CAPSTONE REVIEW

2021-2022

BYU
CAPSTONE

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 CAPSTONE

Welcome to BYU Engineering's 2021-22 Capstone Review.

Included are descriptions of the 50 unique Capstone projects completed by senior-level students in Mechanical, Computer, Electrical, and Manufacturing Engineering this year.

Capstone students were happy to be back on campus this year to participate in-person and to physically gather as teams. We were likewise excited to work side-by-side with our exceptional students and sponsors. This has been a great year for Capstone.

We are very grateful to our sponsors who not only place their trust in us to assist in guiding their projects forward, but who also willingly give of themselves to provide mentorship and support to the students in this culminating experience of their undergraduate education. The experiences provided to students through these real-world projects cannot be duplicated in a classroom environment and are an invaluable educational tool. We express our deepest gratitude to each of our project sponsors.

Finally, to each of the Capstone students, THANK YOU for your dedication, diligence and resilience. We hope you take with you the best of your Capstone experiences. It is a pleasure to work with each of you and we wish you all the best as you embark on what we know is a very promising future.

The BYU Capstone Executive Team
Carl Sorensen, Capstone Director
David Long, Capstone Co-Director
John Salmon, Capstone Instructor
Greg Nordin, Capstone Instructor
Lisa Barrager, ME External Relations Manager
Allyson Gibson, ECEn External Relations Manager
Paula Harper, Capstone Office Manager

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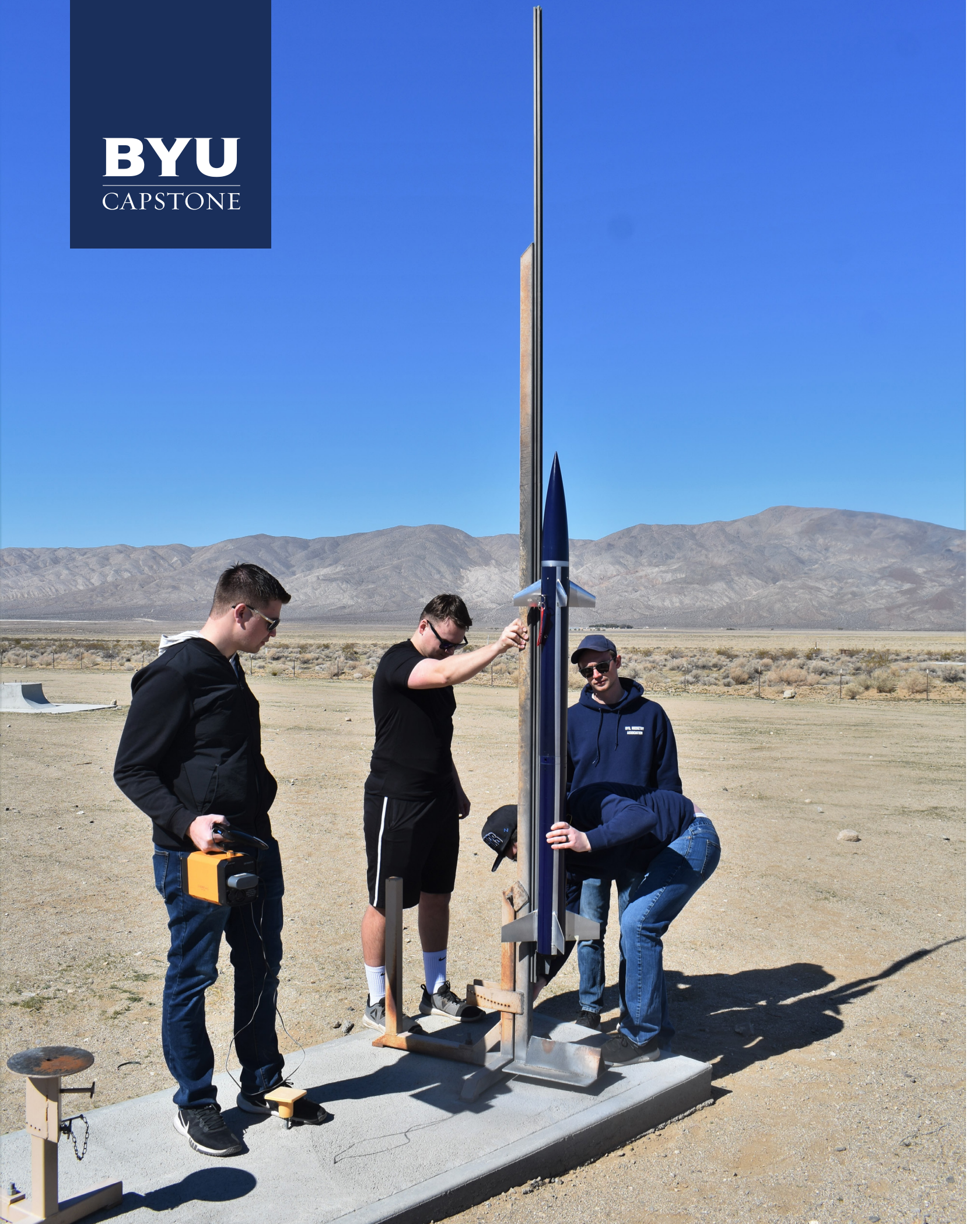

PROJECT SPONSORS

2021-22

- BD
- BOEING
- BURNHAM AND SHIPP ENDOWMENTS
- BURR OAK
- BYU ELECTRICAL AND COMPUTER ENGINEERING
- BYU MECHANICAL ENGINEERING
- BYU MANUFACTURING ENGINEERING
- CG INDUSTRIAL SPECIALTIES
- CHARITY VISION
- CIRQUE
- COLSA CORPORATION
- COURT SHARK
- CSL PLASMA
- FULL MOTION
- GOLD FAMILY FARMS
- IDAHO NATIONAL LABORATORY
- IMSAR
- INNOVATIVE SCIENTIFIC SOLUTIONS INC.
- WESTECH
- INTEGRITY LLC
- JELLYFISH LIGHTING
- L3HARRIS TECHNOLOGIES
- LOS ALAMOS NATIONAL LABORATORY
- MANTIS TECH LLC
- MEDTRONIC
- NEVADA NATIONAL SECURITY SITE
- NORTHROP GRUMMAN
- OC TANNER
- OKLO
- POLAR BEARS INTERNATIONAL
- QUARTZDYNE
- RAYTHEON TECHNOLOGIES
- RINCON RESEARCH CORPORATION
- SHIPP FAMILY FUND
- UTAH DEPARTMENT OF TRANSPORTATION
- VAREX IMAGING CORPORATION
- VELAFLAME
- WATER FOR LIFE

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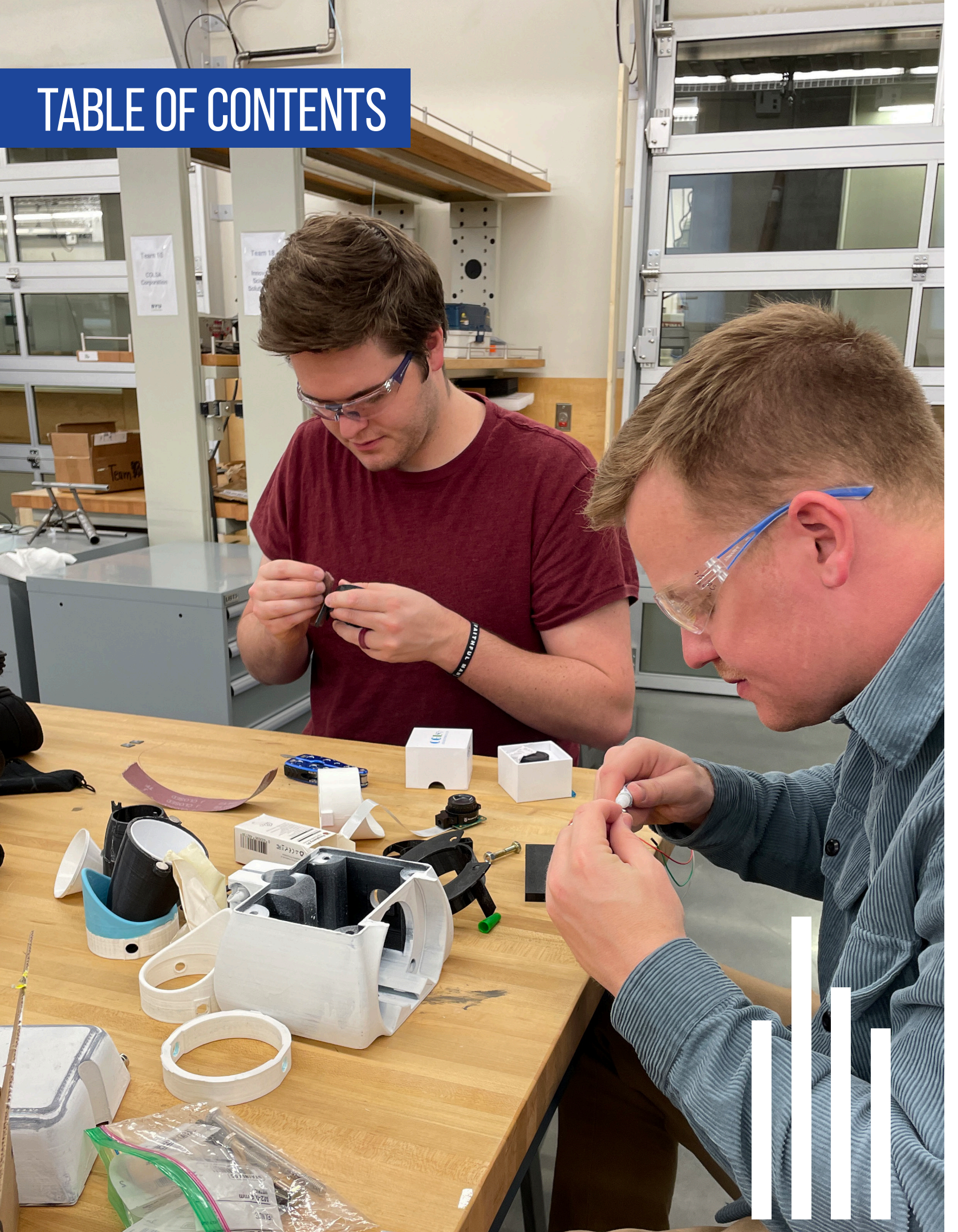


PROJECTS PAGE

FAST FACTS

968

PROJECTS COMPLETED
1990-2022

32

YEARS OF CAPSTONE
1990-2022

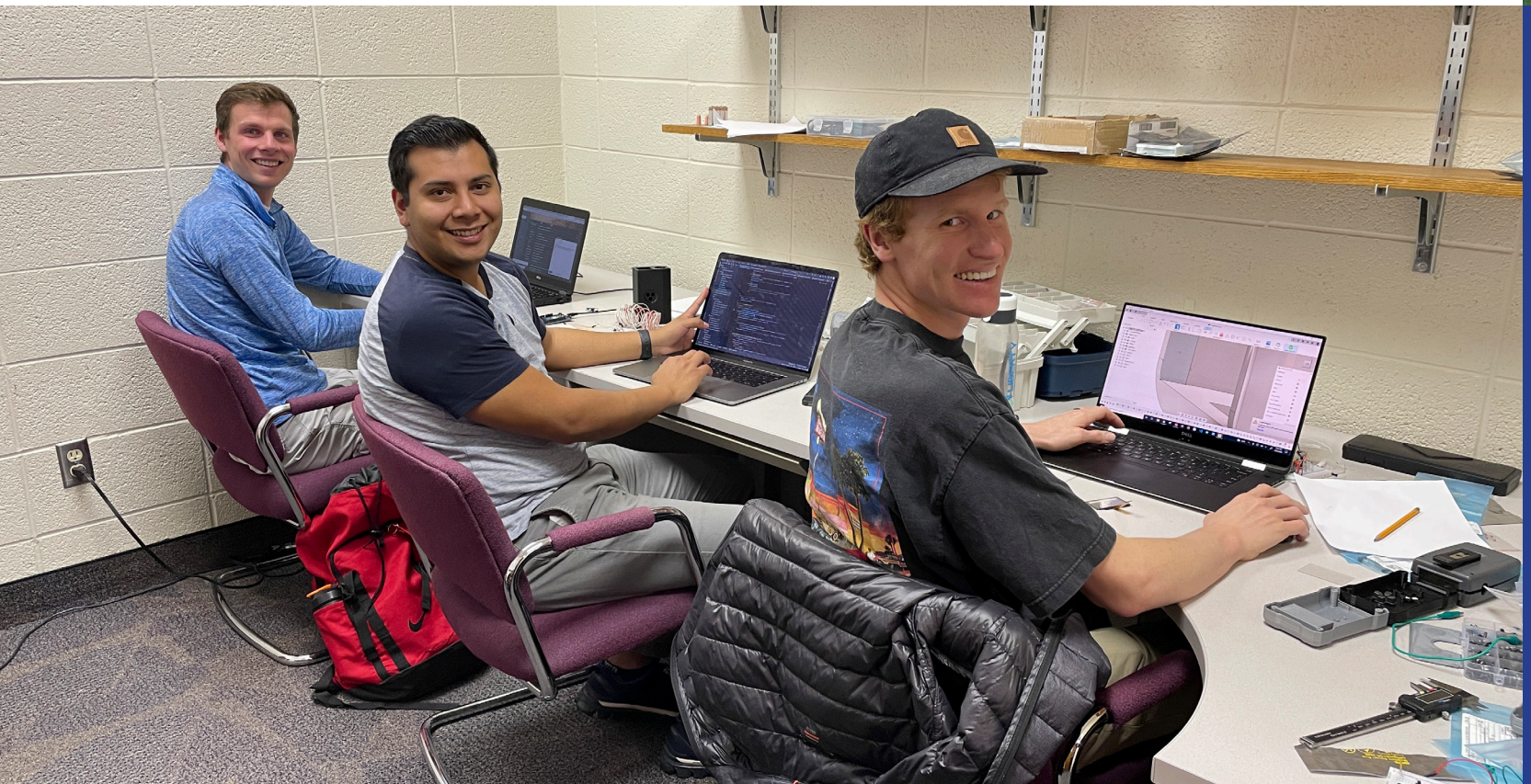
262

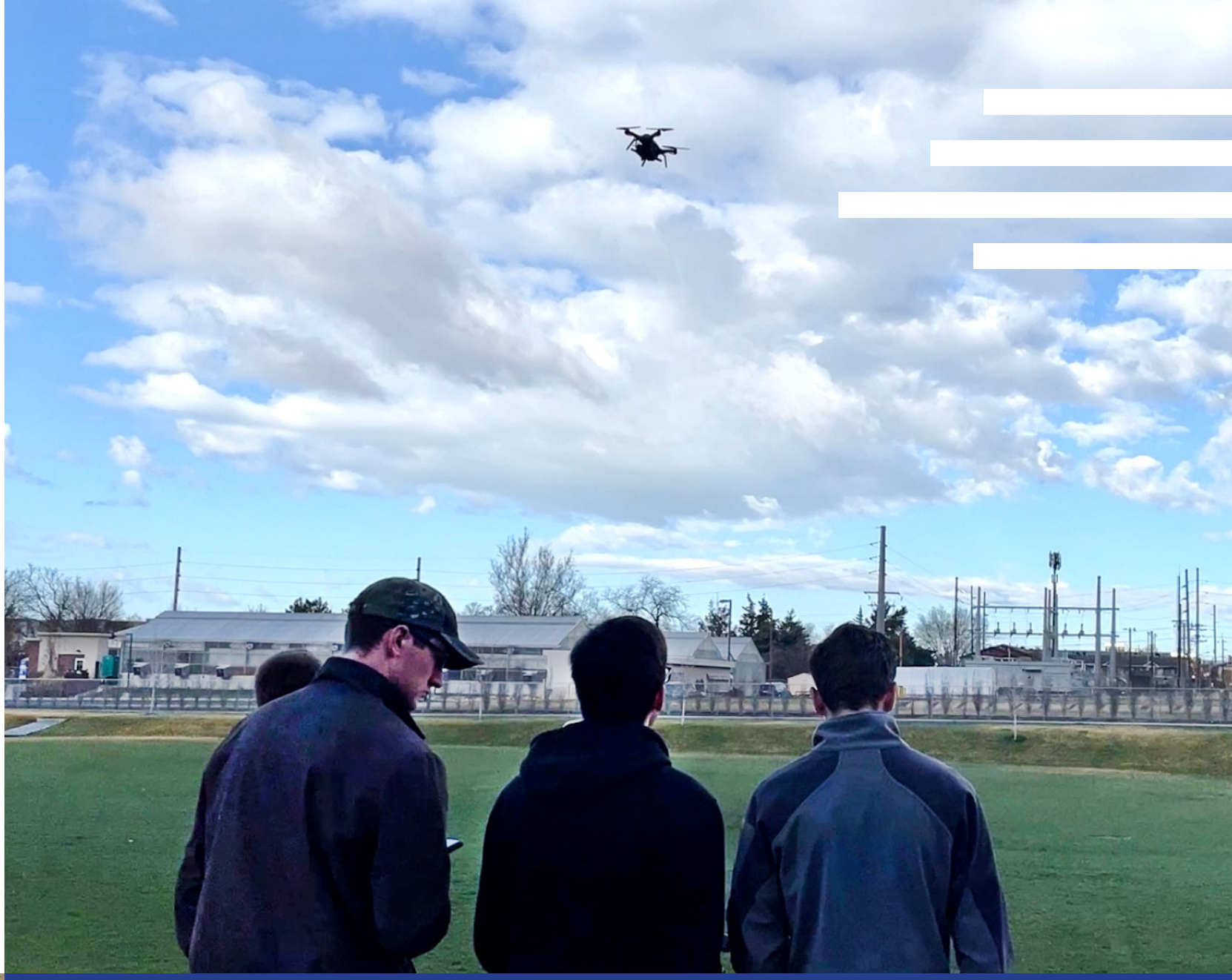
SENIOR ENGINEERING STUDENTS
2021-2022

50

PROJECTS
2021-2022

PROJECTS PAGE





"The former Director of the Defense Intelligence Agency, (ret) General Vincent Stewart, with whom I had the honor of working, recently wrote of the quiet strengths of true professionals, "Be prepared, work hard, and don't own the credit for success. Surround yourself with quality people, empower them and recognize them for what they contribute to an organization." Isolated efforts can give the illusion of low impact, when it is merely that we do not know the wide reaching, subtle and profound effects of hard work, hard won expertise, and focused creativity. We can forget how important we are to something so much grander.

We would like to recognize our BYU Capstone team, for they accomplished much more than they realize; exceeding expectations in objectives, and overcoming further obstacles before having shared them. Their dedication in this Capstone project will positively impact the health and safety of those we serve in significant and long-lasting ways, and for that we would like to express our gratitude. These students exemplify General Stewart's words, as they were each prepared with multiple options to every challenge, diligent in their effort to provide responses to the project needs, and humbly conspired to the collective success of the project.

For the quiet professionals whom I serve, and the unnecessary sacrifices they will not need to make as a result of this Capstone Team's work, thank you." - Scott Sonnon, US Department of Energy | National Nuclear Security Administration, Nevada National Security Site (M&O Mission Support & Test Services)"

PROJECT DESCRIPTIONS

01 HIGH PRESSURE FLOW RATE SYSTEM AND METHOD

PROJECT SPONSOR: BD MEDICAL SYSTEMS

COACH: Dorothy Taylor

TEAM MEMBERS: Brevin Banks, Aris Buitrago Padgett, Nick Hulme, Conner Mantz, Luke Taylor

DESCRIPTION:

BD Medical specializes in the development of a variety of medical products, including IV catheters used in MRI and CT scans. These catheters operate under high pressures – up to 325 psi. During CT scans, lab technicians set a specific flow rate on a machine that injects a contrast through the IV and into the patient being scanned by the CT machine. The flow rate selected is specific to the gage of catheter being used and must be an appropriate and accurate value, found through testing, to achieve precise results and minimize risk to the patient. The current method used to tabulate the flow rate values for IVs is expensive and time intensive. The team's goal is to develop a pressure-driven test method for measuring flow rate and pressure in intravenous catheters when injected with simulated contrast fluid. The test method must maintain a constant pressure of 325 psi while pushing contrast through the IV and onto a scale. The obtained mass measurement is used in conjunction with test time to calculate the flow rate within 1% of the actual value. This allows for newly developed IV catheters to be tested, approved, and moved to market quicker and cheaper, while also improving CT scan performance and patient experiences worldwide.

02 ONE-SHOT MOTOR COUNTERSINK DWELL

PROJECT SPONSOR: BOEING

COACH: Aron Madsen

TEAM MEMBERS: Jarom Bartlett, Adam Berry, Jerran Cook, Enchi Luo, Talbot McLaws

DESCRIPTION:

The objective of this project sponsored by Boeing is to to save time during their empennage assembly of the 787 aircraft. The project was to develop a lightweight easily serviceable mechanism for the ST-1200 motor that allows a consistent high quality finish countersink without causing excess internal gear wear. This motor comes from the manufacturer with a hard stop whose purpose was to allow for a dwell at the end of the drilling cycle. However, this hard stop also causes premature failure of the motor due to extreme internal forces. Currently, Boeing runs the motor without the hard stop and must perform a secondary post-processing operation to bring the holes within tolerance. The team has designed a modification that will allow the motor to produce countersinks that are in tolerance without causing premature failure of the gears by introducing a third state of dwell between the forward drilling and the retract. This was accomplished by splitting the pawl gear responsible for stopping the drilling and when stopped retracting. This split means the motor can continue to spin without advancing by the two halves of the pawl rotating through a single rotation (relative to each other) after separating from the forward drive but before stopping thus creating the dwell. Successful completion of our objective will eliminate the need for post-processing which will save Boeing 4.5 hours of time per shipset and reduce ergonomic risk by half.

03 CONTAINERIZED WATER TREATMENT PLANTS FOR PAKISTAN

PROJECT SPONSOR: BURNHAM AND SHIPP ENDOWMENTS

COACH: Corry Cloward

TEAM MEMBERS: Bethany Parkinson, James Shawkey, Spencer Stoltz, Owen Tolley, Jacob White

DESCRIPTION:

The Church of Jesus Christ of Latter-Day Saints is increasing its efforts in humanitarian work in Pakistan. One major need is for clean drinking water in poor and rural areas. Existing infrastructure in the country is inadequate and the quality of ground and surface waters is deteriorating. Sickness and death from contaminated water are common. Buying clean water can be expensive. The BYU Capstone team was tasked with designing a water treatment system that could be manufactured and widely distributed in Pakistan to provide water for hundreds or thousands of communities. The system must be "containerized" as to be easily transported to rural areas. It must have a low operating cost, be easy to maintain, easy to operate and have the capacity to provide clean water to a community of 6000 people each day during an 8-hour period. The Capstone team's design is very simple, consisting mainly of an electric pump, and three off-the-shelf filters which can all be purchased and assembled in Pakistan. The operation and maintenance costs are very low, which will bring safe water to many people at a fraction of current costs, save lives, and improve awareness of the Church in Pakistan.

04 DIE AND BOLSTER TAKE-OUT SYSTEM

PROJECT SPONSOR: BURR OAK

Burr OAK Tool

COACH: Mike Ridges

TEAM MEMBERS: Isaac Fife, Jacob Janson, Tyler LaPerle, Josh McMullan, David Thompson

DESCRIPTION:

Burr Oak Tool Inc. manufactures large scale dies used in heat exchanger production. Multiple dies can be used in one press and are supported by a bolster plate. Burr Oak challenged the team to optimize the current changeout procedure to include a die and bolster changeout. The team lowered the takeout table to allow the bolster to be placed on the table and under the die. All locating features that were previously on the bolster have been moved to the takeout table and press bed. New tool free die straps were designed to secure the die during tool changeout and storage. The team specified higher load capacity bearings to be used in the new takeout table to allow die/bolster sets to grow in size. The team achieved a significant time savings by incorporating the bolster into the die changeout process. This new design is retrofittable between multiple Burr Oak press models and allows Burr Oak customers to changeout larger die/bolster tooling with minimal downtime.

05 SIMPLIFIED DIE TO PRESS CHANGE-OUT PROCESS

PROJECT SPONSOR: BURR OAK

Burr OAK Tool

COACH: Lisa Barrager

TEAM MEMBERS: Brent Blackwell, Nathan Combrink, Connor Horrocks, Gabi Johnson, Jacob Stephens

DESCRIPTION:

Burr OAK Tool Inc. Designs and produces high quality fin dies, presses, and other stamping equipment. Their large fin die presses, which hold dies up to 20,000 lbs., have a significant die change out time. Burr OAK would like to see the change out process, which takes one to two hours, reduced to under 10 minutes. Along with decreased change out time, the main project objectives include reducing the required operators from two operators to one and keeping the increased BOM cost under $20,000. The team designed a system with two types of hydraulically actuated clamps that will significantly reduce change over time by replacing the existing die attachment system, which utilizes a system of hand tightened bolts. This improved attachment system will significantly reduce change over time which will increase customer fin die press production and throughput resulting in increased customer profit.

06 VIRTUAL ROBOTX COMPETITION

PROJECT SPONSOR: BYU ELECTRICAL AND COMPUTER ENGINEERING

BYU Electrical & Computer Engineering

COACH: Dexter Francis

TEAM MEMBERS: Caden Ellis, Jeanette Fullmer, Ammon Gilliland, Mason Peterson

DESCRIPTION:

Virtual RobotX (VRX) is a competition created by RoboNation and the Office of Naval Research (ONR). In this competition, robotics teams from around the world write code to operate a simulated, autonomous vehicle in a virtual environment. Teams must attempt to complete certain tasks, such as wayfinding, wildlife avoidance, object localization and characterization, and more. BYU's Electrical and Computer Engineering Department challenged the Capstone team to design a Wave Adaptive Modular Vessel (WAM-V) controller to complete the first three tasks in the VRX challenge. The team has done this by developing innovative solutions to estimate the vehicle's position, generate efficient trajectories, and localize and characterize objects. These accomplishments have created a foundation for future Capstone teams to be able to complete all the tasks in upcoming VRX competitions. Eventually, BYU Electrical and Computer Engineering can have Capstone teams compete in the RobotX challenge, which involves a physical WAM-V rather than a simulated vehicle.

07 REACTION TANK DYNAMIC SIMULATION SOFTWARE

PROJECT SPONSOR: CG INDUSTRIAL SPECIALTIES

CGIS
The World's Best Valves®

COACH: Steve Wilson

TEAM MEMBERS: Daniel Blanchard, Daniel Everson, Surendra Gurung, Jacob Watabe

DESCRIPTION:

In the mining industry, a large assembly known as an autoclave is used to extract precious metals out of ore slurry using chemical processes. CG Industrial Specialties, a valve manufacturer, requested a software application that displays a simulation of the internal processes of the autoclave, including properties like slurry mass flow and autoclave pressure that are controlled by their valves. A capstone team from last year built an application that calculates and displays static properties of autoclave contents. The objective of the the team was to build on the previously-created software by adding dynamic modeling capabilities and making general upgrades to the user interface. The team was successful in updating the software application to calculate slurry height, temperature, and autoclave pressure as functions of time. The interface was transferred over to a .NET framework, allowing the software to animate the calculated properties, create graphs of the data, and export datasets for external use, all in a more professional-looking user environment. The added functionalities are a major step towards a complete autoclave simulation package. The new animation and charts display the direct results of valve operations; a huge leap in the usefulness of the software for CGIS.

08 TELEMEDICINE CAMERA APPARATUS & ANNOTATION APP

PROJECT SPONSOR: CHARITY VISION

CharityVision

COACH: Brandon Sargent

TEAM MEMBERS: Jared Awerkamp, Marin Fisher, Ben Scott, Austin Shaffer Joshua Shepherd

DESCRIPTION:

CharityVision is a Provo-based charity that offers eyecare services in underdeveloped countries worldwide with the goal of treating curable sight impairments. In addition to expanding traditional eyecare, CharityVision is now aiming to extend simple eyecare services to people who live in rural areas by opening micro-clinics and employing a telemedicine strategy. The team was tasked with designing a new eye imaging device that could be used in these micro-clinics and a camera apparatus that takes high quality images of the eye by significantly reducing glare, creating even lighting, and ensuring a focused picture. Our design also includes an Android-compatible app that can control the camera apparatus and annotate the images taken. This project has the potential to impact millions of lives because over 1 billion people worldwide suffer from visual impairment. According to the World Health Organization, vision is the gateway to every other sustainable development goal. When you provide vision you provide quality education, fight poverty, eliminate hunger and aid in overall economic growth. Enabling good vision is the most cost-effective way to change someone's life for the better.

09 KALMAN FILTERING IN TOUCHPAD PERFORMANCE

PROJECT SPONSOR: CIRQUE

COACH: Eric Quist

TEAM MEMBERS: Trey Blackwell, Jayson Duffy, Blake Hoggan, Kayla Lyman, Dallan Olsen,

DESCRIPTION:

Cirque is the inventor of capacitive touch technology and continues to push the innovation envelope today. As part of their continuous efforts to improve the technology, Cirque asked the Capstone team to research the effectivenesss of implementing a Kalman filter in their touchpad software. Cirque currently has filters that they have developed for 40 years, and their filters work well at removing noise and following the actual motion of the user. Human motion is inherently noisy. People may twitch or simply may be unable to perfectly perform their intended motion. When only filtering noise from the touchpad, the user's actual motions rather than their likely intended motion is stored. The Kalman filter would provide noise reduction and smooth lines and curves that represent a user's intention rather than the motion their fingers actually produce. This would make touchpads even more user-friendly. Based on the work of the team, it was determined that Cirque's current filtering techniques provide more accurate results, answering the question Cirque posed of whether or not Kalman filtering would be an improvement on their methods at this time.

10 AUTOMATED MOTORIZED SPACE FORCE GROUND ANTENNAS

PROJECT SPONSOR: COLSA CORPORATION

COACH: Rob Cloward

TEAM MEMBERS: Kevin Baker, Steven Miller, Ethan Perrins, Jon Rees, Ryan Ruth

DESCRIPTION:

The US Space Force uses satellite dish antennas to read data from satellites in space. The task of moving these dishes is difficult and requires multiple people to move it manually. For this reason, COLSA Corporation utilized BYU Capstone to design, build, and present a retrofit to motorize a 3.7-meter satellite dish that will decrease person hours and simplify usability required to acquire satellites. To meet the requirements of the project, the team found motors to move the dish vertically and horizontally. These motors have to be able to fit onto the base of the dish without any needed modifications to the current base hardware. The design solution can withstand wind forces and weather, and be controlled via user interface on an external device. The device connects to the motors via wire plug-ins. The team succeeded in creating a fully working automated antenna which decreases person hours needed and simplifies the process to move satellite dish antennas at the various locations.

11 COMPUTER VISION PICKEBALL SCORE KEEPER

PROJECT SPONSOR: COURT SHARK

COACH: Annette Steed

TEAM MEMBERS: Jackson Hogan, Ryan Johnson, Tyler Rhea, Shad Torrie, Truman Welling

DESCRIPTION:

In the world of sports, accurate line calls are crucial to a fair game. Players and viewers alike desire the outcome of their games to be determined by skill, not by inaccurate calls. This accuracy can be difficult to achieve in a fast-moving sport like pickleball. CourtShark challenged the team to solve this problem. The team explored many techniques, and, after selecting the best hardware for the problem, developed software to detect, track, and analyze the movement of the pickleball across the play area. The team's work to prove this can be done will be further developed and may soon lead to a commercial product that you'll see in your neighborhood pickleball courts.

12 PARTICULATE INSPECTION SYSTEM

PROJECT SPONSOR: CSL PLASMA

CSL Plasma
Good for You. Great for Life.

COACH: Donna Clayton

TEAM MEMBERS: Marcus Behling, Braden Huffman, Connor Millett, Caroline Paxton, Drew Sumsion

DESCRIPTION:

CSL Plasma is a subsidiary of CSL Behring, a global biotherapeutics company that develops plasma-derived medicine to treat a variety of serious and rare diseases. CSL Plasma operates one of the world's largest and most sophisticated plasma collection networks. Plasma donors are injected with a solution of saline (to rehydrate them) and anti-coagulant (to prevent blood clotting during the venous return portion of donation). The inspection process for these bags of solutions is currently performed manually by employees, but this creates significant variability and additional expense for the company. The team has designed and prototyped an automated inspection system for bags of anti-coagulant solution using computer vision to test for plastic particulate that can be created when the bags are being filled. The automated inspection system prototype gives CSL a working design that they can hand off to an automation vendor to refine and upscale to meet their production goals. A fully working automated inspection system will significantly decrease labor cost and inspection variability, and it will increase the throughput of inspected bags.

13 ANKLE MOBILIZING DEVICE

PROJECT SPONSOR: FULL MOTION

COACH: Rich Smith

TEAM MEMBERS: Tyler Graham, Jonah Kendell, Taylor Quain, Morgan Sasser, Alek Sperry

DESCRIPTION:

Due to injuries, age and other extenuating circumstances, the ankle can become stiff, which in turn decreases its overall mobility. Decreased mobility of the lower leg has been implicated in limiting athlete performance, increasing fall likelihood in the elderly, and destabilizing the leg and hip as a whole. This problem can be treated by physical therapists in a clinical setting, as the project sponsors do on a regular basis. However, this kind of treatment would greatly benefit the general public if they were able to do so without direct supervision from a clinician. Full Motion commissioned the Capstone team to tackle this challenge and validate their preliminary design to bring this therapy to people's homes through a device that imitates the actions of a physical therapist. The device design has proven to be both effective and attractive.

14 PLANT EXTRACTOR MACHINE

PROJECT SPONSOR: GOLD FAMILY FARMS

GOLD FAMILY FARMS, INC.
Where quality and value meets the extraordinary

COACH: Ryan Butters

TEAM MEMBERS: Jacob Anderson, Darian Emmett, Danni Figueroa, Lorena Iannicelli, Mitchell Jacobson, Amanda Lytle

DESCRIPTION:

Gold Family Farms is a plant nursery located in Hillsboro, Oregon. They are leaders in automation within the farming industry and have already made significant strides in automating repetitive, labor intensive processes at their facilities. Employing automation allows Gold Family Farms to continue operating even when it is difficult to find workers to perform these repetitive, physically intensive jobs. Because of this they are able to reallocate employees to more important tasks, like quality control and overseeing the automated systems. Thus, the machines add significant value to Gold Family Farms. This year, the Capstone team has creating a plant extractor machine. A plant at Gold Family Farms undergoes repotting at least 2 times during the growing process. Currently, plants are extracted from their small pots and inserted into the larger pots by hand. The team created a machine to remove the plants from their small pots, remove the empty pot from the work area, and send the plant on its way to the next step of the repotting process. There are no machines on the market that will perform this task, so the team design a custom solution to integrate into Gold Family Farms' current processes.

15 INTRUSION DETECTION SYSTEM FOR MALCOLM PLATFORM

PROJECT SPONSOR: IDAHO NATIONAL LABORATORY

COACH: Rich Ziegler

TEAM MEMBERS: Jake Arscott, Nate Dunn, Anthony Glad, Melanie Pierce

DESCRIPTION:

The Department of Energy's Idaho National Laboratory (INL) is responsible for providing essential cybersecurity services for various industrial control systems and power plants across the United States. Their projects help to ensure the safety of critical infrastructure nationwide. One prominent tool that is critical to providing these services is Malcolm, an open-source Intrusion Detection System (IDS) and cybersecurity analysis software. Currently, Malcolm provides users with various IDS tools for network analysis, such as Zeek and Arkime, as well as colorful and robust visual dashboards to give a sense of how a network is performing. Despite Malcolm's current usefulness, however, there have been many suggestions made for adding additional software to Malcolm which would help provide more details and information concerning network traffic and threats to their users. This Capstone team integrated a powerful open-source Intrusion Detection System, Suricata, via docker into the Malcolm Tool Suite for use with the rest of the Malcolm Framework. We also modified Malcolm's existing pipelines to route data to and from Suricata properly to ensure proper end-to-end functionality. Suricata will provide users with analysis on HTTP/DNS and several other protocols, along with powerful multi-threading and acceleration capabilities to help ensure a secure network.

16 PROJECT NAME

PROJECT SPONSOR: IDAHO NATIONAL LABORATORY

COACH: Scott Cutler

TEAM MEMBERS: Landon Andrews, Brandon Bassett, Matthew Fisher, Michael Souwan, Nathan Wilson

DESCRIPTION:

Idaho National Laboratory's science-based approach to nuclear energy research yields technically achievable, economically competitive and environmentally sustainable options for the entire nuclear energy enterprise. One area of focus is research surrounding nuclear fuel rods. For the irradiation process, these nuclear fuel rods are encased in a THOR (temperature heat sink over power) capsule in which the fuel rod is surrounded by sodium. To examine these fuel rods, the fuel rods must be removed remotely from the capsule in a radioactive hot cell. These hot cells are argon environments with mechanical equipment that allows operators to remotely handle objects within the hot cell. The Capstone team created a fixture and process that will assist the operators in removing the fuel rod from the THOR capsule. This process and the fixture will provide a way for INL to remove the fuel rod from the THOR capsule in a safe and controlled manner, allowing INL to examine the fuel rod after it has been irradiated.

17 SECURITY FOR HIGH-END EMBEDDED SYSTEM

PROJECT SPONSOR: IMSAR

COACH: Previn Menon

TEAM MEMBERS: Stephanie Carlson, Austin Laney, Spencer Nelson, Randy Openshaw, Casey Sorensen

DESCRIPTION:

IMSAR develops high performance multi-mode radar systems capable of all-weather imaging, monitoring, and surface search. Their radars are simple to integrate on manned and unmanned aircraft of all sizes. For this project, IMSAR challenged a multi-disciplinary team to provide a robust security system using both hardware and software solutions that could be used to protect Intellectual Property on an embedded computer system. The Capstone team, consisting of ECE, Cybersecurity, and ME students, achieved 100% full-disk encryption and robust prevention of physical tampering.

18 TURBINE NOZZLE TRAVERSING PROBE

PROJECT SPONSOR: INNOVATIVE SCIENTIFIC SOLUTIONS INC.

COACH: Scott Thomson

TEAM MEMBERS: Joseph Andrew, Logan Camilletti, Colby Greenwood, Sophia Sok, Nicholas Yoshikawa

DESCRIPTION:

Innovative Scientific Solutions, Inc. (ISSI) is an engineering research and development company providing innovative measurements in the areas of fluid dynamics, aerodynamics, etc. In the effort to help ISSI, this project's goal is to develop an automated measurement traversing probe in the nozzle of the engine. Currently, the company employs a fixed measuring apparatus, called a rake with multiple probes. The main challenges with this current solution are that the probe is in set positions, the rake cannot be used on more than one turbine nozzle, and it disrupts the flow from its size. Our goal is to design and construct a semi-universal traversing system for a single probe that can fit to a variety of nozzles. This system must be capable of recording the position of the probe while the engine is running. The prototype meets the objectives of operation in high temperature settings and testing displays high fidelity of accuracy. In design, the traverse system will work on multiple nozzles and various probe sizes. The design is also cost effective and easy to manufacture. This project is important because it will help ISSI's objective to increase the spatial density of measurements in the nozzle of the engine.

19 AUTOMATED MEASURING DEVICE FOR MITRE SAW

PROJECT SPONSOR: INTEGRITY LLC

COACH: Doug Cook

TEAM MEMBERS: Joseph Douglas, Joe Erickson, Cameron Haar, Eric Monson, David Quinlan

DESCRIPTION:

Finish carpenters can make hundreds of cuts per day using a miter saw. Using a tape measure can be time consuming and frustrating, and it's easy to make mistakes that create waste. Long pieces in particular are difficult to cut to the right length. Integrity, LLC challenged the team to develop an accurate, low-cost solution. In response, they designed and prototyped a device that clamps on to the saw stand next to the miter saw. A long track extends to the side, supporting the cutting material and automatically measuring it. A carpenter simply enters how long he/she wants to cut a piece and a stop moves automatically into position. This solution is portable, easy to use, accurate, and inexpensive. Similar devices are already on the market, but they are far more expensive. The Capstone team's solution comes in at a much lower price point that makes it available to finish carpenters. This has the potential to revolutionize carpentry at an efficient cost and may also expand to other industries.

20 BLUETOOTH ACCESSORY FOR SMART DEVICES

PROJECT SPONSOR: INTEGRITY LLC

COACH: Chris Bailey

TEAM MEMBERS: Jacob Cardwell, AJ Frankman, Brian Long, Sarah Smith, Daniel Yirenya-Tawiah

DESCRIPTION:

A common challenge for people in medicine, carpentry, construction, and machining is the need to efficiently record data while their hands are busy. Integrity, LLC challenged this Capstone team to design and build a bluetooth speech-to-text accessory for smart devices that can be manufactured at a cost of less than $15 per unit. The Capstone team designed an early system that will be further refined and developed by Integrity, LLC.

21 SMART LIGHTING DMX CUSTOM INTEGRATION

PROJECT SPONSOR: JELLYFISH LIGHTING

COACH: Daniel Smalley

TEAM MEMBERS: Ethan Durrant, Nate Howard, McKay Humpherys, Trevor Oldham, Jackson Smith

DESCRIPTION:

JellyFish Lighting is a wholly owned subsidiary of BigFish Automation, a company that provides residential lighting solutions. They recently started exploring the commercial lighting space and found that their current solution was incompatible with industry standard DMX512 protocols that are essential to support commercial lighting solutions. DMX512, or DMX for short, is a protocol used in commercial industries to control strands of RGB lights. The Capstone team successfully updated the current JellyFish Lighting system to be compatible with this standard in two ways: using direct DMX hardware input and using Art-Net through the existing Ethernet port. Art-Net is a protocol to transfer DMX data over an Ethernet network. Now that the system is compatible with industry standards, commercial businesses and larger scale operations can use the JellyFish Lighting system and have access to the suite of solutions that it provides, expanding JellyFish Lighting's market significantly.

22 ARBITRARY WAVEFORM GENERATOR USING SDRS

PROJECT SPONSOR: L3HARRIS TECHNOLOGIES

COACH: John Snow

TEAM MEMBERS: Hollis Belnap, Alex Blackham, Jonathan Thompson, Garrett Westover

DESCRIPTION:

L3Harris produces tactical radios, avionics and electronic systems, antennas, and wireless equipment for use in the government, defense, and commercial sectors. To test their equipment, they use arbitrary waveform generators to simulate noisy environments. These are expensive, bulky, and have more complex features than necessary for many uses at L3Harris. This Capstone team created a cheaper, smaller, and more portable arbitrary waveform generator from off-the-shelf components to supplement L3Harris's commercial test equipment. Having a portable and inexpensive waveform generator allows L3Harris to perform field signal testing more easily and with significantly lower cost.

23 CAVE RADIO EXTENDER

PROJECT SPONSOR: L3 HARRIS TECHNOLOGIES

COACH: Gavin Ransom

TEAM MEMBERS: Dallin Dahl, Michael McLean, Matt Osburn, Austen Probst

DESCRIPTION:

L3Harris Technologies is an agile global aerospace and defense technology innovator who provides advanced defense and commercial technologies across space, land, air, sea, and cyber domains. A world leader in tactical communications, they are addressing the challenge of communications in remote, rugged terrain. The Capstone team's objective for this project was to develop an intuitive prototype mesh network for reliable non-line-of-sight (NLOS) communications in caves and slot canyons. To answer the challenge, the team has succeeded in creating a prototype that supports NLOS communications, has an open-air range of 260 meters, is capable of dynamically adding and removing nodes from the network, and notifies the user when it's time to drop a new node. This design is an important step forward in enabling reliable communications in difficult environments. In settings such as a rescue mission, being able to communicate effectively can be the difference between life and death. With the team's cave radio extender, rescuers will be able to deploy a communication network with ease and focus on rescuing those who need help.

24 PROBE DESIGN FOR MANUFACTURE

PROJECT SPONSOR: LOS ALAMOS NATIONAL LABORATORY

COACH: Quentin Allen

TEAM MEMBERS: John-Michael Frye, Kyle Komm, Jason Metten, Zach Taylor, Kameron Woodruff

DESCRIPTION:

Los Alamos National Laboratory (LANL) is a national security research laboratory for nuclear and defense devices, with the mission of solving national security challenges through scientific excellence. LANL uses Photonic Doppler Velocimetry Probes, known as PDV Probes, to gather data regarding the pressure and velocity of nuclear detonation devices. The initial manufacturing for the probes involved tedious sanding, alignment, and gluing processes to be performed by hand. This limited yearly production and increased variation in performance. This project's objectives were to redesign the probes for increased manufacturability to increase yearly production while maintaining the functionality of the original design. Having met the objectives, the Capstone team made it possible for LANL to produce hundreds of capable probes every year and nuclear detonation devices to be consistently and accurately tested. The probe redesign leads to monetary and resource savings in national defense, progress in the science of nuclear devices, and increased national security.

25 SMART SHOT TIMER

PROJECT SPONSOR: MANTIS TECH LLC

COACH: Abraham Teng

TEAM MEMBERS: Carson Brown, Noah Eliason, Scott Jensen, Ryan Parco, Mauro Zuniga

DESCRIPTION:

Mantis Tech is a technology company comprised of engineers and shooters that designs and develops tools that help marksmen analyze and improve their shot mechanics. The company mission is to train 1 million shooters every year. To assist in accomplishing that mission, the Capstone team was tasked with designing and developing a new tool, a smart shot timer, to add to their line of products. This smart shot timer will track marksmen's shot intervals and display the data to the integrated device as well as to the user's mobile phone on our companion app. The team designed and created an aesthetically pleasing housing, a PCB board for the electrical components, firmware to create the desired functionality and an accompanying Android app to facilitate use and data display. This project will help Mantis Tech accomplish their goal in training more shooters with a new product that is wanted and used by new and experienced shooters.

26 SMART TRIGGER GAUGE

PROJECT SPONSOR: MANTIS TECH LLC

COACH: Steve Wilson

TEAM MEMBERS: Brandon Heiner, Brad Hollingworth, Michael Johnson, Brenden Peel, Jeremiah Scott

DESCRIPTION:

The team's project from Mantis Tech LLC. was to create a trigger gauge that would have a manual and mechanical option for obtaining data. The trigger guage be used by those that wish to optimize their guns to have a specific trigger pull weight. Once the data is read, the max force is displayed on the LCD display that is on the trigger gauge. There is also an option to send the data to an app via a Bluetooth connection and display it on an app that the user can interface with and store data in. To meet these objectives, a load cell was used that could measure up to 15 lbs. consistently and accurately. The PCB has a Bluetooth module that can send data to an app, and we have created an app for users to interact with. This will benefit those that modify their guns as they will have a better way to get more consistent and accurate force readings from their trigger mechanisms on their firearms.

27 HUGO RAS END EFFECTOR SURGICAL INSTRUMENT

PROJECT SPONSOR: MEDTRONIC

Medtronic

COACH: David Barker

TEAM MEMBERS: Jason Bledsoe, Wesley Bohn, Grant Hamilton, Nolan Howes, Adam Neil

DESCRIPTION:

Medtronic has recently released a new robotic assisted surgical system and is looking to develop a new end effector for the robot. The team's task was to take pre-developed electronics from their manual ultrasonic cutting instrument and create a miniaturized, robot-compatible design that is sterilizable, has an actuatable jaw, and is small enough for minimally invasive laparoscopic surgery. The team developed an instrument only ten millimeters in diameter, complete with a fully-actuatable jaw and a sealed housing, that can be integrated with Medtronic's Hugo Robotic-Assisted-Surgery system. This instrument is capable of both dissection and cauterization of tissue, allowing for multiple processes to be performed with a single instrument. Paired with the robotic system it will provide the means for faster, more precise, and less invasive surgery.

28 MODULAR UAS PAYLOAD FOR MULTI-MISSION CAPABILITY

PROJECT SPONSOR: NEVADA NATIONAL SECURITY SITE

NEVADA NATIONAL NNSS SECURITY SITE

COACH: Mike Witting

TEAM MEMBERS: David Akagi, Bruce Averill, Reese Clawson, James McNab, Emily Quan

DESCRIPTION:

Mission Support and Test Services (MSTS), a contractor at the Nevada National Security Site (NNSS), a Department of Energy testing site, has been creating attachments to drones that can map out different substances and signals in various environments. The next iteration is measuring Wi-Fi signal strength, which is used in applications that range from disaster relief to activity monitoring. This team's challenge was to create a payload that could detect a specific device and pinpoint its location based on its Wi-Fi signals. The team's solution consists of a series of Wi-Fi sensing chips, GPS, antennas, and Long-Range radios housed in a custom-designed, 3D-printed casing, which can be attached to a drone. The payload uses the antennas and GPS to report signal strength and location via long-range radio to the operator and displays the data in a real-time heatmap. As the drone is flown in the search area with the attachment, the operator uses the heatmap to efficiently and accurately pinpoint the exact location of the Wi-Fi signal. NNSS will continue to develop this technology.

29 PRE-SYMPTOMATIC INFECTION DETECTION

PROJECT SPONSOR: NEVADA NATIONAL SECURITY SITE

COACH: Cory Estes

TEAM MEMBERS: Kent Ashby, Alex Bean, Luke Johnson, Brett Layer, Matthew McKinney

DESCRIPTION:

Researchers at Nevada National Security Site (NNSS) are investigating methods to use physiological data to recognize illness before symptoms are present. NNSS tasked the Capstone team with creating a software package that employs machine learning and advanced algorithms to analyze heart rate and breath volume synchronization. This data is reported via a graphical user interface that can alert to potential pre-symptomatic illness. While still in the early stages of research, the results of using this method are promising.

30 EXTENDED REALITY FOR ELECTRONICS MANUFACTURING

PROJECT SPONSOR: NAME WITHHELD

COACH: Yuri Hovanski

TEAM MEMBERS: Elijah Becerra, Jacob Garn, Parker Rogers, Michael Sorensen, Jon Wallace

DESCRIPTION:

The project sponsor, a leading innovator in the aerospace and defense industry, assembles circuit cards that are used in technologies from the Mars rover to airplanes. To improve speed and accuracy during the manufacturing process, the Capstone team created an extended reality experience for computer chip manufacturing that improves overall user experience, gives live data updates to engineers, and assists with reducing errors. Extended reality software was employed to recognize a circuit card and provide assembly animations and instructions on screen that interact with the card. To maximize benefit to the sponsor, the extended reality assembly system can be applied to multiple circuit cards. It is anticipated that the work of this team will provide a basis for future development that will expand the possibilities and capabilities of circuit card manufacturing.

31 LIDAR SCANNER FOR LARGE DIAMETER PIPING

PROJECT SPONSOR: NORTHROP GRUMMAN PROPULSION

COACH: Rob Messenger

TEAM MEMBERS: Luke Gardner, Daniel Harman, Jacob Lawrence, Josh Seibert, Chase Vanfleet

DESCRIPTION:

Northrup Grumman is a leading innovator in aerospace and defense. While attempting to remotely scan for deformities in a large diameter pipe they discovered that as the scanner was extended through the pipe, wobble along the boom created inaccurate scan data. The problem is similar to the warping seen when a panoramic photo is taken without a steady hand. The Capstone team was tasked with creating a system that factored out this wobble error allowing for accurate 3D scans. The system requirements stated that accuracy must be maintained for up to a 40-foot length with a 15-foot diameter. Furthermore, the system was restricted to use only the two openings at the ends of the pipe since the system could not interfere with the pipe's inner surfaces. Ultimately a motion tracking system was created using two cameras and two LED constellations that emitted IR light. Using the known positions of the constellations' LEDs, an adapted n-point algorithm is used to compute and locate where the sensor is in free space. With the calculated Cartesian and angular position, an accurate 3D scan can be created by subtracting out the positional error in the scanner data.

32 MOTORIZED SKEETER CART

PROJECT SPONSOR: OC TANNER

COACH: Andrew George

TEAM MEMBERS: Charles Carter, Eli Perrins, Quinn Riley, Jay Stout

DESCRIPTION:

This goal of the team's project was to improve the movement of materials within and between warehouses at O.C. Tanner. The challenge was to design, test and build a simple, robust, reproducible, and maintainable electric cart to replace the pushcarts currently in use. While in the early design phase of the project, the team suggested several features and made prototypes for the most promising ideas. Some of these were received well by O.C. Tanner and became a big part of the final design including a ride on feature, joystick controls and motorized wheels placed at the center. After many iterations and subsystem testing with a plywood and PVC prototype, the team designed and produced a prototype of a final, metal cart. This project will provide O.C. Tanner with an improved ability to move materials and products while also improving the experience of those working with it directly.

33 ADVANCED NUCLEAR VESSEL INSPECTION DEVICE

PROJECT SPONSOR: OKLO

COACH: Troy Munro

TEAM MEMBERS: Zach Barrett, Brent Edgerton, Shaden Moss, Yoshiya Sato, Michael Seneca

DESCRIPTION:

Oklo Inc is a California startup looking to change the nuclear power industry for the better by designing new reactors that are safe, efficient, and modern. Their reactors will help combat climate change by providing "always-on, emission-free energy." In conjunction with Oklo Inc, our task was to design, build, and test a remotely controlled inspection device that accurately positions an ultrasonic sensor around a nuclear pressure vessel to detect and measure voids in the vessel structure. The inspection device will allow safe operation of nuclear pressure vessels by scanning the exterior surfaces for cracks. Challenges were fitting within a 17 cm gap around the vessel, measuring tangent to the vessel in the lower hemispherical region, and doing so with high resolution for a 15-meter-tall vessel. The team's design has overcome these challenges by fitting within the 17 cm space, providing a resolution of 0.67 mm for movement around the circumference of vessel and 0.05 mm for movement up and down the vessel.

34 SAR POLAR BEAR DETECTION

PROJECT SPONSOR: POLAR BEARS INTERNATIONAL

COACH: Terri Bateman

TEAM MEMBERS: McKay Formica, Brent George, Nicholas Hilke, Lucas Stock

DESCRIPTION:

Polar bear dens are dug into snow pack and are generally invisible from the surface. Organizations, such as Polar Bears International, are interested in identifying polar bear den locations in order to conduct polar bear research and conservation efforts. Previous research has used Forward Looking Infrared (FLIR) technology to detect dens but has only achieved a detection accuracy of ~40%. The Capstone team tested Synthetic Aperture Radar (SAR) as an alternative den detection technology and conducted two validation experiments in Churchill, Canada and Svalbard, Norway. An initial identification accuracy of 45% was achieved using SAR, and the team documented refinements that could further increase this accuracy. Many of the challenges encountered involved low signal to noise ratios and imprecise flight paths. Concurrent research from other parties shows that neural networks and other machine learning techniques can overcome these challenges to some degree, indicating that SAR may be a promising candidate to become the industry standard for polar bear den detection.

35 AUTOMATED POSITIONING SYSTEM FOR LASER WELDING

PROJECT SPONSOR: QUARTZDYNE

COACH: Dorothy Taylor

TEAM MEMBERS: Jeremy Green, Jack Harmon, Nathan Miller, Kyler Nordgran, Rickey Taylor

DESCRIPTION:

Quartzdyne is a leading producer of pressure transducers for the oil and gas industry. During the production process, a high-power laser is used to weld wires to pins of internal circuits. The task of the Capstone team was to design and build an automated positioning stage that accurately and repeatably positions varying circuits and transducers under the laser. Pins of circuits were 0.025 inches in diameter and the active height of the mechanism was constrained to be less than 2.5 inches due to focal length limitations. To meet these constraints, the team designed an X-θZ system using precision actuators. Transducer fixturing was redesigned to standardize critical dimensions and speed up the manufacturing process. The control system package was presented to the end-user in the form of a GUI to allow easy interaction with the software. Quartzdyne prides themselves on the quality of their products. The automated system improves the quality of welds, which is critical for the hazardous environments in which the transducers are used. The software has a modular design that easily allows new software paths for other transducers to be added to the system.

36 DUAL POLARIZATION DETECTION AND CHARACTERIZATION

PROJECT SPONSOR: RAYTHEON TECHNOLOGIES

COACH: Michael Duersch

TEAM MEMBERS: Joey Fredrickson, Ian Hammond, Rebecca Haymore, Daniel Nybo, Devon Ward

DESCRIPTION:

Raytheon's Applied Signal Technology group builds reconnaissance systems and remote sensing technologies that monitor space, airborne and terrestrial environments. For this project, the Capstone team was challenged to design and build an at-the-edge system to receive and recognize multiple polarizations of electromagnetic (EM) waves. Implementing a dual polarization model with transmission provided by Raytheon and receiving implemented by the team, they were able to speed up polarization detection of incoming EM waves. The team's system is small enough to be mounted on a roaming quadcopter, where on-board processing prevents the need for transmitting unnecessary data, saving both power and time.

37 REMOTE SERVER ROOM ROBOT v2.0

PROJECT SPONSOR: RAYTHEON TECHNOLOGIES

COACH: Jason Weaver

TEAM MEMBERS: Brennen Clark, Ashly Lott, Matt Moore, Benjamin Parker, Daniel Phillips, Tyler Reedy

DESCRIPTION:

Raytheon Technologies, a global intelligence and defense company, is pursuing a solution for maintaining server rooms remotely. Currently, data center technicians monitor and must often travel to various server rooms to complete simple tasks. Last year, a Capstone team began development on a server room robot that could be controlled remotely to manage small tasks. This year, the team was tasked with further refining and optimizing that rebote, adding additional functionality. The team's robot allows personnel to monitor racks and perform tasks without needing to be physically present in the server room. The team's solution includes design improvements to the graphical user interface and the actuation system, as well as newly designed systems for cooling and localization and navigation. The upgraded robot will significantly decrease labor and operations costs and provide the benefits of remote monitoring and maintenance.

38 NETWORK OF RF SIGNAL EMULATORS

PROJECT SPONSOR: RINCON RESEARCH CORPORATION

COACH: Scott Lloyd

TEAM MEMBERS: Tom Bates, Ben Karlinsey, Erik Pedersen, Jason Thomason

DESCRIPTION:

Radio frequency signals are used in phones, wireless networks, radio towers, medical devices, and more. As the signals from these various technologies interact, they create complex RF environments. Rincon Research Corporation wants to create such environments and asked the Capstone team to build a programmable network of RF signal emulators that allow the user to remotely configure each node's RF transmission in real time. The team designed a compact, portable, and affordable solution that will allow for quick deployment of RF emulators. This product design will facilitate rapid and accurate tests of Rincon Research Corporation's products in controlled RF environments.

39 HUMAN WASTE MANAGEMENT FOR MONGOLIAN GER DISTRICTS

PROJECT SPONSOR: SHIPP FAMILY FUND

COACH: Jeff Niven

TEAM MEMBERS: Jacob Blake, Julie Harris, Brad Hunt, Jesse Nebeker

DESCRIPTION:

Just outside the capital city of Ulaanbaatar, Mongolia, lie the ger districts, where over 900,000 people live without any formal infrastructure, including a sewage system. Currently, people living in the ger districts use pit toilets that empty directly into the ground, causing groundwater and soil pollution from human waste. With funding from the Shipp Family Fund and under guidance of the Church of Jesus Christ of Latter-day Saints, the Capstone team was challenged to create a low-cost, long-lasting toilet that limits pollution in the ger districts. The team produced an instruction manual for ger district users to construct their own pit toilets where the waste is contained in a plastic vault that is emptied with a vacuum truck every few months; the vacuum truck then deposits the waste in a wastewater treatment facility. The new pit toilet design is safe, eliminates pollution from human waste, is affordable, and lasts a lifetime. With these new pit toilets, groundwater and soil pollution will be greatly reduced in Ulaanbaatar and the people of the ger districts will enjoy a better quality of life.

40 SNOW PLOW SENSOR AND DATA TRANSMITTER

PROJECT SPONSOR: UTAH DEPARTMENT OF TRANSPORTATION

UDOT Keeping Utah Moving

COACH: Rich Ziegler

TEAM MEMBERS: Kenny Baker, Nick Ellis, Nathan Harris, Chloe Kincaid, Landon Smith

DESCRIPTION:

The Utah of Department of Transportation (UDOT) focuses on maintaining safe roads that can effectively transport citizens. UDOT has a snow budget of $24.5 million for each winter season, with each snowstorm costing approximately $1.2 million. UDOT desires to better analyze snowstorm costs through careful recording of relevant data such as spreader gate height, snowplow position, and rate of salt composite discharged from the truck. The Capstone team designed a springwobble sensor to detect if the front snow plow is engaged, along with a push button that indicates the relative height of the rear spreader gate. To mitigate bouncing of the front plow due to bumps in the road, the team also designed a debouncing module to eliminate any noise in the data relayed. The biggest challenges the team faced included ensuring that this system will be weatherproof and that it is able to seamlessly transmit accurate data in real time. With more accurate data, UDOT will be able to streamline budgets and save taxpayer money long-term.

41 CURVED IMAGE ACQUISITION SYSTEM

PROJECT SPONSOR: VAREX IMAGING CORPORATION

COACH: Brian Jensen

TEAM MEMBERS: Travis Elmont, Christian Hall, Josh Johnson, Hunter Stevenson

DESCRIPTION:

Varex Imaging manufactures x-ray tubes and related hardware. New curved x-ray tube designs are under development. These tubes can be used for medical imaging and other applications. Tubes are tested for quality by measuring emitted x-rays using a flat panel detector. X-rays emitted by the tube pass through a pinhole camera and impact the detector. The distribution of x-rays on the detector is then analyzed to measure x-ray tube performance. It is essential that the panel remain perpendicular to the x-ray emitter windows on the tube during testing. Each tube can have up to 100 emitter locations which all need to be tested. The team designed, built, and tested a mechanism to orient and move a panel detector along curved X-ray tubes of varying radii. The mechanism is controllable from a graphical user interface (GUI) and the GUI design allows for either manual or semi-autonomous control. This system will enable Varex to perform consistent and accurate quality control tests on the emerging curved tube designs.

42 GS2000 AND GS3000 X-RAY SOURCE HOUSING

PROJECT SPONSOR: VAREX IMAGING CORPORATION

COACH: Richard Gee

TEAM MEMBERS: Miles Christensen, Mynette Evans, Michael Gailey, Ethan Lindeman, Michela Lo Russo

DESCRIPTION:

X-ray machines function behind the scenes throughout the world, assisting doctors and dentists in medical applications, keeping airports safe, and improving work in industrial applications. Unfortunately, updates rarely occur due to the difficulty in maintaining safety and compatibility with existing equipment. Varex Imaging, a leading supplier or medical X-ray tubes and image processing solutions, and their GS3000 X-ray, initially designed 30 years ago, is the focus of the project. The Capstone team's task is to design a new, fully compatible GS3000 X-ray housing with reduced cost and equivalent reliability and performance. This requires compatibility with customer hook ups and gantry geometries while lowering manufacturing and assembly time costs. The new design changed from a cylindrical tube to a clamshell shape with adjustments made for mounting on the bottom half. The team's clamshell design cuts manufacturing costs by ~10% and assembly time by ~35% while maintaining housing strength and radiation shielding. Through these modifications the new clamshell X-ray housing design incorporates the required changes without compromising performance and safety.

43 ELECTRO-MECHANICAL FLAME BULB

PROJECT SPONSOR: VELAFLAME

VELAFLAME

COACH: Darrell Goff

TEAM MEMBERS: Valerie Fisher, Ian Jensen Nathan Jensen, JuHang Kim

DESCRIPTION:

Many electronic candles on the market today lack realistic color, movement, and candle light appearance from all angles. Even fewer, if any, electronic candles allow the user to control the flame from a phone. The Capstone team set out to design, build, and test a lightbulb that mimics the movement and appearance of a candle flame. The key features of the product include realistic candlelight movement, controllability by a remote device, a wide range of light intensity output, and a small package size. The final product is a Bluetooth controlled LED flame bulb that fits in a standard socket and is comparable in size to standard candelabra light bulbs. The flame bulb can vary the light intensity, color, and motion of the flame element through an app developed by the team. The final product can provide the warmth and comfort of candle light without the danger or hassle of a live flame.

44 SEDIMENT PRE-FILTER STRAINER SYSTEM

PROJECT SPONSOR: WATER FOR LIFE

WATER FOR LIFE CHARITY
SAVE LIVES. Give Clean Water.

COACH: Jon Blotter

TEAM MEMBERS: Jake Adams, Tayler Biehn, Jake Eames, Colten Yardley

DESCRIPTION:

Water For Life Charity provides 0.1 absolute micron water filters for developing countries. These water filters remove harmful bacteria and diseases from the native area's drinking water. Unfortunately, these filters become quickly clogged with sediment, which slows the flow rate exiting the 0.1-micron filter. This frequently results in users discarding th filters when they stop working as expected. The team's objective was to create a pre-filter that could be used to prolong the life of the existing 0.1 absolute micron filter. The pre-filter needed to remove particulates, adjust to different bucket sizes, and be easy to use. The pre-filter needed to meet these requirements while also being compact, durable, and cost-effective. The team's selected pre-filter design uses a 5-micron, nylon mesh material, with an elastic bungee and slipknot tightening system. The 5-micron, nylon mesh material provides durability, and the needed filtering characteristics to improve the 0.1-micron filter. The elastic bungee provides an easy solution for fastening the pre-filter onto different bucket sizes, while also providing a strong fit on the bucket. By creating and designing this pre-filter, the existing 0.1-micron filters can be used much longer without clogging, to provide more safe drinking water to people in developing countries.

45 EARTHQUAKE-SAFE SUBMERGED MECHANICAL STRUCTURE

PROJECT SPONSOR: WESTECH

WesTech®

COACH: Tom Atkins

TEAM MEMBERS: Tyler Bang, Kaytlin Collins
Michael Lohrey, Kyle Taylor, Andrew Wilson

DESCRIPTION:

Wastewater treatment is a critical public service. In the event of an earthquake, the internal structure of a wastewater treatment tank can be damaged by large waves generated by ground movement. The central column of the tank, where the wastewater is pumped in, is the most critical component to be protected during an earthquake. This project consisted of taking the feedwell, or baffle, that is around the central column, and redesigning it in a way to lessen the force imparted onto the central column in a seismic event. During this project, a scale model of a treatment tank was constructed to simulate a seismic event and the subsequent sloshing inside the tank. The scale model was an eight-foot diameter water tank that was filled with 350 gallons of water. The team discovered through rigorous testing that by using a flexible material for the baffle instead of stainless steel, the force imparted onto the central column during a sloshing event could be reduced by over half, without sacrificing any functionality of day-to-day operations. The new design of the baffle will allow WesTech to meet seismic requirements in states with more stringent standards while still providing a critical service.

46 BYU SPACECRAFT: MISSION ELIAS

PROJECT SPONSOR: BYU ELECTRICAL AND COMPUTER ENGINEERING

BYU Electrical & Computer Engineering

COACH: James Smith

TEAM MEMBERS: Ben Fogg, Adam Hales,
Conner Miles, Joseph Richmond, Bryson Schiel,

DESCRIPTION:

The BYU Spacecraft Group develops powerful, low-cost technologies and operates them in space, training a new generation of skilled and passionate spacecraft engineers in the process. To expand BYU's opportunities to launch CubeSat devices into Low Earth orbit, the ELIAS Capstone team was formed to streamline the CubeSat production process. The Capstone team focused on designing a base system that contains all necessary functionality for a CubeSat to survive a mission lifetime of several months. From this base system, the CubeSat can be customized according to the mission. This multi-year project will give many students the chance to be involved in creating industry-worthy spacecraft. As BYU continues to develop the spacecraft capabilities of its students, students will enter the industry more prepared to make a global difference for good in an ever-expanding field.

47 COLLEGIATE WIND COMPETITION

PROJECT SPONSOR: BYU ELECTRICAL AND COMPUTER ENGINEERING

BYU Mechanical Engineering

COACH: Julie Crockett

TEAM MEMBERS: Andre Amaral Marrey Ferreira, Kyle Bleazard, Ara Bolander, Spencer Drennan, Adam Kagi, David McClintock, Spencer Truman, Scheridan Vorwaller

DESCRIPTION:

The National Renewable Energy Lab created the Collegiate Wind Competition to help college students gain experience with real world problems currently facing the wind energy industry. As part of the competition, the BYU CWC team was tasked with designing and building a scale model of a turbine, with the goal of maximizing electrical power output at specific wind speeds inside a wind tunnel. Additionally, to simulate the challenges of an offshore wind turbine, the scale turbine may only be supported by a foundation inserted into a tank of sand and water. This foundation must keep the turbine stable, with no measurable movement, throughout the entire testing period. A competition among 15 sponsored college teams will be held May 15-18, 2022.

48 ROCKET ATTITUDE CONTROL MECHANISM

PROJECT SPONSOR: BYU ELECTRICAL AND COMPUTER ENGINEERING

BYU Mechanical Engineering

COACH: Dexter Francis

TEAM MEMBERS: Jayson Davis, Daniel Ertel, Logan Morse, Andrew Santa, Mark Sweeney, Michael Williamson Tabango

DESCRIPTION:

Each year, the BYU Rocketry High-Power Team enters the Spaceport America Cup with the goal to launch a rocket to a specific target altitude. More points are awarded the closer the rocket is to the target altitude. There are several factors that can lead to an unpredictable apogee. The Capstone team, a subset of the BYU Rocketry Club, was tasked with addressing flight orientation by developing an Attitude Control System. If the rocket does not fly vertically, the final altitude can diverge by hundreds of feet. For example, if a rocket diverges by 10 degrees from vertical at the beginning of a flight, it will miss its target apogee by 4%. To solve this issue, the team developed a canard-based control system. The canards are airfoiled fins placed on the nosecone of a rocket that are rotated to change the rocket's direction. The lift produced by the canards generates a force that corrects the rocket's trajectory. This has the effect of steering the rocket back to a vertical course. Time will tell, but the team anticipates an outstanding performance at the Cup in June.

49 MARS ROVER CHALLENGE

PROJECT SPONSOR: BYU ELECTRICAL AND COMPUTER ENGINEERING

BYU Engineering
IRA A. FULTON COLLEGE OF ENGINEERING

COACH: Marc Killpack

TEAM MEMBERS: Brianna Bischoff, Dinah Bronson, Michael Bronson, Alejandro Brozalez, Daniel Cheney, McKay Christensen, Dallin Cordon, Brad Ferguson, Ben Glines, Ben Graff, Blake Harsh, Rock Kim, Joe Liechty, Alexa Lindberg, Connor Mattson, Jake Nance, Aaron Newman, Kyle Rippstein, Berrett Robison, Colin Rubow, James Sorge, Austin Stone, Chris Sypherd, Charlie Tainter, Miguel Urbina, Matthew Wilding, Alex Wonnacott

DESCRIPTION:

The BYU Mars Rover Team is sponsored by the BYU Electrical, Computer, and Mechanical Engineering Departments to compete in the University Rover Challenge. The team is tasked with representing BYU engineering in an inter-university competition by designing and building the next generation of Mars rover that will one day work alongside astronauts exploring the Red Planet. The team team developed a planetary rover that is capable of performing a set of specific tasks as defined by the University Rover Challenge. A newly redesigned chassis and folding rocker-bogey system allows the rover to traverse rough terrain while carrying objects of up to 7 kg, and a real-time kinematic GPS system lets it autonomously travel to GPS coordinates with an accuracy of less than 10 cm. A newly implemented inverse kinematic software package allows the rover arm to manipulate doors and switches, and even to type on a keyboard. A robust science module equipped with visual and chemical tests help the rover collect and analyze soil samples to determine the presence of life with an accuracy of 95%.

50 BAJA SAE COMPETITION

PROJECT SPONSOR: BYU ELECTRICAL AND COMPUTER ENGINEERING

BYU Engineering
IRA A. FULTON COLLEGE OF ENGINEERING

COACH: Richard Gee

TEAM MEMBERS: Jack Damiano, Tanner Empey, Bradley Garrett, Chloe King, Andrew Mabey, Caleb Marsh, Brad Nelson, Adam Pullan, Madi Snell, McLane Townsend

DESCRIPTION:

BAJA SAE is an international collegiate competition where teams of university students develop rugged, lightweight, single-seated vehicles to compete in an intensive off-road competition. This year's BAJA capstone team was tasked with developing a competitive 4-wheel drive system that would integrate into the current BYU BAJA vehicle. A successful 4-wheel drive system provides a competitive edge to BAJA SAE teams in events such as the hill climb and the endurance test, where the vehicle has to handle steep, challenging obstacles. Significant restraints and requirements included efficiency, horsepower capacity, and weight. The team's solution to these restraints and requirements involved a light-weight chain-drive system with innovative 3D-printed chain guides that transmitted power from the gearbox up to a shaft at the front of the vehicle. Power was then transmitted from this shaft to the front wheels through a combination of axles and ratcheting, articulating, tool CV joints. The ratcheting feature of these joints helped increase system efficiency as power would only be sent to the front wheels when the rear wheels began to slip.

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

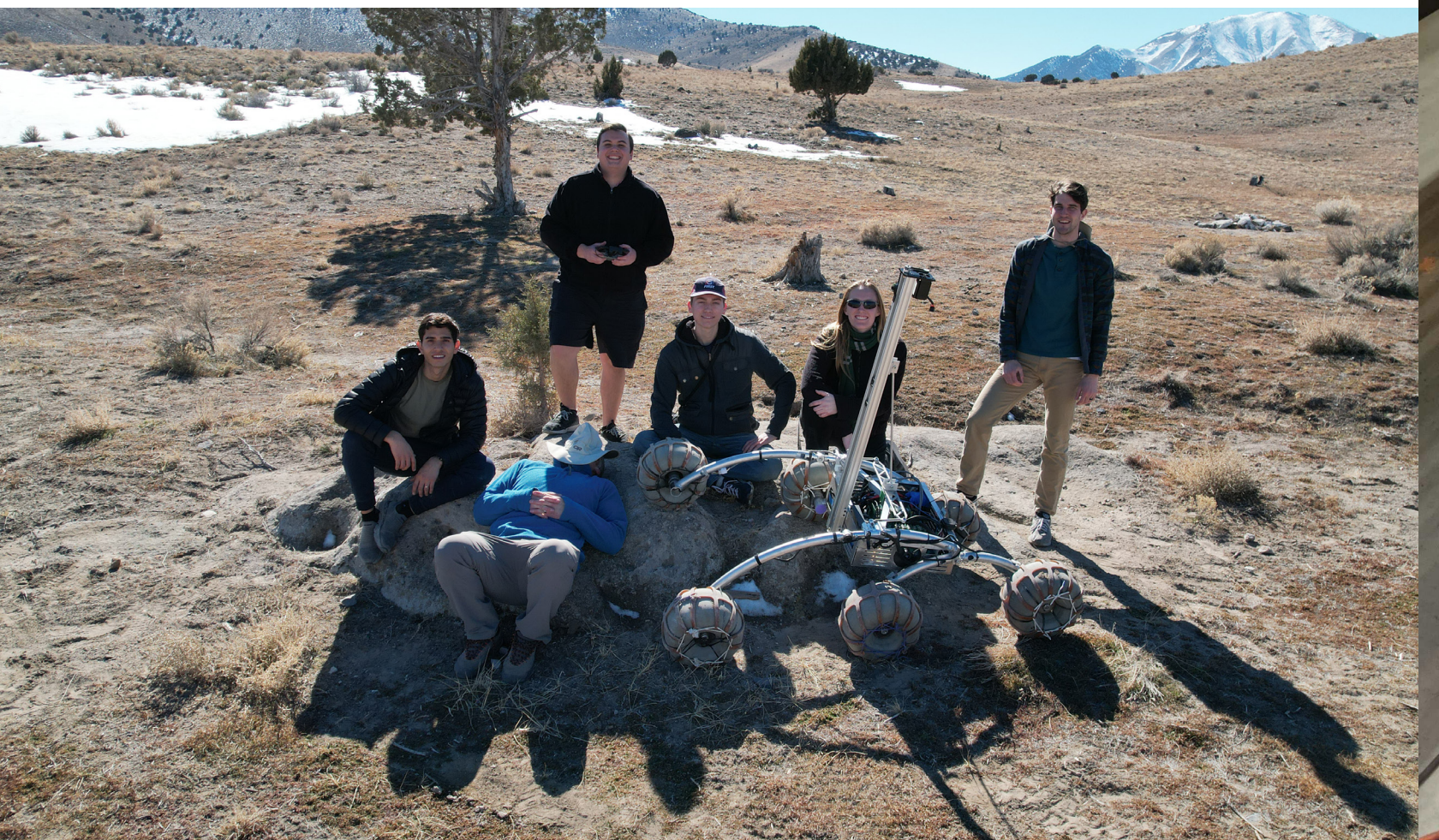
Capstone teams are supported by a full-time staff who manage purchasing, arrange travel, plan and carry out events, and handle the day to day details of administering the Capstone course.

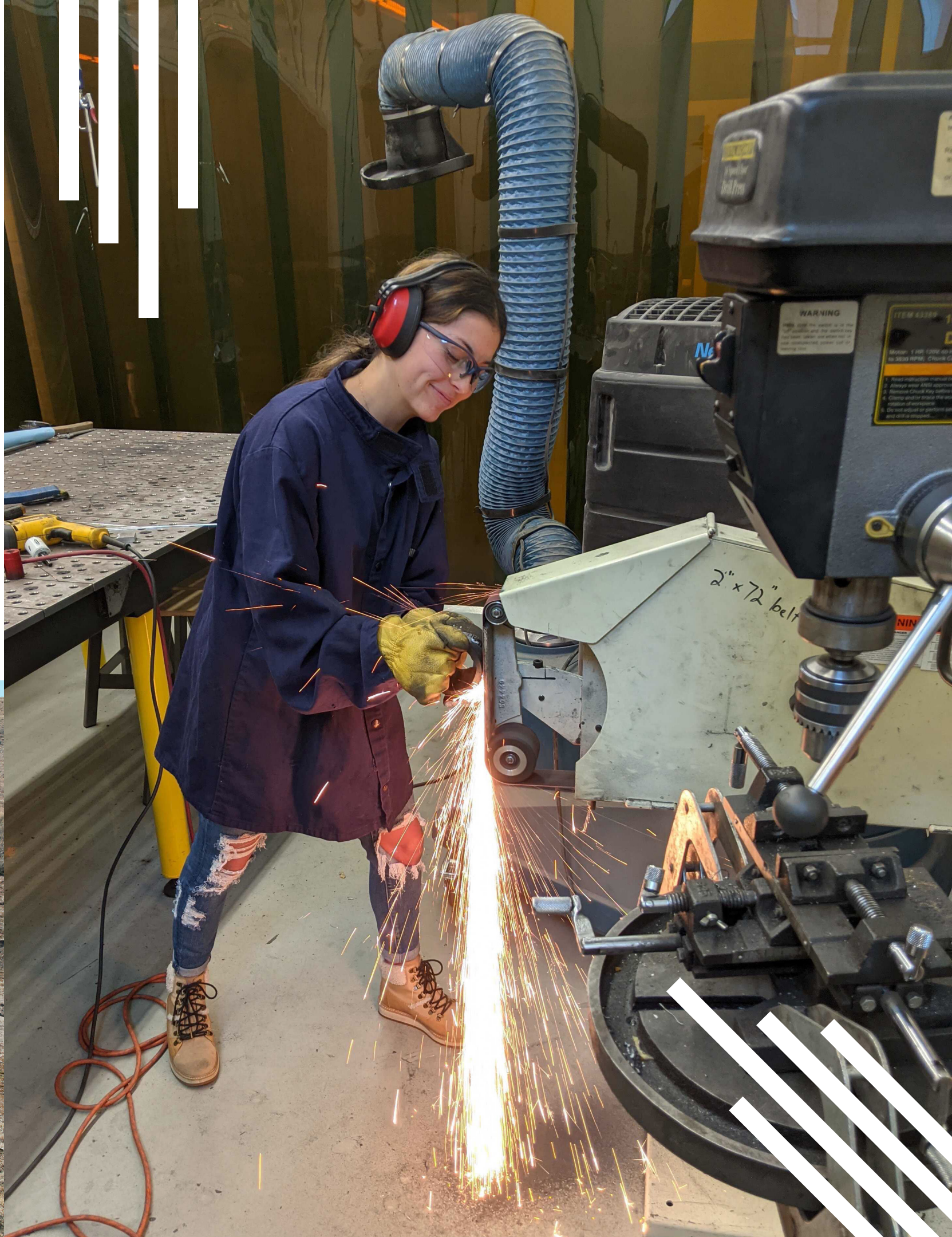
SPONSOR LIAISON ENGINEERS

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.

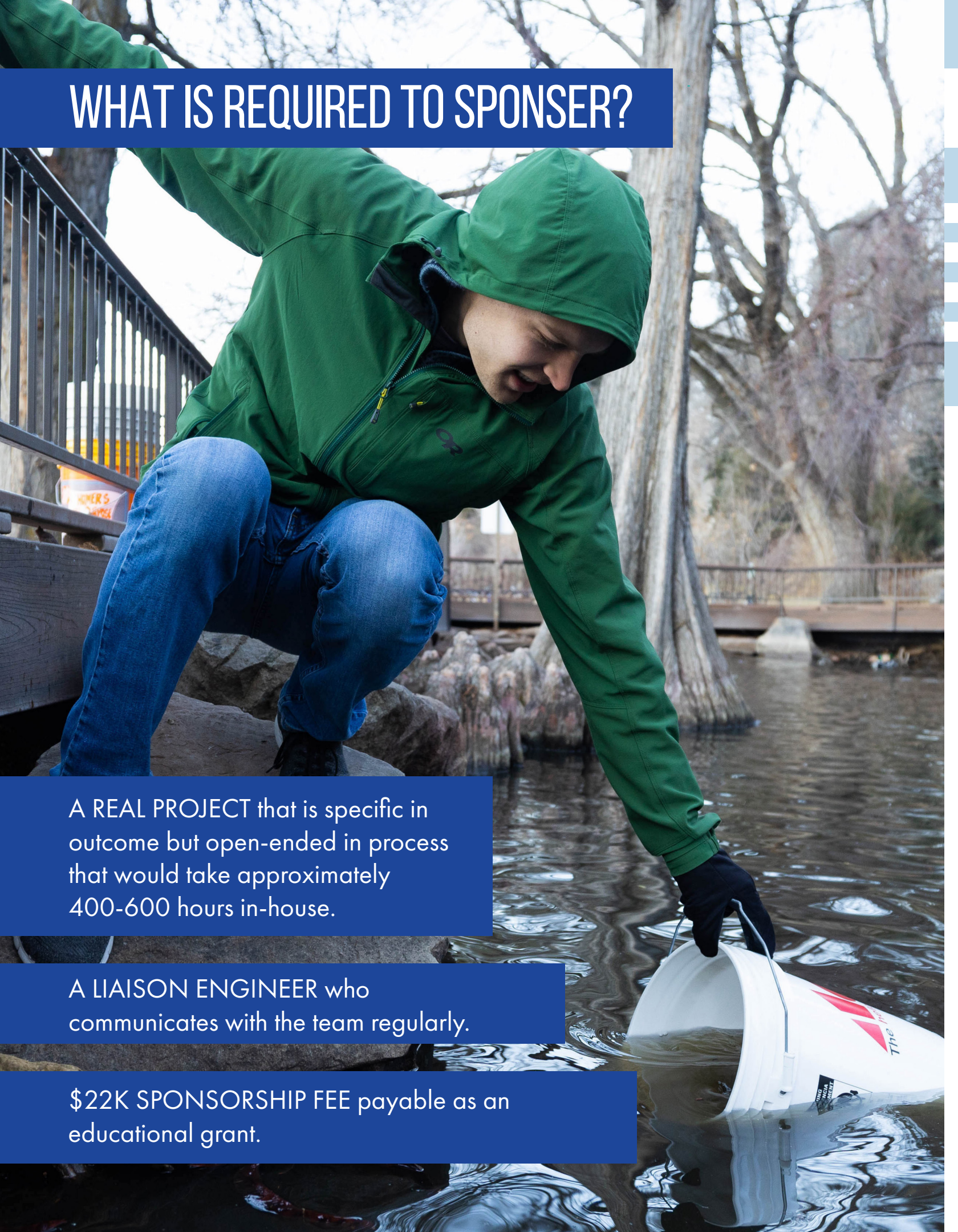
SPONSORS

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.




WARNING
2" x 72" belt

WHAT IS REQUIRED TO SPONSER?



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

A LIAISON ENGINEER who communicates with the team regularly.

$22K SPONSORSHIP FEE payable as an educational grant.

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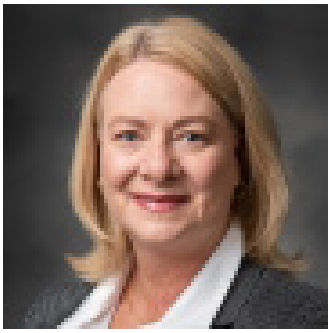
TO DISCUSS YOUR PROJECT IDEAS OR INITIATE A PROJECT, PLEASE CONTACT:



LISA BARRAGER

MECHANICAL AND MANUFACTURING ENGINEERING
EXTERNAL RELATIONS MANAGER
801-422-8680
LISA_BARRAGER@BYU.EDU

ALLYSON GIBSON

ELECTRICAL AND COMPUTER ENGINEERING
EXTERNAL RELATIONS MANAGER
801-422-7962
ALLYSON_GIBSON@BYU.EDU

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