Gonzaga University

School of Engineering & Applied Science

Center for Engineering Design & Entrepreneurship

Design Exposition Day

May 3, 2017

GONZAGA UNIVERSITY | School of Engineering & Applied Science

Message from the Dean

To Our Seniors and Design Exposition Day Attendees:

On behalf of our School of Engineering and Applied Science, I would like to welcome you to Design Exhibition Day.

To our visitors, please know that this day represents the culmination of a year of creativity, team effort, and hard work for our seniors, their faculty, their project partners, our support staff, our Design Advisory Board and numerous others involved with the senior capstone experience. We hope that you have the opportunity to recognize the work of our seniors in transforming what were simple proposal ideas in September into the final designs and design presentations you see before you today.

To our seniors, I hope that you recognize that, through your detailed planning, challenges, frustrations, and accomplishments associated with these projects, you have gained real-world experience to carry forward into your professional and life experiences. Thank you for your dedication and efforts. In particular, I want to express my deep pride in the many and diverse accomplishments of this, our largest ever, senior class. Thank you for the honor of being your Dean throughout your Gonzaga experience.

I want to congratulate all of you for the effort that has brought you to this day, an effort that began not just last September, but when you first entered Gonzaga as freshmen or transfer students. Please know that all of the faculty and staff of our School welcome you to a profession in which you can find life-long excitement, continuing opportunities to challenge and improve your skills, and many opportunities to serve both humanity and nature as reflections of God's creation.

Stephen E. Silliman
Dean of Engineering & Applied Science

Message from the Academic Director

Congratulations to our Capstone Class of 2017! We proudly celebrate your success and accomplishments today! We wish you the best in the future and hope that you will keep us updated on your post-graduation engineering and computer science experiences.

Thank you to all the people who support the education of our students and help to foster the next generation of engineers and computer scientists. Your gifts and mentorship help sustain and grow our program. We especially thank the sponsors who supply the capstone projects and the liaisons to guide the students. Thank you to the faculty, staff, Design Advisory Board and Capstone Committee.

Go Zags!

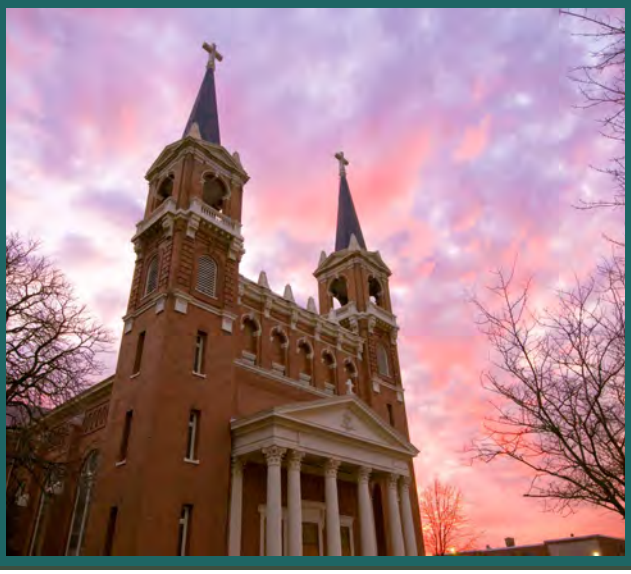
Toni Boggan
Academic Director
Center for Engineering Design & Entrepreneurship

Welcome to Design Exposition Day 2017

Gonzaga University's Center for Engineering Design & Entrepreneurship was established in 1992 to enhance the design experience for senior engineering 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 and computer science 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 can work on it during their Capstone year. In the 2016-2017 school year, twenty of the 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).

Employer of the Year – Avista

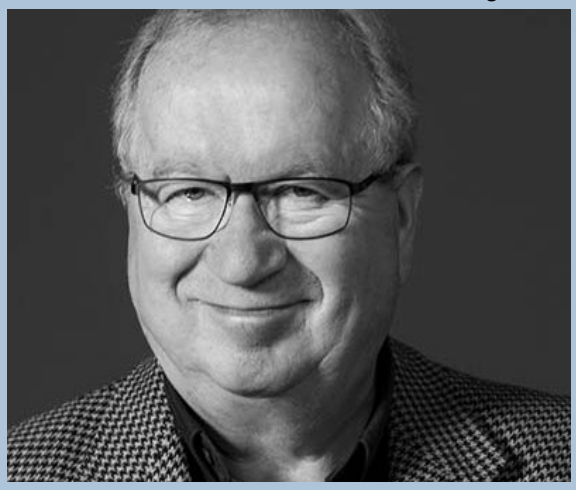
The Center for Engineering Design and Entrepreneurship is indebted to many public and private entities that have sponsored and supported senior projects during the past 25 years. The students have benefitted from the guidance and expertise of the liaisons that the companies have provided and the resources they have supplied. In an effort to recognize these contributions, one sponsor per year is named as the Outstanding CEDE Sponsor.

The Outstanding Sponsor of the Year for 2016 – 2017 is AVISTA. AVISTA has collaborated with Gonzaga's CEDE program for over 20 years, and sponsored approximately 40 projects. AVISTA provides strong liaisons for our projects, which assist our students in their professional development. These dedicated professionals have influenced dozens of our seniors and help put them on a pathway to success.

Thank you, AVISTA, for your commitment to the Spokane community and to Gonzaga's School of Engineering and Applied Science!

CEDE Excellence Award – Les Bohush

The CEDE Excellence Award is presented to recognize an outstanding contribution to the Senior Design Program. The 2017 CEDE Excellence Award is proudly presented to Les Bohush for his long-term commitment to the Capstone Program.



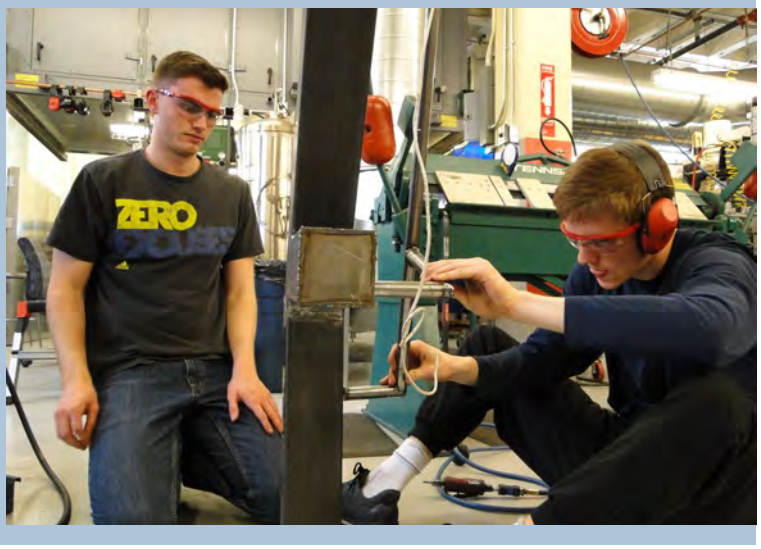
Since the creation of the Center for Engineering Design and Entrepreneurship (CEDE) in 1992, a group of dedicated volunteers known as the Design Advisory Board (DAB) has supported Gonzaga students from the School of Engineering and Applied Science. These DAB members are engineers and computer scientists who lend their expertise to the student teams by attending project presentations and completing design reviews. The Excellence Award for 2017 is presented to Les Bohush for his amazing 25 years of service to this board.

Les is always first in line to assist the center by his involvement with our student teams. He has served as a sponsor, recruited DAB members and referred companies that have sponsored projects. Les received a master's degree in mechanical engineering at the Technical University in Kosice, Czechoslovakia and is a licensed Professional Engineer. A member of American Society of Mechanical Engineers (ASME) since 1971, he was named the Engineer of the Year in 1980 by the Inland Empire Chapter of ASME. He operates a consulting company called ECC (Electronic Communication Consultants) and is the senior vice-president at Gibby Media. Les and his wife, Katarina, have been married for 52 years.

Thank you, Les Bohush, for your dedicated service!

Student Design Teams

Senior Design teams usually consist of three to five students and a faculty advisor who work with a liaison from a sponsoring company. The students' initial task is to generate a plan and define strategies that will bring the project to fruition. Students must make effective use of available resources to manage their project activities. Specific milestones are identified, including written reports and oral presentations. Faculty advisors lend knowledge and experience to each team with guidance in the technical and managerial decisions required by the project. Liaisons help monitor team progress and assist in making the best use of the sponsor's resources and facilities. Some projects are multidisciplinary, reflecting the importance of collaboration across skills to solve real-world problems.



Computer Science

CPSC 01
Dragon Academy

Jasmine Jans
Kristina Spring
Myanna Harris
Jimmy Sherman

Advisor: Rob Bryant
Sponsor: Next Generation Zone
Liaison: Trina Clayeux

Our main goal for our senior design project was to provide a more accessible and less expensive option of GED preparation to students at the Next Generation Zone, a young adult career center in Spokane. We wanted to create an Android mobile app that helps students who have a more kinesthetic learning style and who respond better to constant feedback and attention. Our app, Dragon Academy, comprehensively teaches 24 algebra math lessons of the GED. In each lesson the user is taught through videos, pictures, examples, a game and a question and answer assessment. Our app also provides a great deal of encouragement and positive feedback through achievements that the students can earn while using the app and through accessories they earn at the completion of each lesson that they can use to dress up the main character of the app, the dragon. Our mobile app also features study tools such as a fraction to decimal converter and a slope calculator that further helps students learn GED math skills outside of the 24 algebra lessons.

CPSC 02, Pizza VRia

Patrick Chadbourne
Nicholas Gibson
Gina Kirkland
Christopher Leu
Andrew Robbins

Advisor: Rob Bryant
Student proposed project
Sponsored by Gonzaga University

Pizza VRia is a virtual reality game designed for the HTC Vive. The player wears a headset that shows them a 3D recreation of a pizzeria. Two controllers are used to let the player use their hands for a variety of tasks, such as placing ingredients and picking up a pizza peel. The player receives orders that are randomly generated and is then give money for how well they make the pizza; the better the pizza, the more the cash. Purchasing ingredients and managing stock is left up to the player so they can have full control of their new business.

Computer Science

CPSC 03, Sports Activity App

Jimmy Boyle
Emily Suhadolnik
Bert Heinzelman

Advisor: Shawn Bowers
Student proposed project
Sponsored by Gonzaga University

CPSC 03 worked on a web application developed for people who are looking to be involved in recreational sport games and activities in their community. The app will serve as a hub for facilitating sports games and activities. Users can login and search for what other sports people are currently playing. If they find a game they wish to participate in, it is easy to join the activity and they will be kept up to date on anything related to their chosen game(s). Users can easily create a game or activity that others can join. Sports enthusiasts will no longer have to find the proper Facebook pages or groups to join in order to be active in their community. This app will serve as a way to bring people together to continue playing the sport they love.

CPSC 04
Off Campus Housing App

Leah Talkov
Elma Herrera
Scott Taylor

Advisor: Shawn Bowers
Liaison: Megan Wertman
Student proposed
Project sponsored by
Gonzaga University

Our project is an iOS app, named OCHA, that provides Gonzaga students with a new way to find off-campus housing. The app provides up-to-date apartment, house and room listings in the Gonzaga area, filters to help students narrow down their search, and the ability to favorite a property so they can return to it later. Student-created property reviews provide students with insight into the overall quality of a property. Additionally, OCHA gives landlords a quick and mobile way to create and edit property listings that will be viewed by Gonzaga students.

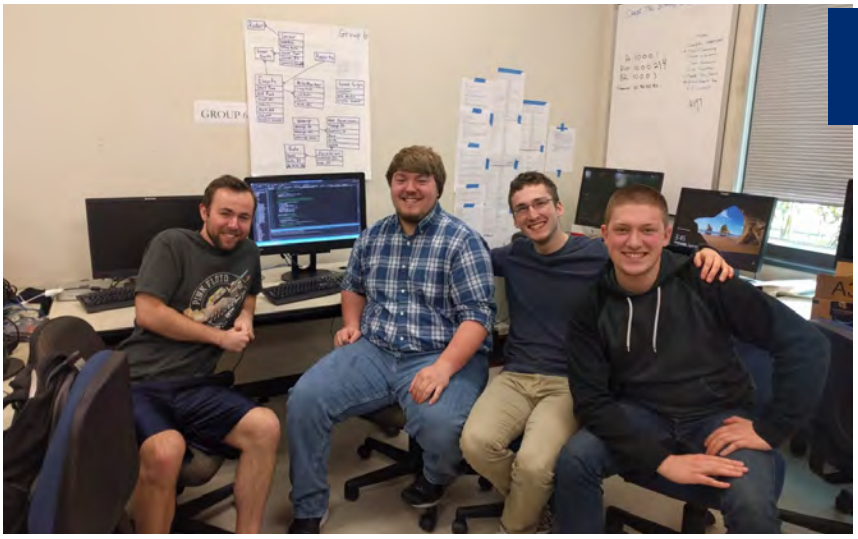
Computer Science

CPSC 05, Live Band Mix

Spencer Ballo
Tony Wang
Bethany Bogensberger
Luke Johnson

Advisor: David Schroeder
Sponsor: GU Center for Engineering Design and Entrepreneurship
Liaison: Patrick Nowacki

We set out to create a website that would facilitate productive communication between artists and their audiences. At live events, we wanted audience members to be able to request songs, chat with the artist and others attendees, and rate the songs that were being played. We created a mobile web application so that attendees could participate without installing any new application. By simply entering a code that the artist displays at the concert, an audience member can become a part of a digital space where they can participate in a whole new but familiar way. We learned a lot during the creation of exogig. We were new to web development and we choose to use only new languages, frameworks, and tools that are useful to know in industry. We have learned a lot and made a useful tool for connecting artists with their audience members.



CPSC 06
Traffic Operation Portal

Dominic Soares
Christian LaPlante
Michael Barclay
John Houston

Advisor: Bruce Worobec
Sponsors: WYDOT and McFarland Management
Liaisons: Vince Garcia, Fred Kitchner

CPSC Team 06 is working with the Wyoming Department of Transportation to analyze and package all of the traffic data that they are collecting for Interstate 80. Through the use of a web portal, the traffic data is collected from the sensors and displayed using graphs and tables. The data can also be packaged into reports, allowing specific analysis on past weather and traffic events. This platform will be used by the Wyoming Department of Transportation to analyze their response effectiveness to weather and traffic emergencies.

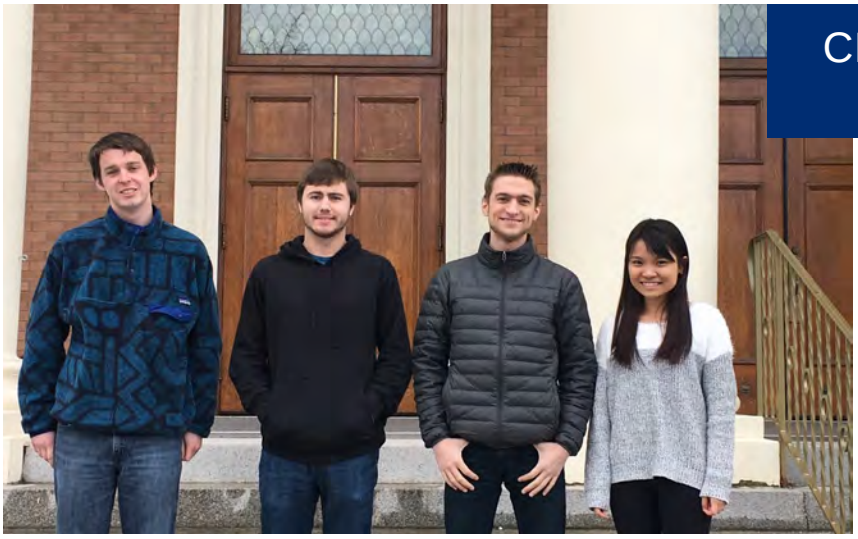
Computer Science

CPSC 07, Smart Cities

Malcolm Chaney
Carter Timm

Advisor: Shawn Bowers
Sponsor: Avista Utilities
Liaison: Mike Diedesch

Our project entails the design and implementation of a communications interface between the Avista corporation and smart-buildings. These buildings are pre-equipped with devices known as building automation controllers which manage building subsystems such as HVAC and lighting. Avista wants to be able to send a message to buildings and have those interpreted into a language that these building automation controllers can understand. With this interface, Avista can control these building subsystems to optimize energy usage and power flow across the grid.



CPSC 08, Social Platform for Higher Education

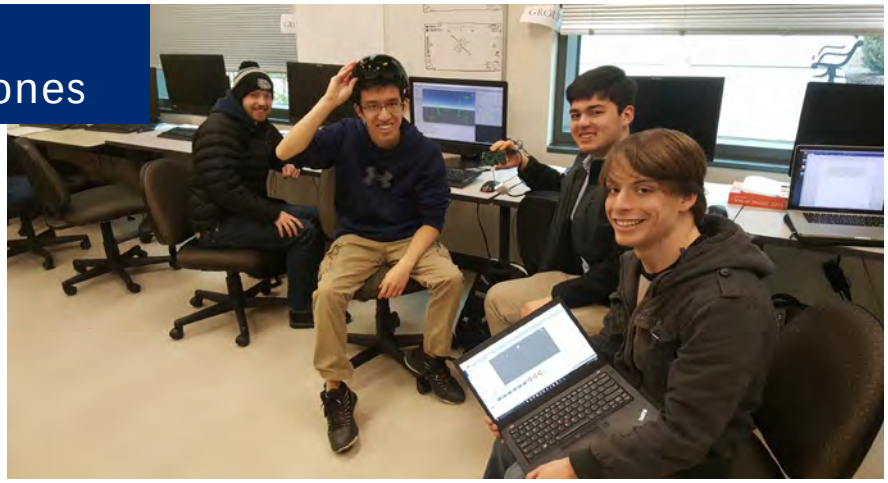
Darragh Ruane
John Bac
Blake Erickson
Van Nguyen

Advisor: Bruce Worobec
Sponsor: Revive Education
Liaison: Preston Ramirez

This year, our goal was to create a user-friendly gradebook that gives professors the tools they need to tailor their courses to the needs of their students. To do this, we looked into the ways one could expand the capabilities of a gradebook to create a system allowing professors track the progress of both individual students and entire classes, provide feedback, and have discussions outside of the classroom. We started off by building a basic gradebook designed to be as easy to use as possible and from there we integrated the rest of our features, including survey tools, a discussion forum, detailed grade analytics and a dashboard to display them. We incorporated professor and student feedback gained through extensive testing to deliver a polished and user-friendly experience. By adding these additional features we believe that Revive can become an extremely useful tool that students and professors enjoy using.

Computer Science

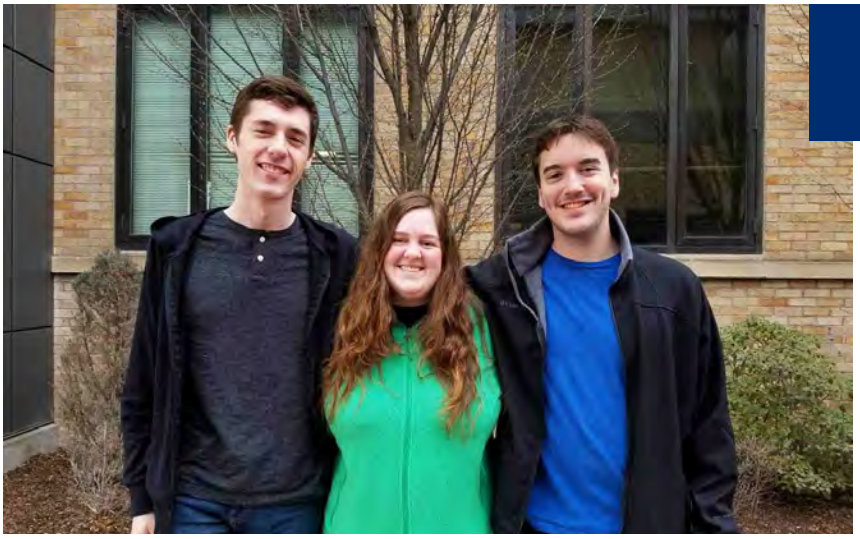
CPSC 09
Telemetry System for Drones



James Black
Kevin Do
Grant Ikehara
Jordan Boulanger

Advisor: David Schroeder
Sponsor: Paraxis Air Sports
Liaisons: Jesse Marcel, Brent Barr, Chinery Lutkin

Our goal for the Heads-Up Telemetry for Drones project was to develop a heads-up display (HUD) for users of Praxis Air Sports' personal air vehicle. This vehicle, much like a skateboard that can hover, is still in the early design phase. When on the vehicle, riders need access to flight information, such as airspeed and altitude, so we decided to use an augmented reality device, the Microsoft HoloLens, to display graphics directly within the user's field of view. To obtain the information, an external Raspberry Pi computer generates flight data and sends it to the HoloLens over Wi-Fi. Later, the Pi will collect real data through sensors. Other displays include current g-force, fan speed, temperature, and a compass/turn angle display. We decided to incorporate elements of military aircraft HUDs along with video game influences to make the displays easy to understand and "cool" to look through.



CPSC 10, Water Rescue Dive App

Mark Houston
Katreina Carpenter
Andrew Burke

Advisor: Shawn Bowers
Sponsor: Spokane County Sheriff's Office
Liaisons: Michael Mudge, Jon Thorpe, Thad Schultz

Computer Science Team 10 has worked closely with the Spokane County Search and Rescue Dive team to develop a data collection and management software to be used on ruggedized field laptops during search and rescue dive missions. The primary goals of this software are to aid Spokane County's dive team by providing a straightforward and reliable method for collecting data before, during, and after dive operations, and to incorporate database functionality to store, maintain, and generate reports from diver and mission records. Written in C# under Microsoft's .NET framework, this student developed application will be handed off to Spokane County's IT department for further refinement before being integrated into the Search and Rescue Dive Team's work flow.

Mechanical Projects

ENSC 01, Food Waste Energy Generator

Walker Capra-Smith
Tyler Hamke
Harrison VanTil
Conner Brueske

Advisor: J. McCall
Liaisons: Kylie Allen, John Cleary
Student proposed project
Sponsored by Gonzaga University

In developing countries, access to electricity is not always secure and many areas are not connected to a reliable electric grid. Having a source of electricity to charge cell phones and provide lighting after dark is vital for daily life. Conventional fuels can be quite expensive, however organic waste is a potential source of energy that is currently unutilized. To address these issues, this project focused on developing a system to convert food waste into useful energy. A small scale anaerobic digester, which converts food waste into combustible biogas, was designed and tested. Additionally, a Stirling engine was designed to convert the biogas into electricity. Based on modeling and testing of these sub-systems, a complete design kit has been published which details the design and operation of the overall system.

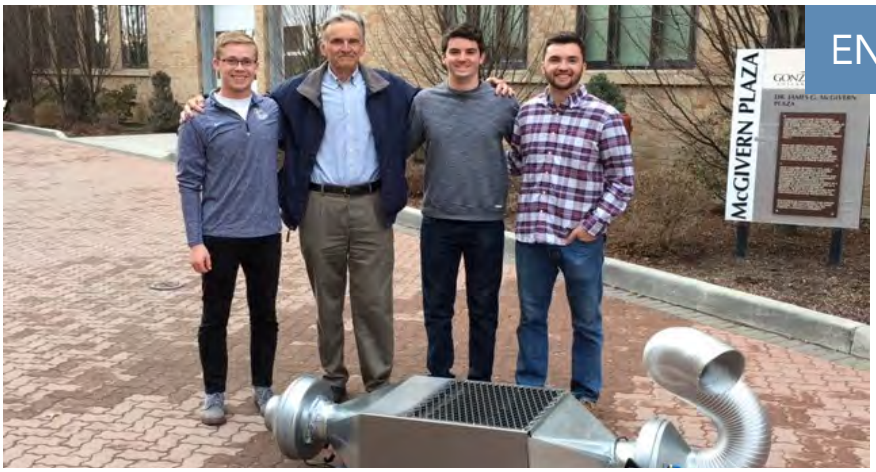
ENSC 02, Geared Differential

Evan Purdy
Zach Parker
Ryan Cook
Sawyer Crane

Advisor: Chris McFarland
Sponsor: SAE Baja Club
Liaison: Marc Baumgardner

The geared differential is designed to replace the unit that was previously used in the Gonzaga Baja car. The previous geared differential is an off the shelf Dana H12 gearbox from a Gravely Treker UTV. It weighs approximately 35lbs, has a 10.15:1 gear ratio, an open differential, and incorporates a reversing gear. The geared differential we have designed is smaller in exterior dimensions, has a 9.67:1 gear ratio, a spool instead of a differential (i.e. both half shafts are locked together), and only a single forward gear. These characteristics are important to improve the performance of the vehicle acceleration and top speed without reducing the torque output significantly.

Mechanical Projects



ENSC 03, Pipeline Ventilation

Tyler Shellenberg
Tim Przybyslawski
Tucker Toelke

Advisor: Jacob Late
Student proposed project
Sponsored by Gonzaga University

Our group developed a working prototype of a ventilation system that would help create a safe working environment for pipeline entrants. This unit would mitigate the harsh working conditions caused by heat that entrants must face while conducting maintenance on utilities used during the installation phase of the pipeline. It will provide additional air conditioning and ventilation for the entrant that is unavailable to them while inside the pipeline casing. A transport cart, which is already used by the entrant to travel to the desired area for maintenance of the pipeline, will tow the unit so that the entrant has cool air wherever they may work. Our unit will help reduce the amount of time pipeline and tunneling jobsites are shut down due to working conditions and help those companies save money and time on projects.

ENSC 04
Piper Cub Pontoons

Andrew Ringquist
Nick Bice
Michael Thomas
Adam Haldeman

Advisor: Gabe Achenbach
Liaison: James Haldeman
Student proposed project
Sponsored by Gonzaga University

Our project consisted of designing an attachment point for pontoons for a J5 Piper Cub aircraft. This involved: frame design, pontoon modeling, attachment brackets, and submittal of FAA paperwork to the owner for review. In order to achieve this goal, we needed to create three-dimensional models of the frame of the aircraft and the pontoons. These models were used for stress analysis of the aircraft's frame, and buoyancy calculations of the pontoons. We used both computer simulations and hand calculations for this process. At the end of the project, we completed a drawing package for the owner of the aircraft, advising on what would be required for a retrofit. We also filled out the FAA STC paperwork for review by the owner to begin the process of FAA certification of the aircraft.

Mechanical Projects

ENSC 05, Real Design Matters (ME)

Jeff Shaw
Chad Hawn
Nick Brandon
Alex Gross

Advisor: Anthony Schoen
Student proposed project
Sponsored by MW Consulting Engineers

As a group, we wanted the senior project to be a meaningful experience where we learn the design process as practiced in our profession as engineers. To do this, we have taken a building that was designed locally in 2016 and performed a redesign for the heating, ventilation, and air conditioning (HVAC) system. This system is not intended to replace the current system, but to allow us to learn the process of professional design work. In addition to our group, a civil engineering team has redesigned the structure of this building and we have coordinated with them throughout the design process.

ENSC 06, Hybrid Still

Zachary White
Marilyn Hoag
Brett Paul
Kyle Ishikawa
Kalev Sepp

Advisor: Steve Silliman
Student proposed project
sponsored by
Ron and Sara Seubert

The aim of this project is to design a water purification system for off-grid health centers in developing countries. This system will provide these health centers with an adequate quantity of water for the use of sterilizing medical tools, cleaning woods, and other hospital needs. After reviewing a number of distillation techniques, the chosen focus for this project was an active distillery system. An active still utilizes external energy sources to heat water to a point of evaporation as well as to cool a surface for the water vapor to condense on. The proposed system will harness solar energy via solar panels for the energy demand. An analogue control system will regulate both the heating and cooling of the distillation process. Theoretical analysis of the various design components guided the design and production of a 1/5 scale-working prototype. The 1/5 scaled-production prototype was tested to verify that the theoretical model can be used to size a unit for any specific environment, desired production rate, or energy demand.

Mechanical Projects

ENSC 07, Automated Vehicle Platform

Aaron Schramm
Weston Staab
Joe Keane
Chris Hines

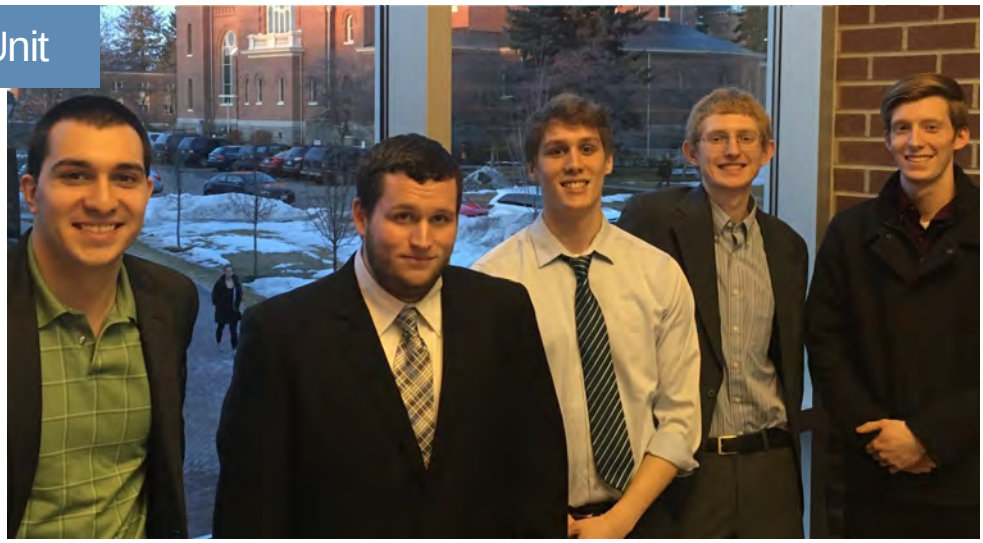
Advisor: Colleen Nolting
Student proposed project
Sponsored by Gonzaga University

Starting with the ambition to construct a solar powered, automated lawn mower for sports fields, ENSC 07 refined the project to focus on the automation aspect. With the Automated Vehicle Platform (AVP) as the new scope, the team began to break down the problem into its key elements: vehicle design, path planning, and sensor implementation. The vehicle was designed to emulate a mower. Path planning a safe, efficient, and executable route was critical for the project to stand out from automation competitors like Roomba, via exponentially increasing the efficiency. The team forged the AVP path planning by blending and modifying existing CAD and CNC software. The vehicle's sensor design enables the AVP to monitor its surroundings, facilitate the path planning and maintain safety. ENSC 07 has successfully constructed a prototype e vehicle capable of converting human inputted geometry into an executable path.

ENSC 08, Tire Inflation Unit

Luca Capobianchi
Aaron Breen
Cameron Brown
Patrick Moeller
Wesley Egan

Advisor: Mason VanLith
Liaison: James Weston
Student proposed project
Sponsored by Gonzaga University



The goal of the Tire Inflation Unit project is to design and build a device that continually monitors and adjusts tire pressure of most consumer vehicles. Our finished device converts the heat generated by the braking system of a car to power a small compressor. It does this by having the heat transfer through thermoelectric generators, which then store electrical energy in batteries. The system is mounted behind the wheel of the vehicle and would be able to communicate with an LCD or smartphone on the dashboard to let the user know when the tires are being inflated and what pressure each tire is at. Such a device would eliminate fuel loss due to underinflated tires, as well as extend tire life.

Mechanical Projects

ENSC 09, Apex Trekking Axe

Amanda Johnson
Luke Lafontaine
Neville Morris
Michael Konopaski
Mollie Freel

Advisor: Art Miller
Sponsor: SmartALEX Product
Liaison: Alex Kortuem

The Apex Trekking Axe is a unique tool that is designed to combine the functions of two common pieces of mountaineering equipment. Our device performs both as a trekking pole and a self-arresting axe. The main goal of this project was to improve upon the two existing forms of this hybrid tool; the Grivel Condor, and the Black Diamond Whippet. The Apex Trekking Axe features a blade that recedes fully into a compact trekking pole grip, distinguishing our design from the two competitors. Our design was inspired by the innovation of our team combined with the guidance of expert mountaineers. Throughout this project we emphasized simplicity of operation, integrity of assembly, and elegance of form.

ENSC 10, Edge Seal Application

Mateo Ledesma
Meghann Kenneally
Kevin Kearney
Lauren Spencer
William Nemitz

Advisor: Pat Ferro
Sponsor: ATC Manufacturing
Liaisons: Mark Puyear, Phillip Montour

The goals we set, in conjunction with ATC Manufacturing, have stayed relatively the same: applying epoxy to the carbon fiber edge within specification and increasing process efficiency to decrease costs. After 8 months of idea collaboration, testing, analyzing, failing, rethinking the process, failing a little less eventually making serious progress, and working with talented engineers and advisors, we have been successful. We now have a robot at ATC Manufacturing programmed to meet specifications for multiple geometries while increasing efficiency by tenfold. As a result of our work, what used to take between 5-7 minutes per part now takes 30 seconds by reducing not only the manual application, but also post-drying touch-up work.

Mechanical Projects

ENSC 11
Flood Control System

Benjamin Dubois
Veronica Do
Mitchell Beard
Patrick Marinelli

Advisor: Josh Fort
Sponsor: Altec
Liaison: Greg Partch

This re-usable flood bladder system is designed to mitigate damage from floods with a maximum height of one and a half feet, in a manner more efficient than sandbags. It consists of a rubber bladder, air compressor, pressure-relief valve, water pump, and pressure switch. These components come together to create a system that allows residential homeowners with a limited water source to completely fill their system within five hours, compared to the eleven hours needed when only using a basic hose. The bladder system is set up to fill simultaneously with the hose and air compressor initially for one hour. At which time both can be removed and replaced with the water pump. The water pump is designed to pump flood water, allowing for a more rapid fill rate. After the flood danger has passed, the bladder may be opened, drained, and then stored away until the next flood event.

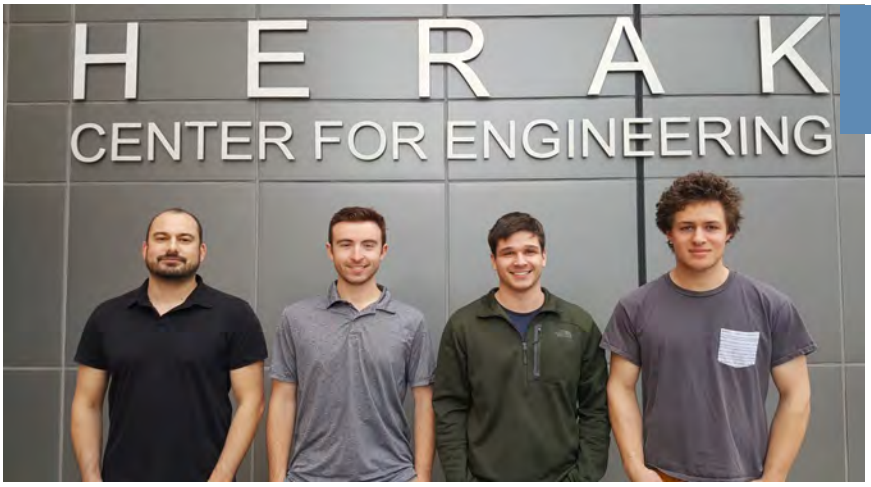
ENSC 12
User Engagement System

Mitchell Ellingson
Luke Hatanaka
McKenzie Andreatta
Scott Acker

Advisor: Rich Thomas
Sponsor: Next Gen Tech Bar
Liaison: Scott Griffith

Our project dealt directly with the space within the Hemmingson Center called the Next Gen Tech Bar (NGTB). The NGTB has the mission of getting students, faculty, and staff interacting with and around advanced technology. Currently, the NGTB has no way of tracking total usage or specific reasons for use of their space. Our group has designed and implemented a machine that solves this issue. We created a series of mechanisms that are not only visually appealing to the user but also track basic metrics for the NGTB. Our system allows people who visit the NGTB to select one of eight possible categories corresponding to the reason why they entered the space. This data is stored both physically and digitally for the NGTB use.

Mechanical Projects



ENSC 13
High Static Pressure Fans

Cameron Johnson
Michael Schoen
Michael Nadig
Joshua Alexander

Advisor: Bob Reed
Sponsor: Praxis Air Sports
Liaisons: Jesse Marcel, Brent Barr, Chinery Lutkin

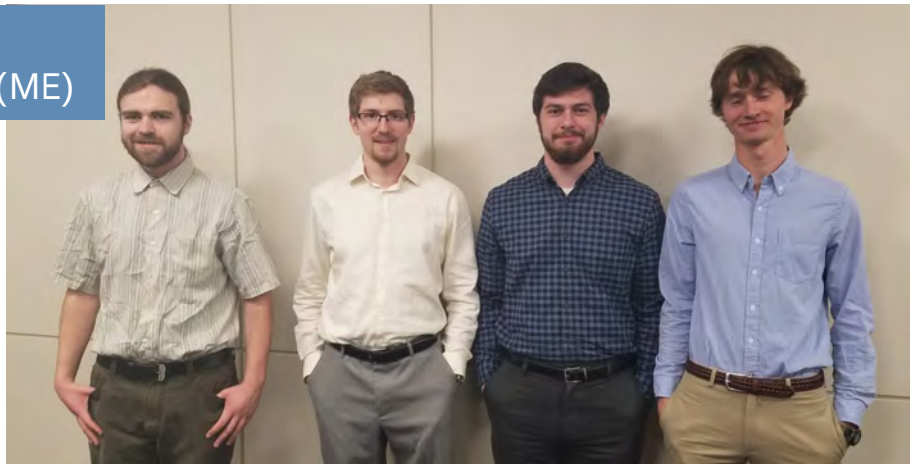
We were contracted by Praxis Air to design and manufacture an electric ducted fan (EDF) prototype that provides high static lift while maximizing efficiency. The goal of this project was to serve as a proof of concept that our design does work and could be scaled up for incorporation into a hover board.

Our first step was to research how EDF's work and how to design one. Having only a very basic understanding of aerodynamic properties, it took us a large amount of research to reach a point where we were ready to begin designing.

We also worked with Cascade Composites to prepare our design for manufacturing. Cascade was extremely helpful, and offered to print our propeller for free as a donation to the school.

We then built a test bench and conducted a series of tests to determine our EDF's performance, measuring criteria such as power input and thrust.

ENSC 14
Energy Conversion System (ME)

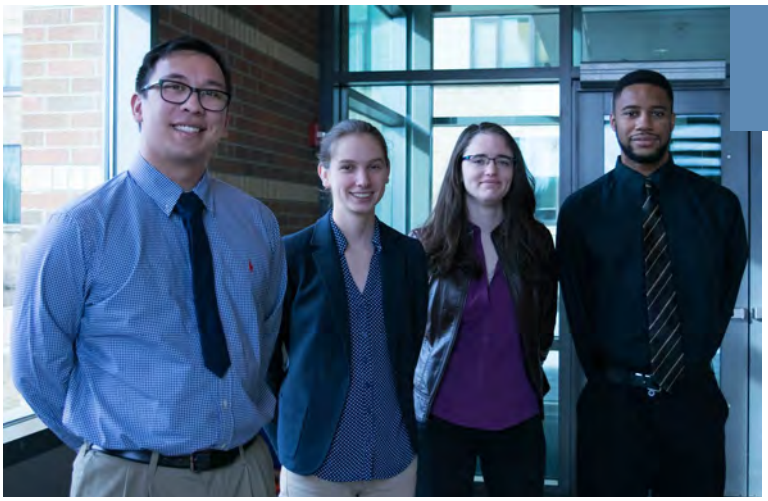


John Jozwiak
Cedar Kelly
Richard Postera
Sean Johnson

Advisor: Art Miller
Sponsor: NIOSH
Liaison: Eric Lutz

The goal of this project was to take hot groundwater out of deep underground mines, and convert the energy in that water to usable power. This power could then be used to cool the mine and to pump the hot water away. This was achieved using a Stirling engine, which runs off the temperature differential between a hot and cold source. The hot source was the groundwater in the mines and the cold source was river water that was already being brought down in order to run systems already in place in the mine. A Stirling engine could generate power at a reasonable efficiency with the given relatively small temperature differential (80°F). Building a Stirling engine is difficult because it has to function with the smallest possible amount of friction without lubrication, or loss of pressure. We designed, manufactured and tested our engine with all of this in mind.

Mechanical Projects



ENSC 15, 3D printing of Orthotic Braces

Nicholas Johnston
Katherine Wagner
Heather Bucklin
Kai Phillips

Advisor: Bryan Woodberry
Sponsor: Gonzaga Center for Engineering Design & Entrepreneurship
Liaison: Peter Springs

The goal of this project was to identify a 3D printed material that would be suitable in manufacturing an ankle foot orthosis (AFO). AFO are braces worn on the foot and ankle that assist people with poor muscular control, enabling them to walk. The current process for constructing AFO is time consuming and doesn't allow for much modification. Switching to a 3D printed process would have the benefits of reduced time costs as well as the ability to further customize the product to each patient's needs. The team conducted materials research including tensile and relaxation tests to identify promising materials and then printed half scale AFO models to demonstrate the viability of these materials for use in AFO manufacture.

ENSC 16, Alternative Fan Base

Gustavo Flores
Emilio Chacon
Alex Yuska
Hannah Ebi
Charles Marks

Advisor: Ryan Leahy
Sponsor: Haakon Industries
Liaison: Cole Youngers

The goal of this project was to design, prototype, and test an alternative to the current fan base Haakon Industries creates for use in their custom air handling units and HVAC equipment. The current process for producing the fan base is labor intensive with up to 12 hours of labor and waiting time, and our project has addressed these issues in the manufacturing process with an alternative design that takes roughly twenty minutes to manufacture. Haakon Industries excels at sheet metal manufacturing, therefore our design of a sheet metal fan base has added value and cut costs to the manufacturing process as well. The sheet metal design has reduced the overall part count and eliminated the need for welding and the extra steps in the process, while still being able to support the weight of the fan and the motor in the assembly.

Mechanical Projects

ENSC 17, Light Board

Hannah Resnick
Nikolas Schmitz
Alexander Ballanger
Daniel Fiorino

Advisor: Peter McKenny
Sponsor: Gonzaga Virtual Campus
Liaison: Maciej Kosinski

Our goal for the year was to develop a functional 1/4 scale proof of concept lightboard, as well as a full size 8' by 4' lightboard for use in Gonzaga's Virtual Campus. It will be used in online lectures allowing the instructor to keep his focus on his audience (the camera) while teaching his or her online course. We are pleased to say that we were successful in our endeavors. We were able gather a large amount of insight from our prototype design phase, making the design of our full size model relatively simple. The bulk of our work included ordering parts, designing the frame, configuring the electronics, and testing our prototype. Overall, we are very excited with our final product and hope that students after us will benefit from our lightboard.

ENSC 18, Lycofit Ergonomic Tool

Tore Kelln
Jesse Tarr
John Hylden
Kevin May

Advisor: J. McCall
Sponsor: Avista Utilities
Liaison: Josh Fort

In order to more easily emplace gas lines in residential areas, Avista asked us to find a way to take an 18" wrench out of the equation for their QRP-100 tool. We explored different power tool options, from impact drills to electric drills, and found that while an impact drill was unable to overcome the impulse on the QRP-100 tool's gear teeth, a handheld electric drill with a 5:1 torque multiplier would easily work. We began researching gearbox designs; in the interest of space conservation and power multiplication, a planetary gear system was selected to increase the torque and a bevel gear set converts it 90 □ so the drill can easily come in from above. After researching manufacturers and materials, we designed and built a 10:1 multiplier system that will quickly and easily put the gas line fittings together.

Mechanical Projects

ENSC 19, Emergency Rope System

Jose Phillips Rangel
Thomas Spitzer
Jessica Birmingham
Emily Stevenson
Gregory Wirth

Advisor: Andrew Johnston
Sponsor: Spokane County **Sheriff's Office**
Liaisons: Jon Thorpe, Thad Schultz

The ENSC 19 design team sought to aid the Spokane County Dive Team by developing a working prototype of a rope bag stuffing tool that would automate and expedite the Dive Team's tedious rope retrieval process. After a lengthy design process, we produced a compact two-wheeled system powered by a cordless electric drill that reduced the retrieval process to minutes. Our device is capable of operating in a wide range of conditions with various sizes and types of rope to bag the ropes quickly and efficiently. This basic design provides a first step into a previously unexplored market, with great potential for further advancements. The design team thoroughly enjoyed working with the Dive Team to provide them with such a pivotal tool and would also like to thank our advisor, Andy Johnston, for his constant support throughout the design process.

ENSC 20, Disk Taper Measurement

Cole Snyder
Kory-Jordan Agag
Gabriel Roach
Nikolas-Jordan Linayao
Peter Lavery

Advisor: Christopher Nichol
Sponsor: UTC Aerospace Systems
Liaison: Christine Honkomp

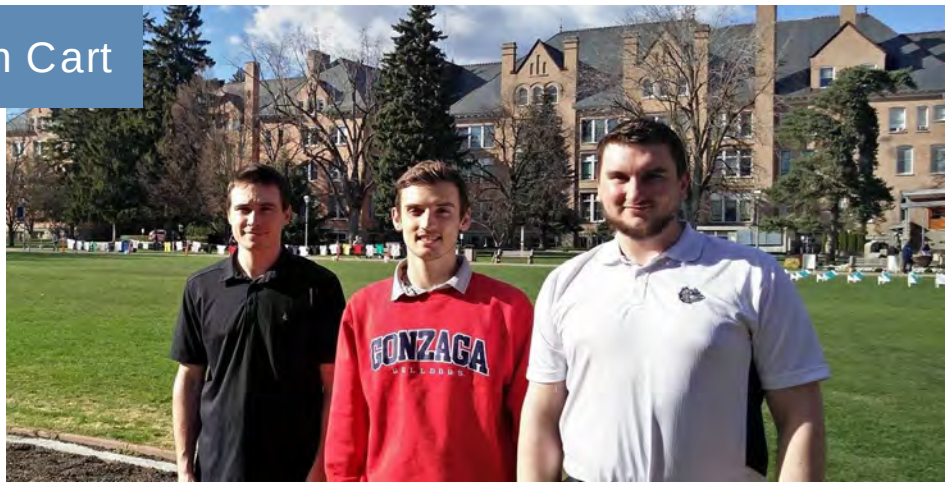
Our project team was tasked with designing and building a working prototype of a device that measures the deformities in carbon fiber disks. The device then outputs the amount of taper that the user enters into their machine. By doing this it ensures that the disk is as flat as possible so that later in the manufacturing process the deformities become less apparent and don't have to be scrapped. The device uses a laser to measure the disk's distance away from the laser at the inner and outer diameters. The goal was to create a device that is easy-to-use, durable and has a low operating time.

Mechanical Projects

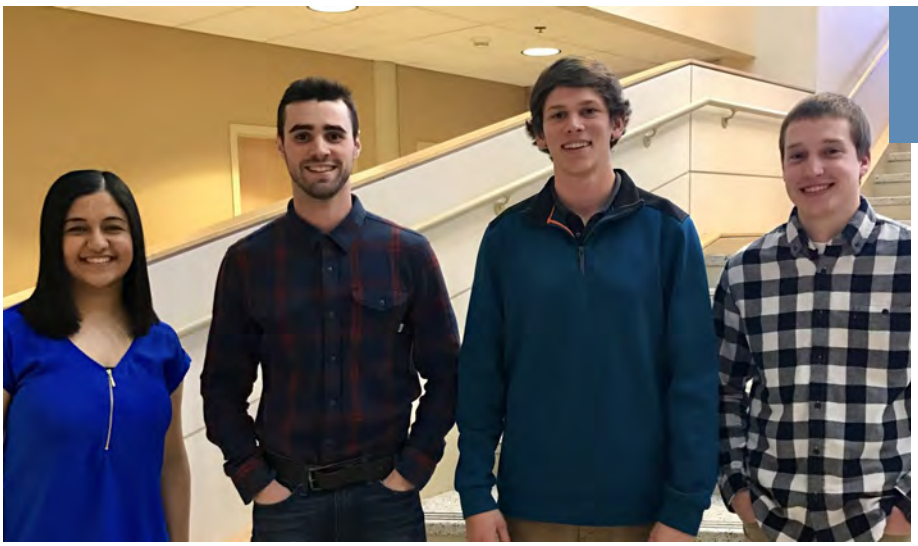
ENSC 21, Textile Bobbin Cart

Nathanael Bell
Nicholas Vildibill
Jonathan Sailer

Advisor: Josh Fort
Sponsor: UTC Aerospace Systems
Liaison: Spencer Scott



Our goal for this capstone project was to design and develop a new cart design to transport large textile bobbins between industrial machines at UTC aerospace systems. The point of our project was to make a process that could replace the overhead cranes that are currently being used at UTC. We were able to create a cart design that could interface with multiple machines and the most important machine interface required us to lift the carts off the floor with manually controlled linear actuators once they were positioned in the machine. Important features of the cart consisted of an ergonomic handle that allowed the operator to move the cart and fixed bearings which the textile bobbin was fixed to.



ENSC 24, Repurposing Excess Carbon Fiber

Aleena Ajmal
Alex Charvoz
Tucker Carlson
Davis Caldwell

Advisor: Renee LaRocca
Sponsor: Boeing
Liaisons: Jeff Barnhart, John Lockleer, Cindy Chan

Our project repurposes remnant carbon fiber from the Automated Tape Layup Machines (ATLMs) in the new 777X Composite Wing Center. The goal was to find a way to repurpose the remnant carbon fiber into a part that most efficiently uses the material to reduce the carbon footprint while also generating the highest return on investment for Boeing. To achieve this goal the Gonzaga Engineering team created a design of a layup tool that mocks the functionality and capabilities of an ATLM in a non-CNC manner, and will layup repurposed Carbon Fiber Reinforced Plastic into aerospace parts.

Mechanical Projects

ENSC 25, Aluminum Alloy Testing

Alan Lytton
Alex Brown
Kevin Moran
Katrina Freeland

Advisor: Bob Reed
Sponsor: Boeing
Liaison: Gary Weber, Mercedes Keyser

This research determined the feasibility of replacing Aluminum alloy 7075 with a new generation of Aluminum-Copper-Lithium alloys in structural aerospace applications. Currently, the 7075 alloy requires multiple manufacturing steps. The replacement with an Al-Cu-Li alloy will save time and money in the manufacturing process by reducing the number of steps in the heat treatment and roll forming processes.

Quasi-static tensile tests were used to gauge the longitudinal and transverse tensile strength of the new alloy with varying degrees of cold-work imparted to the material. Hardness testing was conducted that correlated strength with temper time. Microstructural analysis was utilized to correlate the level of material anisotropy with degree of roll reduction. Experimental results and data analysis were presented. Conclusions were made and recommendations were given.

ENSC 26
Adjustable Chassis Mount

Andrew Nett
Bradley Ballard
Nicholas Granberg
James Nevin
Amy Boerner

Advisor: Jeff Nolting
Sponsor: EZ Loader
Liaison: Randy Stewart

Based in Spokane, EZ Loader has been building boat trailers since 1953. ENSC 26 focused on the Adjustable Aluminum I-beam boat trailers with torsion axle suspension systems in three different configurations: Tandem Axle, Triple Axle, and Extended Body Triple Axle. Our goal was to design, prototype, and test mounting methods for the axles, fenders, and steps of each trailer that allow each component to be adjusted forward and backwards without drilling holes into the I-beam frame. ENSC 26 finalized three designs; the axle, fender, and step, that could be implemented on all three of the trailer configurations. We performed testing on each design, compared our results with EZ Loader's current non-adjustable designs, and performed Finite Element modeling to ensure safe design. Our final prototype was a full tandem trailer with our 3 adjustable mounts implemented.

Mechanical Projects

ENSC 27
Honeycomb Core

Thomas Gill
Joseph Boesch
Andrew Schmidt
Christopher Finkelson

Advisor: Christopher Nichol
Sponsor: Boeing
Liaison: Michael Plahuta

The goal of Honeycomb Core project ENSC 27 was to test material properties of honeycomb cores with off-axis core-to-face sheet bonding. We performed ASTM-365 compression tests on two different core materials, Aluminum 5052 and HTP Fiberglass. In order to gather the baseline data we needed, we performed a simple compression test on honeycomb coupons with both a normal core-to-face sheet bond, and a 45° bond. Following this baseline testing, we tested coupons at 10° increments up to 40°, testing six coupons for each angle for each material. For each angle, we completed compression tests to failure with three coupons in the W-orientation and three coupons in the L-orientation, computing both compression and shearing properties in the process. Through this testing process, we were able to determine which angles and or orientations are stronger than others, as well as when a dramatic drop in overall strength occurs in the core.

ENSC 28, Rainwater Harvesting System

Jacob Bills
Brennan Sutey
Brittany Johnson
Alexandra Fox
Nathan Ducey

Advisor: Noel Bormann
Student proposed project
Sponsored by UTC Aerospace
Liaison: Shari Russell

The project team, the Rainglers, has been working with UTC Aerospace Systems in Everett, Wash. to help the company reach its goal of reducing their potable water usage by 25 percent. The Rainglers helped UTC reach this goal by designing a system for their facility that harvests rainwater from the building's roof and reroutes it for use as flush water in their toilets. This design will reduce UTC's potable water usage by over 32 percent. Analysis of design alternatives included the development of a unique diverter valve that would allow the roof surface to be rinsed of some contaminants prior to storage in the tank.
In addition, the Rainglers created conceptual designs for reusing rainwater as drinking water and for irrigation in order to allow UTC to evaluate the cost versus benefit of rainwater harvest for alternate levels of public water use.

Civil Projects

ENSC 29, Real Design Matters (CE)

Adam Hutchinson
Cami Burger
Jaylene Atha
Arei James

Advisor: Aaron Zwanzig
Student proposed project
Sponsored by Integrus Architecture

Throughout these past two semesters, the four of us have gone through the typical design process required for a building structure. This required us to develop loads and design members to resist these loads. Our project, an Airport Rescue Firefighting Facility, consisted of a bay for the trucks to park, which required large open areas, as well as residences for the firefighters to train, eat, and sleep.

ENSC 30, Operations Connected Vehicle

Michaela Burr
Lea Manley
Robert Bridges
Tyler Pejza

Advisor: Rhonda Young
Sponsors: WYDOT and McFarland Management
Liaisons: Vince Garcia, Fred Kitchner

Connected Vehicle Technology is an innovation being tested by the USDOT and is expected to have enormous impacts on driver safety and roadway efficiency. This technology allows short-range communication between vehicles and roadway infrastructure to provide drivers with posted speed limits and potential oncoming dangers. The focus of Group 30 is to determine if drivers will have better speed compliance within variable speed limit zones on I-80 in Wyoming as a result of this technology. The goal of this project is to create speed data analysis methodology and baseline performance measures for the I-80 corridor in Wyoming. The methodology developed will be passed to next year's team who will then compare data once the pilot program has started in 2018 and determine whether connected vehicle technology has made a positive impact on the corridor.

Civil Projects

ENSC 31, Baseline Crash & Road Closure Analysis

Jacob Sellner
Douglas Paff
Christian Rodriguez
Nicholas Mauzy
Lauren Barany

Advisor: Rhonda Young
Sponsors: WYDOT & McFarland Management
Liaisons: Vince Garcia, Fred Kitchner

Better Than Dirt Engineering is working with the Wyoming Department of Transportation (WYDOT) to create a baseline of crash statistics to measure the safety impacts of Connected Vehicle (CV) technology. CV technology is a short range communications system that allows vehicles traveling on the roadway to instantly relay information about road conditions and crash events to WYDOT and each other. This technology is expected improve safety and lower crash rates by giving drivers warnings on the dashboard about approaching hazards.

This project's analysis has focused on creating baseline crash statistics and a methodology that will be used by WYDOT to compare the effects of CV deployment in regards to safety and road closure rates. To measure the effectiveness of the CV tech with regards to safety, performance measurements dealing with specific characteristics of the corridor were selected. These include: work zone crashes, weather related crashes, vehicle type crashes, and the number of vehicles involved in crashes.

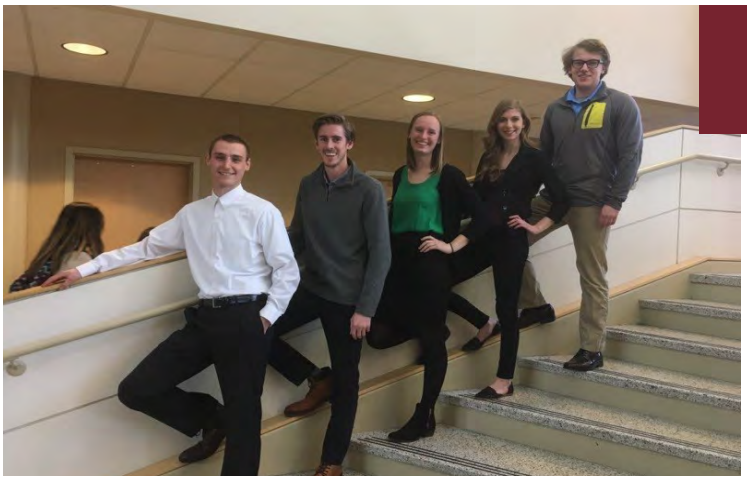
ENSC 32, Gonzaga Transportation Impact

Daniel Waight
Shannon Bauman
Theodore Lathrop
Johnnie Duguay

Advisor: Rhonda Young, Jonathan Isacoff
Sponsor: Kim Stoltz
Liaison: Jim Simon

Gonzaga University is committed to reaching net-zero carbon emissions by 2050, as outlined in Gonzaga's Climate Action Plan Roadmap (CAP). Approximately one-third of Gonzaga's emissions in 2009 came from indirect sources such as air travel and commuting. Team 32, composed of two Civil Engineering students and two Environmental Studies students, analyzed the university's current transportation practices and help Gonzaga reach its emissions reductions targets through policy recommendations. The goal of the project was to aid Gonzaga in reaching its CAP targets through sustainable transportation choices. The team completed four tasks to achieve the project goal. First, to compare current emissions to the 2009 CAP baseline and to future reductions targets. Second, to develop methodology for analysis of transportation data. Third, to develop scenarios that achieve reduction targets. Fourth, to develop policy to incentivize behavior that reduces carbon-intensive transportation choices in accordance with the scenarios outlined in the third task.

Civil Projects



ENSC 33, Metal Manufacturing Facility

Aiden Behar
Troy Aitken
Emily Diedrich
Anna Starr
Connor Reid

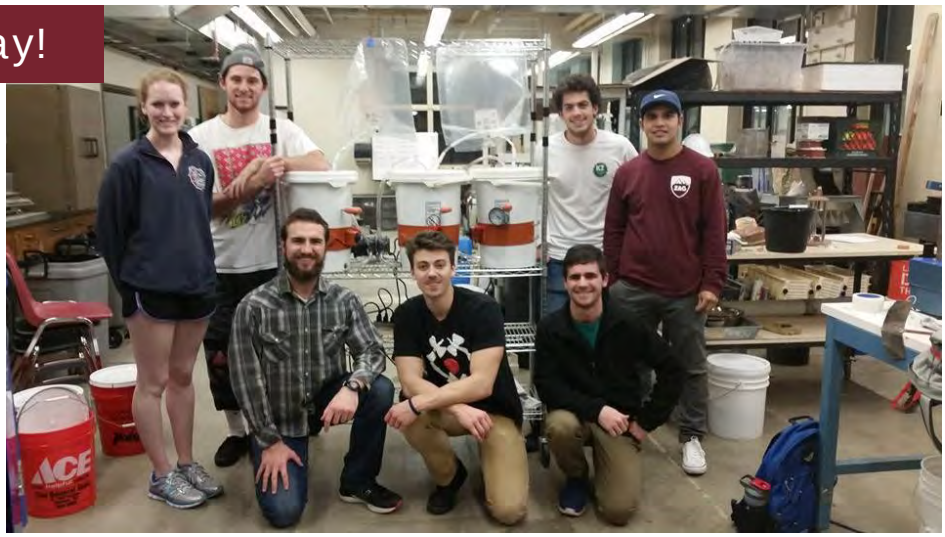
Advisor: Sushil Shenoy
Sponsor: Eclipse Engineering Inc.

ENSC 33 has spent the year designing a Metal Manufacturing Facility in Lewiston, Idaho. The ultimate deliverable includes a complete calculation package and a set of construction documents to be given to the client. Through finding the governing gravity and lateral loads, ENSC 33 was able to design the corresponding resisting systems for the structure. After framing and foundation plans were developed, they were compiled into a deliverable through drafting and detailing.

ENSC 34, Hold that Tray!

Emily Follansbee
Anthony Vadino
Sean Morton
Daniel Padrnos
James Consiglio
Donovan Quiocho
William Lynn

Advisor: John Cleary
Sponsor: WA Department of Ecology
Liaison: Mark Fuchs



Project goal: To demonstrate that Gonzaga can convert 100% of the university's food waste into energy and usable byproducts to further campus sustainability and save money on waste processes.
How do you do that? Anaerobic digestion. Simply put, food and wastewater create bacteria. Bacteria creates methane. Methane creates energy.
What did we do? We built a bench-scale (2 foot by 4 foot) digester that continuously feeds on the COG's food waste.
How did we get there? We researched, we learned from universities and companies that have built digesters, we tested feedstocks, we built, failed, and rebuilt.
What's next? Our hope is that our research and model will allow future senior capstone groups to work with Gonzaga to eventually design and build a large-scale digester that will take full advantage of the potential of the university's food waste and help Gonzaga reach its goal of 0 emissions by 2050.

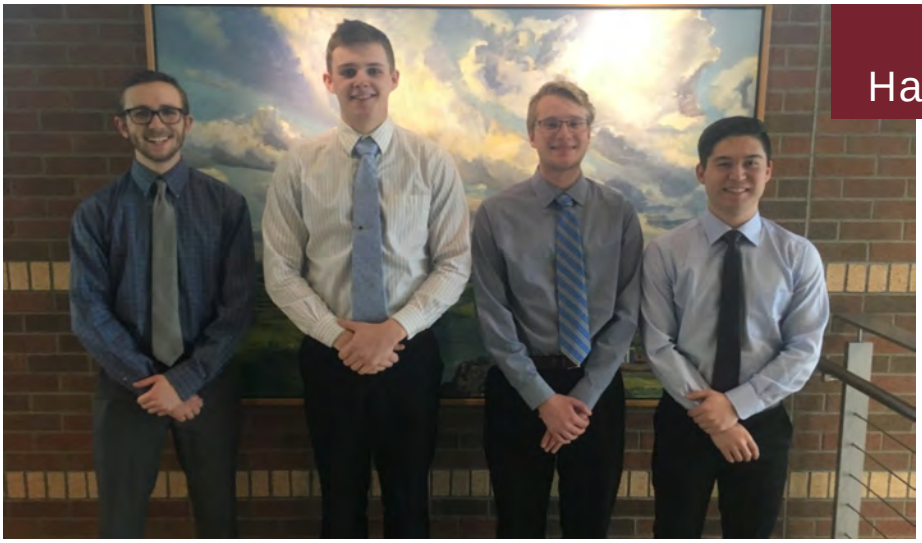
Civil Projects

ENSC 35, Camp Cowles

Cody Street
Max Kaderabek
Jennifer Hoefel
James Finnegan

Advisor: Doug Forkner
Sponsor: INW Boy Scouts of America
Liaison: Joe Madson

Camp Cowles is a structural based senior design group inspecting 6 selected pre-existing buildings at Boy Scout Camp Cowles, north of Spokane. Site visits revealed concerning features with some of the buildings including: holes in the foundation, poorly design trusses, and animal infestation among other issues. These concerns at the camp pose risks to the safety of those who use the facility. We plan to reveal our findings to our client, the Boy Scouts of America, and produce flowcharts that will help guide them in their decisions to either keep, rebuild, or refurnish the buildings. To provide them with sufficient information, we called contractors to obtain pricing estimates for buildings, researched local codes, and exercised our best engineering judgement evaluating the structures.



ENSC 36
Hangman Creek Overflow

Keaton Leander
Trevor Masterson
Lars Berglund
Kerrick Eagle

Advisor: Scott Marshall
Sponsor: HDR, Inc.
Liaison: Ryan Haddeland

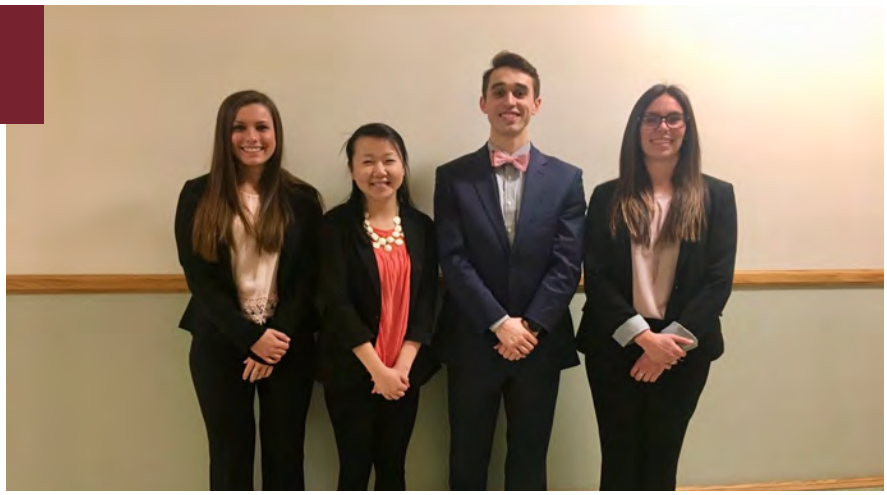
ONCOR Engineering was tasked with designing a structure to replace an existing cast-in-place concrete stiff-leg culvert located southeast of Tensed, Idaho on US Highway 95. We completed both a hydrologic study and hydraulic report using Idaho Transportation Department (ITD) standards and HEC-RAS modeling, respectively. Using a decision matrix, our team decided to design and implement a Geosynthetic Reinforced Soil-Integrated Bridge System (GRS-IBS) replacement structure for the project. Also, within this project, and in accordance with HEC-26, our team designed the GRS-IBS so that acceptable water surface elevations and velocities were met to allow for adequate fish passage through the structure. Once the structure was designed, the team completed the roadway design for the project, which included the creation of a new alignment and both vertical and horizontal profiles ensuring that ITD requirements were met. Our final deliverable is a complete engineering plan sheet, which consists of a title sheet, bid item sheet and overall cost estimate, plan and profile views, typical sections, construction staging plan, traffic control plan, and a few other miscellaneous specifications.

Civil Projects

ENSC 37
City of Medical Lake

Madison Scully
Emma Conley
William Garrard
Michaela McDermott

Advisor: Matthew McDonald
Sponsors: Esvelt Environmental Engineering and
WA Department of Ecology
Liaison: Lucy Peterschmidt



The purpose of this project is to maximize reclaimed water use opportunities for the City of Medical Lake. Our team focused on submitting a Water Rights Impairment Analysis to the Washington State Department of Ecology, providing recommendations for updates to the West Medical Lake - Lake Management Plan, and finding viable reclaim opportunities to best manage the treated effluent from the Medical Lake Water Reclamation Facility. The Lake Management Plan recommendations aim to update data in the historical data report as well as install a lake gauge and monitoring technologies at West Medical Lake. The water reuse opportunities include irrigation to local development projects, high school irrigation, and expansion of existing irrigation uses. The team has created a water budget model tool to increase functionality and feasibility of the reclaimed water. Over the past year, we have researched and explored water reuse opportunities to benefit the Medical Lake community.

ENSC 38, Energy Conversion System (CE)

Michelle Ruzicka
Jessica Powell
Bo Youn (Sarah) Chae

Advisor: Art Miller
Sponsor: NIOSH
Liaison: Eric Lutz

The Energy Conversion System CE team was one part of a three team collaboration, made up of three different disciplines (civil, mechanical, and electrical). The overarching objective for all three teams was to create an energy conversion system that can convert geothermally heated water found in mines into energy. The CE team's specific objective was two-fold: fit this system into the context of mines and provide water for the system to run effectively on exposition day. Extensive research was done to ensure the feasibility of this system in a mine and the CE team was able to produce an excel calculator and an EPANET base-model that mines with varying conditions can use to properly implement the energy conversion system. The CE team was also able to work with given parameters to make this engine's run outside of a mine to properly display the engines capabilities on exposition day.

Civil Projects

ENSC 39
Sustainable Plastic Systems

Charlotte Trebilcock
Jacob Welton
Kyle Elliott
Jack Dean

Advisor: Lauren Heine
Sponsors: Northwest Green Chemistry and Grow Plastics
Liaison: Mike Waggoner

Grow Plastics tasked ENSC 39 (TRAY PLAy) to investigate the sustainability of four different takeout-food clamshells. The goal of this project was to create an overall sustainability assessment that is transferrable to any polymer in question. TRAY PLAy defined sustainability as, ''A product that has the least negative impacts on the environment from cradle-to-grave, and is able to either be recycled or repurposed in either the production or end of life stage''. The sustainability of each clamshell was broken down into four different assessments: a Lifecycle Analysis, a Chemical Hazard Assessment, a Performance Testing Assessment, and an End of Life Assessment. TRAY PLAy hopes that its take on assessing the sustainability of a polymer will be beneficial in the creation of a global standard for sustainability.

ENSC 40, Alternative Construction for Affordable Housing

Nathan Foster
Kassandra Zohn
Angela Lanning
Mariano Laguna

Advisor: Mark Muszynski
Sponsor: Gonzaga Center for Engineering Design & Entrepreneurship
Liaison: Paul Trautman, Arlene Patton

Affordable housing plays an important role in providing equal opportunity for individuals to achieve success within communities in the United States. The research being presented focuses on the construction of affordable housing projects in the greater Spokane area. The results of this research include an encompassing understanding of the current construction practices as well as an evaluation of alternative construction approaches to building successful affordable housing. The analysis of these various construction techniques is for a one story single-family unit design. The information presented will prove to be vital for aiding to reduce construction costs associated with affordable housing projects.

Civil Projects

ENSC 41
Beavers Land Council

Michelle Kinsey
Kayla Kassa
Rachel Ainslie

Advisor: Sue Niezgoda
Sponsor: The Lands Council
Liaison: Joe Cannon

The ENSC 41 team consists of Michelle Kinsey, Kayla Kassa, Rachel Ainslie, and advisor Dr. Sue Niezgoda. The goal of the project was to use Beaver Dam Analogs (BDAs) to accomplish the goals of lowered stream temperatures, decreased sediment loads in the stream, the creation of a steady stream hydrology, and the reduction of bank erosion. Beaver Incorporated (BINC) created a long term monitoring plan to evaluate the effectiveness of these BDAs at accomplishing these goals. This plan included a hydraulic analysis, watershed and rapid geomorphic assessments, data collection, and recommendations for future teams. BINC found that the BDAs were successful in trapping sediment and reducing high flow which will overall reduce bank erosion, but due to the longevity of the project, insubstantial data was gathered for this first year. Recommendations for future teams include lengthening the BDAs, purchasing more temperature loggers, installing another BDA, and using different modeling tools.

ENSC 42
Sleep Orbit Sensor

Michelle Llamas
Abdullah Alhassan
Graison Le
Jessica Peretti

Advisor: Peter McKenny
Sponsor: SleepOrbit
Liaison: Jason Moore

Measuring one's sleep quality has been no easy feat: commercial sleep trackers are inaccurate in recording data and actigraphy devices are too costly. The Sleep Orbit project aimed to analyze this issue more efficiently by integrating a three-part system consisting of an iOS app, a bedside console, and a wearable. By conducting a four week case study which tracked the Fitbit sleep data of student subjects, the group was able to pinpoint certain sleep variables that most affect sleep quality, including stress levels, caffeine intake, light and sound exposure. Recording this data onto a separate database allowed a proper development of algorithms that were stored on the iOS app to evaluate the necessary sleep coaching assessments. All records from the study assisted in successful integration between the bedside console and the app. Due to budget constraints, the group was unable to implement the wearable with the rest of the system.

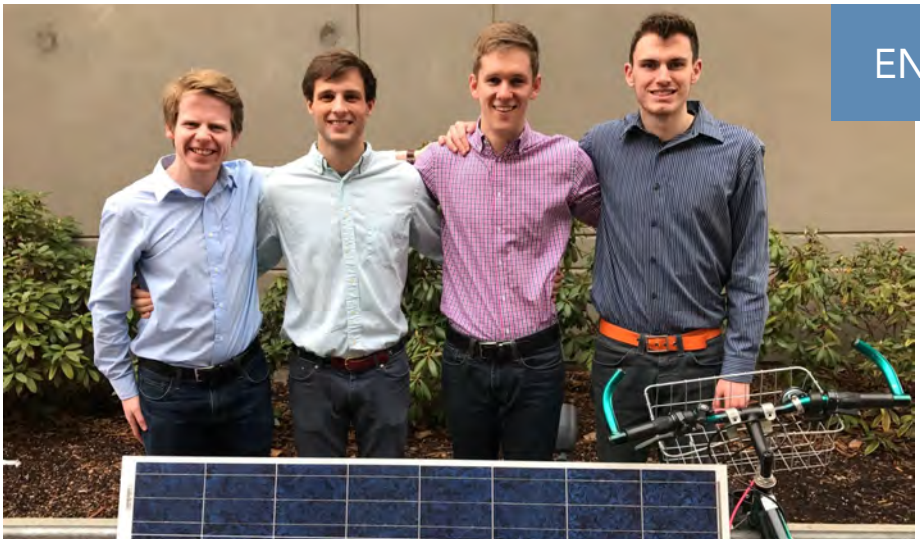
Civil Projects

ENSC 43
Stormwater Bioretention Pond

Garrett Goudy
Satya Dhital
Lacey Mehlert
Kyler Higgins
Russel Groves

Advisor: Aimee Navickis-Brasch
Sponsor: Spokane County
Liaison: Matt Zarcor

Pollution in stormwater runoff negatively affects the quality of water in rivers and streams around developed areas; bioretention ponds seek to alleviate issues that concern the removal of these pollutants from runoff by utilizing the natural filtration properties of plant material and a high carbon content soil layer. Our project is about evaluating the effectiveness of an 18-in and 12-in bioretention ponds at removing common stormwater runoff pollutants. The objectives of our project are: a detailed literature search for background information on bioretention ponds, determine if the current BSM depth will work to the required levels in Eastern Washington, compare the effectiveness of ponds with a BSM depth of 18-in to a shallower 12-in, and present findings to a Design Advisory Board (DAB) in May and at Storm-Con in August.



ENSC 44, Smart Bike Rack

Ryan Fraser
Christian Linder
Travis Callahan
Mitch Middleton

Advisor: Kevin Damron
Liaison: Pat Faulkinberry
Student proposed project
Sponsored by Gonzaga University

Bike theft is a prominent and widespread concern for college students. The objective of this project was to improve the security and ease of use of public bike storage systems. Based on their proposed idea, the team designed and manufactured the functional product. Powered via solar energy, the Smart Bike Rack utilizes a microcontroller system to intuitively lock bikes both quickly and securely. Users simply scan their student ID card to store and retrieve their bicycles.

Electrical Projects

ENSC 45, Braille Extrusion Display

Jinous Esmaeili
Fahad Al Basheer

Advisor: John Tardus
Student proposed project
Sponsored by Gonzaga University

A refreshable Braille display is a piece of hardware that provides Braille output from a computer. All displays have 8-dot refreshable Braille cells and refreshable because they change, according to the part of the screen that has the computer's attention. According to the American Foundation for the Blind, these refreshable Braille cells are the costly part of the machinery; the more cells a device has, the more expensive the display will be.

Many people around the world today cannot afford a refreshable Braille display because they cost anywhere from $2500 to $6000. By making this technology affordable, we are hoping to improve a blind person's experience with education and literacy.

This project will develop a low-cost, hand-held device that will allow text to be translated more quickly, display predefined shapes into a tactile experience, and act as an input device with customizable shape; thus allowing any sight impaired person to participate more fully in their education or work environment.

ENSC 46, Doppler Radar

Luis Perez, Jordan Hendricks, Max Hernandez-Brito, Alex Meyer, Jun Li

Advisor: Bob Conley; Student proposed project sponsored by Ron and Sara Seubert

The GU Doppler RADAR team goal was to build a proof of concept/prototype of a small-scale Doppler RADAR system. This system utilizes a pair of custom made 2.4 GHz horn antennas, one transmitting and the other receiving, to track solid objects. These antennas could be scaled up in a production system to track storm clouds. The system is also capable of adding our passive parabolic dish antenna that listens for RADAR signals sent out by the National Weather Service. The antennas are aimed by a servo motor controlled mount capable of 360° horizontal rotation and up to 90° vertical rotation. A microprocessor compiles the signal into a usable display of the surroundings for a user.

Electrical Projects

ENSC 47, Flying Bulldog

Alec Reed
Hunter Ramp
Jacob Beardemphl
Cole Wilhelm

Advisor: Michael Santora
Student proposed project
Sponsored by **Gonzaga's Next** Generation Technology Bar
Liaison: Scott Griffith

The goal of this project is to design and build an aerial multirotor that will primarily be used by the Next Generation Technology Bar (NGTB). The 360° camera already possessed by the NGTB can be utilized for a full virtual campus tour. Ultimately, the aim of the Flying Bulldog is to give current and prospective students a unique opportunity to interactively experience Gonzaga, while simultaneously facilitating educational opportunities in an emerging field. Our design will focus on producing comparable specifications and performance to similar commercial products, at a lower cost. Furthermore, the modularity of our design will assure that the funds invested at this time, or at least a significant portion of them, will see use for many years.

ENSC 48, Solar Powered Charger for PewGo

Evan Repplier
Maximilian Oseland
Reid Dorrance
Todd Brady
Barrett Nelson

Advisor: Shane Pacini
Student proposed project
Sponsored by Gonzaga University

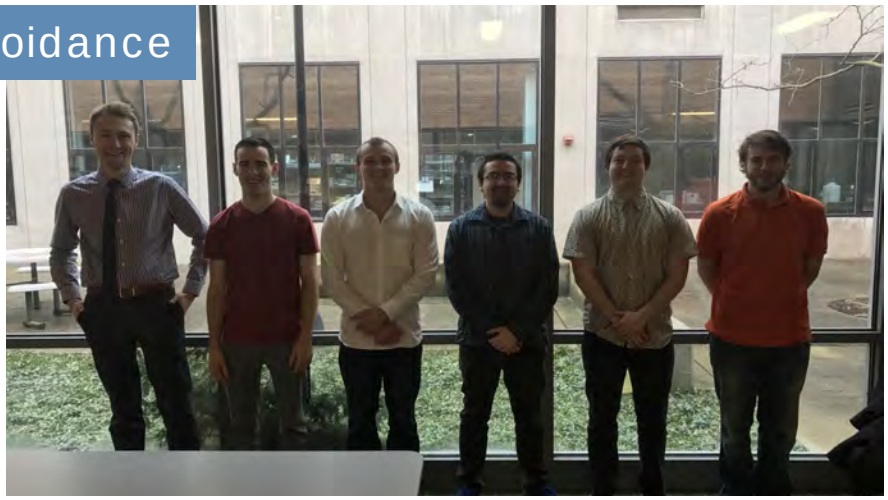
Our senior project group is responsible for creating a solar powered car charging station for the electric golf cart on campus. Throughout this project, we have been working with several Gonzaga Organizations to achieve funding and to determine the design parameters of our project. In addition to this criteria of the project, it has us working with the city of Spokane and the Spokane Fire Department to approve our design and mount the solar panels on campus. The project itself has been a design challenge to order electrical components and learn about the characteristics of battery charging. As well as a mechanical design challenge to provide proper ventilation of the battery box and to have the solar panels bare the harsh conditions of Spokane (e.g. snow load and wind load). Team Pewgo has still a long way to go in order to get our designs approved and contractors found to install our project on the roof of Herak. However, we pride ourselves in the work we have accomplished and the information we have learned about getting a project approved and actually completed. In the next coming months we hope find solutions to all of our problems and being able to show off a completed design to our fellow peers.

Electrical Projects

ENSC 49, Drone Terrain Avoidance

Jordan Palmer
Michael Cook
Zachary Taylor
Eric Haines
Caleb Lance
David Meece

Advisor: Michael Santora
Sponsor: Praxis Air Sports
Liaisons: Jesse Marcel, Brent Barr, Chinery Lutkin



Praxis Air, through their aspirations of developing hover skis and a hover car, has requested the need for a sensor/hardware package that can be mounted to a drone and provide autonomous navigation over an obstacle while airborne. This technology will be essential to their future endeavors. The system is responsive to any type of terrain and utilizes Xbox Kinect™ technology as a forward-facing depth sensor. This sensor data, along with information from velocity and altitude sensors, will appropriately increase or decrease power to the drone motors, and thereby stimulate a change in elevation.

ENSC 50, Energy Conversion System (EE)

Colton Boswell
Jonathan Josten
Colin Brown

Advisor: Art Miller
Sponsor: NIOSH
Liaison: Eric Lutz

The goal of this project was to research, design, and build a prototype of a system that converts thermal energy from hot mine water in order to use the extracted energy to pump water out of a mine. This project was completed in tandem with a CE and ME team. Through research, a Stirling engine was determined to be the most feasible option for extracting energy from the low temperature heat source. The EE team was responsible for designing a monitoring system to evaluate the engine operating parameters, as well a system to store the energy and provide electrical power to the water pumps.

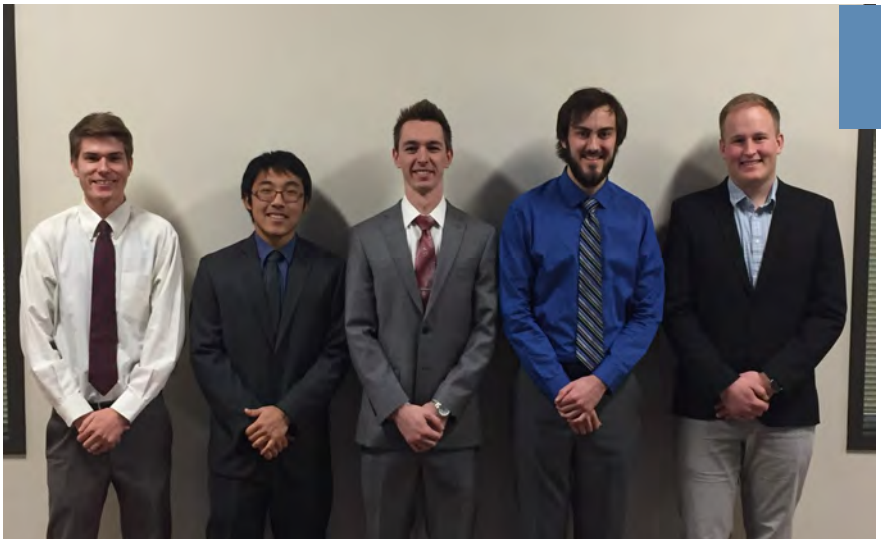
Electrical Projects

ENSC 51
"Smart" Pole Sensor

Michael Wilson
George Muriithi
Ava Zebzda

Advisor: Caitlyn Greeney
Sponsor: Avista
Liaisons: Doug Forkner, Gary Holmesmith

The task assigned to ENSC 51, sponsored by Avista Utilities, was to develop a self-powered, weather proof sensor capable of communicating via Wi-Fi to report "pole down" in the event of a utility pole failure. The goal was to reduce the reliance on customers who currently telephone in the location of a downed pole. A working prototype was developed using a microprocessor, accelerometer, GPS module and a solar panel. The solar panel was attached to a power boost so as to keep its footprint as small as possible and still supply the microprocessor and GPS module with the power needed to run. A lithium ion battery coupled with USB connections allowed for the device to simultaneously run and charge and mitigated the chance of overcharging the battery.



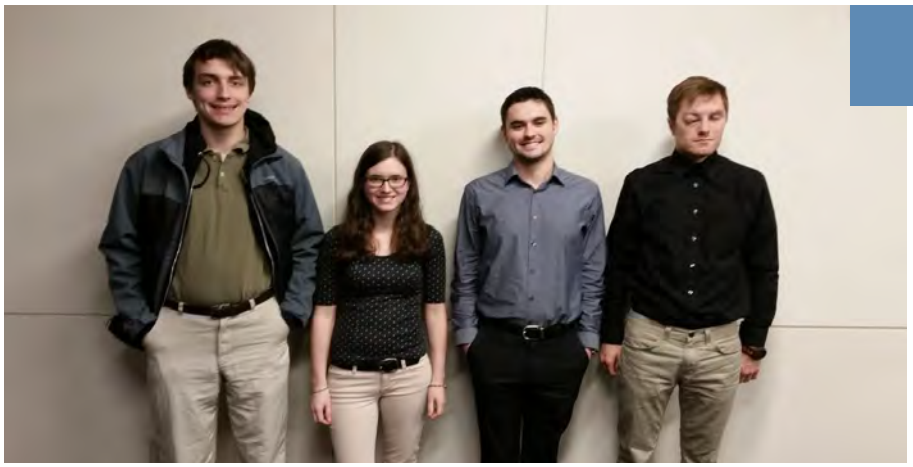
ENSC 52
Flex Circuit Antenna

Caleb Tjelle
Kent Uyehara
Michael Rossi
Steven Beres
Christopher Williamson

Advisor: Steve Schennum
Sponsors: SARL & GU Center for Engineering Design & Entrepreneurship
Liaison: Bob Conley

The team has designed a circularly polarized helical antenna on flex circuit. Left and right hand circularly polarized antennas may be used together in an array to achieve any antenna polarization which is possible. This concept makes the designed antenna very effective for penetrating through interfering communications on the same operating frequency. Using flex circuit for this design allows the antenna to be scalable to higher frequencies than has been possible for similar implementations. A plastic non conductive radome was designed to both protect the antenna and provide the ability to fasten the antenna to a mount. Another goal of the project was to make the antenna easily manufacturable, so a manual was created documenting the chemical etching manufacturing process for the antenna.

Electrical Projects



ENSC 53, Orion

Joseph Hemmingson
Kaylin Hunter
Paxson Matthews

Advisor: Sam Shoemaker
Sponsor: Sapien LLC
Liaison: JJ Moritz

The goal of our project was to take an existing prototype of an Omni-Directional Multi-Polarized Helical Antenna (OMPHA) and investigate a manufacturing friendly approach for its fabrication. The initial design was assembled from coaxial cable and required fabrication methods that were not suitable with known manufacturing approaches. To overcome this, we completely redesigned the antenna while maintaining the performance of the original OMPHA. First, we designed prototypes using software simulations. We then fabricated and tested these prototypes using available materials and equipment. Additionally, we designed a matching network to improve the performance of our OMPHA using the same methodology. After multiple iterations of these prototypes, we settled on an optimal design and created a ready-to-send purchase request that met manufacturing standards and developed a report estimating the cost and manufacturability of our final prototype.

Design Advisory Board Members

The Center for Engineering Design and 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. Thank you, Design Advisory Board!!

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Brennan Dunlap	Boeing
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Phillip Pintor	Coffman Engineers
Sam Shoemaker	MW Engineers
Scott Ratterman	Eclipse Engineering
Tim Graybeal	Lydig Construction
Ty Weeks	Moss Adams

Greg Partch and Jim Weston

CEDE Senior Design, Final Presentations

Wednesday, May 3, 2017

10am-2pm Poster Session, Hemmingson Main Floor

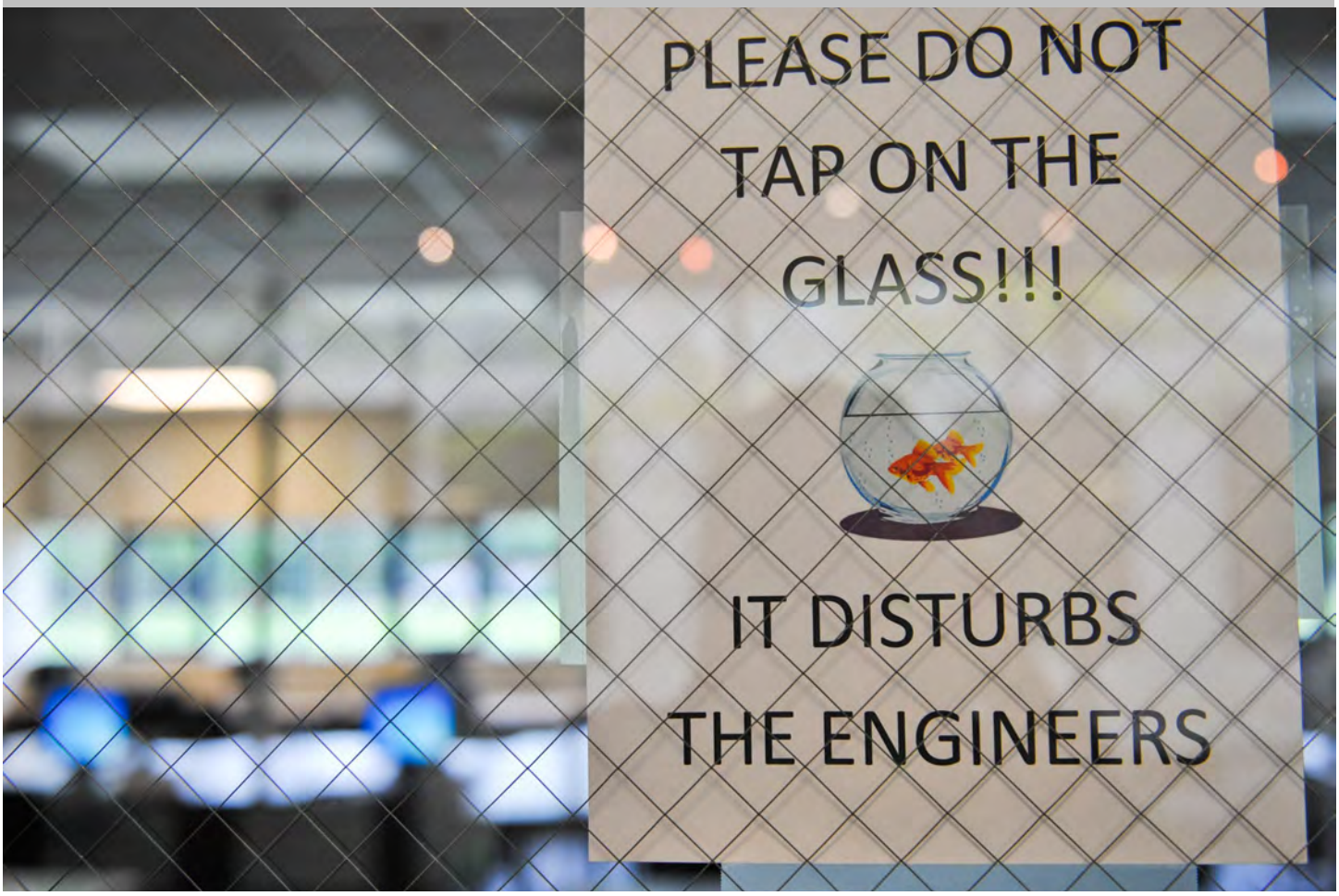
3:10-6pm Final Presentations, Various Classrooms

6-8 pm Senior Celebration, Hemmingson Ballroom

Herak 244–Computer Science	**CPSC 02 Pizza VRia**	**3:10 p.m.**
DAB: Melissa Migliuri, Dan Lenz	**CPSC 06 Traffic Operation Portal**	**3:40 p.m.**
Chris Sharman	**CPSC 01 Dragon Academy**	**4:10 p.m.**
	CPSC 05 Live Band Mix	**4:40 p.m.**
	CPSC 09 Telemetry System for Drones	**5:10 p.m.**
Herak 245– Computer Science	**CPSC 04 Off Campus Housing App**	**3:10 p.m.**
DAB: Chris Sharman, Mike Herzog	**CPSC 08 Social Platform for Higher Edu**	**3:40 p.m.**
Ty Weeks, Mike Mudge	**CPSC 03 Sports Activity App**	**4:10 p.m.**
	CPSC 07 Smart Cities	**4:40 p.m.**
	CPSC 10 Water Rescue Dive App	**5:10 p.m.**
Jepson 103-Mechanical Engineering	**ENSC 13 High Static Pressure Fans**	**3:10 p.m.**
DAB: J. McCall, Les Bohush	**ENSC 11 Flood Control System**	**3:40 p.m.**
Greg Partch, Wendy Crispin	**ENSC 19 Emergency Rope System**	**4:10 p.m.**
	ENSC 01 Food Waste Energy Generator	**4:40 p.m.**
	ENSC 18 Lycofit Ergonomic Tool	**5:10 p.m.**
Jepson 109-Mechanical Engineering	**ENSC 06 Hybrid Still**	**3:10 p.m.**
DAB: George Coleman	**ENSC 07 Automated Vehicle Platform**	**3:40 p.m.**
Kevin Oldenburg, Ryan Leahy	**ENSC 26 Adjustable Chassis Mount**	**4:10 p.m.**
Phil Pintor	**ENSC 16 Alternative Fan Base**	**4:40 p.m.**
	ENSC 15 3D printing of Orthotic Braces	**5:10 p.m.**
Jepson 122-Mechanical Engineering	**ENSC 20 Disk Taper Measurement**	**3:10 p.m.**
DAB: Nick Questad, Michael Maffeo	**ENSC 21 Textile Bobbin Cart**	**3:40 p.m.**
Tom Zysk, Gary Weber,	**ENSC 25 Aluminum Alloy Testing**	**4:10 p.m.**
Brennan Dunlap	**ENSC 27 Honeycomb Core**	**4:40 p.m.**
	ENSC 24 Repurposing Excess Carbon Fiber	**5:10 p.m.**
Jepson 123-Mechanical Engineering	**ENSC 02 Geared Differential**	**3:10 p.m.**
DAB: John Olsulfka	**ENSC 10 Edge Seal Application**	**3:40 p.m.**
Doug Pooler, Jim Weston	**ENSC 03 Pipeline Ventilation**	**4:10 p.m.**
Luke Blanchart	**ENSC 05 Real Design Matters (ME)**	**4:40 p.m.**
	ENSC 04 Piper Cub Pontoons	**5:10 p.m.**
Herak 237-Mechanical Eng.	**ENSC 14 Energy Conservation System (ME)**	**3:10p.m.**
DAB: Sam Shoemaker	**ENSC 09 Apex Trekking Axe**	**3:40p.m.**
David Knaggs, Jim McCall	**ENSC 53 Orion**	**4:10p.m.**
Keith Davidson	**ENSC 12 User Engagement System**	**4:40p.m.**
	ENSC 08 Tire Inflation	**5:10p.m.**
College Hall 101 –Civil Eng.	**ENSC 29 Real Design Matters Civil**	**3:10p.m.**
DAB: Tim Graybeal	**ENSC 33 Metal Manufacturing Facility**	**3:40p.m.**
Lindsay Gilbert, Jerry Tombari	**ENSC 35 Camp Cowles**	**4:10p.m.**
Scott Ratterman, Melissa Verwest	**ENSC 40 Affordable Housing in Spokane**	**4:40p.m.**
Dannielle Haraldson	**ENSC 38 Energy Conversion System CE**	**5:10p.m.**

Presentation Schedule, Continued

College Hall 203- Civil	**ENSC 28 Rainwater Harvesting System**	**3:10 p.m.**
DAB: Katy Allen,	**ENSC 36 Hangman Creek Overflow**	**3:40p.m.**
Bill Fees, Scott Marshall	**ENSC 37 City of Medical Lake**	**4:10p.m.**
Matt Zarecor, Joel Lee	**ENSC 41 Beavers Land Council**	**4:40p.m.**
Dave Moss	**ENSC 43 Stormwater Bioretention Pond**	**5:10p.m.**
College Hall 245- Civil	**ENSC 34 Hold that Tray!**	**3:10 p.m.**
DAB: Dave Duncan	**ENSC 39 Sustainable Plastic System**	**3:40p.m.**
Jim Roletto, Bob Turner	**ENSC 31 Baseline Crash and Road Closure**	**4:10p.m.**
James Simon	**ENSC 30 Operations Connected Vehicle**	**4:40p.m.**
	ENSC 32 Gonzaga Transportation Impact	**5:10p.m**
Herak 123- EE	**ENSC 47 Flying Bulldog**	**3:10 p.m.**
DAB: Jeff Owen, Michael Santora	**ENSC 17 Light Board**	**3:40p.m.**
John Gibson, Terra Donley	**ENSC 49 Terrain Avoidance for Drones**	**4:10p.m.**
	ENSC 42 Sleep Orbit Sensor	**4:40p.m.**
	ENSC 45 Braille Extrusion Display	**5:10p.m**
	ENSC 50 Energy Conversion System EE	**5:40 p.m.**
Herak 301- EE	**ENSC 46 Doppler Radar**	**3:10p.m.**
DAB: Paul Robertson,	**ENSC 51 "Smart" Pole Sensor**	**3:40p.m.**
Kaitlyn Helsing, Gary Holmesmith	**ENSC 52 Flex Circuit Antenna**	**4:10 p.m.**
	ENSC 48 Solar Powered Charger for PewGo	**4:40p.m.**
	ENSC 44 Bike Lock System	**5:10p.m.**



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