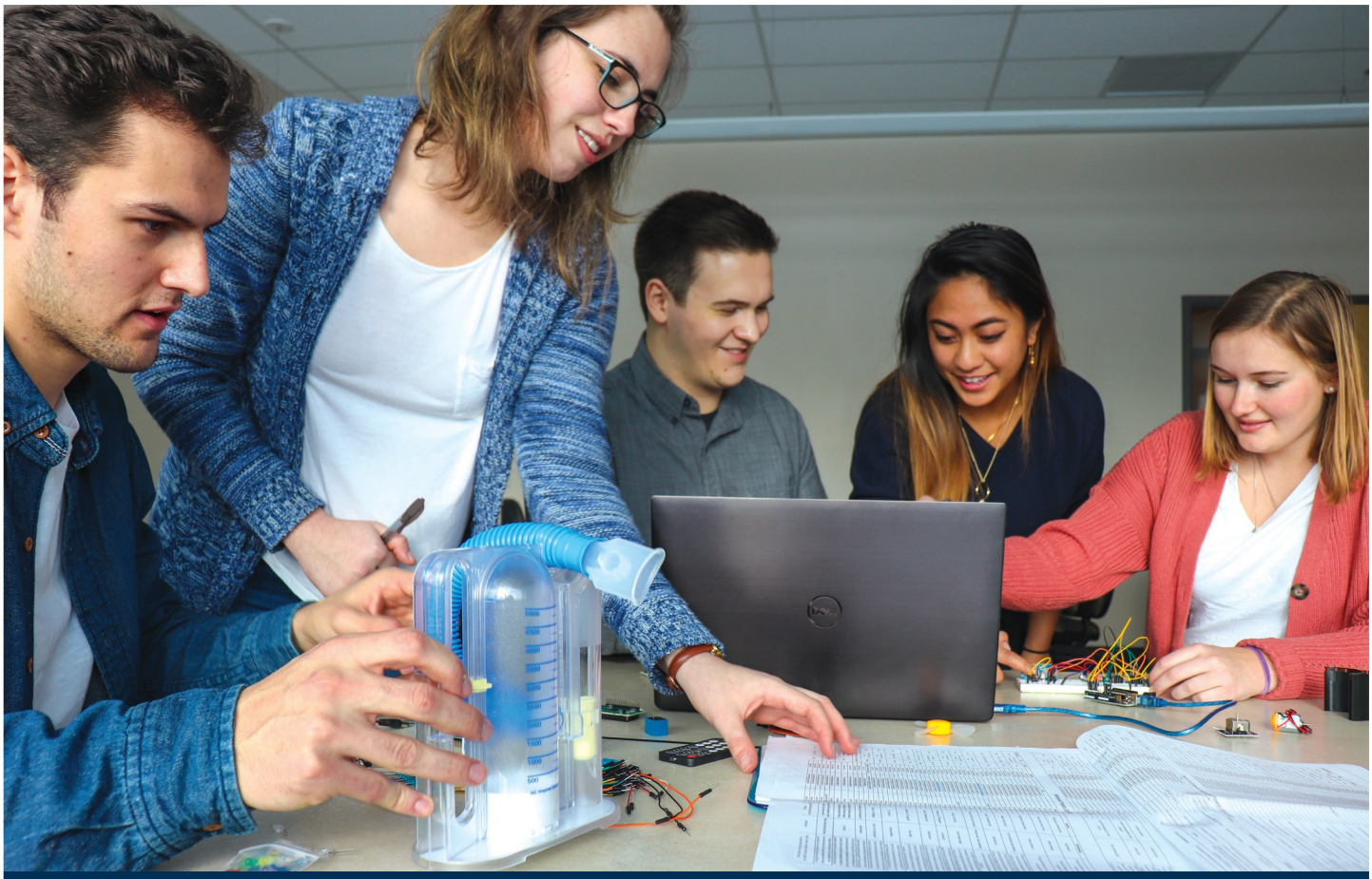


2020 SENIOR DESIGN SHOWCASE

GONZAGA UNIVERSITY | School of Engineering & Applied Science

CENTER FOR ENGINEERING DESIGN & ENTREPRENEURSHIP

Message from the Dean

Welcome to Senior Design Showcase 2020 for our School of Engineering and Applied Science in Spokane, WA.

We are in a rather unusual time in our history attempting to deliver 100% of our courses by digital/distance learning. This also includes celebrating an important milestone in our engineering and computer science students' program of study – that of completing their two-semester sequence of senior design. This daunting feat requires input and support from our faculty, industry sponsors, supervising faculty and numerous community members to help transform technical ideas into prototype construction and testing. Along the way, our students learn about project planning, teamwork and communications, report writing and technical drawings, and budgeting and resource management from practicing professionals.

I am especially thankful for the dedication of the faculty and staff of the School of Engineering and Applied Science that have contributed to the success of our students and this day. Academic Director, Toni Boggan, and the SEAS Capstone Committee members deserve major credit for their tireless efforts in bringing this day to fulfillment.

To our senior SEAS students, I want to congratulate you on achieving this milestone in your capstone project. Since the start of your senior year, you worked with your design team to take the project from ideation to the physical realization we see today. Thank you for your dedication and commitment to excel in this challenging but rewarding pursuit.

Finally, I want to wish all the graduating seniors much success in all your future endeavors. Go Zags.

Dr. Karlene Hoo, PhD
Dean, School of Engineering and Applied Science

Message from the Academic Director

I am humbled and inspired by the resiliency of our students, faculty, sponsors and Design Advisory Board members who completed the 2019-2020 Academic year under challenging circumstances. The transition caused by the Coronavirus was unexpected, sudden, and stressful but our teams responded with perseverance and agility. Deliverables were adjusted with help from the Capstone Committee and final reports told stories of success and growth through trial. These adaptations taught us lessons of flexibility and the importance of finding new ways to be a team which will serve everyone well in future challenges we may face. We are saddened by the loss of rites of passage that our seniors have endured but we remain hopeful that these strong students will find new methods of leading all of us to a future full of promise.

Thank you to everyone for a strong dedication to find the new finish line for senior design. Special thanks to our sponsors and Design Advisory Board members who continue to support our program and our students. Thank you to Megan Weed for organizational wizardry and a continued positive personae, and thank you to everyone from the Manufacturing Technology Center and the Dean's office.

Congratulations to our seniors! We hope to see many of you in September at the graduation celebration. Please keep in touch with us and send us word of your challenges and successes. We believe in you and your future! I wish you all health and strength!

Toni Boggan
Academic Director
Center for Engineering Design and Entrepreneurship

Welcome to Senior Design Showcase 2020

Gonzaga University's Center for Engineering Design & Entrepreneurship was established in 1992 to enhance the design experience for senior engineering and computer science students. The Center organizes projects for the academic year and many are commissioned by sponsors in the private and public sectors. Prospective sponsors are sought throughout the year for projects involving all engineering, computer science, and computational thinking programs. Many projects are interdisciplinary.

Participating sponsors provide a definition, resources, and funding for the projects. They also commit a liaison from the sponsoring company to guide and support the students throughout the academic year. Sponsors receive several benefits from the Senior Design Program including a project completed by students and faculty members. Additionally, the sponsoring company has the opportunity to work with bright and enthusiastic individuals with innovative ideas. This team experience is an opportunity to evaluate senior students as prospective employees.

Recently, another type of project developed which is the student proposed project. During their junior year, engineering and computer science students research and refine potential projects which are then reviewed by a faculty committee. If a project is accepted, the students who proposed it work on the project. In the 2019-2020 school year, 13 of our projects were developed by student teams.

All projects are periodically reviewed by faculty and the Center's Design Advisory Board (DAB). The DAB is comprised of engineering and computer science professionals in both the private and public sectors. They are instrumental constituents for the Center and a major factor in guiding the students. The review process brings an outside perspective to the teams and is a component required to meet design guidelines established by the Accreditation Board for Engineering and Technology (ABET).

Featured on the front cover is **ENSC 47**. For more information on this team, please visit page 22.

Design Advisory Board Members

The Center for Engineering Design & Entrepreneurship is supported by a dedicated group of volunteers from the engineering community who lend their expertise to our students and our program by reviewing our student's presentations and reports.

Aaron Warren	Gibby Media
Adam Miles	DOWL
Alana Wallace	Katerra
Alek Marinos	Keytronic
Andrew Asper	ACI Mech. & HVAC
Andrew Matsumoto	Civil West Svcs
Art Miller	NIOSH
Berry Ellison	City of Spokane
Bethany Alcamo	Vera Water and Power
Brad Snow	MSI Engineers
Brenna Doll	Boeing
Brent Barr	f5
Bill Fees	WA Dept. of Ecology
Bill Galle	Spokane County
Bob Turner	City of Spokane
Chris Sharman	Soft Dev Systems
Christian LePlante	Kaiser Aluminum
Colleen Little	Spokane County
Cory Frashefski	Katerra
Dan Lenz	Quad/Graphics
Daniel Harmon	NAES Corporation
Dannielle Haraldson	Boeing
Dave Duncan	Dept. of Ecology
David Moss	Spokane County Utilities
David Sweet	NIOSH
Dillon Turnbull	SEL Inc.
Doug Pooler	Empire Lab Systems
Eric Ryan	SEL Inc.
Erik Fuentes	DCI Engineers
Erik Lee	Avista
Gary Holmesmith	Kaiser Aluminum
Henry Loehner	WSDOT
J. McCall	Reiff Molding
Jacob Koopmans	Boeing
Jasmine Jans	Next It / Verint

We are so grateful for the invaluable relationships forged with our students and the Design Advisory Board. If you or someone you know would be interested in serving on the Design Advisory Board, please contact Toni Boggan, boggan@gonzaga.edu, 509-313-3913, or visit us on the web at www.gonzaga.edu/cede.

Design Advisory Board Members

Jeff Barnhart	Boeing
Jeff Owen	SEL Inc.
Jesse Tarr	MW Engineers
Jim McCall	Reiff Molding
Jim Roletto	Enrico Consulting/HMH
Jim Simon	Gonzaga University
Joel Lee	Metro Engineering
John Gibson	AVISTA
Joseph Dumoulin	Next It / Verint
Josh Comfort	DCI Engineers
Kaitlyn Helsing	Itron
Karen Malen-Hogle	Boeing
Katie Larimer	WA Dept. of Ecology
Katy Allen	City of Liberty Lake
Kaela Mansfield	Osborn Consulting
Les Bohush	Gibby Media
Lindsay Gilbert	CH2M
Malcolm Chaney	Search Discovery
Matt Zarecor	Spokane County
Melissa Verwest	Oldcastle Precast
Michael Barclay	Limelyte Tech Group
Michael Maffeo	Boeing
Michael Herzog	Itron Corporation
Mike Mudge	Avista
Mitch Beard	Haakon
Nick Questad	Boeing
Paul Robertson	SEL Inc.
Phillip Pintor	Coffman Engineers
Russell Connole	Stantec
Ryan Hendrickson	SEL Inc.
Ryan Leahy	Haakon
Sam Shoemaker	MW Consulting
Sean Stadelman	SEL Inc.
Stu Barton	Jacobs
Terra Donley	HDR Inc
TJ Bolser	DCI Engineers
Wayne Johnson	Keytronic EMS

Computer Science Projects

CPSC 01—Design Architectural Tessellation Optimizer (DATO)

Kevin Mattappally
Mauricio Velazquez
Parker Mooseker
Aaron Dodge

Advisor: Dr. Gina Sprint
Sponsors: Skimore Owings and Merril (SOM) and Dr. Joshua Schultz

The goal of our application is to provide a tool for architects to turn sketches and images into a tiling pattern. Coming up with tiling patterns given a base shape is generally very difficult, so our application will be used to assist users in this process. The user would take a photo or scan in a digital sketch into our application, which will then process the image and model the shape into its basic form. From there, that shape is then processed in our shape identification module, which will use math and geometry to determine the different ways the given shape can tile, which will be shown to the user as recommendations. These recommendations are then used to create a tiling in our tessellation engine, which from there the user can export as a csv file to use in CAD or other related software.

CPSC 02—BuzzerBeater Live

Thomas McDonald
David Ihle
Patrick Seminatore
Hunter Congress

Advisor: Dr. Gina Sprint
Sponsor: John Correia

As a basketball player, one of the most challenging skills to master is how to bounce back from a shooting slump, or how to keep a hot streak going without getting too excited. These are difficult skills to develop because they are typically only practiced in real-game scenarios with a live crowd watching, cheering, and taunting. Our Senior Design project, BuzzerBeater Live, will help simulate these high-pressure scenarios by providing a realistic audio simulation while a user performs a basketball shooting workout. This will, in turn, help shooters develop mental toughness, consistency, and remain calm under pressure. BuzzerBeater Live can be set up on a basketball court, detect shots made and missed, and mimic a crowd's reactions. The system would allow anyone to practice any scenario so that when they face the same situation in real life, they're comfortable with the pressure and can perform.

Computer Science Projects

CPSC 03—ComSem Machine Learning

Thomas McKenzie
Allison Fellger
Vincent Lombardi
Davis Fairchild

Advisor: Rob Bryant
Sponsor: Dr. James Hunter, Comsem.net

ComSem is an open-source tool for English as a Second Language (ESL) educators and students. As the third senior design team to work on the project, our goal was to clean up bugs and add several new features. These included a machine learning algorithm for error classification, a new educational review tool for students, and new corpus search functionality for research purposes. We have managed to meet our outlined goals and went on to attempt our stretch goals – adding new error types to our classification model.

CPSC 04—BioPath: Tools for Learning Biochemistry

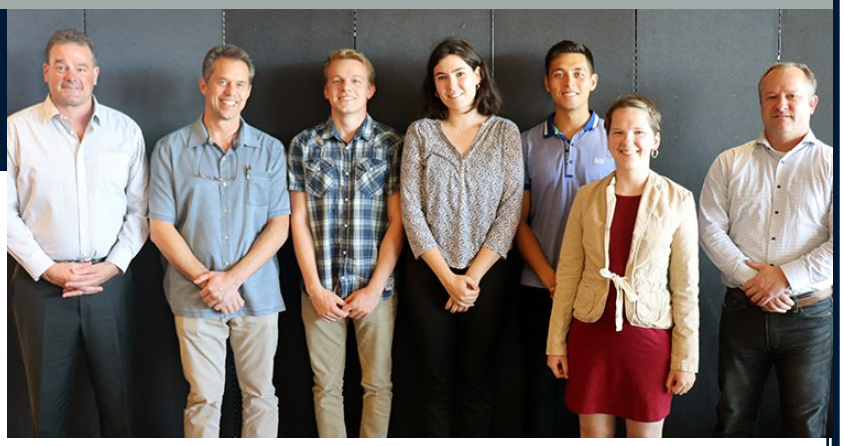
Benjamin Bladow
Joshua Go
Andrew Brodhead
Zach McKee

Advisor: Rob Bryant
Sponsor: Dr. Jeffrey Watson

The overall issue that our project addresses is the lack of quality interactive tools present in the biochemistry teaching community. To be more specific, the current tools that are used to teach students about different biochemical pathways, or linked sets of chemical reactions occurring within a cell, are unclear and difficult to comprehend. Additionally, the standard biochemical study materials are non-interactive and rarely graphical, which makes learning more difficult for those who learn best visually. We have created an interactive website that allows students to create models of different intracellular pathways and to show the chemical reactions on a computer. This product will provide a platform on which educators can build interactive simulations of various pathways to improve learning and data retention for their students. Additionally, we have made sure the tool is accessible on mobile devices, so that instructors can use it in a classroom environment.

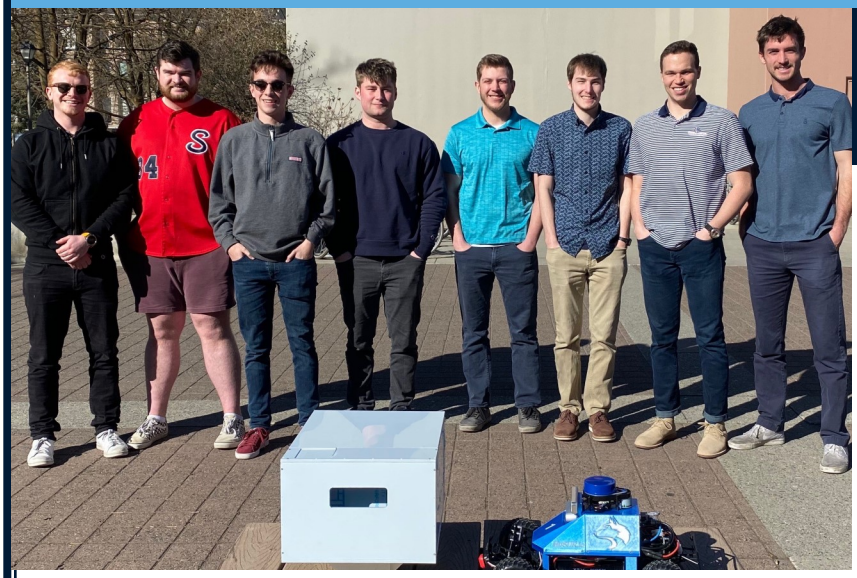
Computer Science Projects

CPSC 05—SpiroDVT



Isak Bjornson
Hanna Brender
Cole deSilva
Kelsey Lally
Advisor: Bruce Worobec
Sponsor: Lung Technologies LLC, Kerry Curran

SpiroDVT is a revolutionary post surgical-rehabilitation medical tracking application to accompany new "smart" medical devices to improve patient recovery post surgery. Our application will pair with electronic Incentive Spirometers and Deep Vein Thrombosis (DVT) Prevention devices. Spirometers are used to perform lung exercises that can prevent complications, including pneumonia. DVT is a large blood clot that can form in a patient's leg following surgery due to their inactivity. These clots can restrict blood flow and lead to complications such as stroke or death. The issue with these current devices is that they offer no feedback, so the doctor has to rely on the patient to provide feedback of their progress which is often inaccurate. To solve this problem, we have designed an application to allow doctors to easily and accurately track patients' use of these devices, helping to significantly improve patient health outcomes.



CPSC 06—Autonomous Delivery Robot

Reid Whitson
Kevin Hance
Jackson Paris
Luke Hartman
***Also pictured: ENSC 69**

Advisor: Bruce Worobec
Student Proposed Project

The Gonzaga University Autonomous Delivery Robot project set out with the goal of providing a delivery option for on campus stores. Being as cars can't access most locations on campus, our teams have designed and developed an autonomous delivery robot, capable of navigating campus to deliver items that were ordered by users on our corresponding web application. Our custom designed user-facing web application allows users to place and receive orders to their specified location. To attain a fully autonomous vehicle we have designed software which will enable the robot to navigate autonomously utilizing continuous planning and object detection. This has been accompanied by a user-friendly and sleek food delivery box which has captured the ability to safely and securely store, transport, and deliver the goods that have been ordered. This provides the platform by which the vehicle design and software components integrate to form the Gonzaga University Autonomous Delivery Robot.

Computer Science Projects

CPSC 07—Driving Reality Interface in Virtual Reality (DRIVR)

Timothy Rodriguez
Connor Cooley
Brooke Hughes-Brauner
Donovan Farar

Advisor: Bruce Worobec
Student Proposed Project

Project D.R.I.V.R. aims to combat driver shortages in the trucking industry and potentially attract other industries by creating a Virtual Reality application that utilizes the HTC Vive headset, FPV (First Person View) cameras, and a truck controlled by steering wheel and pedal to allow a user to drive a truck in real time in a virtual environment. The user will also be able to switch control between multiple trucks to remotely control a fleet of vehicles. We have created a proof of concept of this system with an RC Car and Steering Wheel pedal control that shows that this system will be usable by the trucking industry, or any other industry looking to remotely control vehicles. Specifically, D.R.I.V.R. will be useful to any company looking to remotely control a fleet of vehicles with a fraction of the drivers normally required.

CPSC 08—Gonzaga Campus Walking Tour

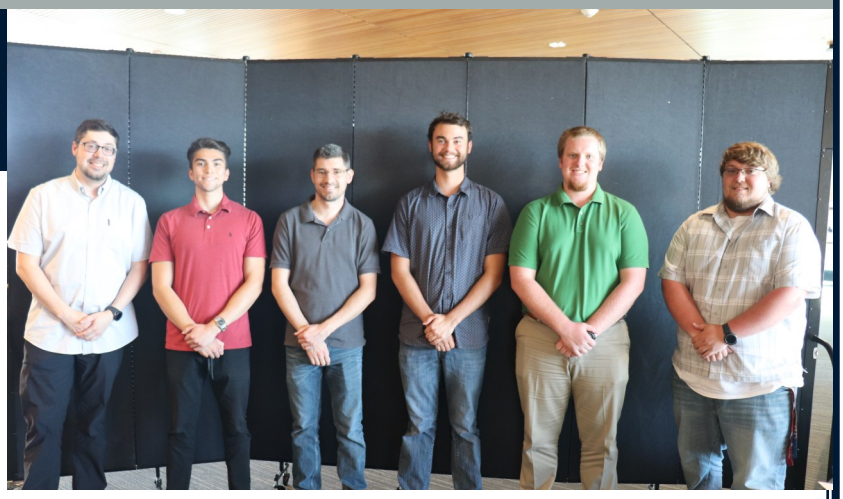
Mason Dellutri
Ryan Hays
Alexa Andrews
Maxwell Heinzelman

Advisor: Bruce Worobec
Sponsor: Dr. Veta Schlimgen

The Gonzaga Campus Walking Tour project was created as a way for Gonzaga HR to give faculty health benefit deductions for staying healthy and active. They worked in conjunction with the Gonzaga History Department to create walking tours of Gonzaga's campus to teach the history and background of the school. The best deemed application for this goal was to create a mobile application that users can follow while both learning Gonzaga's history and recording their distance walked. This resulted in an iOS application that can be downloaded from the Apple App Store for anyone to install and explore. Tour photos and information is stored on a database that can be uploaded to by the History Department administrators using a computer-based web application. This provides ease of use for the History Department to create and update tours as they please.

Computer Science Projects

CPSC 09—Vehicle Status Notification Engine



Bryan Fischer
Christian Kruep
Mario Maldonado Santos
Michael Newell

Advisor: Dr. Daniel Olivares
Sponsor: City of Spokane, Laz Martinez

The problem we addressed with our project was to make repair notifications to city employees more efficient by sending text notifications on behalf of fleet services of Spokane when repairs are completed on fleet vehicles. The major features we have implemented are the logging database that will store all the incoming messages, the service bus, web service layer, and processor. When a notification event is triggered, it travels through the various components of the architecture until it is processed and all activity is logged into a SQL database. The main project deliverable is the software itself, which includes the service bus, web service layer, processor, and logging database. These are hosted by the Azure cloud using the City's subscription account. The project has been delivered by giving our source code to our Sponsor, Laz Martinez, where he will review it and deploy to the cloud.

CPSC 10—Helping Tenants and the Climate

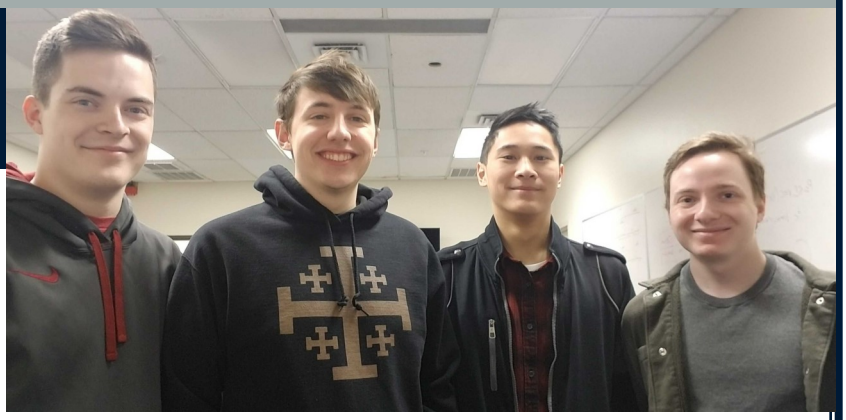
Vincent Rettke
Kathrine Gibson
Eugene Krug
Gage Gutmann

Advisor: Dr. Daniel Olivares
Sponsor: Dr. Brian Henning

The Logan neighborhood is filled with outdated, inefficient homes built prior to 1940 and has a very low vacancy rate at approximately 6%. The goal of our project was to create an application to combine utility and rental costs for a property. There are two key objectives: help prospective tenants find a property, and call attention to the positive impacts an efficient home can have towards the climate. In the early phases of the project, the team met with Avista to obtain utility data, city councilwoman Kate Burke, and community advocates. The final product is a desktop and mobile friendly web application, *True Living Cost*. Our application allows the user to view a sticker monthly price of a specific address comprised of utility and rent costs. Users can also compare this property to another address within the Logan neighborhood.

Computer Science Projects

CPSC 11— Unity 2D Strategy Game



Andrew Flagstead
Brett Baringa
Michael Fontanilla
Evan Swanson

Advisor: Dr. Kate Schroeder
Student Proposed Project

Our goal for this project was to develop the foundation for a multiplayer 2D strategy game based in the Unity game engine. We wanted to blend the genres of real-time strategy and action roleplaying game and believe that we have succeeded in this venture. We have achieved a working demo, with internet multiplayer, player characters and units, a map, and game objectives all in place. During the course of the project, we have utilized a user testing group to get feedback on how to make the game more enjoyable, which has been vital to achieving the product you see today. Throughout this journey, we have learned how to work with C# and the Unity Engine, how to work in an agile team, and how to meet deadlines on a large-scale project.

CPSC 12—RoadViz VR

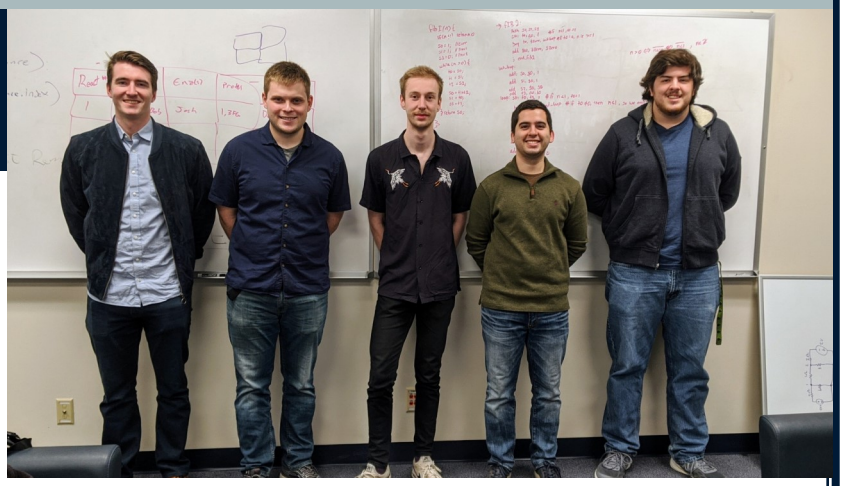
Max Marciel
Luke Sparks
Nathan Vanos
Kasey Davis

Advisor: Dr. Kate Schroeder
Sponsor: Dr. Rhonda Young

RoadViz VR is a virtual reality application designed to facilitate communication between professional urban designers and laypeople. Designers can create roads to specification that community members can interact with and understand. A better understanding of our public spaces can lead to greater appreciation and a stronger capability to provide input and feedback to future changes. We have targeted ease of accessibility by supporting as many virtual reality headsets as possible and by making our software available for anyone.

Computer Science Projects

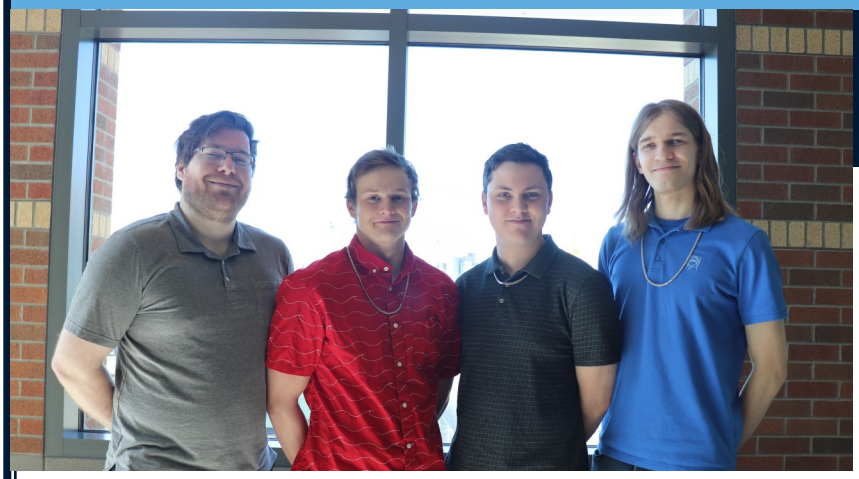
CPSC 13— Education in VR



John David Gruber
Simon Forinash
Sam Jerijervi
Diego Valdez
Jared Elliot

Advisor: Dr. Angie Zhang
Student Proposed Project

Teaching methods in modern schooling are largely lecture-based. Sit down in class, write notes for an hour, and review those notes later for the test. This method of learning works, but it can be bolstered with the addition of hands-on activities to help the more kinesthetic learners. To address this, CPSC 13 has developed an immersive Virtual Reality game where players can learn mathematics and have fun doing it! It's designed to be similar to whack-a-mole, except instead of simply hitting as many moles as possible the player is prompted with a math question and must hit the mole holding the correct answer to score points. This provides the player with fun and physical practice of mathematical concepts, all while surrounded by the colorful scenery of a boardwalk carnival.



CPSC 14—NLP Testing Harness

Harley Davis
Brandon Niblock
John Distinti
Maxwell Sherman

Advisor: Dr. Angie Zhang
Sponsor: Scott Broder

We began the year with the goal of creating an AI virtual assistant, which would enhance meetings by keeping track of points of discussion. As we progressed, we found that the important aspect was choosing the right Natural Language Processing (NLP) APIs. Choosing a provider for NLP services can be a daunting task and is in itself enough of a project for the scope of one year. Thus, we shifted our project to creating a tool that simplifies this process for anyone else considering projects involving NLP services. Users are able to create and manage their own tests, where they can run their own audio through the various providers and compare the results directly to determine which works best for their particular use case.

Civil Engineering Projects

ENSC 20— Blowover Risk— Wyoming Highway System

Ryan Miller
Pei Yun Hsieh
Taylor Eoff

Advisor: Dr. Rhonda Young
Sponsor: Wyoming Department of Transportation

The state of Wyoming has the greatest number of heavy-vehicle crashes per capita in the United States. Blowover crashes due to wind gusts (up to 70 mph) can topple large semi-trucks and result in prolonged road closures across the major state corridor of I-25. This study provides data and analysis to narrow the gap between the available blowover crash research and the wind characteristics. This enhances the ability to inform drivers in real time of the appropriate preventative measures to take. This was completed through GIS crash data analysis of statewide truck blowover crashes in Wyoming, analysis of location wind data, and review of Wyoming Hill as-constructed drawings to develop a roadway design recommendation that aims to minimize truck blowover crash risk. We have generated wind-crash models as well as a review of physical roadway features to propose a mitigation plan to the Wyoming Department of Transportation.

ENSC 21—Active Transportation NE Spokane

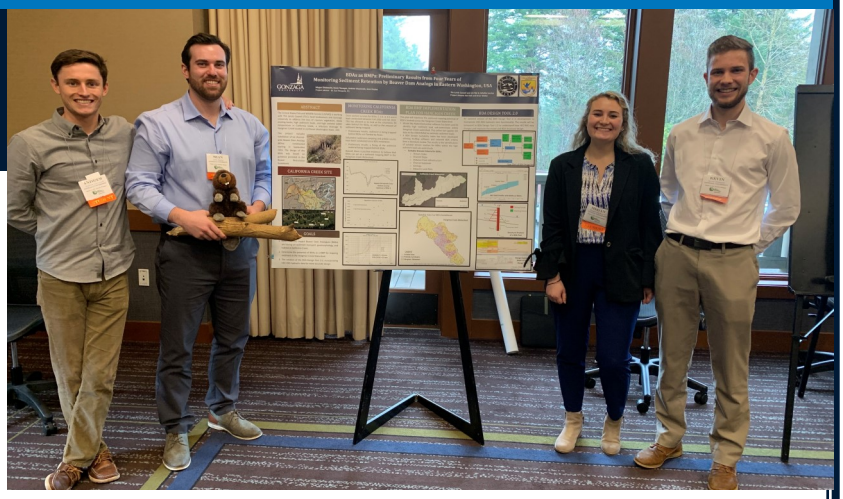
Kyle Winfield
Ryan Ward
Stephen Fellin
Olivia Ramirez

Advisor: Dr. Rhonda Young
Sponsor: City of Spokane, Colin Quinn-Hurst

In our project, we first assessed the needs of Northeast Spokane active transportation users by completing extensive research on current and planned infrastructure in order to identify locations that would most benefit from improvements and investment. Simultaneously, we conducted extensive community outreach in order to hear about the needs of the community from people rather than from statistics. Following the research and outreach, a list of eighteen project proposals were selected, and a decision matrix was developed to rank these proposals. The matrix highlighted locations where projects would improve neighborhood connectivity and safety and were responsive to social equity deficiencies. Four projects that ranked highly in the matrix were selected by the group and advisors. Solutions and improvements at the four identified locations were designed, evaluated for sustainability, and presented before community stakeholders for feedback and revision.

Civil Engineering Projects

ENSC 22— Beaver Dam Analogs



Andrew Clusserath
Sean Healey
Megan Ehlebracht
Kevin Flanagan

Advisor: Dr. Sue Niezgoda
Sponsors: Kat Hall (The Lands Council) and Brian Walker (US Fish & Wildlife Service)

The objectives for our project were to create the Year 4 Monitoring Plan, BDA Best Management Practices Plan, and to develop BDA Design Tool 2.0. We analyzed data that has been gathered over four years at California Creek, estimating how much sediment is being trapped by the BDAs and using Geomorphic Change Detection Software to see how the BDAs have changed the geomorphology of this river. Over the year, the team has also found suitable sites within the Hangman Creek Watershed for future groups to implement new BDAs. This was done using ArcGIS mapping data and a watershed wide sediment analysis. BDA Design Tool 2.0 was designed to incorporate HEC-RAS inputs, allowing people designing BDAs to have a better understanding of the structural stability of the BDAs. A user's manual was developed alongside the tool, allowing new users to troubleshoot and gain an understanding on how to fully utilize the tool.

ENSC 23—Pedestrian Safety Plan

Joseph Parry
Lee Henningsen
Majael Cantu

Advisor: Bob Turner
Sponsor: City of Spokane

ENSC 23's goal was to provide the Logan Neighborhood Council and the City of Spokane ways to promote pedestrian safety within the neighborhood. The team completed a traffic study and interdisciplinary design for two signaled crosswalks within the Logan Neighborhood. This process included requesting data from the City, conducting pedestrian counts, surveying the Gonzaga and neighborhood community, attending neighborhood meetings, and working with experienced traffic engineers to gather and analyze all the necessary data to determine where to install a signaled crosswalk in the neighborhood. The team decided to design a Pedestrian Hybrid Beacon (HAWK crosswalk) on the 500 block of Mission and the Jackson-Hamilton intersection. These designs include structural, foundation, and electrical analysis as well as plans for construction and wiring. They were then given to the Logan Neighborhood Council to assist in their yearly traffic calming application to the City of Spokane.

Civil Engineering Projects

ENSC 24— Geo-Structural Deep Foundation Design

Bennett Lanners
Greyson Charon
Andrew Nelson
Jacob Engdahl

Advisor: Dan Parshall
Sponsor: Quanta Subsurface

The goal of our project was to design a deep foundation for a proposed transmission pole structure outside of Othello, WA. Micropiles were the elements we chose for our design. Micropiles are small diameter driven piles which can be used as an easy alternative to larger piles in soils with gravel, cobbles, or bedrock. Over the course of the school year, our team worked to design a micropile to pile cap system which is able to properly transfer the loads from the superstructure into the foundation, which then transfers the loads into the soil.

ENSC 25—Modeling of Ice Age Floods

Samone Sims
Anna Hirning

Advisor: Taylor Hoffman-Ballard
Sponsor: Berry Ellison, City of Spokane

The goal of this project was to design a stream play feature which demonstrates the hydraulic spectacles that occurred in the Eastern Washington region during the Ice Age Floods between 12,000 and 16,000 years ago. The stream play feature demonstrates the hydraulic processes that formed the landscape features and allows educational, interactive play for children aged K-12. The stream-play feature is to be constructed in an approximately 40'x70' area within the North Bank Project in Riverfront Park. To achieve the project goal, a literature search of the hydrologic features of the Ice Age Floods was performed, and five preliminary alternatives for the play features were designed and evaluated using a weighted decision matrix. From these five designs, two primary alternatives were selected and then modeled using 2D HEC-RAS. These two options were evaluated based on the results of the hydraulic modeling, aesthetic appeal cost, and Spokane Department of Health requirements.

Civil Engineering Projects

ENSC 26— Traffic Calming Project

Sterling Wagner
Mitchel Stephan
Will Sherpa
Dash Cotton
Advisor: Adam Miles
Sponsor: DOWL

The purpose of our project was to engage the Lincoln Heights neighborhood, a Spokane community, to identify, assess, and prioritize all of their neighborhood traffic calming needs using standard engineering practices. We accomplished this by attending quarterly Lincoln Heights neighborhood council meetings and narrowing down their ideas to one final project containing multiple traffic calming ideas. Our project will culminate in a submittal to the City, with the possibility of approval and eventual implementation.

ENSC 27—Topology of Tall Buildings

Brooke Whitsell
Phil Geist
Rachel Dorr
Advisor: Dr. Joshua Schultz
Sponsor: Civil Engineering Dept.

The goal of this senior design project was to develop optimized cantilever trusses as lateral systems for tall buildings through graphic statics and density techniques. The goal of optimization is to minimize cost and ecological impact vis-à-vis minimization of material. With optimization comes a broad range of theory versus practicality in the design of trusses, as the most optimal truss is generally the least feasible to construct. This project will find the balance between constructibility and sustainability in optimizing design, therefore establishing a middle ground for lateral systems. Optimization theory was experimentally tested using 3D printed models comprised of polylactic acid (PLA) members that were printed as fully fixed connections. A small-scale model of our optimized trusses has been printed and a technical article will be submitted to ASCE Structures Congress for their 2021 conference.

Civil Engineering Projects

ENSC 28— Stormwater Management

Tucker Munson
Anna Bonacci
John McNeil

Advisor: Dr. Aimee Navickis-Brasch
Sponsor: Spokane County

StormChasers Engineering worked hard all year to accomplish their goal of furthering the field of stormwater engineering with respect to understanding bioretention soil media performance. They monitored two bioretention cells on the south end of Gonzaga's campus. The team collected and analyzed stormwater samples coming from each bioretention cell in an attempt to answer the following questions: Does a reduction in soil media depth affect soil filtration capability? What other soils would work well to filter stormwater given the results found on-site? What affect does the cold have on bioretention effectiveness and how can the negative effects be mitigated?

ENSC 29—Cost and Embodied Energy Reduction in Long-Span, Gravity Systems

Nolan Seawright
Samantha Ramsey
Nathan Christopher

Advisor: Dr. Joshua Schultz
Student Proposed Project

This project is a student-led cost and embodied energy parametric study of low-rise, long-span structural frames, using the Myrtle Woldson Performing Arts Center as a benchmark for analysis. This building is located on the campus of Gonzaga University and was completed in the spring of 2019. Our study considered the long-span portion of the Performing Arts Center as a basis for determining an optimal structural frame layout with respect to cost and environmental impacts. Findings from this study can then be applied to future gravity systems of low-rise, long-span buildings. It is our hope that this analysis will provide a standard model for future structural engineers to reference when wanting to design an optimal structural steel-framed layout for a long-span building.

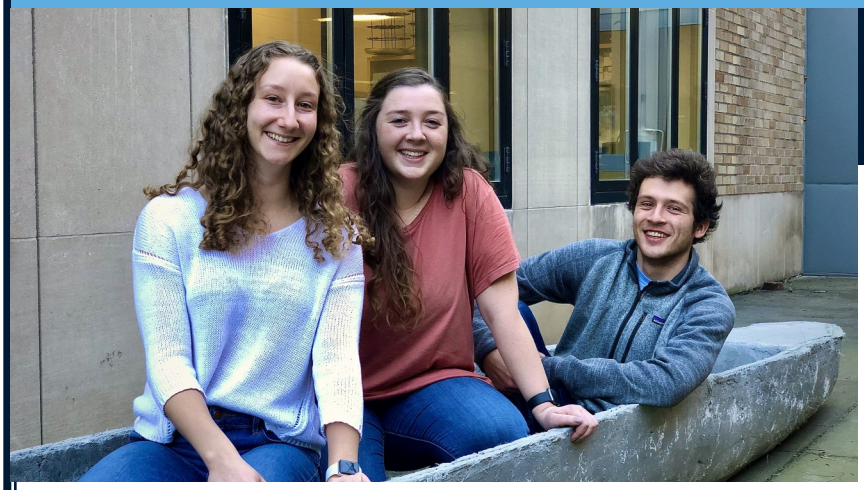
Civil Engineering Projects

ENSC 30— Vivianite Management in Wastewater

Sam Nieslanik
Lillian Lower
Andrew McCall
Noah Schechter

Advisor: David Moss
Sponsor: Jacobs

The "Vivianite Management in Wastewater" team (a.k.a. the "ViviaKnights") has worked hard throughout the year to find a solution to the Vivianite problem at the Spokane County Regional Water Reclamation Facility (SCRWRF). The production of Vivianite crystals, a byproduct of the phosphorous removal process, at the SCRWRF impairs the effectiveness of processes within the Facility's anaerobic digesters. Vivianite also damages the pumps used to remove the crystals from the digesters resulting in replacement costs. One of the largest jobs the ViviaKnights conquered was analyzing the conditions within the anaerobic digesters and tracking how the Vivianite really forms. This included data analyses, research, and testing sludge samples. This information went towards formulating alternative ways to physically remove Vivianite more effectively. The Vivianite problem is far from solved, so the ViviaKnights hope the work done this year will lead future research teams towards the best solution.



ENSC 31—Whitworth Chapel Expansion

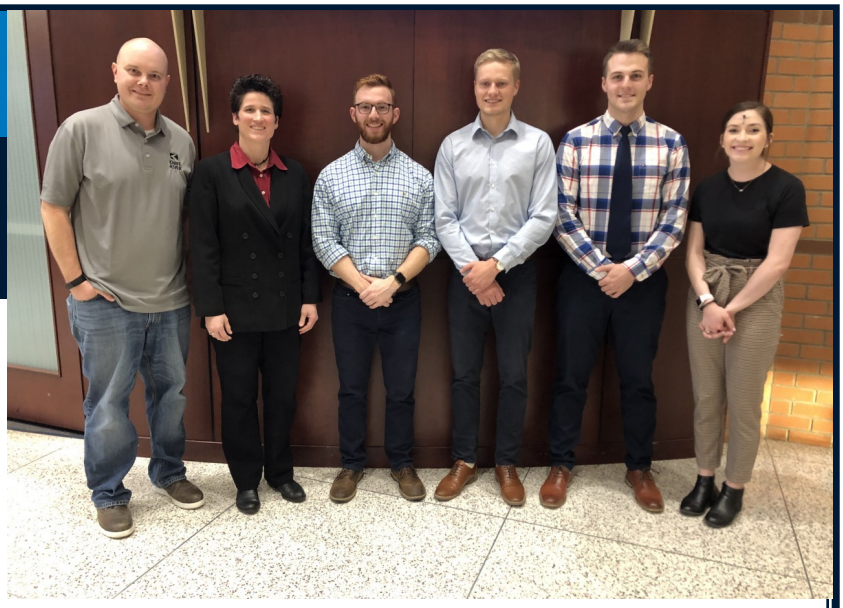
McKenna Milacek
Brooke Powers
Quinn Kopczynski

Advisor: Aaron Zwanzig
Sponsor: Integrus Architecture

Whitworth University's theology program has experienced significant growth and now requires additional space for their staff and students. As a result, the Whitworth Chapel Expansion team has developed the structural plans and a calculation book for this building. The structure is a steel moment frame that accommodates the canopy and large window bays outlined in the architectural plans. The team developed a computerized model to demonstrate the structure's behavior under various load combinations. The structural plan set includes the structural design of the framing plan, foundations, roof diaphragm and connection details. The calculation book compiles all of the calculations—hand and computerized—to demonstrate how each structural component was designed.

Civil Engineering Projects

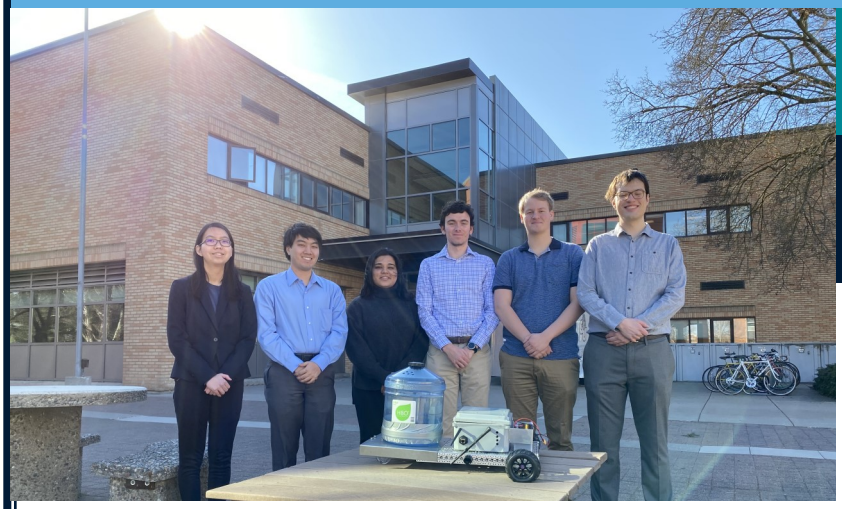
ENSC 32— Concrete Demonstration Structure



Patrick Young
Samuel Kirk
Gavin Orr
Darien Schneider

Advisor: Melissa Verwest
Sponsor: Knife River Corporation

The Civil Engineering student body at Gonzaga has a lack of exposure and real-world visualization of premanufactured materials, specifically precast concrete assemblies, and the ENSC 32 team addressed this issue while also tending to the needs of the student body as a whole. The team designed a demonstration structure that evoked a sense of scale of a larger structure, showed a variety of exposed connections and precast concrete members, and exposed parts of members to reveal the reinforcement or insulation that was hidden within. With the help of local architects, this structure was also designed to be aesthetically pleasing by exploiting the benefits of precast concrete. Though this was an engineering project, this piece was also designed to be used by the greater Gonzaga community by integrating aspects that would allow people to charge their devices and sit on precast concrete members and enjoy the view of downtown Spokane.



Electric and Computer Engineering Projects

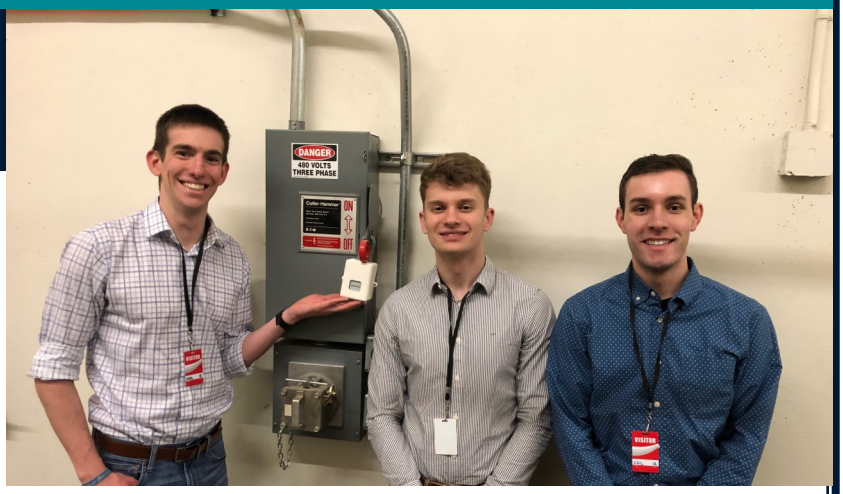
ENSC 40—Agricultural Robot

Esther Tan
Davis Lee
Shreya Shukla
Thomas Detillion
Zachary Wheeler
Ryan Liddell
Advisor: Chris Wood
Sponsor: Dryland SA

ENSC 40 was handed down a project including a robot with few capabilities. The refueling station was operational, but the robot would not function independently. This year, the team worked towards completing the task of getting the bot to work while also adding features to the bot, specifically the ability to refuel the carriage container with water and autonomous operation. A new fueling station was assembled and added to the project. The bot extension, which holds the water (simulating the spraying process) was added behind the bot. This required the wheels on the bot to be upgraded due to the added weight. Finally, the bot can demonstrate the water refueling process, spray the water, and complete a spraying pattern in a field, simulating the spraying of an agricultural field. In addition to this, ENSC 40 has completed documentation of all steps and problems to pass off to Dryland SA.

Electrical and Computer Engineering Projects

ENSC 41— Prototype Web Enabled Smart-Lock



Jack Breese
Payton Lieske
Nicholas Walker

Advisor: Dr. Art Miller
Sponsor: NIOSH

The goal of ENSC 41 was to create a smart-lock and accompanying application to make the Lock Out/Tag Out process in above-ground mines more efficient. The goals surrounding the lock were that it functions as a regular padlock and has an interface to display user information. For the application, the goals were to create a web app that could access the smart-lock from anywhere with internet access and also operate it in real time. The team has accomplished both goals by manufacturing both 3D printed and aluminum prototypes, using Raspberry Pi's for both lock internals and as a gateway device between lock and application, and by using an identity system to authenticate users. ENSC 41 also began prototyping a smaller version of the smart-lock device that NIOSH Spokane plans to continue building upon.

ENSC 43—Helical Antenna Array

David Nawrocki
Paul Scheidt

Advisor: Bob Conley
Sponsor: Smart Antenna and Radio Laboratory (SARL)

A rigid-flex antenna array is under development consisting of two helical antenna elements. The helical elements are orthogonal right and left circularly polarized. This two element array is encapsulated in a radome for protection. The feed network of the array is a 4 layer rigid PCB. The dipole arms are flexible etched copper on a polyimide substrate. This project is a continuation of multiple senior design projects, with the focus of improving the manufacturing process and scalability of the antenna array over desired frequency ranges. The report describes the design, the simulations, manufacturing process, tests conducted, and materials used to build the two element antenna array.

Electrical and Computer Engineering Projects

ENSC 44— Relay Testing Lab Expansion

Allen Edens
Audra Reese
Devin Klee

Advisor: Kevin Damron
Sponsor: 2020 Hands on Relay School, AVISTA

An improved breaker simulator and five relay labs was developed for the 2020 Hands-On Relay School in Pullman, WA. The Relay School is a professional development short course to train protective relay technicians, electrical/power plant technicians, engineers, and protective relay test specialists. The team was asked to review an existing breaker simulator and make improvements so that it can be used in the Relay School. Additionally, five labs have been developed utilizing the breaker simulator, a SEL-751A relay, and an Omicron Test Set to provide real world experience to future relay technicians and specialists. The labs cover over/under voltage, over/under frequency, overcurrent, AC reclosing, and synchronism check relay elements. Before presenting the labs to the Relay School, the labs have been tested by changing settings within the relay and applying different voltages, currents, and frequencies to confirm the settings work as expected.

ENSC 45—Streamline Outlet CO Detector

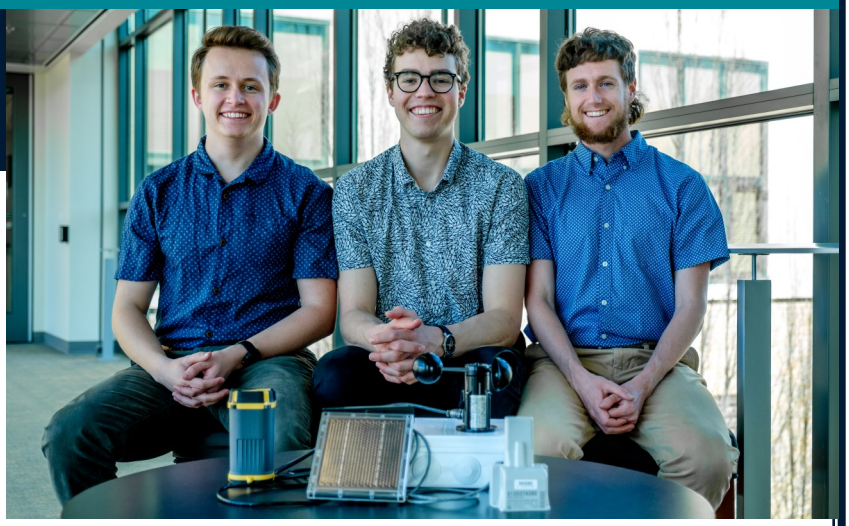
Thomas Hughes
Sean Cassatt
Monica Harrison

Advisor: Debra Offill
Student Proposed Project

To prevent injury from overexposure to carbon monoxide, a poisonous gas, team ENSC 45 has engineered and built a prototype wall outlet integrated with a carbon monoxide detector. The prototype has a rechargeable battery with a two-week battery capacity. The protype also features wireless capabilities that interface with connected devices, including phones and tablets. The software includes a preventative function to detect low level carbon monoxide exposure over extended periods of time. In order to hold the prototype, a scaffold was designed to fit into a four-outlet electrical box with a customized face plate. Separate tests verified battery capacity fulfilled designed parameters and ensured the carbon monoxide detector would detect harmful amounts of carbon monoxide, sound a localized alarm and communicate the danger to a nearby device.

Electrical and Computer Engineering Projects

ENSC 46— Smart Sensor Campus Network



Ben Gibson
Matt Repplier
Phil Fishburn

Advisor: Bob Zavrel
Sponsor: Itron
Student Proposed Project

Internet of Things, or IoT, is a rapidly growing field of internet-connected sensors. Our goal was to create a modifiable IoT network for student development. With our IoT network, we provide real-time information from our sensor nodes on campus to assist student-led sustainability efforts. This data is shared with Spokane's new smart-city initiative, Urbanova. We modified existing, industrial-grade, utilities communication devices for a more robust and reliable network.

ENSC 47—Therapeutic Incentive Spirometer & DVT Preventer

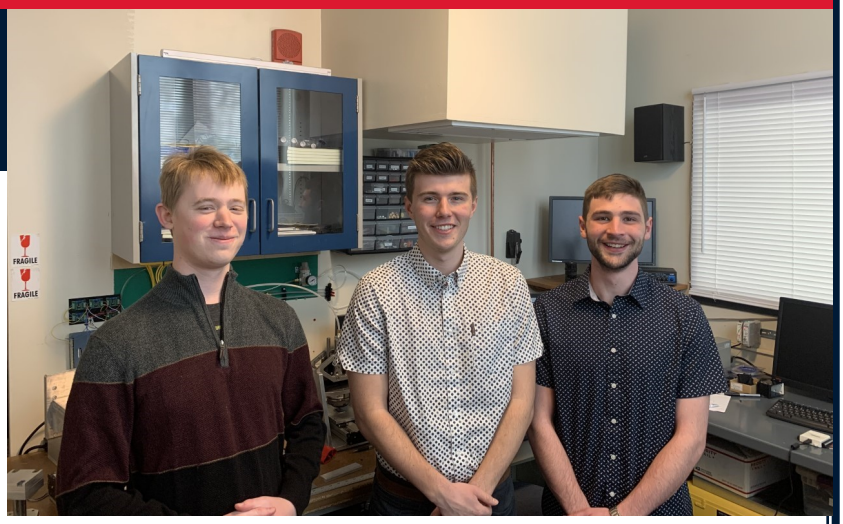
Colin Noonan
Claire Puryear
Alex Banning
Nikki Creamer
Jessica Mangrobang

Advisor: Shane Pacini
Sponsor: Lung Technologies LLC

Our sponsor, Lung Technologies LLC, challenged us to do two separate projects. The first project required us to design and manufacture a mockup Therapeutic Incentive Spirometer, and the second project a Deep Venous Thrombosis (DVT) Preventer. Both are innovative post-surgery rehabilitation medical devices and will make a significant positive impact in the medical industry. We have mechanically redesigned a Spirometer using the Voldyne 5000 model as a baseline, as well as designed a DVT Preventer completely from scratch. Additionally, we have incorporated electronic interfaces that will track important data and send it to an app on the doctor's phone to help maximize efficiency in patient treatment. A computer science senior design team, CPSC 05, created the app that will receive our data. This sister design team is also working on both projects.

Mechanical Engineering Projects

ENSC 50— High Melting Temperature Additive Manufacturing



Connor Williams
Brennan Watkins
Braden Cote

Advisor: Dr. Harman Khare
Sponsor: Mechanical Engineering Department

Our team has designed and fabricated a prototype FFM/FDM 3D printer capable of patterning materials with melting points higher than conventional filament materials such as PLA. Our end goal was to create a prototype that will be able to pattern with Polyether Ether Ketone (PEEK), which is a polymer that has a melting temperature of 343°C. We also set a reach goal for ourselves to try and achieve printing with pure aluminum, a material which is not typically used in this manufacturing method due to its high melting temperature of 660°C. Our team was provided an existing 3D printer system, a Robo3D R1+, with functional XYZ motion control and associated software which we modified by implementing an entirely new extruder, carriage, and cooling system design to achieve sustained operation at the high temperatures we required.

ENSC 51—Adhesive Strength Test

Cameron Cortinas
Ryan Hobus
Thomas Walters

Advisor: Chris Wood
Sponsor: Nicks Boots

Nicks Boots currently uses a two-step primer-adhesive process in their firefighter boots that is difficult to work with and requires additional safety equipment to handle. Our team tested the strength of their current method and explored alternative adhesion methods that Nicks Boots could potentially use with their firefighter boots to replace the current adhesive process. The test methods were developed by last year's team that worked on this project and our team has improved upon the approach and has worked diligently to document the procedure so that if the project is continued in the future, it can be more easily understood.

Mechanical Engineering Projects

ENSC 52— Optical Profilometer

Hunter Hamilton
Cooper Lytle
Evelyn Cooper

Advisor: Dr. Harman Khare
Sponsor: Mechanical Engineering Department

Our team was tasked with designing and constructing a functioning Optical Profilometer that can measure the surface roughness of a sample. An Optical Profilometer is a device that images the profile of a surface via our chemically etched Tungsten probe. The probe is fixed to a cantilever beam which deflects by some angle as it is traced along a surface. The deflection is registered by a laser, which is reflected off the end of the cantilever and onto a lateral effect sensor to measure the distance travelled by the beam. We utilized a 850nm infrared laser passed through a neutral density filter (for reduced intensity) and a reversed Galilean Beam Expander to collimate and reduce the spot size of the beam. For control, we added active tracking to our cantilever with a piezo electric crystal and a LabVIEW

ENSC 53—Assembly Cell Design

Spencer Broden
Blaz Perko
Grant Rosenbaum

Advisor: Ryan Leahy
Sponsor: Haakon Industries

Through the Gonzaga Senior Design program, our team worked with Haakon Industries, a custom HVAC manufacturer, to design and implement a replicable assembly cell that combines the wall, roof, rack, and assembly departments into one ergonomically efficient workspace that allows for expedited unit fabrication and assembly. By simplifying and centralizing the processes that go into building a unit, our team will successfully reduce worker downtime, increase productivity, decrease unit construction times, and increase worker morale by successfully improving workplace ergonomics.

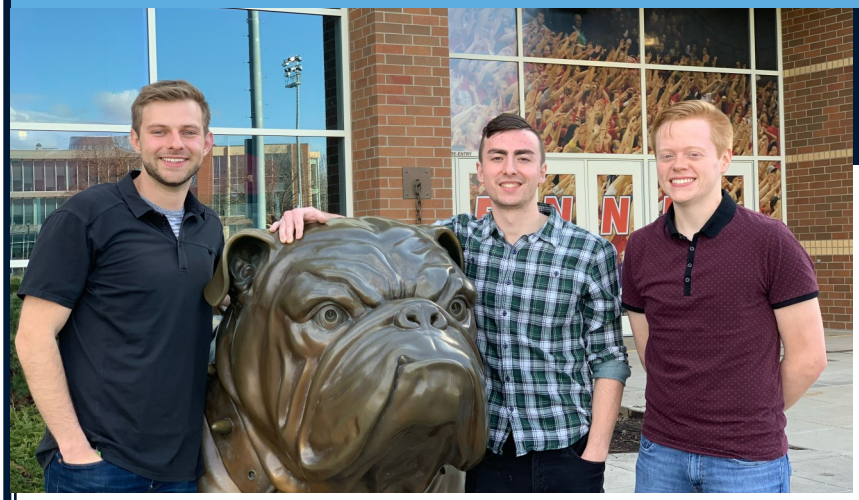
Mechanical Engineering Projects

ENSC 54— Automated Banding Removal

Sam Agyei
Chris Bode Rorem
Ethan Schriever

Advisor: Jacob Laete
Sponsor: Kaiser Aluminum

Over the past year, our team has been working closely with both knowledgeable faculty advisors and teams at Kaiser Aluminum to develop a solution to the faulty safety precaution during the cladding process at the Trentwood facility in Spokane Valley, WA. For a complete solution to the safety problem at Kaiser Aluminum, our team designed an autonomous, robotic, mechanical machine. The main purpose is to mitigate burn and impact risks during the steel band removal process by cutting steel bands at a safe distance and with precise accuracy. Our device has taken human error out of the equation, providing a safer working environment for workers on the aluminum cladding process.



ENSC 55—Black Body Flow Analysis

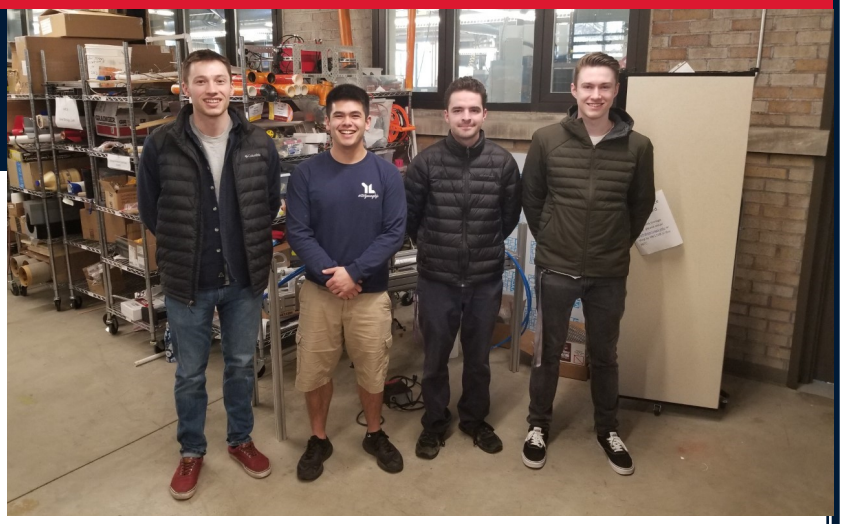
Ben Stockelman
Jack Roberts
Braden Williams

Advisor: Sam Shoemaker
Sponsor: Keytronic

The goal of this project is to model water flow through a blackbody temperature sensor calibration system. The blackbody surfaces present in the system absorb all incidental thermal radiation from outside sources, and emit based on water temperature, which ensures accurate calibration of non-contact temperature sensors. Due to tight tolerance values for the sensors, it is essential that the system maintains a constant temperature within. To obtain a model for the internal water flow, the team used Ansys computational fluid dynamics (CFD) software. Due to limited physical data and a complex geometry of the blackbody system, this model can only be certified as theoretical. Even so, improvements have been analyzed and suggested to potentially reduce the thermal gradient present in the system and control the flow to maintain constant temperature along all the blackbody elements, reducing calibration failure rates.

Mechanical Engineering Projects

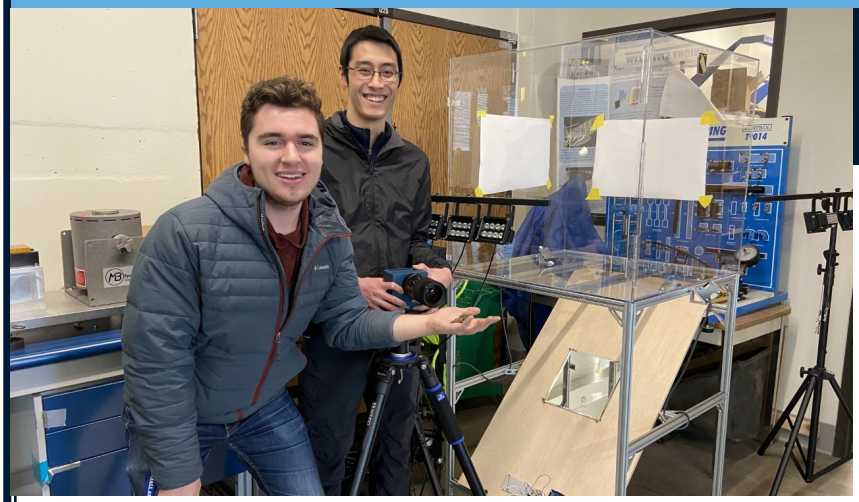
ENSC 56—Shape Memory Alloy Composite Materials Handling



Ryan Wessel
Jason "Bunji" McLeod
Conor Garand
Thomas Skelly

Advisor: Sam Shoemaker
Sponsor: The Boeing Company

Composite manufacturing requires the efficient movement of uncured composite elements. Contemporary concepts most often use pneumatic systems with compressed air generating vacuums to create suction in order to maneuver elements in the manufacturing environment. These Material Handling Systems often require extensive, cumbersome, and expensive infrastructure to use on the manufacturing floor. With the use of Shape Memory Alloy (SMA) technology and its capability to "remember" and return to a trained shape via heating by electric current, this project uses SMA springs to create a vacuum in suction cups that would require only electric inputs, eliminating the need for a connection to compressed air, thereby reducing the needed infrastructure and costs of the present systems. With the advent of the new 777X which utilizes composite wing structures, the Boeing Company is interested in the use of SMA suction cups for composite handling and sponsored this project.



ENSC 57—Free-Flying Insects

Paul Freihoefer
Evan Nusaputra

Advisor: Dr. Tim Fitzgerald
Sponsor: Mechanical Engineering Department

The Free-Flying insects project was tasked with tracking the position of an insect mid-flight by using modern image-processing techniques. To complete this task, the ENSC 57 team built a box and frame to contain the insects while they were recorded on high-speed cameras as well as write code that analyzed the recordings. The team was able to build the "containment cube" and set-up an automated system to activate the cameras when the insects were in the cameras view. They were also able to perform basic image processing techniques to track the insect's wings and display positions with real-world coordinate points. This project was overall a success in incorporating different engineering challenges and disciplines to solve a modern-day research problem. The future of the project is now in the hands of research teams at Gonzaga University, who will be able to use the project to further the research of insect flight.

Mechanical Engineering Projects

ENSC 58—Furnace Crawler

Ian Anders
Will Robinson
Liam Rybar

Advisor: Christopher Nicol
Sponsor: Kaiser Aluminum

Our project was to design and build a maintenance vehicle to move personnel in and out of the heat treat furnaces at the Kaiser Aluminum Trentwood Works in Spokane Valley Previously, Kaiser sent their maintenance personnel in on plywood sheets using the powered rollers to move the boards and personnel through the furnace. This posed a safety hazard to those riding the plywood inside the furnace. Our furnace crawler eliminates the need for the furnace rollers to be powered and allows the passengers to control the movement of the platform, therefore making the process much safer and more efficient. Some of the challenges we encountered while designing the crawler were the very small clearances within the furnace, the structural rigidity of such a large, flat design, and designing our own track system as there are no existing track systems that met our needs.

ENSC 59—Measurements Lab

Christian Knutson
Skye Aldrich
Trevor Dumais
Daniel Holman

Advisor: Dr. Tim Fitzgerald
Sponsor: Mechanical Engineering Department

The Measurements Lab senior design project's main focus was performing an investigative study on existing systems that could, at a future date, be used in the 412 measurements lab of Gonzaga's Mechanical Engineering Department. Our team was tasked with reviewing three previously completed projects. We looked for ways to improve those systems, then took those discoveries and designed solutions that we then implemented. Our three projects included: a hybrid rocket test stand, that uses HTPB fuel and nitrous oxide, to produce a measurable thrust for future students to measure; an inertia measurement device that can measure the mass moment of inertia of irregularly shaped objects; and a wind tunnel load cell that can be used to measure drag loads on bodies in airflow. Each project had a unique area of improvement and allowed us to maximize our learning as a team when we worked to determine the best solutions.

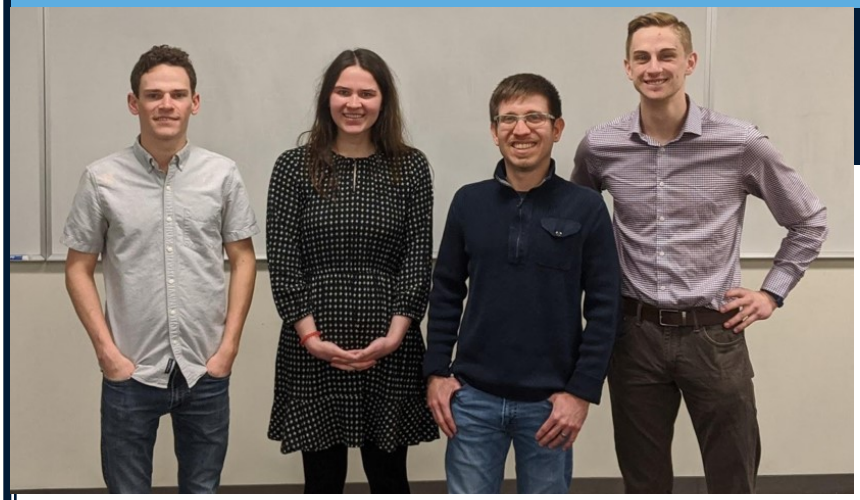
Mechanical Engineering Projects

ENSC 60—Project Design From Recycled Materials

Jackson Elsasser
Kyle Evers
Aubrey Ellerbruch

Advisor: Gabe Achenbach
Sponsor: f5

ENSC 60 is made up of three nature-loving students who want to do their part in tackling the growing volume of discarded plastics by making an innovative and effective product from recycled materials. The deliverable that our team has pursued is a fully-functioning, universal zipping device that can join any two zippers together, no matter the tooth size or manufacturer. The main purpose of this innovation is to connect two sleeping bags along their zipper to create one larger sleeping bag for joint sleeping. This product will be accessible for anyone from recreational campers to advanced backpackers. The overall goal of our group is to enhance the users experience in nature, while also giving back to nature by reusing these harmful materials.



ENSC 61—Flow Meter Loop Control

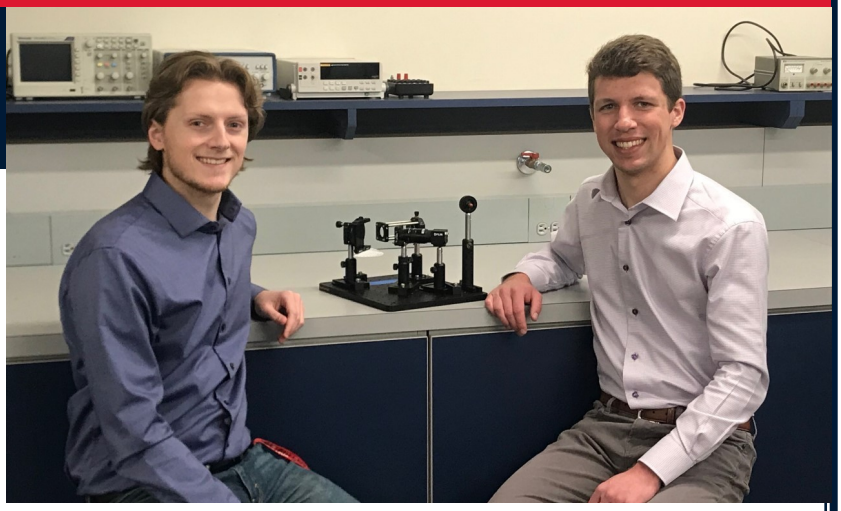
Gavin Bomber
Maegan Chmielewski-Anders
Rory Loe

Advisor: Luis Rodriguez
Sponsor: Triumph

The Spokane branch of Triumph Group manufactures thermoplastic composite parts for aircrafts. Within their manufacturing process, the parts go through a media blaster, which has occasionally caused parts to fail inspection and disrupted production due to improper abrasion. The goals of this project were to gain a better understanding of the parameters governing the machine and identify an ideal operating range. These goals were accomplished through flow research, SolidWorks modeling, and an outline for accomplishing a Design of Experiments (DoEs). The initial study DoEs were designed to test the blast pressure and air intake valve, as they were identified as the most culpable variables. The tests performed at Triumph were also able to give insight to several other variables that influence the complex machine. The final deliverable was a report and presentation to Triumph describing our method, findings, suggestions for future tests, and process control ideas.

Mechanical Engineering Projects

ENSC 62—Raman Spectroscopy



Conrad Weeks
Ethan Durbano

Advisor: Dr. Marc Baumgardner
Sponsor: Mechanical Engineering Department

The goal of our project was to develop a Raman Spectrometer to be used in the Combustion Lab of the Mechanical Engineering Department. The function of the spectrometer is to perform gas-phase chemical speciation for combustion processes. When performing combustion experiments, information about the chemical species present and their concentrations is extremely valuable, however, due to the low density of gases, obtaining Raman shift data is more difficult than testing liquid or solid samples. For this reason, commercial Raman Spectrometers capable of gas-phase speciation are often expensive. This prompted the goal of creating a high resolution spectrometer for a substantially lower price by researching and purchasing the components individually. Once complete, the spectrometer will greatly increase the research capabilities of the Combustion Lab.

ENSC 63—Recycling of Thermoplastic Composites

Alex Brummer
Seiver Lauth
Hunter Inman

Advisor: Gerry Snow
Sponsors: The Boeing Company, ATC Manufacturing, Schweitzer Engineering Laboratories

Through sponsorships from The Boeing Company, ATC Manufacturing, and Schweitzer Engineering Laboratories, this project focused on the investigation of the recyclability of thermoplastic composites. The team developed an understanding of PEKK plastics and worked to generate a theory involving the use and manufacturability of recycled thermoplastic material. The work over the course of the project included the development of a research paper outlining the mechanical properties and forming processes of PEKK. With this came suggested processes and material use outcome from the recommended strategies proposed. The team implemented their research and attempted to produce a prototype as a proof of concept of the emerging recycling process.

Mechanical Engineering Projects

ENSC 64—Repurposing Carbon Fiber Layup

Daniel Erigero
Kelsie Eagon
Kovey Palmaer

Advisor: Gerry Snow
Sponsor: The Boeing Company

Our challenge was to create a prototype to replicate the carbon fiber layup machines that Boeing uses on site, at a much smaller scale. The motivation behind this was to use the remnant materials from Boeing's current process and turn it into useable product rather than garbage, saving Boeing money and reducing their waste. This project is in its third year as a senior project at Gonzaga. Instead of restructuring what was already created, our team decided to start from scratch and redesign the entire functional element of the prototype. It was an ambitious decision, but the team decided it was the best option for the highest quality product. Over the year, the team went through a long, iterative design process, completed manufacturing while overcoming challenges, and finally completed a testing and reworking phase to create the functional prototype shown today.

ENSC 65—Refrigerated Galley Cart Compartment Door Hinge

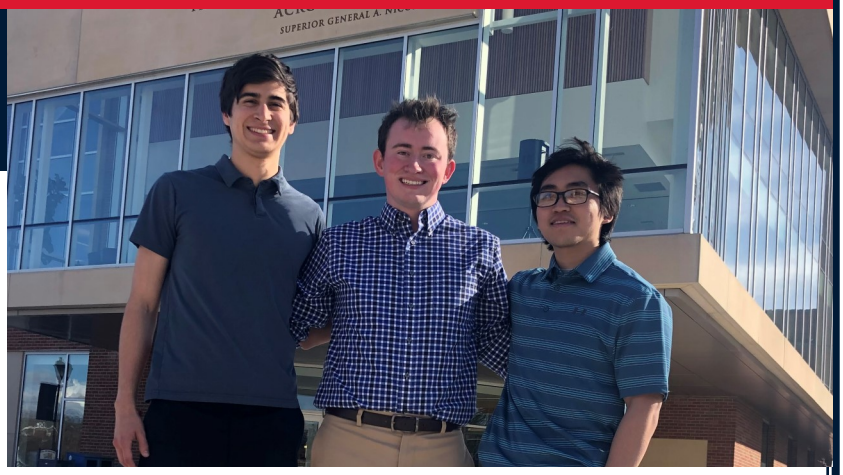
Michael Spray
Mason Matteoni
Ben Glunz
Will Smith

Advisor: Jeff Nolting
Sponsors: The Boeing Company

The goal of ENSC 65 was to increase the thermal efficiency of the refrigerated compartments in Boeing airplanes. Increasing this efficiency would allow Boeing to make the chiller units on the planes significantly smaller, saving weight and operating costs. We were tasked with achieving this goal by improving the heat transfer characteristics of the hinge on the doors to the galley cart compartments. This was accomplished by performing tests on different hinge designs and determining their feasibility for future use in galleys. We performed thermal and durability tests of our own design on several hinges and explored implementing a thermal break that covers the current hinge to provide insulation.

Mechanical Engineering Projects

ENSC 66—Tub Indexer



Jonah Sandoval
JJ Ferres
Tyler Wong

Advisor: Colleen Nolting
Sponsor: Kaiser Aluminum

ENSC 66 was tasked with creating a Tub Indexer that automatically removes an empty tub from the previously designed Tub Dumper (a senior design project from last year). The Tub Indexer that we designed is a fully automated process incorporating numerous sensors, hydraulic components and a single electrical motor that runs in tandem with the Tub Dumper through a PLC. The Indexer we created removes empty tubs, after they have been dumped by the Tub Dumper, allowing the forklift operator to be able to load another tub. This eliminates the need for the forklift operator to manually remove an empty tub. In essence, by automating this process we have increased efficiency. ENSC 66 has submitted mechanical drawings, electrical documents, bill of materials, user manual, cost-benefit analysis, and a 3D printed scaled model to Kaiser Aluminum to aid in the continual development of this project.

ENSC 67—EV Conversion Kit

Sean McCurdy
Jack Burns
John Harvey
Evan Cox

Advisor: Jim Weston
Student Proposed Project

Volt-On is a student proposed Senior Design Project that encompasses the proof of concept for a self-installed electric vehicle (EV) conversion kit for a specific, mass-produced, classic motorcycle. A donated 1978 Honda cb400a serves as our designated frame. Over the past eight months, we have coordinated as a team of four with guidance from our advisor, James Weston. We have successfully designed, manufactured and assembled a one-of-a-kind, fully electric commuter vehicle. This process has been captured within our project portfolio which contains written reports, a slide deck and complete drawing package. This drawing package includes bill of materials, weldment callouts and part drawings which guided the manufacturing process. The 48-volt battery powering the system has been custom built to meet our technical specifications for desired performance. With potential to become a marketable product, our team has coordinated with the New Venture Lab to develop a business model, conduct market analysis and research competitors. We are thrilled with how this project has turned out.

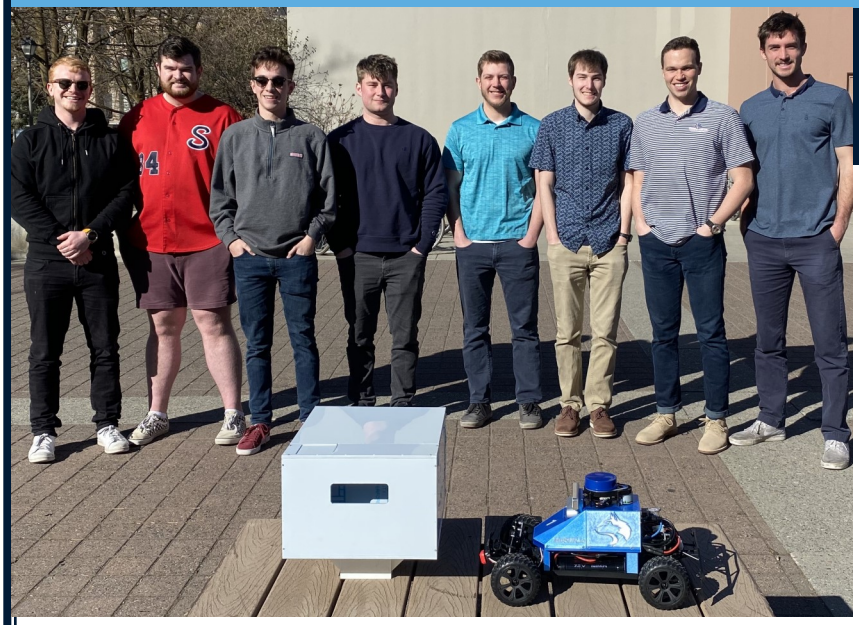
Mechanical Engineering Projects

ENSC 68—Parts Optimization for Manufacturing

Simon Derrer
Adam Pesch
Alana Andrews

Advisor: Dr. Patrick Ferro
Student Proposed Project

Our project, Parts Optimization for Manufacturing, developed a machine learning algorithm to analyze part models prior to 3D printing them with the goal of modifying the design to reduce the material usage by increasing the maximum stress the parts can take before yielding. The algorithm uses the k-nearest neighbors' method of machine learning to determine how to shape the part in ANSYS. The part is split up into a 3D grid of cells and each point is analyzed for stress concentrations, which is then used to determine which cells to fill. The new part is created and fed back into the algorithm to allow it to learn even more. We used enlarged tensile testing specimens, to enable more possible modification to the sample. To train the algorithm we used data from ANSYS, as well as occasionally testing these samples using a tensile testing machine.



ENSC 69—Autonomous Delivery Robot

Scott Younker
Ryan Barclay
Adam Tinucci
Isaac Vanderbosch
***Also pictured: CPSC 06**

Advisor: Anas Delane
Student Proposed Project

The Gonzaga University Autonomous Delivery Robot project set out with the goal of providing a delivery option for on campus stores. Being as cars can't access most locations on campus, our teams have designed and develop an autonomous delivery robot, capable of navigating campus to deliver items that were ordered by users on our corresponding web application. Our custom designed user-facing web application allows users to place and receive orders to their specified location. To attain a fully autonomous vehicle, we have designed software which will enable the robot to navigate autonomously utilizing continuous planning and object detection. This has been accompanied by a user-friendly and sleek food delivery box which has captured the ability to safely and securely store, transport, and deliver the goods that have been ordered. This provides the platform by which the vehicle design and software components integrate to form the Gonzaga University Autonomous Delivery Robot.

Mechanical Engineering Projects

ENSC 70—Space Forks

Jack Williams
Thomas Schmidt

Advisor: Anas Delane
Sponsor: Woodburn Nursery and Azaleas
Student Proposed Project

The goal of this project was to develop a forklift attachment that will automate plant spacing at plant growing nurseries. The primary reason is to make the spacing process more ergonomic, time efficient, and less expensive for our sponsors, Woodburn Nursery and Azaleas, and all nurseries faced with this problem. Through extensive research and communication with our sponsors, Solidworks models and a scaled working prototype of a forklift attachment was created that will pick up the plants, separate the plants into the desired spaced orientation, and then finally unload the plants. The success of this project would cut a two-person operation down to one person and save our sponsors about $30,000 a year.

ENSC 71—Magnetically Repulsed Hip Joint Replacement

Joseph Heston
Megan Nakamura
Charles DeBiase
Madeline Robinson
Bassel Mufarreh
Advisor: Shane Pacini
Student Proposed Project

Currently, individuals under the age of 50 who undergo hip replacement surgery have an 80% chance of requiring secondary surgery within 10 years. Coupled with increasing need for hip replacements among people aged 45 to 54, the need for longer lasting hip joint replacements is undeniable. ENSC 71's solution is a hip joint replacement that utilizes magnetic repulsion to reduce contact forces, thus reducing longitudinal wear and increasing the longevity of the joint. The team designed multiple magnetically repulsed hip joint replacements in Autodesk Inventor Professional 2019, evaluated their magnetic characteristics using ANSYS Discovery AIM, and simulated these effects on the average person's gait within OpenSim.

Mechanical Engineering Projects

ENSC 72—Methanol and Refrigeration

Josh Holsopple
Jackson Wills
Ben Broadstone
Finn Semling
Advisor: Dr. Marc Baumgardner
Sponsor: Mechanical Engineering Department
Student Proposed Project

Many locations in today's world are without reliable electrical grid access. Many of these same locations also receive abundant solar irradiation energy. Our project uses this energy to run a solid adsorption refrigeration cycle with methanol and activated carbon as the adsorbate/adsorbent pair. Our cycle does not involve electricity, rather the radiation energy from the sun is used to pressurize the methanol during the day – this step is analogous to the compression stage in vapor compression refrigeration cycles. Additionally, the system is instrumented to be lab-ready for the Mechanical Engineering Department. Our project, SID-MACC (Solar Irradiation Driven – Methanol/Activated Carbon Cooling) will hopefully enter the market soon. We believe that our project can meet demands of off-grid health clinics in Kenya seeking to reliably keep vaccines at safe temperatures.

ENSC 73—Folding Knife Lock System

James McCall
Kevin Palmer
Michael Gasser
Elijah Wolf

Advisor: Andy Johnston
Sponsor: Buck Knives

ENSC73 Focused on designing a new locking mechanism for foldable pocket knives. We worked with Buck Knives to research existing products and develop a new locking system that would be safe, ambidextrous, and innovative. Through a series of design iterations, we were able to narrow our initial three concept ideas down to one final design that was developed into a working prototype. The final product is a well-tested and prototyped knife with the new locking mechanism in place, ready for production.

Mechanical Engineering Projects

ENSC 74—Knife Blade Rate Meter

Jason Orr
Daniel Dzenitis
Kevin Makens

Advisor: Christopher Nicol
Sponsor: Buck Knives

This project acted as a continuation of a 2019 Senior Design project with the intent of iterating a knife blade rate meter for spring-loaded knives. Utilization will allow for standards to be developed within the factory followed by quality control at the completion of each knife. Upon usage, the knife is individually placed into an insert and clamped using a simple mechanism. The finished rate meter has the capacity of measuring, among other calculations, average velocity and acceleration of the knife upon engagement via infrared photogates, as well as the output of said data on a touchscreen display. Following data collection, exportation allows for ease of access across a multitude of devices. In general, the work began as research to determine the best method of iteration and concluded with the development of concept based on client priorities.

ENSC 75—Workshop/Dust Collector

Peter Szymonowicz
Christie Kaldestad
Luke Hartman

Advisor: Debra Offill
Sponsor: Riverview Retirement Community

Riverview Retirement Community has a state-of-the-art woodworking shop that is used by both the residents and the Spokane Woodturners Club. The dust collection system that was in place did not fulfill the needs of the community. Excess dust was collecting in the ducting, causing a decrease in total airflow and a safety concern. The Gonzaga Senior Design Team was tasked with providing solutions to improve the existing system by making it safer and more efficient.

THANK YOU to our Sponsors!

The design projects and resources required to implement the many engineering and computer science projects during the 2019-2020 academic year were generously provided and supported by the following sponsors:

Above: CPSC 10 working on coding for their phone application, which helps tenants in the Spokane area understand overall utility and rental costs for a property, while simultaneously bringing an awareness the positive impact efficient homes have on the environment.

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