to determine at what pressure the vessel should burst. Compressed gas is then loaded into the vessel, inside a testing chamber built by the team, until it explodes. The pressure at which the vessel bursts is then graphed with a computer program, and the strain of the material is measured with a strain gauge. These results are then analyzed by the team to return to the project sponsor.

#9 Lozier Shelf Load Tester

Jayden Ericson | Douglas Effle | Brody Karls | Brett Luedders

Faculty Supervisor: Keegan Moore



Our objective was to design a shelf testing machine for Lozier Corporation in Omaha. Lozier's current method for testing shelves is to load them manually with bags of steel pellets. This process is time-consuming and labor-intensive and can be inaccurate. Lozier asked us to design a machine that applies load to a shelf evenly across its surface until the shelf fails. It was important that ease of use, speed of use, and safety were considered during the design process. The machine configuration needed to allow for the measurement of load and displacement data during the test. The machine needed to be able to apply a maximum 2,400 pounds of load to a number of standard-sized Lozier shelves. Our design utilizes 40 pneumatic pistons to apply load to Lozier's largest standard shelf. A series of valves can be closed to configure the machine for a given shelf size. An additively manufactured cushion pad is attached to the end of each piston, which evenly distributes this load across the surface area of the shelf. These pads are flexible and remain in contact with the shelf even as it bends and deflects under the loading of a test. Our design is a great improvement upon the current shelf testing setup at Lozier, and we hope it may be useful for the company long after our final prototype is delivered.

#10 Solar Distribution Trailer

Isaac Rademacher | Alex Persson | Connor Higgins | Alex Maxson

Faculty Supervisor: Zhaoyan Zhang

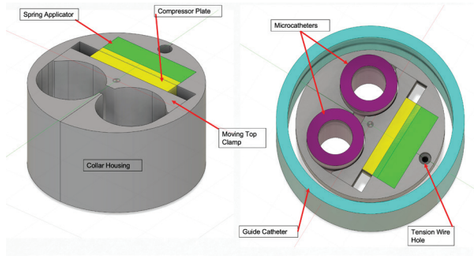
The purpose of our project is to aid in establishing off-the-grid power to water pumps within rural communities. Within the design, three 30 kW inverters are able to be installed and operated within a 6-foot-by-10-foot prefabricated trailer. Along with this weight distribution, electrical code, weather proofing and heat generation all were considered to create a trailer that is safe, efficient and protected.

SENIOR DESIGN PROJECTS

#11 Detachment Mechanism for Double Lumen Catheter

Alaric Schiltz | Jake Green | Mike Altidor

Faculty Supervisor: Sangjin Ryu

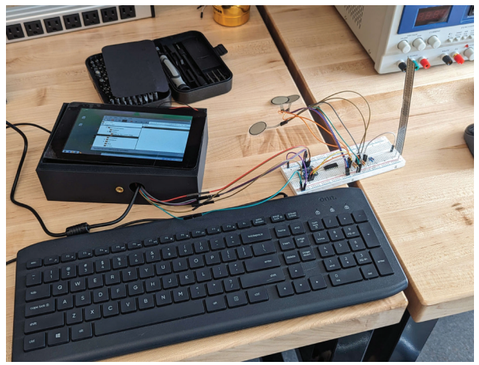


This device will be used for intravascular catheterization procedures, specifically the treatment of intracranial aneurysms. The device will allow for two microcatheters to be used simultaneously with the ability to limit their motion relative to one another. The goal of this device is to give physicians more flexibility in the treatment of intracranial aneurysms.

#12 Ultrasound Probe Pressure Monitoring System

Colton Short | Andrew Cook | Braeden Evenson | Chris Pokorny | Kankoe Teko

Faculty Supervisor: Ruiguo Yang

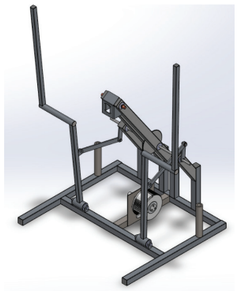


Hand and wrist repetitive stress injuries are common among sonography staff. These injuries are caused by excessive grip pressure exerted on the probe for long periods of time. Our team was tasked with developing a system to track sonography students' grip pressure and provide alerts when excessive grip pressure is used. The goal is to use this feedback system to help develop healthy muscle memory for the grip used by ultrasound operators.

#13 MS Forward – Cardio Machine

Trey Johnston | Luke Roberts | Grant Crockett | Max Gengler | Rodny Penner

Faculty Supervisor: Eric Markvicka



Our group redesigned a cardio machine for MS Forward, a gym in Omaha for people with Multiple Sclerosis (MS). Due to the effects of MS, equipment for the gym must have special considerations, and we had to account for these. To do this, we modified the current machine to maximize reliability and simplicity. To address reliability, we knew we needed to replace the previous resistance mechanism. Previously, a band brake was used to provide resistance to the user. This mechanism was constantly in need of fixing and provided poor repeatability. In our redesign, the band brake was replaced with a permanent magnetic brake. This style of brake was chosen as there are no wearing parts and resistance can be set anywhere from no resistance to max resistance. This resistance mechanism was crucial in the redesign to provide reliability and repeatability. To simplify the machine, the foot pedals from the previous design were removed as they were not being used and were getting in the way. Lastly, 2-inch tubes were added to the base so weights could be placed on top to add stability.

#14 Kawasaki Mule Dashbar

Nazariy Yefimchuck | Casey Rose | Ty Fleshman | Peyton Wilkoski | Garen Quandt

Faculty Supervisor: Qilin Guo

Our group has been working with Kawasaki to improve a welding process for the dash bar of the Kawasaki Mule Pro UTV. The improvement that was requested by Kawasaki was to eliminate a counter weld that runs along the back side of the dash bar for the sole purpose of keeping it from warping during the welding process.

#15 SR-71 SAC Museum Exhibit

Austin Gemar | Mitchel Horvath | Michael Lukaszewicz | Anthony Kowal | John Vovk

Faculty Supervisor: Kurt Palik

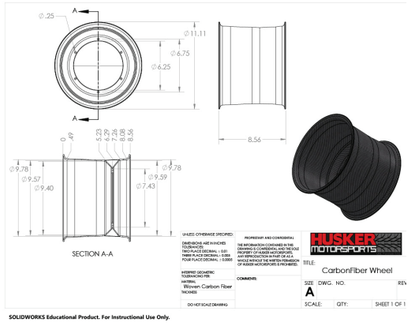
Our team has built a golf ball launcher that is meant to display the speed of the SR-71 in comparison with other fast vehicles such as a Boeing 747 and a Bugatti.

SENIOR DESIGN PROJECTS

#16 Husker Motorsports – Carbon Fiber Wheel

Thomas Crum | Jordan Chapin | Benjamin Bashtovoi | Caden Lind | Michael Pineda

Faculty Supervisor: Yuris Dzenis

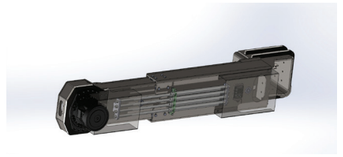


Every year, the Husker Motorsports team participates in a Formula SAE competition that challenges students to design and manufacture a Formula-style vehicle to compete against colleges from around the world. This year, Husker Motorsports sponsored a senior capstone project that will improve the vehicle's performance by reducing unsprung mass. Unsprung mass reduction has numerous benefits on vehicle dynamics, including improved acceleration, handling, and braking. To achieve these performance improvements, the team developed carbon-fiber composite wheels that weigh less than the current wheel solution and provide better rigidity. The team designed and modeled the wheel according to the 2023-2024 competition car criteria, conducted composite loading simulations based on past vehicle performance, and developed a manufacturing plan for future production. In addition to developing the team's 3D modeling, traditional manufacturing, and mechanical testing skills, the project has furthered the team's complex simulation, composite manufacturing, and hands-on skills. As the use of high-performance composites increases in motorsports, this project will provide Husker Motorsports with a product that will improve their competitiveness for future competitions.

#17 Altec Boom Arm

Riley Chase | Alex Schmit | Schuyler Duntz | Spencer Lenoir | Caleb Fowler

Faculty Supervisor: Mehrdad Neghaban

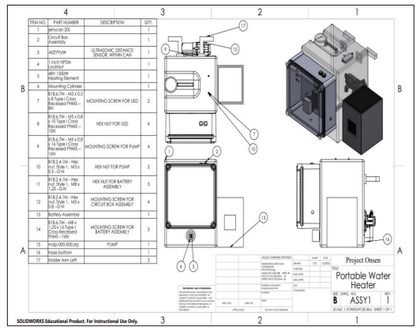


Altec has a LP108-ES cable truck used to transport very heavy spools of cable. Our group was tasked with designing an arm strong enough to pick up a 20,000-pound spool and boom 18 inches on the bed of the truck.

#18 Project Onsen

Reid Stutzman | Tim Goldsmith | Andrew Bednar | Justin Knust

Faculty Supervisor: Mohammad Ghashami

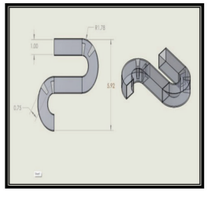


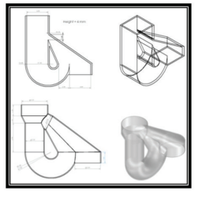
Project Onsen aimed to create an off-grid shower solution for outdoor enthusiasts by designing a portable shower capable of heating five gallons of water to 98 degrees Fahrenheit within 30 minutes, weighing under 45 pounds and costing less than $1,500. The final design features a battery-powered system comprising a jerry can, lithium-ion battery, resistance heater and pump. The heater warms water from 55 degrees Fahrenheit to 98 degrees Fahrenheit in less than 30 minutes with a pump delivering water through a hose and shower head for up to five minutes. We prioritized safety, portability and efficiency, resulting in a product meeting defined constraints and enabling off-grid individuals to enjoy warm showers. The project's sponsor, Keith Aljrew, supported the endeavor, emphasizing the need to surpass current market offerings in volume and accessibility. Despite initially intending to build upon a previous design, the project evolved into a standalone commercial product aligning with the sponsor's vision.

#19 Microfluidic Channel Design

Jacen Reeb | Kyle Delgado | Tyler Wehling | David McCaffery | Isaac Edelbrock

Faculty Supervisor: George Gogos



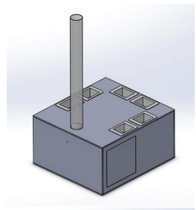


The goal of the project is to design a microfluidic chip that can mix two fluids together within the channels. The goal is to achieve turbulent flow and to create a design that can achieve the best mixing efficiency and the right amount of turbulent flow. Too much turbulent flow could cause a significant amount of backpressure, which leads to a resistance of flow. Too little turbulent flow would result in a bad mixing efficiency.

#20 SAC Museum Restoration Project

Jonathan Schlott | Justin Rohrig | Jacob Pilker | Jackson Slaughter | Luke Dempsey

Faculty Supervisor: Kurt Palik

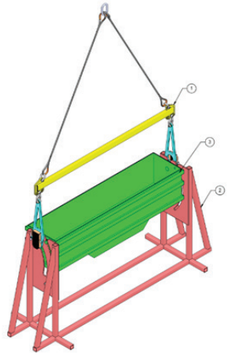


The SAC Restoration Project is intended to showcase the hard work that restoration volunteers do to restore old aircraft at the SAC Museum. The exhibit is specifically dedicated to Jim Fink, an aircraft restoration volunteer with over 15,000 hours of service. This exhibit aims to teach kids about the restoration process at the SAC Museum in two different interactive pieces. The first piece involves a build-your-own rocket launching system, which allows kids to build their own unique model rocket ship and watch it be launched 10-15 feet into the air. The second piece is a hexagonal-shaped table that includes an explanation of the four different steps in the restoration process, an interactive touch screen display with information about aircraft restoration, and an engraved plaque dedicated to Jim Fink.

#21 Automatic Muck Bucket Dumping System

Jaden vonRentzell | Owen Calkins

Faculty Supervisor: Piyush Grover



When creating tunnels, many thousands of tons of material need to be removed. This muck is transported to the tunnel's shaft in a muck bucket and is lifted out with a crane. Some tunneling sites have limited headroom available when dumping. Our sponsor, Kelley Engineered Equipment, wanted an automatic muck bucket dumping system to provide tunneling crews with a space-efficient way of dumping muck removed from tunnels. Our final design concept uses a slotted frame that meshes with the muck bucket via a trunnion and pin and, due to the slot geometry of the frame, forces the bucket to rotate as a crane operator lowers the bucket into the frame.

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