CAPSTONE REVIEW

2022-2023

BYU

CAPSTONE OBJECTIVE

Help students become design professionals who can blend creative, technical, interpersonal, and management skills to develop products that are both desirable and transferable.

A MESSAGE FROM THE DIRECTOR

WELCOME TO BYU ENGINEERING'S 2022-23 CAPSTONE REVIEW!

Welcome to BYU!

As the Capstone Director, it's my pleasure to welcome you to the 2023 Capstone Design Fair. I hope you will enjoy the opportunity to interact with wonderful students who have done significant work on challenging projects. I also hope you'll see evidence that the students are on their way to becoming design professionals who can integrate creative, technical, interpersonal, and management skills to create desirable and transferable designs that solve challenging problems.

This Capstone Design Fair is bittersweet for me. I will be retiring in July after 36 years of teaching at BYU, with 34 of them involved in the Capstone Program. It's been wonderful to see the program grow from 24 students and four projects the first year to 350 students and 56 projects this year. As the program has grown, we've been able to bless the lives of more students who influence the world for good as alumni.

As you visit with the students, I hope you'll appreciate the hard work they've done. I also hope you'll see evidence of the influence of the experience faculty and industrial coaches who have lent their expertise and provided help and advice as the students have met the significant challenges they faced. And I hope you'll appreciate the contributions of the project sponsors, who provide the financial resources to make Capstone possible, and more importantly, expect excellence from the student teams and provide guidance and feedback so necessary to meet their professional obligations.

As you participate in the fair, I invite you to consider how you might continue or increase your support of Capstone. We're always looking for project sponsors. We have ongoing opportunities for project coaches. We'd love to hear ideas about how we can work together to improve the next generation of engineers.

Enjoy the fair!

Professor Carl Sorensen
Capstone Director

PROJECT SPONSORS

2022-2023

- AIR FORCE RESEARCH LABORATORY
- BLUECAP CO.
- BOEING
- BORSIGHT
- BURNHAM & SHIPP/PROTESIS IMBABURA
- BURR OAK TOOL INC.
- BYU CROP BIOMECHANICS LAB
- CAPTIONCALL
- CIRQUE CORPORATION
- COLSA CORPORATION
- ADAM ELLISON MD
- FLOWSERVE CORPORATION
- GEORGIA TECH RESEARCH INSTITUTE
- GLOBEHERO
- GOOGLE
- IDAHO NATIONAL LABORATORY
- JOEY IOMMI-CHITWOOD
- MATT JARMAN
- L3HARRIS TECHNOLOGIES
- LATHAM POOL PRODUCTS, INC.
- LAWRENCE LIVERMORE NATIONAL LABORATORY
- LOS ALAMOS NATIONAL LABORATORY
- MISSION SUPPORT AND TEST SERVICES FOR NEVADA NATIONAL SECURITY SITE
- MOXTEK
- NORTHROP GRUMMAN CORPORATION
- OC TANNER
- RAYTHEON TECHNOLOGIES
- RINCON RESEARCH CORPORATION
- SANDIA NATIONAL LABORATORIES
- SPACE ZERO GRAVITY
- TORC ROBOTICS
- TOYOTA MOTOR MANUFACTURING NORTH AMERICA
- TULA HEALTH
- UTAH DEPARTMENT OF TRANSPORTATION
- VAREX IMAGING CORPORATION
- THE WALT DISNEY COMPANY MARVEL STUDIOS
- ZAP SURGICAL
- ZERONOX
- BYU ELECTRICAL AND COMPUTER ENGINEERING
- BYU MECHANICAL ENGINEERING
- BYU MANUFACTURING ENGINEERING

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01 MINI-TENSILE TESTER

PROJECT SPONSOR: AIR FORCE RESEARCH LABORATORY

Air Force Office of Scientific Research

COACH: OLIVER JOHNSON

TEAM MEMBERS: Ethan Gardner, Jared Yates, Maren Johnston, Tyler Schultz, Reid Ward, Adam Oldham

DESCRIPTION: The US Air Force Research Laboratory in Ohio is dedicated to the discovery, development, and implementation of aerospace technologies. To aid their research, AFRL has tasked the Capstone team, Team SIGMA, with redesigning a mini-tensile stage used for testing ceramic matrix composites. The stage is used in conjunction with an optical microscope and other tests to gather information about how the material behaves under stress. The current mini-tensile stage causes bending strain in the sample, corrupting test data. The project objective was to modify the stage to mitigate this bending strain, enabling the collection of accurate data. To accomplish this, extensive testing was performed to determine the cause of the bending strain. Using data gathered from these tests, we made several design changes to the stage and tested two different prototypes to mitigate the bending strain. These design changes led to a significantly reduced bending strain being introduced to the sample. This reduction will allow AFRL to gather more accurate data, enabling them to use the stage to continue their research and develop new ideas and technologies for the Air Force.

02 WELL MONITORING SYSTEM

PROJECT SPONSOR: BLUECAP CO.

COACH: STEVE WILSON

TEAM MEMBERS: Ian Johnson, Seth Walker, Trevor Call, Chad Schelly, Logan Dame, Charlie Hamblin

DESCRIPTION: Bluecap is a company that makes equipment and systems to monitor wells. Their goal is to make it possible for any user or community to monitor water consumption from their wells. This will ensure that wells are not drying up and allow for early detection of these types of problems. The Capstone team was tasked with building an on-well device that could accomplish this goal. The design solition attaches to a variety of well downpipes and wirelessly transmits the flow rate of the well and also the power used by the system. This helps the user determine how much water they are using and if their water levels are depleting. The device also includes multiple safety measures to guarantee nothing can fall into the well. This product will help users easily monitor their water consumption and ensure they have the water they need.

03 SOLDER SLEEVE QUALITY INSPECTION

PROJECT SPONSOR: BOEING

COACH: AUSTIN HUNTSMAN

TEAM MEMBERS: Mark Petersen, Joe Carter, Ryan Williams, Ben Harris, Topher Johnson, Isaac Nelson

DESCRIPTION: The process of assembling wire looms for airplanes has remained the same for the last 100 years. Currently, wire looms are assembled and hand-laid on peg boards. This is due to the physical size and unwieldiness of the looms. Boeing would like to automate this process by developing an automated visual inspection system to assure the quality and reliability of the loom's solder sleeves. The Capstone team created a visual inspection to specifically check EMF shielding ground wire solder sleeves. The chosen concept uses two mirrors to see the backside of the wire with the use of only one camera. This decreases size and cost. Furthermore, an advanced AI system was developed to interpret the images of the wire and decide if the wires are faulty or not. With our system, Boeing may be able to produce planes faster, with increased quality and greater depth of inspection at a reduced cost.

04 RUGGEDIZED HIGH EFFICIENCY COOLING TRAY

PROJECT SPONSOR: BORSIGHT

COACH: TOM ATKINS

TEAM MEMBERS: Xander Babbitt, Caleb Roberts, Jacob Reedy, Grant Youngblood, Ethan Poole

DESCRIPTION: Borsight Specializes in integrated aircraft solutions such as radar and communications equipment, particularly for military applications. Recently, the Air Force has developed an upgrade to their MIDS-JTRS radio set that would give heavier planes, such as the C-130 and KC-135, datalink capability, allowing them to communicate with other aircraft in the area and map out combat zones for increased situational awareness and pilot safety. Because the upgraded radio develops more heat than the current cooling tray can handle, Borsight asked team ARCS to develop a new radio cooling tray to replace it. Team ARCS was able to meet the objectives and deliver a working solution to Borsight.

05 PROSTHETIC FOOT FORM

PROJECT SPONSOR: BURNHAM & SHIPP

COACH: RYAN BUTTERS

TEAM MEMBERS: Jake Smith, Cody Messick, Paul Walker, Kaleigh Renninger, Lexi Wilson, Jordan Ryan

DESCRIPTION: Protesis Imbabura is a specialized prosthetic clinic in Ecuador that utilizes donated prosthetic parts. Prosthetic foot shells are very hard to get donated and usually cost hundreds of dollars to have shipped to Ecuador. The objective of the project is to design, develop, and deliver a manufacturing process that produces a foot shell costing less than fifty dollars, is visually appealing, can last two years, and can be made locally in country. The team successfully achieved these objectives by first selecting a durable material that stays within cost parameters and is accessible in Ecuador. The foot shell is poured into a silicone mold which is both durable and flexible allowing for an easy removal of the part. They then designed and implemented a fixture that keeps everything aligned and repeatable. The interior of the shell is created by a negative that creates the interface with the foot shell. This project will be beneficial to the sponsor and the world because the cost is less than $20 per shell, and the shell will last more than two years. This process reduces cost and increases availability so that the shells can be produced locally by a simple process.

06 MINI MODULAR VISE

PROJECT SPONSOR: BURR OAK TOOL INC.

COACH: JEFF NIVEN

TEAM MEMBERS: Cole Dunn, Josh Cherry, Wade Lundgren, Ben Wothe, Samuel Taylor

DESCRIPTION: The Capstone Team was given the challenging task of miniaturizing Burr OAK Tool's six-inch modular vise that is used to fabricate many of their parts for clients. The miniature vise needs a roughly three-inch width, compared to the six-inch width of the original vise and must perform to approximately to the same design standards, including clamping forces and cost to manufacture. The most important feature that needed to remain the same as the larger model was the smaller vise's ability to hold a part in the same place every time without the part adjusting or rising. The team had to be creative and explore alternative methods of part alignment than would fit within the design envelope, eventually discovering that they could use the same design principles as within the six-inch vise, but with subtle modifications to allow all of the mechanical components to fit in the three-inch vise. The three-inch vise creatively works around its size constraints to deliver a superb product that lives up to all of the same performance requirements of the six-inch vise, without taking up as much space. The team is eager to see how the development of the three-inch vise helps Burr OAK create more and higher quality parts.

07 AUTOMATED CROP STALK MEASUREMENT

PROJECT SPONSOR: BYU CROP BIOMECHANICS LAB

COACH: KEN HARDMAN

TEAM MEMBERS: Suzanna Gilbert, Jarom Harris, Sam McKinnon, Clark Miller, Jacob Chase

DESCRIPTION: US corn farmers lose about $3.8 billion a year simply because the corn stalk snaps or breaks before the corn can be harvested. A corn stalk's stiffness is related to how resilient the plant will be to stalk failure. Existing technology for measuring stalk stiffness takes 20 seconds to measure the stiffness of one cornstalk, making it difficult for farmers and corn breeders to get stiffness data when they need to measure acres of cornstalks at a time. The BYU Crop Biomechanics lab, with an award from the USDA, challenged a team of Capstone students to build an automatable stiffness measuring device for grain crops. The result is the ARM: Assessment of Rigidity in Maize. The ARM can measure the stiffness of stalks in one second or less and be mounted to a tractor or robot for large scale automation. Farmers and corn breeders can use the ARM to gather unprecedented amounts of data on crop stiffness values, enabling them to make better decisions with their harvests and research.

08 AUTONOMOUS BYU CAMPUS TOUR VEHICLE

PROJECT SPONSOR: BYU ELECTRICAL AND COMPUTER ENGINEERING

COACH: DOUGLAS GILBERT

TEAM MEMBERS: Harrison Godfrey,Teancum Taylor, Elayna Zalit, Tye Kerr, Kiley Atkinson, Aaron Thomas

DESCRIPTION: The Capstone team was challenged by the BYU ECEn department to work with the BYU Admissions office to create a safe, autonomous driving system that will be incorporated onto a golf cart. This cart will be able to give autonomous tours to incoming and prospective students to show them what a BYU student can accomplish. The design solution includes five subsystems: steering, braking, accelerating, sensors, and power. The steering, braking, and accelerating subsystems include servo motors controlled by Arduinos to allow for precise actuation. The subsystem also includes force sensors that revert the cart back to manual mode when the user touches the steering wheel or pedals. The sensors subsystem consists of LiDAR, cameras, an IMU/GPS, and ground radar. Each sensor is placed in a specific location on the cart to return data to the main computer, which will then be processed to create the autonomous algorithms. Finally, the power subsystem consists of two boards, one to power the sensors and one to power the motors. There is also a kill switch that will shut off the motors, reverting the cart to manual mode. We look forward to seeing the cart driving itself around campus soon.

09 JOURNALING APP

PROJECT SPONSOR: CAPTION CALL

COACH: GARY MANGUM

TEAM MEMBERS: Harrison Godfrey,Teancum Taylor, Elayna Zalit, Tye Kerr, Kiley Atkinson, Aaron Thomas

DESCRIPTION: CaptionCall is an industry leader in developing hardware and software for individuals who suffer from hearing loss. Phones and mobile apps have been developed to allow these users to add captions to any phone call, making it much easier to carry out conversations. To engage more users, CaptionCall asked the team to built an app with daily prompts that users can respond to through voice or text responses. The Capstone team designed and built the Snippets app -- a storytelling app that allows users to record voice and text responses to a unique daily prompt. Designed to be simple and engaging, Snippets is available on both the Apple and Android platforms. This app will allow CaptionCall to continue to create better technology for those with hearing loss.

10 ESTIMATING OBJECT SIZE ON A CAPACITIVE TOUCHPAD

PROJECT SPONSOR: CIRQUE CORPORATION

COACH: PHILIPPE PASSERAUB

TEAM MEMBERS: Bryson Fenn, Jon Rodriguez, Sam Owens, Valerie Harris, Rachel Jensen

DESCRIPTION: Capacitive touchpads are used in millions of devices from laptops to grocery store checkouts. Cirque Corporation is a leader in Capacitive touchpad development. At present, capacitive touchpads have no reliable way to determine the size of an object on a touchpad. Adding this functionality would allow touchpads to be more versatile. Cirque Corporation tasked the Capstone team with creating an algorithm that can quickly and accurately determine the size of an object on a touchpad. The team's work will allow Cirque to expand the functionality of touchpads, furthering their accuracy, versatility, and reliability, thereby improving the general user experience.

11 US SPACE FORCE AUTO-TRACKING ANTENNA

PROJECT SPONSOR: COLSA CORPORATION

COACH: KEN HARDMAN

TEAM MEMBERS: Mitchell England, David Martin, Kai Hicken, Emily Szamosfalvi, Laura Landon

DESCRIPTION: The aim of this Capstone project is to retrofit manual antennas with motor and control systems to enable automated satellite signal acquisition, saving significant time and expense. The project sponsors, the Air Force Life Cycle Management Center (AFLCMC), and their partner, COLSA Corporation, are responsible for maintaining a fleet of antennas globally. However, the current manual antenna system requires significant manpower and time to adjust and acquire satellite signals. This project will ensure that the existing infrastructure is upgraded and can be used efficiently without significant financial outlay. The team was able develop code to control the motors previously installed. The code allows automatic acquisition of satellite signals. This process includes peaking and poling to maximize signal readout. The project's benefits extend beyond the sponsor and the enterprise, as it would allow for re-allocation of manpower and funding, better utilizing the American taxpayer's money.

12 ARTHROSCOPIC BONE TUNNELER

PROJECT SPONSOR: ADAM ELLISON MD

COACH: DAVID BARKER

TEAM MEMBERS: Mitchell England, David Martin, Kai Hicken, Emily Szamosfalvi, Laura Landon

DESCRIPTION: For decades, torn rotator cuffs were repaired via open surgery (i.e., making a large opening through the skin and muscle to provide access to the tendons). In recent years, minimally invasive arthroscopic techniques (i.e., inserting tools and a camera through small incisions to perform the repair) have replaced the open method, improving recovery times dramatically. These procedures, however, commonly use expensive plastic suture anchors that are drilled into the bone individually, increasing surgery cost in both time and materials. Dr. Adam Ellison, MD, challenged the Capstone team to design and validate a minimally invasive surgical device that efficiently passes a suture through bone. The team has successfully developed a working prototype that fulfills all of the desired requirements. This prototype is such that Dr. Ellison can present the concept to an engineering company to optimize the design for manufacturing and apply for medical approval. We expect this device to reduce surgery cost and time, provide better patient outcomes, and make this surgery more accessible to those who need it.

13 CONTROL VALVE ACTUATION SPEED PREDICTION

PROJECT SPONSOR: FLOWSERVE CORPORATION

COACH: JEFF HILL

TEAM MEMBERS: Rui Qian, Greg Hill, Nate Phelps, Justin Butler, Dean Anderson, Jacob Groberg

DESCRIPTION: Valves are the control systems for many industrial flow applications, including oil pipelines and nuclear power plants. In order to protect personnel and valuable equipment, many companies require their valves to shut quickly in case of an emergency. Flowserve designs their valve assemblies to meet this criterion but doesn't have the information to predict exactly how the valve will behave in the design phase. In order to ensure that their valves close in time, Flowserve tests their assemblies before shipping them to the customer. If the build fails to close quickly, expensive rework and retesting is required. For this reason, Flowserve wanted to have a better system for predicting the amount of time a valve build will take to close based on the amount of equipment connected to the pneumatic control system. The measurement system built by the BYU Capstone team tests pneumatic components that are often attached to Flowserve's valves in order to determine the flow coefficient and dwell time of individual components or components in series. This data is then compiled into a database that Flowserve can reference to increase their prediction accuracy and decrease the number of valves that need to be reworked.

14 FPGA-BASED CRYPTOGRAPHIC ACCELERATORS

PROJECT SPONSOR: GEORGIA TECH RESEARCH INSTITUTE

COACH: SCOTT LLOYD

TEAM MEMBERS: Noah Hanks, Jacob Burtenshaw, Kaden Hardy, Alek Farmer, Kepa Zubeldia, Sara Divingnzzo Chapman

DESCRIPTION: Cryptography is used around the world to protect business transactions, send secure messages, and ensure the integrity of data through encryption. Georgia Tech Research Institute's Trusted Microelectronics Program Office researches microelectronic applications, tools, and architectures to evaluate the security and reliability of microelectronics. The team was tasked with implementing an open-source cryptographic core, determining if it met National Institute of Standards and Technology (NIST) standards, and identifying potential security threats. They succeeded in implementing the open-source core using a Xilinx Pynq-Z2 field programmable gate array (FPGA) board. They also verified that the core complies with NIST standards and is formally equivalent according to GTRI's tools. Finally, the team identified three side channel attack tasks as potential methods of penetrating the security of the cryptography engine. This project can be considered preliminary work into showing what kinds of attacks are possible. Future work could include potential counter-measures against side channel attacks.

15 TRAINING RANGE TERRAIN SERVER

PROJECT SPONSOR: GEORGIA TECH RESEARCH INSTITUTE

COACH: PREVIN MENON

TEAM MEMBERS: Tanner Ellison, Dallas Meldrum, Colby Weber, Nate Baker, Kirgan Hilton

DESCRIPTION: The United States Air Force is developing simulation software to help train pilots for combat. It is crucial that the simulations are as close to reality as possible so that pilots learn how to correctly use various weapon systems and aircraft. To improve the US Air Force's current simulation models, Georgia Tech Research Institute (GTRI) asked the Capstone team to improve the 3D elevation of the terrain in the simulations. The team was asked to build a terrain server that can store elevation data and provide it to their training simulation software, thus enabling higher-fidelity simulations and pilot training. In addition, GTRI asked the team to develop an augmented reality HoloLens application that interfaces with the terrain server to display elevation data. The Capstone team designed and built a terrain server and HoloLens application that meets the requirements set by GTRI for their pilot training simulations.

16 IMPROVED BLEACHER CHAIR

PROJECT SPONSOR: GLOBEHERO

COACH: TERRI BATEMAN

TEAM MEMBERS: Austin Christenson, Spencer Witt, Grant Ogilvie, Reed Mortensen, Jared Hunter, Todd Lainhart

DESCRIPTION: GlobeHero is a company that makes a variety of consumer products and tasked the Capstone team of students with designing the ultimate stadium bleacher chair. The market has a wide variety of bleacher chairs in various forms made by several different companies, but there is no recognized best brand. The team was challenged to design and prototype a comfortable, portable, and durable personal bleacher chair that improves the fan experience more than current market options and costs less than $40 to manufacture. The Better Bleachers team has designed a chair with two attachment hooks on the frame for secure holding to the bleacher. There is a dynamic reclining mechanism that allows users to recline at the angle most comfortable to them. The chair back is taller than other chairs for better back support. Arm rests have ratcheting hinges to allow for the most comfortable arm height and the chair includes a mesh cushion for optimal breathable comfort. This chair will allow fans of all sorts to be able to enjoy their events in comfort.

17 FPGA INTERFACING AND MONITORING

PROJECT SPONSOR: GOOGLE

COACH: ERIC QUIST

TEAM MEMBERS: Hayden Beames, Zephram Tripp, Tyler Ricks, Grant Goates, Pablo Lopez

DESCRIPTION: Google is interested in open-source FPGA design. They have sponsored and produced open-source design tools that can be used to design and test new hardware on FPGAs. For part of this research, they want to add new functionality to the Xilinx® Alveo™ U280 Data Center accelerator card so that they can adequately use the High Bandwidth Memory for tests. The team implemented bandwidth generators onto the FPGA fabric of the Alveo U280 board through the open-source LiteX Alveo U280 project. The generators can perform different types of continuous reads and write to allow for proper testing of the HBM bandwidth. The team also created a simple way to run the project and perform the tests so the average user can see and use the functionality of the HBM. The team has laid the foundation through documentation and a public GitHub repository for other research groups to test and see how they can use Alveo u280's HBM in different ways and test the functionality of an HBM within a free and open-source environment.

18 ARCHITECTURE FOR VULNERABILITY TESTING

PROJECT SPONSOR: IDAHO NATIONAL LABORATORY

COACH: RICH ZIEGLER

TEAM MEMBERS: Brendon Johnson, Chandler Evans, Tanner Meeves, Roman Vish, Megan Warren

DESCRIPTION: Idaho National Laboratory (INL) focuses on research in renewable energy solutions, nuclear energy, and national security. INL asked the Capstone team to create an infrastructure-as-code solution that can be easily accessed and used to test multiple virtual machines against specific exploits. This work will be used by the United States government and its variously affiliated bodies to test the security of critical industrial control systems to improve national security posture.

19 CRAWFISH DESHELLING

PROJECT SPONSOR: JOEY LOMMI-CHITTWOOD

COACH: ARON MADSEN

TEAM MEMBERS: Jason Prescott, Andrew Clawson, Megan Stickley, Tyler Vail, Jacob Taylor, Philip Klocke

DESCRIPTION: The crawfish market in Louisiana has slowly been declining due to steep competition from Chinese imports of crawfish into the United States. One big issue that the United States crawfish industry faces is that it is expensive to pay employees to deshell crawfish by hand. If this cost could be minimized, crawfish deshelling companies would be able to better compete with the prices of crawfish imported from China. With funding from Joey Iommi-Chittwood, the team was challenged to create a proof of concept, fully automated crawfish deshelling device that is more efficient and cost effective than paying employees to deshell crawfish by hand. The team designed an automated crawfish deshelling system that receives a cooked crawfish in any orientation, orients the crawfish, separates the head and tail of the crawfish, and leaves the separated crawfish tail in a location for the meat to be ejected and collected in future steps.

20 GAMIFICATION PHONE CHARGER

PROJECT SPONSOR: MATT JARMAN

COACH: DALLAS HAUETER

TEAM MEMBERS: Karl Knapp, Joshua Fife, Asa DeBuck, Eric Barker, Ethan Belliston

DESCRIPTION: As our world has become inundated with technology, many individuals spend increased amounts of time on smartphones. Research has shown that excessive smartphone usage can have negative side effects such as mental illness and poor relationship skills. With funding from a private sponsor, the team developed a multi-port phone charger specifically designed to incentivize decreased smartphone usage. The incentivization is done by collecting data about when and how a smartphone is connected to the phone charger. Points are assigned based on this data. To encourage competition, a satellite display is used to show the point values of individual users. A family would use this charger to compete for the most points. The intended effect of the competition would be decreased smartphone usage. With less time spent on smartphones families will have more time to interact with each other, improving relationships and mental health.

21 BISTATIC RADAR

PROJECT SPONSOR: L3 HARRIS TECHNOLOGIES

COACH: FRANZ BUSSE

TEAM MEMBERS: Kyle Cribbs, Thomas Andrews, Michael Goedel, Davis Hansen, Sage Romney

DESCRIPTION: Radar is commonly used to detect and localize vehicles. Monostatic radars are the most common and operate by emitting a pulse, then receiving and measuring energy reflected back to this same location. However, monostatic radios must repeatedly turn off their transmitter in order to listen for return signals. Instead, the team created a bistatic radar system using two, non-collocated BladeRF software-defined radios (SDRs). One SDR was used to continuously transmit a BPSK signal, the other was used to receive the BPSK signal using two antennas separated by a fixed distance. With these two receive antennas, the team was able to calculate the time difference of arrival (TDoA) and angle of arrival (AoA), ultimately providing the information needed to localize a vehicle.

22 AUTOMATIC SWIMMING POOL COVER

PROJECT SPONSOR: LATHAM POOL PRODUCTS, INC.

COACH: RICH SMITH

TEAM MEMBERS: Joshua Hansen, TJ Hall, Adison Wirth, Layne Bangerter, Dallin Anderson

DESCRIPTION: Latham Pool Products is a company that produces swimming pools and pool equipment. Latham's pool cover division recently acquired two companies with two different track design systems. These systems are used to retrofit existing pools with safety covers by installing them on top of the pool rather than embedded in the pool. The objective of this project is to consolidate and replace the two existing track design systems into one patentable design to reduce the number of inventoried parts and update the aesthetics. The team used their mechanical and product design skills to achieve a design that meets the objective through a new two-part track profile that is easier to install and more aesthetically appealing. Additionally, the team designed a new rope-securing slider body which advances the previous design from outdated and bulky to modern and sleek. Additional changes were made to small parts to interface with the new track and slider body design. This project will potentially result in three patents, giving Latham a competitive edge in the pool cover industry.

23 AUTONOMOUS DRONE CHARGING SYSTEM

PROJECT SPONSOR: LAWRENCE LIVERMORE NATIONAL LABORATIORY

COACH: MIKE WITTING

TEAM MEMBERS: Braydon Tatton, Adam Wangeman, Bryant Stegman, Clint James, Gracie Richens, Adam Stephens

DESCRIPTION: Lawrence Livermore National Laboratory (LLNL) seeks to enable U.S. security and global stability through pursuing bold and innovative science and technology. To further their mission, LLNL deploys unmanned aerial systems (UAS) from unmanned rafts for their missions out on the ocean. Currently, the UAS are limited to a single mission as they can't be charged autonomously. The team was challenged to add the capability of running multiple missions through autonomous charging in an ocean ocean environment where corrosion and salt buildup are critical issues. To help meet this need, the Capstone team designed and built an autonomous UAS landing pad capable of charging an UAS battery within 2 hours in an ocean environment. This will provide LLNL with the capabilities to run multiple missions with their UAS without having to manually charge them for each mission.

24 RUGGED RAFT

PROJECT SPONSOR: LAWRENCE LIVERMORE NATIONAL LABORATIORY

COACH: JASON CARLING

TEAM MEMBERS: Bryce Hamilton, Tyler Crisp, Tyson Humphrey, Dan Budge, Kade Waite, Carson Zeller

DESCRIPTION: Lawrence Livermore National Laboratory is contracted by the Department of Energy (DOE) and the Department of Defense (DOD) to test weapon systems for the nation. The Capstone team was assigned the task of designing a raft to be sent in harm's way and collect important impact data. The raft, quite literally, is a large floating target. The BYU BOATS Team designed, built, and tested a raft which will protect diagnostic equipment and remain recoverable after being exposed to fragments traveling at high speeds while deployed in the open ocean. While the project's scope is small in comparison to the overall national security, it plays a role in ensuring each citizens' protection.

25 DELAY GENERATOR FOR DETONATION CONTROL SYSTEM

PROJECT SPONSOR: LOS ALAMOS NATIONAL LABORATORY

COACH: JOHN SNOW

TEAM MEMBERS: Josh Hanni, Abi Austin, Steven Johansen, Jacob Capito, Matthew Bruun, Mitch McLane

DESCRIPTION: Los Alamos National Laboratory (LANL) is the senior laboratory in the Department of Energy solving national security challenges. The Detonator Science and Technology Group (Q-6) within LANL works on Firing Control Systems that are used all over the country. Q-6 is currently developing a new modular framework that uses an open-source communication protocol called SpaceWire that is known for its simple circuitry, low power usage, and low error rate. This framework will include one controller, a user interface, and multiple modules. The team project was to design a delay generator module to be used in this new Firing Control System. The design was implemented with VHDL on an FPGA and communicated with other modules via SpaceWire protocol.

27 SiPM-BASED CURRENT MODE RADIATION DETECTOR

PROJECT SPONSOR: MISSION SUPPORT AND TEST SERVICES FOR NEVADA NATIONAL SECURITY SITE

COACH: ROB MESSENGER

TEAM MEMBERS: Sam Lahti, Tom Carson, Stephen Watts, Braden Eggers, Vance Huntsman

DESCRIPTION: An important function of Mission Support and Test Services (MSTS), the management and operating contractor for the Nevada National Security Site (NNSS), is nuclear stockpile stewardship. Part of this mission involves performing subcritical nuclear experiments and measuring the resulting flux of radiation. the most common device used to measure that flux is a photomultiplier tube (PMT), which requires the use of a vacuum tube and a very high voltage. With vacuum tubes being phased out by manufacturers, the NNSS is interested in exploring replacing PMTs with emerging solid-state silicon photomultiplier (SiPM) technology. The Capstone team was tasked with evaluating the viability of using a SiPM in place of a PMT for the NNSS purposes.

This document has been reviewed by a DC/RO and confirmed to be UNCLASSIFIED.
Name: Rick Hatch
Date: 03/23/2023
NNSS eDC/RO ID: 1266

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This work was done by Mission Support and Test Services, LLC, under Contract No. DE-NA0003624 with the U.S. Department of Energy.
DOE/NV/03624--1651

26 LOCALIZATION ALGORITHM FOR SEARCH AND RESCUE

PROJECT SPONSOR: MISSION SUPPORT AND TEST SERVICES FOR NEVADA NATIONAL SECURITY SITE

COACH: CORY ESTES

TEAM MEMBERS: Noah Boehme, Brook Hatch, Caleb Swain, Henry Ward, Benjamin Kretschmer, Kayla Russon

DESCRIPTION: Among its many other capabilities and missions, the Department of Energy's Nevada National Security Site (NNSS), managed by Mission Support & Test Services, creates advanced technologies for emergency search-and-rescue operations and remote sensing. The Capstone team was tasked with outfitting a drone with a payload of sensors that can relay signal strength data to a base station. That data is combined with GPS and elevation data to create a probability heat map displayed on a graphical user interface (GUI). Continuing this multi-year project, the team reduced the size and weight of the payload housing, interfaced the payload with a drone, and added elevation data to the reporting algorithm and improved the heat map overlay for real-time updates. The size and weight were reduced to increase flight time. The payload-housing interface and real-time heat map with overlay allow the project to be used in search-and-rescue scenarios.

28 ACCELERATED CURING SYSTEM

PROJECT SPONSOR: MOXTEK

COACH: DOROTHY TAYLOR

TEAM MEMBERS: Jacob Busby, Isaac Doddridge, Dallin Charters, Justin Hawkins, Kevin Lin, Kathryn Wheelhouse

DESCRIPTION: Moxtek Inc. is a leading supplier of advanced nano-optical and x-ray components used in display electronics, imaging, and analytical instrumentation. High voltage circuitry boards are used in one of their products. Because arcing occurs at such high voltages, Moxtek uses silicone potting to insulate the high-voltage components to prevent arcing. The current process of potting the silicone at Moxtek is a slow and problematic process. It involves leaving the units in an oven for several hours to ensure that the potting is cured, and then leaving the units until they are cool enough to handle. Team Silicure has designed and built a system with a heating tool, cooling tool, safety guard, and control software to cure the potting in under 30 minutes.

29 MANUFACTURING PROJECT

PROJECT SPONSOR: NORTHROP GRUMMAN CORPORATION

COACH: YURI HOVANSKI

TEAM MEMBERS: Adam Ith, Tad Anderson, James Isabell, Damon Gale, Connor Folkman

Project cannot be disclosed

30 MBT ERROR LOGGING

PROJECT SPONSOR: NORTHROP GRUMMAN CORPORATION

COACH: RICH ZIEGLER

TEAM MEMBERS: Keaton Morris, Nick McMurdie, Nate Burnett, Ethan Tew, Jake Edvenson

DESCRIPTION: Northrop Grumman uses several machines known as Mix-Bowl Transporters (MBTs) in their day-to-day work. Since these MBTs were created by Northrop Grumman, they have undergone many modifications and the diagrams for them have become unorganized. To remedy this, Northrop Grumman requested a consolidation of all of their MBT diagrams. They also requested the creation of software to aid in streamlining the process of tracking their MBTs' statuses. This automatic encoded message decoder stores all information in a SQL database and can be displayed on a webpage. The team consolidated all of Northrop Grumman's diagrams into one master diagram with an excel table to reference for easy navigation. Additionally, the team designed an efficient and unified process for continually parsing, decoding, and storing status updates from MBTs.

31 SPRAY ROBOT PLC CODING

PROJECT SPONSOR: NORTHROP GRUMMAN CORPORATION

COACH: JASON WEAVER

TEAM MEMBERS: Holly Reed, Rebecca Estes, Jonathan Evans, Matt Larkins, Zachary Alvarez

DESCRIPTION: Northrop Grumman is a leading manufacturer of solid, liquid, and gel propellant systems for national defense and commercial use. The cases that house these propellant systems on a rocket or missile are prepared by a Spray Lance Robot (SLR), which is controlled using Programmable Logic Controller (PLC) code and a Human Machine Interface (HMI). These systems were designed decades ago with numerous engineers editing the code since then. The result of multiple people making changes has made the code nearly unreadable. The code also needed to be updated to newer versions of the software so it can work on a more current operating system. The team's project was to decipher the existing code and write it in a more clear and concise way so that it will be easier to troubleshoot while also updating it to the new operating system and versions of the software. Rewriting this code allows a full system update that will make it easier for an operator to run the Spray Lance Robot and make troubleshooting far simpler.

32 VARTM PERMEABILITY TESTING

PROJECT SPONSOR: NORTHROP GRUMMAN CORPORATION

COACH: ANDY GEORGE

TEAM MEMBERS: Michael Shinedling, Keven Garrett, Ben Kitzmiller, Matthew Markham, Cera Gowans

DESCRIPTION: Northrop Grumman is one of the nation's premier aerospace producers, producing thousands of pounds of aerospace grade composites annually. Vacuum Assisted Resin Transfer Molding, or VARTM, is one method of saturating the fibers with resin to create the composite. In this method, a pressure gradient is created that forces resin to flow through the fiber reinforcements. Accurate modeling is vital to creating good VARTM parts. In order to create these models, permeability data must be collected. The objective of this project was to create a device that would allow Northrop Grumman to collect permeability measurement data in-house. The student team built two devices to provide a method for capturing permeability data on different fibers and materials. The first device measures in-plane permeability by forcing resin to flow through the fibers in one direction. The second device measures both in-plane and through-plane permeability by forcing resin through a stack of fibers. As composites modeling improves, composite parts improve. This makes failure less likely and improves safety.

33 AWARD BASE SLOT CUTTING AUTOMATION

PROJECT SPONSOR: OC TANNER

COACH: ALMY HOLLIS

TEAM MEMBERS: Cameron Hepworth, Jacob Henderson, Seth Huston, Spencer Carter

DESCRIPTION: OC Tanner creates a variety of high-quality awards at a high volume. They will soon be releasing a new award where small metal figures and charms are inserted into slots in a walnut block for display. Currently the walnut blocks are precision milled one at a time, which takes more than three minutes per block. OC Tanner is looking for an alternative production method to reduce time without sacrificing surface or slot cut quality. The team was able to develop a robust production machine that reduces cut time from three minutes to 6.5 seconds while also decreasing overall training time and keeping surface and slot quality. This new machine will increase the output of OC Tanner's awards base, allowing them to keep up with their high volume demands.

34 SERVER ROOM MAPPING ROBOT

PROJECT SPONSOR: RAYTHEON TECHNOLOGIES

COACH: GAVIN RANSOM

TEAM MEMBERS: Mark VanDyke, Tanner Pearson, Nathan Blaylock, Jacob Noorda, Jayden Clark

DESCRIPTION: Raytheon Technologies is an intelligence and defense company pursuing a solution for maintaining server rooms remotely. The Capstone team was tasked with further developing, refining, and optimizing a server room robot design created over the past two years by previous teams. This robot can be controlled remotely to minimize the amount of time and personnel needed to maintain server racks. The team programmed the robot to map out a server room by scanning QR codes and recognizing images. Once a server room is mapped out, it will be easier for IT personnel to identify, locate, and fix issues as they arise within a server room. The robot has the potential to significantly decrease the time needed to maintain a server room.

35 SERVER ROOM SPYGLASS AUGMENTATION

PROJECT SPONSOR: RAYTHEON TECHNOLOGIES

COACH: QUENTIN ALLEN

TEAM MEMBERS: Ryan Best, Alex Zaugg, Trevor Mangum, Jake Beus, Jade Ashford, Kevin Hilton

DESCRIPTION: Setting up and maintaining server rooms is an expensive and time-intensive process for many businesses. Working with Raytheon Technologies, this Capstone team designed a system to boost the productivity of server-room technicians. To accomplish this, the team developed an Augmented Reality (AR) tool on the Microsoft HoloLens 2 that provides technicians with useful navigational information, helping them locate equipment faster. The AR headset implements a point-to-point navigational system, scanning the room for QR codes and highlighting them in the user's view. In addition, the program provides real-time state-of-health information about a given piece of equipment. This equipment information that the HoloLens displays is housed on a separate server that the headset queries. This "master" server handles requests by compiling information from a sensor and a database. The master server then sends this information back to the headset. The success of this project provides a proof of concept for an AR-based solution to enhance server-room technician productivity. It is also a good starting point for Raytheon to build an industry-ready product.

36 DOPPLER DIRECTION FINDING SYSTEM

PROJECT SPONSOR: RINCON RESEARCH CORPORATION

COACH: ANNETTE STEED

TEAM MEMBERS: Riley Johnson, AJ Horton, Alex McBride, Christian Sorenson, Matthew Burns, Maya Savage

DESCRIPTION: Rincon Research Corporation (RRC) is an employee-owned company that designs, builds, tests, and fields high-performance digital signal processing (DSP) products and services for the U.S. Defense and Intelligence communities. Thee team created a prototype device for RRC's future research, which required building a direction-of-arrival (DoA) finding device using an emulated Doppler effect by electronically switching between pairs of elements in a nine-element circular antenna array. The final design has an accuracy of 15 degrees, an operating range of 10m, and can be tuned to multiple frequencies. DoA is often an expensive feature that requires multiple SDRs and expensive, multiport RF hardware. By achieving accurate DoA with only two receiving ports, marketability of this type of product is greatly increased. Implementation could grow to include unmanned aerial vehicle (UAV) deployment.

37 WEARABLE DYNAMIC LIFT ASSIST DEVICE

PROJECT SPONSOR: SANDIA NATIONAL LABORATORIES

COACH: ROB CLOWARD

TEAM MEMBERS: Tyler Dickson, Brinler Tanner, Joseph Edmund, Isaac Sorensen, Joshua Vanderpool, Christian Payne

DESCRIPTION: Department of Energy (DOE) workers in nuclear waste sites routinely lift and move led radiation shields weighing up to 90 lb. Many of the workers experience bicep and deltoid tears as a result of muscle fatigue from repeatedly lifting the heavy shielding. Sandia National Labs hopes to reduce the frequency of musculoskeletal injuries by providing a lift assist device. To meet this objective, the Capstone team worked with Sandia to design a one-armed lift assist device that DOE workers can use on-site. The device uses load cells in an ergonomic handle and an arduino to react to both load and user intent. Upon sensing a load, the arduino controls a motor that transfers 50% of the load from the handle to a motor via an over-the-shoulder cable, then to the trunk of the worker. This pathway allows for a decrease in muscle load and activation in the bicep and deltoid of the worker during the lifting process.

38 LASER COMMUNICATIONS CUBESAT

PROJECT SPONSOR: SPACE ZERO GRAVITY

COACH: SPENCER MAGLEBY

TEAM MEMBERS: Javier Nicolas, Oliver Britos Granado, Jayden Smith, Jared Read, Tyson Danby, Jordan Jones

DESCRIPTION: The increased development and popularity of CubeSats has opened worlds of possibility for companies hoping to put their ideas into orbit. Space Zero Gravity Mexico aims to take advantage of this opportunity by launching several CubeSat satellites to test an innovative communications payload. The goal for this Capstone team was to create a design for a service module that fits in 1.3U of a 3U satellite. Within this space, the service module must be able to orient the satellite in space and to supply power and necessary communications to the payload. The Capstone team researched a set of components, created a volume model showing all components fitting in the required volume, and generated several estimated power scenarios. This design will serve as a foundation for Space Zero Gravity as they continue to finalize the details of the mission and get closer to putting their designs into orbit.

39 VEHICLE LANE CHANGE PREDICTION

PROJECT SPONSOR: TORC ROBOTICS

COACH: KEVIN RUST

TEAM MEMBERS: Jacob Swartz, Michael Wood, Taylor Farnsworth, Jackson Sahleen, Colton Crapo

DESCRIPTION: Torc Robotics is developing self-driving semi-trucks with the mission of saving lives. A major area of safety for self-driving vehicles is predicting what other vehicles on the road will do. The Capstone team was challenged to use Torc Robotics' data to develop a machine learning approach to accurately predict lane changes made by other vehicles on the road. Torc Robotics will take lessons learned from this project to develop their own design for predicting the behavior of other vehicles on the road. While the team's code will not be used on Torc's vehicles, their work serves as an outstanding proof of concept to warrant further development work.

40 ROBOT END EFFECTOR FOR PALLET UNLOADING

PROJECT SPONSOR: TOYOTA MOTOR MANUFACTORING/NORTH AMERICA

COACH: DONNA CLAYTON

TEAM MEMBERS: Michael Ballantyne, Brandon Garnica, Ammon Olson, Michael Murphy, Austin Turner, Alex Schroeder

DESCRIPTION: Toyota Manufacturing Project Innovation Center (MPIC) is a division within Toyota Motor North America, Inc. dedicated to enhancing manufacturing processes employed in North America. Innovations developed at Toyota MPIC are deployed across 15 North American manufacturing facilities operated by Toyota. Recently, Toyota MPIC started a project to automate the unloading and sorting of vendor products that are shipped to their facilities. Currently, vendor product is shipped to Toyota factories in plastic crates that are packed into compact shipping containers. Once the container arrives at a Toyota facility, it is unloaded and sorted by workers. The Capstone team was tasked with designing a custom end-of-arm-tool (EOAT) for a six-axis robot that can unload any of the plastic crates used to ship vendor product. The team created a complete design package of the custom EOAT including manufacturing drawings, a bill of materials, and FEA simulations. With the successful deployment of the EOAT, the project to automate the unloading and sorting of vendor product will be one step closer to completion. Upon project completion, Toyota will be able to redeploy their workers to more ergonomic and engaging tasks.

41 WELDING ELECTRODE VISION-BASED INSPECTION

PROJECT SPONSOR: TOYOTA MOTOR MANUFACTORING/NORTH AMERICA

COACH: CHRIS BAILEY

TEAM MEMBERS: Dallin Bruschke, Ethan Fullwood, Hunter Hinnen, Jared Warburton, Jon Orgill, Brayden Steimle

DESCRIPTION: Toyota Motor North America is one of the world's largest automobile manufacturers. Toyota has a reputation for being a leader in innovation that stems from making continuous improvements to its manufacturing processes. On the assembly line, robotic spot welding is used to precisely join metal components together. To maintain high-quality welds, the welding electrodes are routinely reshaped by trimming down the face. This "dressing" process needs to be inspected to make sure that it is done properly and thoroughly every time. The Capstone team's project was to create a low-cost computer vision system to automate the inspection of dressed electrodes. This system includes a camera and optics setup that is protected by a custom housing and compatible with being clamped by the welding robot. In addition to the physical system, the team developed a process for imaging the electrode faces and custom software to analyze the quality of the dressing. Using this system, Toyota will be able to quantify electrode condition and create stronger and more consistent welds.

42 MULTI-MODAL SENSOR INTEGRATION

PROJECT SPONSOR: TULA HEALTH

COACH: WOOD CHIANG

TEAM MEMBERS: Bryce Johnson, Michael Jones, Aaron Oleson, Ethan Stubbs, Joseph Peterson, Matthew George

DESCRIPTION: Tula Health is a medical device company that strives to use innovation as a means to improve the lives of those they help. Tula Health has recently been pursuing the possibility of a non-invasive blood glucose monitor through research into two sensors—an optical and a bioimpedance spectrometer. Although a lot of progress has been made with each sensor individually, it was the team's task to integrate the two sensors into a single, wearable device so that data can be collected and recorded from both sensors simultaneously to further the research into a truly non-invasive blood glucose monitor. Through designing and building a series of custom circuitry to correctly route the signals to and from the sensors, as well as creating a few unique pieces of hardware to hold the sensors in place on the subject during testing, the team was able to achieve a successful solution to the challenge. Although the project may not be used as a consumer product, the work of the team accomplishes a critical step on the path to developing a non-invasive blood glucose monitor which has the potential to drastically change the lives of millions of people around the world.

43 PASSIVELY COOLED ELECTRONICS ENCLOSURES

PROJECT SPONSOR: UTAH DEPARTMENT OF TRANSPORTATION

COACH: ANDREW KAY

TEAM MEMBERS: Jaxon Hale, Chris Fitzgerald, Zac Keeney, Spencer Fisher, Michael Painter, Nathan Mortensen

DESCRIPTION: During the summer in Southern Utah, the internal temperature of traffic control boxes can reach up to 160° F. This increased temperature causes the electrical components that control traffic lights and collect traffic data to fail prematurely. UDOT asked the Capstone team to find a passive cooling solution to help reduce the internal temperature of the box while limiting the increase in cost of operation and maintenance. The team designed a radiation shield that will reduce internal temperature of the box. Reducing the temperature of the box without use of an active cooling system will save taxpayer dollars by reducing electronic waste and keeping operating costs low.

44 ANODE ASSEMBLY AUTOMATION CELL

PROJECT SPONSOR: VAREX IMAGING CORPORATION

COACH: ABRAHAM TENG

TEAM MEMBERS: McKell Ruiz, Emily Brown, John Garrow, Parker Allred, Jon Backman

DESCRIPTION: In today's age, automation is crucial to a manufacturing company's success. The sponsor of this project, Varex Imaging, makes X-ray units for medical and other purposes. An anode is an integral part of each X-ray unit and spins rapidly during X-ray generation. It is crucial that the anode spins straight (runout) and no parts fly off (screw staking). Currently, Varex uses a manual process to measure runout and perform screw staking on X-ray anode tubes. The Capstone team's objective was to take this current manual process and automate it. The team was successful in meeting this objective through careful design, use of automated slides, laser sensors, and high-level computer programming. This design will allow more X-ray anode tubes to be produced each day to build more life-saving X-ray units.

45 HEATED VACUUM TESTING CHAMBER

PROJECT SPONSOR: VAREX IMAGING CORPORATION

COACH: RICHARD GEE

TEAM MEMBERS: Ming Li Yew, Hannah Eddy, Drew Vincent, Marshall Rawlins, Samuel Packard

DESCRIPTION: Headquartered in Salt Lake City, Utah, Varex Imaging is the world's largest independent manufacturer of X-ray imaging components. X-rays are produced in a sealed high-vacuum environment and components that are sealed inside need to be extremely clean. The team's project was to design and build a heated vacuum test chamber that will determine if a set of components is clean enough to be sealed inside an X-ray tube. The system will quantify the amount and determine the potential contaminants. With a contaminant detection system, components are better evaluated which will significantly reduce cost and labor.

47 TELEPRESENCE ROBOT: CONTROLS

PROJECT SPONSOR: THE WALT DISNEY COMPANY/MARVEL STUDIOS

COACH: DEXTER FRANCIS

TEAM MEMBERS: Raelyn Winn, Tracy Vogel, Riley Kuttler, Anaïs Dawes, Saroya Avery

DESCRIPTION: The Walt Disney Company is one of the leading studios in the modern film industry. A growing market, recent travel restrictions, and the abundance of geographically distinct filming locations have revealed a need for natural remote communication between people in different locations. The Walt Disney Company challenged two Capstone teams,working together, to determine what telepresence technologies currently exist and how these technologies can be adapted to a filmmaking environment. This Capstone team, in conjunction with team 48, modified an off-the-shelf telepresence robot from Ohmnilabs to demonstrate the feasibility of using telepresence technology on movie sets. The team programmed an indicator that was created with off-the-shelf parts that can be controlled by mouse or through VR. This will enhance an "as if you were there" experience for a remote user.

46 X-RAY TUBE-MOUNTED HEAT EXCHANGER

PROJECT SPONSOR: VAREX IMAGING COPORATION

COACH: MATT JONES

TEAM MEMBERS: Aaron Martin, Joe Spencer, Dallin Jacobs, Ryan Hansen, Trevor Talbot

DESCRIPTION: Varex Imaging has tasked the Capstone team with designing a compact cooling system that mounts to their new X-ray tube. Varex's current cooling solution for the tube is expensive and incompatible with a surgical environment, and thus requires long and hazardous oil lines running between the tube and a utility closet. The goal of the new design is to mount the cooling system to the X-ray tube while avoiding interference with the surgical environment and the X-ray tube itself. The X-ray tube produces approximately 9.5 kW of heat that the cooling system must remove to prevent overheating. To accomplish this, our cooling system circulates dielectric oil through the x-ray tube, absorbing heat. It also exchanges heat between the oil and the water supply to keep the oil at a sufficiently cool temperature. As the oil heats up, it expands significantly, so the new system also accommodates thermal expansion. This new system has a pump, plate heat exchanger, and an accumulator to accomplish these goals. The new design costs less than the current solution and mounts to the tube within its design envelope while operating safely and quietly.

48 TELEPRESENCE ROBOT: MOBILE ROBOT BASE

PROJECT SPONSOR: THE WALT DISNEY COMPANY/MARVEL STUDIOS

COACH: DEXTER FRANCIS

TEAM MEMBERS: Brendan Mitchell, Colin Gillespie,Jared Montiel, Austin Brown,Landon Shumway, Jacob Dicou

DESCRIPTION: The Walt Disney Company is one of the leading studios in the modern film industry. A growing market, recent travel restrictions, and the abundance of geographically distinct filming locations have revealed a need for natural remote communication between people in different locations. The Walt Disney Company challenged two Capstone teams,working together, to determine what telepresence technologies currently exist and how these technologies can be adapted to a filmmaking environment. This Capstone team, in conjunction with team 47, modified an off-the-shelf telepresence robot from Ohmnilabs to demonstrate the feasibility of using telepresence technology on movie sets. The team increased the height and the stability of the commercial robot to enhance the remote and on-set user experience and developed an indicator using off-the-shelf parts that will allow remote users to point out objects on set as if they were there.

49 GYROSCOPIC RADIOSURGERY COOLING SYSTEM

PROJECT SPONSOR: ZAP SURGICAL

COACH: BRAD ADAMS

TEAM MEMBERS: Carina Watson,Ethan Gifford, Alison Langford, Alex Hale, Adam Reinsch, Jakob Bates, Gavin Johnson

DESCRIPTION:

ZAP Surgical Systems provides non-invasive, radiosurgery treatments for individuals with cranial tumors through their ZAP-X Gyroscopic Radiosurgery System. The ability of the ZAP-X device to rotate on multiple axes allows delivery of these high precision x-ray doses at virtually any angle. However, the rotary unions which connect ZAP-X components to an offboard chiller leak cooling fluid. Therefore, ZAP Surgical Systems challenged our team to eliminate these fluid connections by creating an onboard cooling system for their device. The team designed and prototyped a small-scale cooling system comprised of a radiator; fans; a pump; a heater; and pressure, temperature, and flow sensors. This prototype demonstrated the ability of the cooling system to regulate component temperature, function in 360-degree orientations, reside onboard the ZAP-X device, and maintain a comfortable patient experience. After this validation, the team designed a cooling system concept for the full-scale ZAP-X system. This solution improves the functionality of ZAP-X device, reduces installation and maintenance costs, and maintains a desirable treatment environment, allowing ZAP Surgical Systems to increase treatment accessibility.

50 ELECTRIC DRAGSTER POWERTRAIN CONTROL SYSTEM

PROJECT SPONSOR: ZERONOX

COACH: DARRELL GOFF

TEAM MEMBERS: Braeden McKee, Ian Briggs, Evan Petrie, Benjamin Fisher, Garth Naillon, Will Andersen

DESCRIPTION:

Electric vehicles are beginning to replace fossil fuel powered vehicles in almost every sector due to their potential for sustainability. Zero Nox Inc., an off-highway electric vehicle manufacturer, is interested in building a dragster and donating it to a local high school, where it would race the quarter mile in under 7 seconds and give students the opportunity to learn about electric vehicles. They tasked the Capstone team with designing and testing a powertrain and control system for the dragster with scaled-down (lower power) components and that will simulate the performance of full-scale components. The team selected a vehicle control unit (VCU), battery management system (BMS), and driver display for the dragster and integrated these in a test bench setup. They also modeled how various electric motors would affect racing performance and tested various battery chemistries to their limits to verify their capabilities. With the working setup and research efforts, Zero Nox can finish building the dragster and provide future engineers and technicians the chance to join the electric vehicle revolution.

51 CUBESAT DEVELOPMENT PROJECT

PROJECT SPONSOR: BYU ELECTRICAL AND COMPUTER ENGINEERING

COACH: DAVID DRAPER

TEAM MEMBERS: Levi Powell, Jared Ryan, Phillip Sisco, Benjamin Davis, Moises Campos

DESCRIPTION:

The Electrical and Computer Engineering Department at Brigham Young University has already flown two CubeSats in orbit. To streamline the design process for future CubeSat flights, the Capstone team was challenged to create a design for the non-recurring engineering needs for each CubeSat such as the physical structure and the control , communications, and power systems. Future missions will be able to use this platform for any payload, saving critical time as each CubeSat payload is individually developed.

52 COLLEGIATE WIND COMPETITION

PROJECT SPONSOR: BYU MECHANICAL ENGINEERING

COACH: STEVE WILSON

TEAM MEMBERS: Jake Numbers,Ariel Cable, Bryce Dickey, Amanda Dame, Jake Sweet, Crewse Petersen,Garrett MacKay,Cody Arvonen, Bryce Richard, Ezekiel Jensen, Jacob Child, Carson Townsend, Kevin Steele

DESCRIPTION:

The Department of Energy (DOE) works with the National Renewable Energy Laboratory (NREL) to host an annual wind energy competition. BYU is one of 13 schools selected to participate in the 2022-2023 interdisciplinary challenge. The Capstone team works closely with the BYU Wind Energy Club to understand the wind energy industry, make a functional wind turbine, and design a mock wind farm while competing with the other schools. The team worked hard to build an optimized, automated wind turbine for use in a wind tunnel under strict competition requirements while also presenting important facts about wind energy to elementary students and compiling a proposal for a feasible offshore wind farm. These accomplishments prepared students for potential work and research in the wind industry to help society transition to clean energy.

53 ROCKETRY CAPSTONE

PROJECT SPONSOR: BYU MECHANICAL ENGINEERING

BYU Mechanical Engineering

COACH: MATT ALLEN

TEAM MEMBERS: Brennen Dover, Jacob Hansen, Gerritt Graham, Hayden McDow, David Andelin, Connor Fazar

DESCRIPTION: The 2022-2023 Rocketry Capstone team developed an adaptive airbrake system, designated as ICARUS, which integrates a PID flight control algorithm with a simple umbrella-like structural design. The system is designed to fit any High-Powered Rocket Airframe, has a mass of just under 4 kg, features a user-interface and status indication hardware, and has a versatile controller that can damp any flight to the desired altitude.

54 BYU UNIVERSITY ROVER CHALLENGE

PROJECT SPONSOR: N/A

COACH: BRIAN JENSEN, MARK COLTON

TEAM MEMBERS: David Hill, Josh Augenstein, Josh Miller, Doug Cave, Ryan Lee, Andy Avila, Jon Black, Hyunook Kim, Caitlin Bingham, Daniel Butterfield, Joseph Cannon, Jessica Stastny, Sam Craven, Jarom Christensen, Spencer Ashford, Adam Welker, Elizabeth Clark, Josh Stansfield, Benjamin Havens, Jaxon Jones, Aarohi Bhatt, Ryan Black, Isaac Shaw, Sam Merritt, Josh Blackham

DESCRIPTION: Each year the Mars Society holds the University Rover Challenge (URC), an inter-university competition held at the Mars Desert Research Station in southern Utah. URC challenges student teams to design and build the next generation of Mars rovers that will one day work alongside astronauts exploring the Red Planet. The BYU Mars Rover Team was tasked with representing BYU engineering at the competition. The team has built on last year's success to produce a robust and refined rover capable of scoring in the 90th percentile in the four competition missions. These missions include tasks ranging from autonomous traversal to dexterous tool manipulation and even life detection. Redesigned legs increase rover stability and enhance driving characteristics, while a new integrated PCB offers better power delivery and more secure connectors. Software packages have been refactored and updated improving modularity and aligning with single-responsibility practices. A new sample collection module was developed for use in the science task which allows the rover to collect and return a soil sample to meet competition requirements. Additionally, the team has redesigned the module packaging to improve rigidity and instrument mounting.

55 SUPERMILEAGE FUEL EFFICIENCY CONTROL SYSTEM

PROJECT SPONSOR: BYU MECHANICAL ENGINEERING

BYU Mechanical Engineering

COACH: KEN BEATTY

TEAM MEMBERS: Efrain Salazar, Isai Sanchez, Jonny Nance, Calvin Rogers, Yazan Tuffaha, David Calabuig

DESCRIPTION: The Supermileage Performance Capstone team has designed and built a system to improve the competition performance of BYU's Supermileage competition vehicle. Using an identical engine mounted to a sensor test bench, they have been able to measure existing engine performance in their efforts to develop engine modifications and tuning parameters that improve the engine's fuel efficiency during competition. They have integrated additional sensors and components that have allowed for automatic efficiency tuning during competition events. These new sensors allow the engine to compensate for changes in elevation and weather, and give the Supermileage vehicle a competitive edge. Utilizing custom ECU tuning parameters, the team has built a computerized tuning procedure that reduces vehicle tuning time by 96%. Additionally, this transferable engine control system developed by the team has shown to improve engine efficiency from 14.00 to 17.69%.

56 BAJA SAE COMPETITION

PROJECT SPONSOR: BYU DEPARTMENTS OF MECHANICAL AND MANUFACTURING ENGINEERING

BYU Mechanical Engineering
BYU Manufacturing Engineering

COACH: RICHARD GEE

TEAM MEMBERS: Parker Jackson, Jacob Lesa, Paul Russell, Ryan Fullerton, Max Hansen, Denver Steed, Ian Yskes, Kyle Larson, Paul Blackhurst, Scott Dye

DESCRIPTION: The SAE Mini Baja competition is an annual event organized by the Society of Automotive Engineers (SAE) for undergraduate engineering students. The competition involves designing, building, and testing a single-seat, offroad vehicle that can navigate through a rough terrain course while demonstrating various performance metrics such as acceleration, maneuverability, and endurance. The competition aims to provide students with practical experience in designing and building a vehicle, as well as testing and refining their engineering skills. The event also offers students the opportunity to network with industry professionals and showcase their talents to potential employers. The competition typically attracts teams from universities around the world and has been running since 1976. This year's Capstone team's objectives were to enhance the performance of the BYU Baja vehicle by: reducing the turning radius to be shorter than the length of the car, redesigning the rear suspension system to be lighter and more robust, establishing a reliable telemetry system for better communication during the race, and improving the clutch system for more reliable 4WD engagement.

CAPSTONE TEAM SUPPORT NETWORK

INSTRUCTING PROFESSORS

Four engineering professors serve as instructors for the course, providing technical oversight to every team. They teach lectures, lead design reviews, and oversee all teams.

FACULTY COACHES

Each team is mentored by a dedicated faculty coach. Coaches provide mentorship and leadership, assisting teams with soft skills, pointing them to technical resources as needed, and guiding them through the product development process.

EXTERNAL RELATIONS MANAGERS

External Relations Managers are seasoned engineers who work with sponsors to define projects, advocate for sponsors throughout the project, and assist student teams to ensure sponsor needs are met.

SUPPORT STAFF

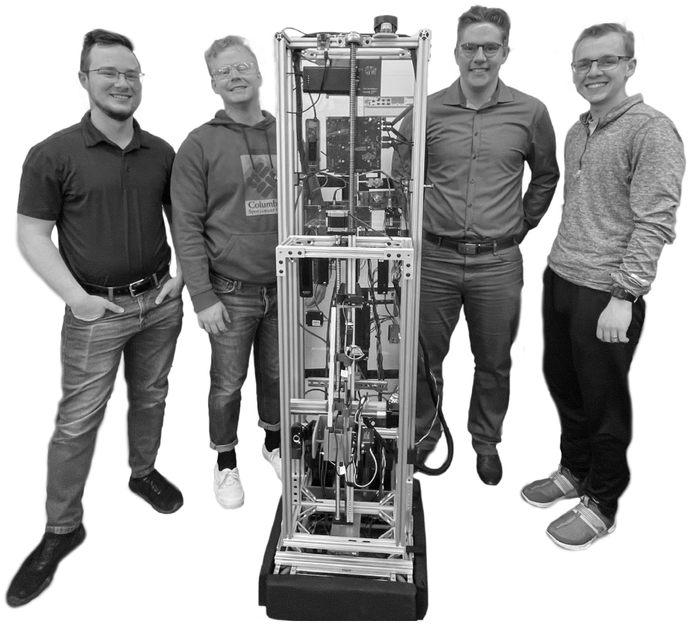
Capstone teams are supported by a full-time staff who manage purchasing, arrange travel, plan and carry out events, and handle the day to day details of administering the Capstone course.

SPONSOR LIAISON ENGINEERS

Each Capstone sponsor designates a liaison engineer (or engineers) to work with the Capstone team. The liaison engineer communicates with the team about an hour each week, usually remotely. Liaison engineers assist the team in understanding the changing needs of the sponsor, the technical needs of the project, and the sponsor's priorities.

SPONSORS

Sponsors form the foundation of our Capstone program. Real-world projects provide experiential learning that cannot be duplicated in the classroom. Sponsors provide functional requirements and technical challenges that inspire students to investigate, experiment, and evaluate solutions.



READY TO SPONSOR?

HERE'S WHAT YOU NEED:

1. $22K SPONSORSHIP FEE payable as an educational grant.

2. A LIAISON ENGINEER who communicates with the team regularly.

3. A REAL PROJECT that is specific in outcome but open-ended in process that would take approximately 400-600 hours in-house.

TO DISCUSS YOUR PROJECT IDEAS OR INITIATE A PROJECT, PLEASE CONTACT:

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