

Gonzaga University
School of Engineering & Applied Science
Center for Engineering
Design & Entrepreneurship



Design Exposition Day
April 27, 2016

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, 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.

A special note to our seniors: As a new Dean in the fall of 2012, I looked upon an enthusiastic, dedicated, and innovative freshman class as an example of the type of students with whom I would want to be associated. Now that many of you who were freshmen are present today as seniors, I can only express deep pride in the many and diverse accomplishments of this class, my first four year class as your Dean. 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 Senior Capstone Class of 2016! 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, the Design Advisory Board and the Capstone Committee.

Go Zags!

Toni Boggan
Academic Director
Center for Engineering Design & Entrepreneurship

Welcome to Design Exposition Day 2016

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 individual with innovative ideas. This team experience is an opportunity to evaluate senior students as prospective employees.

Recently, another type of project has developed which is the student proposed projects. 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 2015 2016 school year, ten 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 projects and is a component required to meet design guidelines established by the Accreditation Board for Engineering and Technology (ABET).

Employer of the Year

The Center for Engineering Design and Entrepreneurship is indebted to many public and private entities who have sponsored and supported Senior projects during the past 24 years. The students have benefited from the guidance and expertise of the liaisons that the companies have provided and the resources they have supplied. In an effort to recognize this contribution, we will name one sponsor each year as the Outstanding CEDE Sponsor of the Year starting this year.

The Outstanding CEDE Sponsor of the Year for 2015 – 2016 is UTC Aerospace Systems. UTC has sponsored teams for the past 13 years. The expert scoping and guidance they provide has resulted in a large number of excellent projects. Many years, UTC provides multiple projects for Gonzaga's Senior Capstone class. Over the years they have sponsored 22 projects with 10 resulting in fixtures or systems that have been put into service on the floor of UTC. The liaisons and engineers from UTC have impacted approximately 80 of our seniors and put them on a path to success.



Thank you, UTC, for your commitment to Gonzaga's School of Engineering and Applied Science!

CEDE Excellence Award

The CEDE Excellence Award for 2016 is a new award, presented to recognize an outstanding contribution to the Capstone Program. The first CEDE Excellence Award is proudly presented to **Ron Oscarson** for his long-term commitment to the Capstone Program.

Since the creation of the Center for Engineering Design and Entrepreneurship in 1992, a group of dedicated volunteers known as the Design Advisory Board (DAB) have supported Gonzaga students. These DAB members are engineers and computer scientists who lend their expertise to the student teams by attending project presentations and completing design reviews. Two members of the DAB have served on this volunteer board for an amazing 24 years, Ron Oscarson and Les Bohush.



This year, Ron Oscarson is retiring from the DAB and from his position as Spokane County Facilities Director. Oscarson, a mechanical engineering alumnus from Gonzaga, has inspired hundreds of students and encouraged them to accomplish big things. Some of his favorite projects have been the "Gonzaga Without Borders" projects which included developing water filtration systems. "Those projects can change the world," he said. As Oscarson prepares for a new direction, he is excited for what retirement may hold. He and his wife are admitted ski bums and look forward to more time on the mountain in the coming year. Thank you for your years of service!

Student Design Teams

Most Senior Design teams 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. Several projects are multidisciplinary, reflecting the importance of collaboration across skills to solve real-world problems.



Computer Science

CPSC 01, Automated Agriculture System



Adam Smith
Landon Kissinger
Daniel Bladow
Brandon Castaing

Advisor: Shawn Bowers
Sponsor: Gonzaga University
Liaison: Melissa Migliuri

The goal of our project was to enable small market farmers in becoming more efficient and competitive in our current technological era. We aimed to decrease labor costs, and increase water efficiency. In order to accomplish our goal, we implemented a sensor network to monitor hydration levels as well as automated valve controls for irrigation. We used a website as our user interface for our farmer to understand the water level throughout the farm and control the irrigation. We have worked with a hardware team (ENSC 08) that has developed the physical system. In the future we would like to continue testing our system and potentially start a company.

Computer Science

CPSC 02, FormCycle

Adam Cross
John Ragan
Cody Valle
Merrill Lines

Advisor: Shawn Bowers
Sponsor: Gonzaga University
Liaisons: Dan Lenz,
Kevin Dentler



FormCycle is an iPad application specially designed to eliminate the majority of paper forms being used in a local bicycle shop. FormCycle manages and creates records which are then stored via a database making them available to access for later viewing. This provides consistency of the records and makes the process much more convenient by speeding up data entry and retrieval. We have accomplished the major features needed to make our app successful. These features include an encrypted login and the functionality to create a new work order and close that order when it's done. FormCycle also integrates a useful and informative home screen by providing information about current and future workloads.

CPSC 03, GPS Tracking App

Kaitlin Anderson
Martin Johnsson
Chauncy Cullitan
Sara Prata

Advisor: Shawn Bowers
Sponsor: Bloomsday
Liaisons: Dan Lenz,
Don Kardong

**This team is featured on the cover*



Our goal for this project was to create an iOS app that would allow participants in the Bloomsday Run to track their own progress during the race as well as tracking their friends who are also running the race. This year, we have accomplished several features in our app such as, providing users with general information about what to do before and after the race, the ability to track user's during the race and saving that information as running history, and tracking user's friends who are running the race.

Computer Science

CPSC 04, Digital RTP Binders



Sterling Miller
Adam La Mar
Richard Riley
Tara Hanson
Eric Jobes

Advisor: Shawn Bowers
Sponsor: Gonzaga University
Liaisons: Darren Owsely,
Brian Steverson

The goal of this project was to develop a web-based application to help transition the reappointment, promotion, and tenure (RPT) process at Gonzaga University away from a paper-based system to a digital system. The paper-based model for RPT not only consumes resources (purchasing of binders, paper, printing, and photocopying), but is inconvenient for both faculty putting together binders and the various committees that evaluate RPT cases. Our team was tasked with designing an interface to support the RPT process. We have built a fully functional and professional looking application to support the digital binders, as well as tutorials and user-guides for those involved in the RPT process.

CPSC 05, ELC Web App

Kevin Wisdom
Chris Harvey
Ryan Menezes
Brian Ramaswami
Brendan Kennedy

Advisor: Shawn Bowers
Sponsor: Gonzaga
English Language
Center
Liaisons: James Hunter,
Chris Sharman



Our goal at the beginning of this year was to provide service to Gonzaga's English Language Center (ELC) in order to improve on the center's two main functions: language teaching and language scholarship. At the ELC, language learning primarily takes the form of "SmallTalk" sessions, in which students speak in class while professors transcribe students' language usage errors, later distributing them to students so that they may learn from their mistakes. Our team has developed a robust Database Management System for storing and accessing this data so that teachers, graduate students, and language researchers may use it for research. The core of our project is a web service that provides access to this database and facilitates and expands the SmallTalk system, serving the students and teachers of the ELC by improving the learning process and the resources available for language research.

Computer Science

CPSC 06, Sleep Improvement App

Mark Pikulik
Matthew Bilsborough
Cameron Aubert
Carter Currin

Advisor: Shawn Bowers
Sponsor: Somnutech
Liaison: Jason Moore



Our goal was to make an application that incorporates the baseline features of other consumer sleep applications and encourages users to improve their quality of sleep via user goals and simple analytics. In addition, this application will help facilitate the process of assessing Somnutech's in-house sleep patients as well as create an opportunity for scalability in order to reach a wider client base. We have created an iPhone application that includes the following functionality: incorporates an alarm system, allows a user to specify daily influences that might affect sleep behavior, displays daily statistics, trends, and basic analytics, suggests simple user goals, and prompts the user with Somnutech's official sleep survey to help better tailor the application to the user's needs. We hope that this application will invoke users with a desire and ability to improve their sleep patterns and overall health.

CPSC 07, Providence Wayfinding App

Ruth Manthey
Andrew Becker
Shaun McBurney
Taras Kravchuk
Michael Bilsborough

Advisor: Shawn Bowers
Sponsor: Providence Health Care
Liaison: Danita Petek



Spanning 44 acres, Providence Sacred Heart Hospital's extensive campus is often confusing for visitors to the hospital to navigate. Our task was to create a wayfinding app that would make visiting the campus easier. We have designed an app that gives users turn-by-turn driving directions to the parking lot closest to their destination followed by step-by-step walking directions from their location on the medical campus to their specific destination. Our app also includes a directory as well as additional maps to give users other information that could be useful in finding their way. We limited our app to the four main buildings of the campus, which are not only the most visited, but also some of the most confusing buildings to navigate. Visiting a hospital is rarely stress-free, but we hope our app will make visiting Providence Sacred Heart a little easier.

Engineering Projects

ENSC 08, Agricultural Automation



**Drew Washut
Carlos Limon
Derek Bruno
Ryan Lowry
Chris Frager**

**Advisor: Peter McKenny
Sponsor: Gonzaga University**

Production costs are the largest expense that any business encounters whether they are in medical, technological, or agricultural industries. Our project aimed at using automated systems as a solution to both labor and resource costs within the apple orchard industry. The cost and use of water assets is expensive and inefficient, as growers require staff to be present or commute to locations in order to operate current irrigation systems. The goal was to improve the current irrigation methods. Throughout the project several variables were discovered in order for the system to operate properly, such as temperature of soil, soil type, and root systems. The system consists of moisture sensors buried at varying depths, automated water valves, and a way for the grower to monitor and control the field's water consumption through an application. Sensors monitor the soil's moisture levels, allowing for dynamic system control, which increases water efficiency and decreases the cost of labor.

ENSC 09, Little Falls Spillway Rehab

**Chris Dowd
Taylor Ziegler
Donald Jones
Sophia Dien**

**Advisor: Doug Forker
Sponsor: Avista
Liaison: Doug Forker**



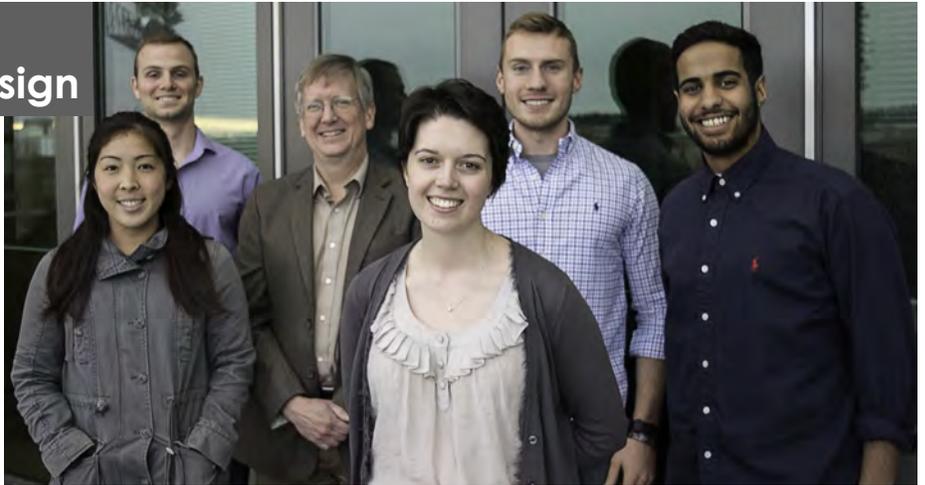
Project ENSC 09 Little Falls Rehab is a project sponsored by Avista. The goal of this project was to find a safer alternative to the use of flashboards. Flashboards are used to maintain a certain water level for the dam to operate. The senior design team of Little Falls Rehab is responsible for investigating how water impacts the dam's operation and creating a safer alternative to maintain a desired level water for the dam to operate. In addition, the team developed a design rubric to compare the possible solutions to this problem.

Engineering Projects

ENSC 10, Beinin Risk Assessment & School Design

Cara Itai
Devin Drake
Amy Kryston
Chris Vavrica
Omran Alhazmi

Advisor: Stephen Silliman
Sponsor: Gonzaga University
Liaison: Stephen Silliman



Our team has been tasked with analyzing a school building in the village of Adourekoman, Benin, a country located in west Africa. There were two primary steps to this project. First, we needed to explore the school building and other structures in the village to identify potential structural issues. Based on these studies and a comprehensive review of similar buildings in developing communities, the team was able to develop a structural stable design for the school building. A numerical analysis was also performed in order to ensure the safety of the structure.

Second, we endeavored to find creative solutions to problems that arise within the classroom environment. Currently, the school buildings in village have limited lighting, ventilation, and protection from outside elements. In making these adjustments to improve the learning environment the overall goal was to ensure the safety of the school building.

ENSC 11, Tanzania Community Center

Carlos La Torre
Chris Collins
Anna Kirdahy
Whitney Dunlap

Advisors: Sue Niezgoda,
Melissa Verwest
Sponsor: MSAADA Architects
Liaison: Kennet Bertelsen



The goal of this project was to create a design study report (DSR) for the facilities at the Fahushi Educational Event Center to be constructed in Mwanza, Tanzania. Our project was split into four main tasks: preliminary structural design, water treatment and supply, stormwater management system, and wastewater management. Each task involved preliminary design of multiple options and development of a decision matrix unique to each task. Final recommendations were provided to the client in the DSR using the highest rated options from the decision matrix. Overall, working on this senior design project with our advisors helped to prepare our team for a multidisciplinary work environment.

Engineering Projects

ENSC 12, EPA Kitchen Tech Zambia



Daniel Zentner
Anthony Zucca
Allie Reiling
Zac Chelini
Ryder Ueki

Advisor: Noel Bormann
**Sponsor: Environmental
Protection Agency P3 Grant**

The Zambia Kitchen Technologies project worked to improve air and water quality in North western Zambia. The team met this goal by developing a more sustainable cookstove and an alternative drinking water source. The stove developed uses a shortened rocket elbow design approach. The new stove reduces boiling time, exposure to pollutants, and fuel consumed compared to previous stove designs. The alternative water source was designed as a drilled well. It will reduce villagers exposure to crocodiles when collecting water from the river. Use of simple chlorination methods will reduce secondary contamination of the water being consumed in the homes. The team also developed maintenance and education plans. In addition, the team will travel to Zambia in May to implement the project.

ENSC 13, Hardened Connex

TJ Bolser
Elizabeth Hassebrock
Carney Devereux
Hank Thurston
Ty Partington

**Advisors: Aaron Zwanzig,
Anthony Schoen**
**Sponsors: Berg Premier Co,
KEEN Foundation**
Liaison: Jason Satran



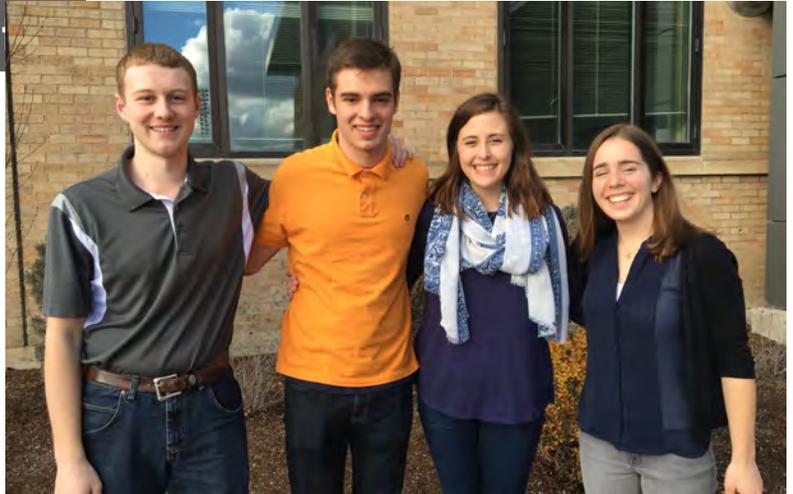
Since 1883, Berg Premier Camp Solutions, a local Spokane business, has developed innovative and functional camp solutions for a wide variety of uses. This includes the transformation of old shipping containers into military connex boxes, which are used for barracks, dining halls, latrines, and other necessary camp structures. Our project was inspired by Berg's work, as well as by the experience of two of our team members, who served overseas in the United States military. Our project goal was to add to the functionality of Berg's connex boxes by making a ballistic armoring system that integrates into Berg's current design. We approached this project in two main categories. Our structural team designed an aluminum skeletal frame that can surround the connex box, attaching to the corners where there are preexisting pick points. Our mechanical team worked on the development of ballistic panels. These panels attach to the aluminum skeleton, so that they may be replaced if significant damage is received.

Engineering Projects

ENSC 14, Cle Elum Surface Water

**Cody Sprague
Alex Marvick
Michele Cusick
Allie Nichols**

**Advisor: Russell Mau
Sponsor: Esvelt Engineering
Liaison: Mark Esvelt**



The goal of this project is to complete a design study and recommend a filtration technology for the Cle Elum Surface Water treatment facility. Currently, the treatment facility can treat 4 million gallons of water per day but needs to expand to treat 6 million gallons per day. The team has researched rapid sand, slow sand and membranes as alternatives for the addition. The team created flow schematics, cost analysis, and sustainability analysis in order to recommend a filtration alternative for the expansion.

ENSC 15, Moctileme Creek

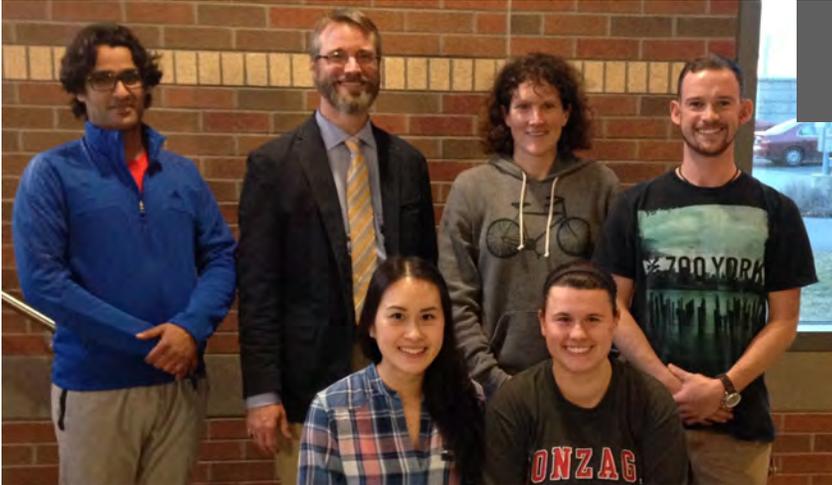
**Ryan Haddland
Jeffery Kvamme
Edward Benson
Kim Au**

**Advisor: Scott Marshall
Sponsor: HDR Engineering
Liaison: Scott Marshall**



Moctileme Creek is located in Benewah County, Idaho and passes under US Highway 95 through a box culvert. Fishbowl Engineering, team ENSC 15, was tasked with replacing this box culvert as well as the roadway through the curve south of the bridge. The team redesigned the culvert to meet the current standards for both fish passage through the culvert, and for fish passing over the culvert. The roadway through the curve slowed traffic to 45 miles per hour, and the team redesigned the roadway to allow cars to travel safely at 60 miles per hour. The roadway was also designed to have wider shoulders to increase the safety for drivers passing through the curve and over Moctileme Creek.

Engineering Projects



ENSC 16, Permeable Pavement Monitoring

Abdullah Alotaibi
Malcom Long
Lyn Do
Erin Routledge

Advisors: Mark Muszynski,
Sue Niezgoda
Sponsor: City of Spokane
Liaison: Mark Papich

ENSC 16 has spent the year evaluating multiple design options for the capture of stormwater on Sharp Avenue. The capture of stormwater will occur under the porous asphalt that will be installed on Sharp Avenue in 2017. This will allow water to be taken into a monitoring vault for sampling. Using a decision matrix with weighting and criteria that the team developed, the team selected the most feasible design option. The team then constructed a 2' by 4' box with pervious concrete in order to determine how well the selected design option will behave in the field and to test flow and sampling equipment. ENSC 16 has also poured their own slabs of porous asphalt and pervious concrete and designed an infiltration study to see the infiltration behaviors of these two permeable materials.

ENSC 17, Permeable Pavement Water Quality

Clara Olson
Emily Zikmund
Sarah Penso
Garrett Benson

Advisor: Aimee
Navickis-Brasch
Sponsor: City of Spokane
Liaison: Mark Papich



The ultimate goal of this project was to help the City of Spokane determine if porous asphalt can be used as an effective method for treating stormwater runoff. Specifically, whether or not it meets the Department of Ecology's standards for a BMP of reducing pollutants in stormwater. To achieve the city's goal, a laboratory study was completed to evaluate the effectiveness of porous asphalt cores reduction of regulated pollutants. Past research influenced the current study and contributed to determining current gaps in research. A laboratory experiment was designed, built, and tested to evaluate porous asphalt's effectiveness. Influent and effluent samples were collected, analyzed, and compared to Ecology's performance requirements to finally make conclusions whether or not porous asphalt could be considered a BMP for stormwater treatment.

Engineering Projects

ENSC 18, BioInfiltration Pond

Connor Trimble
Matt Winterle
Jason Neibergs
Kevin Krzyzewski

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



ENSC 18 has spent the 2015 2016 academic year demonstrating the effectiveness for bio infiltration ponds in Eastern Washington. New technology allows ENSC 18 to automatically collect samples from qualifying storm events, to evaluate the two ponds. On site one pond utilizes a 12 inch depth of soil and the other uses a depth of 18 inches of soil. The team determined the amount of pollutants that were reduced for each pond through water quality testing. This data allows the team to provide an educated recommendation of what soil depth should be used. The design criteria, installation, operation, and maintenance of the monitoring equipment were developed by ENSC 18 through lab testing, and previous years work on the project. The statistical analysis of a qualifying rainfall events in Spokane helped the team determine what qualifying events should be, and the depth at which simulated rainfall events should simulate to collect additional data.



ENSC 19, Building 15 SFCC

Vicente Varas
Mike Kelly
Krishen Desai
Nolan Saam

Advisor: Aaron Zwanzing
**Sponsor: Integrus
Architecture**
Liaison: Aaron Zwanzing

This year our senior design team worked on the Spokane Community College Building 15 Addition. The goal of this project was to create design drawings for the Building 15. This was done by analyzing the different components that affect the design of this building. Some of these components were: soil conditions, vertical loading, horizontal loading, and detailing. Using a design matrix, our team chose steel framing as the main design type for the building. Using this design type, all of the steel members were designed using the different components that were described above. Finally, the design drawings were completed and delivered to the client.

Engineering Projects

ENSC 20, Campus Circulation & Safety

Lucas Braafladt
Kesey Chan
Mgan Cunningham
Al Kravtsov

Advisors: Rhoda Young,
Bob Turner
Sponsor: City of Spokane
Liaison: Bob Turner



The team assessed the safety and circulation at both the Spokane Community College and Spokane Falls Community College campuses. After performing sufficient research to identify the traffic related safety and circulation problems on the campuses, the team came up with possible solutions. Using a decision matrix that took into consideration the safety, circulation, cost, maintenance, and sustainability of each solution the team determined the best options from the proposed solutions that would most benefit the modes of transportation used on campus. Using Synchro software, the team modeled two chosen solutions for each campus to provide a visual aid to show how effective the solution may be.

ENSC 21, EPA Fire Resistant Housing



Gabriel Agrisi
Luke Blanchart
Jon Thrope
Maddy Fritzen
Lauren May
Ian Morrell
Daniel Barad

Advisors: Noel Bormann,
Andrea Hougen
Sponsor: EPA- Okanogan County

Gonzaga University created this multi disciplinary team of students working on a capstone project to reduce wild fire damage. Fewer homes burned will reduce both waste generation and energy used to recover from future wildfires. The team, called Fire Ignition Resistant Engineering for Sustainable Solutions (FIRESS), uses designs with improved energy efficiency and fire resistance. This team set goals to construct original wall sections and models as well as prototypes of innovatively designed shutter systems. A Monte Carlo model (pictured above) provides estimates of damage avoided to balance the cost of the construction. As project products, Team FIRESS will present three separate 6' x 2.5' x 1' wall sections to provide visual aids for depicting structural elements and prototyped mechanical shutter systems. The team will provide two laptops displaying research data, photographs, Monte Carlo Simulations for housing damage costs, and relevant graphs/ attachments.

Engineering Projects



ENSC 22, Martin Center Energy Audit

Brad Barrow
Joe Virden
AJ Serrano
Cole Mosman

Advisor: David James
Sponsor: Avista Utilities
Liaison: Carlos Limon

Our group's purpose was to evaluate current energy systems in the Martin Center to see where improvements could be made. This will save money for the university as well as make the Martin Center more environmentally friendly. We focused on five critical areas that had high energy usage. These categories were lighting, current boiler efficiency which includes domestic hot water and central heating, Rudolf Fitness Center pool leakage, atrium windows, and the rooftop AC units. Our goal for this project was to perform an energy audit similar to one done by Avista, our sponsor, and suggest more efficient solutions to the current problems associated with each category. Some examples are, replacing current lights with LEDs, increasing boiler efficiency by replacing current three way valves with two way valves, and replacing the current atrium window glass with low e glass. We feel we have completed our goal to the best of our abilities and have come up with feasible solutions for each category we focused on.

ENSC 24 AVISTA Relay Lab

Mohammad Alshoibi
Eric Rogers
Eric Lozoya
Will Warren

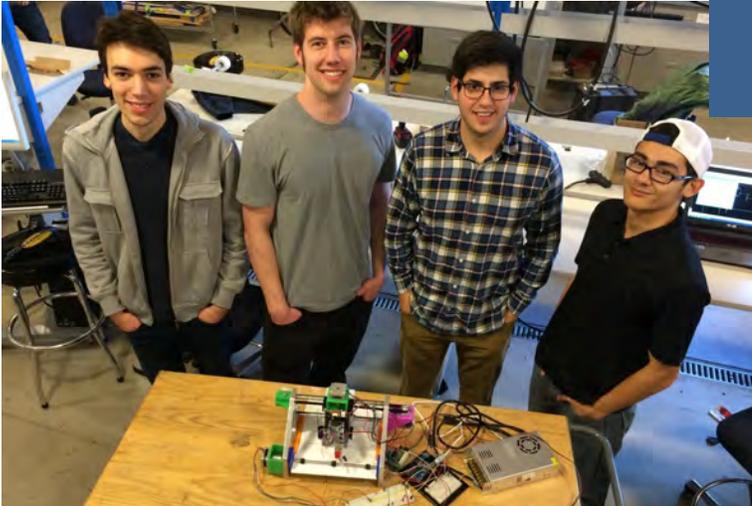
Advisor: Kevin Damron
Sponsor: Avista Utilities
Liaison: Kevin Damron



Protecting the modern electrical power system is an integral part of ensuring a safe and reliable power system. Due to the importance of this field, the Avista Protection Lab senior project developed a power system protection laboratory to educate undergraduate electrical engineers. The labs developed will teach future students about the basics of power system protection using industry standard equipment to protect assets. This team developed a transmission grid utilizing LabVolt modules and used SEL relays to protect the transmission grid. The grid contains fault modules (modules which create an electric current higher than normal due to a short circuit) and when activated, the SEL relays will take action to open the necessary breakers to clear the fault of the system. Project accomplishments this year included creating new labs and new protection schemes to be tested and observed using the different SEL relays and Omicron test equipment.

Engineering Projects

ENSC 26, Braille Printer



Gustavo Rocha
Jamison Schacht
Miguel Alvarez
Tre Uson

Advisor: Steven Zemke
Sponsor: Gonzaga University
Liaison: Steven Zemke

Our goal for this project was to design and build a relatively inexpensive braille printer prototype. This printer converts an English text file into a braille pattern and then utilizes 3D printing technology to deposit a raised braille pattern onto a sheet of paper. Our final deliverable is a proof of concept rather than a marketable product intended for blind users. This project required an interdisciplinary team of engineering students in order to complete mechanical, electrical and software based design work. The mechanical work consisted of the design and manufacture of the printer frame and extruder assembly, the electrical work consisted of the design and manufacture of drivers for the printer, and the software work consisted of the design of a program that translates English text into braille and then into commands that are sent to the motors.

ENSC 27, Braille Refresh Reader

Joe Wilson
Caitlin Croskrey
Mark Rawson
Ingrid Stansberry

Advisor: Bob Conley
Sponsors: Gonzaga University,
KEEN Foundation
Liaisons: Jason Varnadow,
Emily Stevenson



The idea for our project originated from what we observed as a void in disability access to technology, specifically for blind students. Current Braille displays are limited by mechanics and can only display a single line. As such, we set our goal to develop a multiple line tactile Braille display. After detailed research encompassing many different ways to produce a Braille dot, we concluded that the most promising display would be created using electro tactile haptic technology, which mimics the tactile feeling of Braille cells. We designed high voltage electrodes that imitate the tactile feeling of real braille dots when fingers run across it. Experimentation determined ideal electrode spacing and waveform shape in order to maximize the tactile sensation for the user. The system is controlled by a micro controller. In addition to increasing the accessibility of Braille materials, we hope that our project can help generate interest in disability accommodations and prompt engineering development in Braille technology.

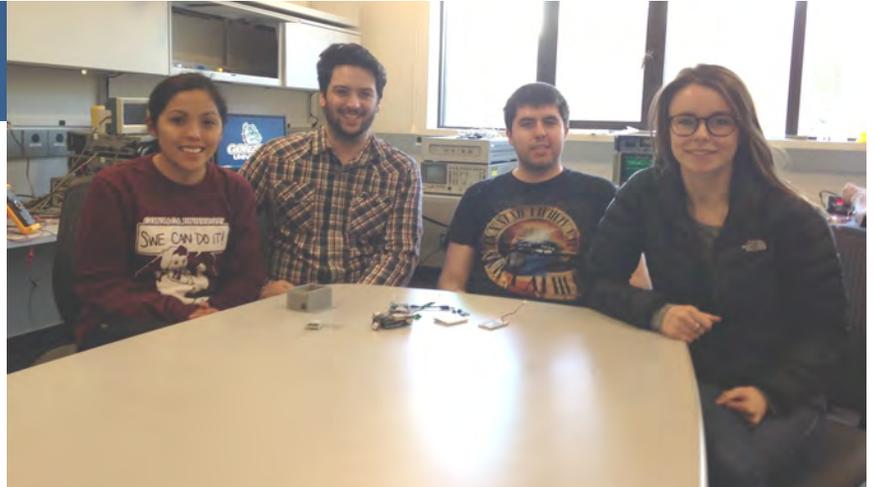
Engineering Projects

ENSC 28, GPS Tracking System

Susie Lira
Andrew Petrucci
Isaac Trueblood
Katie Morris

Advisor: Shane Pacini
Sponsor: Bloomsday
Liaison: Don Kardong

**This team is featured on the cover*

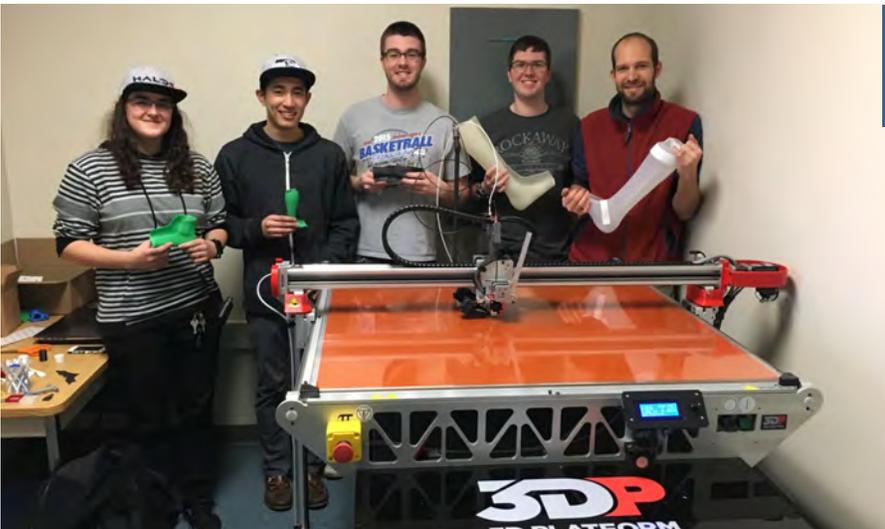


The Rome Marathon, Boston Marathon, and Bloomsday are all major road races that attract many participants and spectators annually. Many people participate for various reasons such as to raise money for cancer awareness or to raise money for a club. On the other hand, spectators attend these events to see their athletes run but often find themselves seeing their runner only at the beginning and end of the race. Our goal was to develop a wearable device that the athlete can wear during the race to allow their friends and family to track them live during the event. This would be beneficial for safety reasons and to give spectators an interactive experience during the race. Location coordinates are sent to a webserver where the iOS app developers draw information to portray a live feed of the runner. Thus, the runner will not be inconvenienced by having to run with a large phone in order for spectators to watch him/her throughout the duration of the race. This also allows a spectator to take a more interactive role in supporting the athlete during the race.

ENSC 29, 3D Orthosis

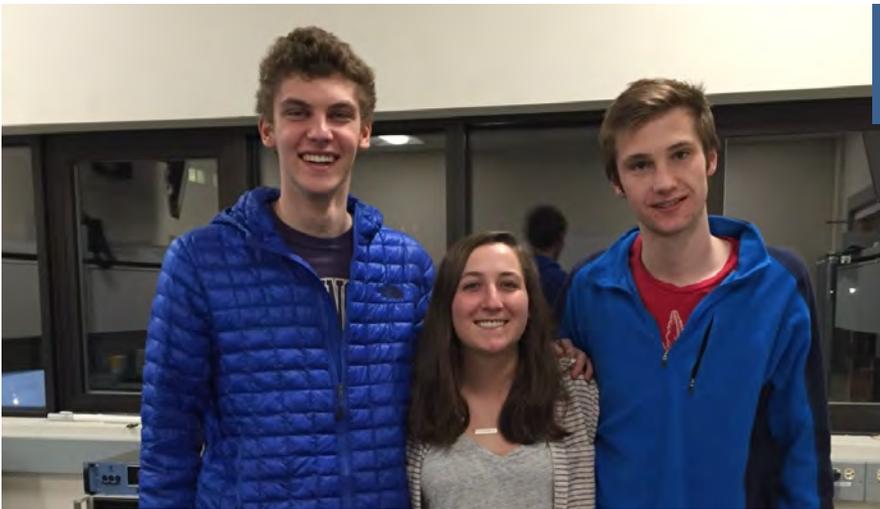
McKenzie Horner
Colin Le
Shane Derrick
Quinn Walters

Advisors: Patrick Nowacki,
Peter McKenny
Sponsor: KEEN Foundation
Liaison: Peter Springs



Our team worked with Peter Springs, a certified orthoptist and prosthetist to develop a process for 3D printing AFOs (Ankle Foot Orthosis) for children. These leg braces assist children with poor muscular control and allow them to walk. By creating a 3D printing manufacturing process, we can reduce both the time and cost of these important braces. We did tensile and fatigue testing to determine the best materials to print with and determined an overall process for getting a 3D scan to a completed product using different software and our 3DP1000 large format 3D printer. We provided our liaison with a full scale proof of concept after printing with a variety of materials and a simplified process to build off on for future research and development.

Engineering Projects



ENSC 30, Somnutech Breadboard

**Marko Barievic
Jacqueline Murphy
Luke Hanson**

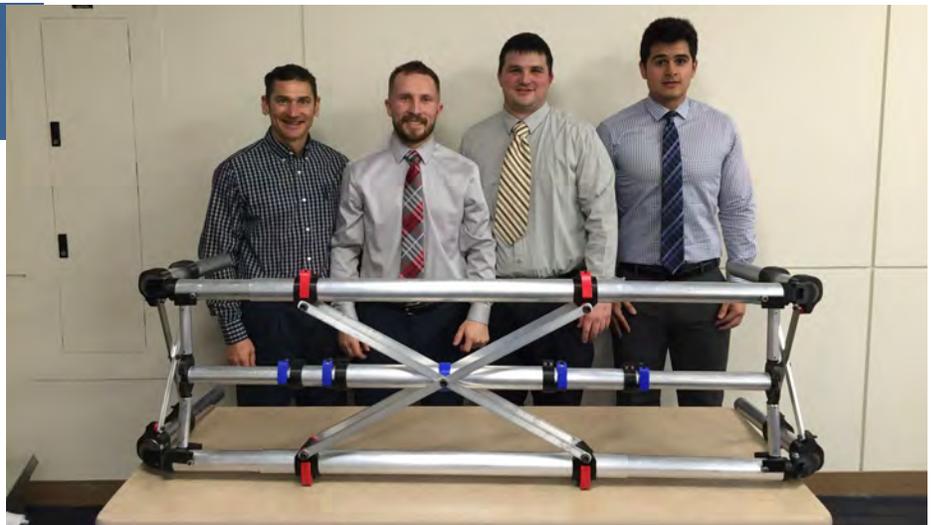
**Advisor: Grigore Braileanu
Sponsor: Somnutech
Liaison: Jason Moore**

Our senior design project aimed to create a proof of concept device to improve sleep quality. The device tracks body vitals and environmental factors to measure the quality of sleep. A separate project team CPSC 06 is developing a mobile app designed to give users personalized feedback based on data collected from our sensors.

ENSC 31, Truck Bed Extender

**Ryan Magee
Thomas Adams
Adan Arreguin**

**Advisor: Jeff Nolting
Sponsor: Gonzaga University
Liaison: Jason Moore**



All compact pickup truck owners suffer payload size restrictions due to small pickup bed dimensions. Many of these individuals purchase a product that extends the Original Equipment Manufacturer (OEM) bed. The bed extenders currently available on the market are oversized, cumbersome and difficult to store.

ENSC31 developed a fully collapsible truck bed extension system that addresses the shortfalls of available bed extenders. The ENSC 31 truck bed extender meets or exceeds the strength capabilities of currently available bed extenders, attaches with minimal effort and requires no permanent hardware. When not in use, the extender breaks down quickly and easily to a manageable size allowing it to be stored within the cab of a small pickup or alongside items in the pickup bed.

Engineering Projects

ENSC 32, Cathead Guard

Kyle Branch
Travis Tran
Andrew Algermissen
David Sweet

Advisor: Art Miller
Sponsor: Center for Disease Control
Liaison: Grant King



The shrimping industry is one of the most dangerous industries in the US. The industry is also unique in that no boat is the same. However, the one common thing on all the fishing boats is the winch they use. The winches being used on the boats are very old and very dangerous. Because of the danger, NIOSH has asked us to develop a system to protect the fishermen from a part of the winch that caused a 15 year old boy to lose his life. The dangerous part of the winch is the cathead, which is used to haul cargo and bring in nets. Our job was to create a system that will not only protect the fisherman but also is cost effective. We believe our final design covers all the bases and the cathead guard system is ready for sea trials.

ENSC 33, Diesel Heat Pump

Shane Guy
Joao Lasalvia
Chance Cole
Jamie Tonna

Advisor: Chris McFarland
Sponsor: Hotstart
Liaison: Chris McFarland



The task assigned to ENSC 33 was to design a heat pump to preheat the coolant for the backup generator behind McCarthy Center. The project goal was to ensure that Hotstart would be able to create specialized heat pumps to be sold to the industry. There were three main phases of the project: research, design, and build/test. The team researched the cycle of the heat pump, the necessary components and the differences in refrigerants. Using decision matrices, the team chose R410A as the refrigerant and to selected the necessary components for this system. Following, the team designed the layout of the mounting plate based on measurements of the envelope size inside the generator. The team continued with calculations and theorized what the coefficient of performance would be. Finally, the team tested the heat pump and used the results to determine the actual coefficient of performance of the heat pump.

Engineering Projects



ENSC 34, Takeup Fixture

Jason Burgad
Alex Reid
Bryant Robins

Advisor: J. McCall
Sponsor: FLSmidth
Liaison: Jacque Mostert,
Bryon Kanenwischer, Harold Molony

FLSmidth is a leading provider of large scale mining equipment to the global minerals industry. They make extensive use of conveyor belts in their designs to move material. To operate correctly, these machines need their belts to be tensioned in real time. In order to design better tensioning (takeup) systems, FLSmidth wanted to simulate the real world dynamics of a belt in a compact, portable package. The ENSC34 team has designed a Takeup Test Fixture to meet this need. The test fixture is capable of simulating the dynamic running characteristics of a variety of belts in a portable package the size of a semi trailer.

ENSC 35, Boeing Firewall S

Kyle Mulvaney
Kellen Kennedy
Ruben Ruvalacaba Macias
James Komperud

Advisor: Andy Johnston
Sponsor: Boeing
Liaison: Patricia Blankenship



Our team was tasked with finding an alternative firewall seal for Boeing's new 737MAX engine thrust reversers. When engine thrust reversers are deployed, they reverse the airflow around the engines to produce a rearward thrust to slow the plane upon landing. The current firewall sealant takes four hours to fully cure. This is an issue because the Engine Anti Icing valve (EAI) will need to be replaced approximately every 2 years, and the sealant will need to be reapplied after each maintenance. This places a huge burden on airlines by creating a 4 hour in fleet maintained time. We discovered an alternative sealant that required a significantly reduced cure time and conducted tests that mimicked FAA fire tests and simulated an engine fire. We also tested Boeing's current sealant in order to compare and contrast our new sealant.

Engineering Projects

ENSC 36, HVAC Base Design

Conner Jensen
Brian Cope
Diana Fisher
Kyle McLaughlin

Advisor: Sam Shoemaker
Sponsor: Haakon Industries
Liaison: Ryan Leahy



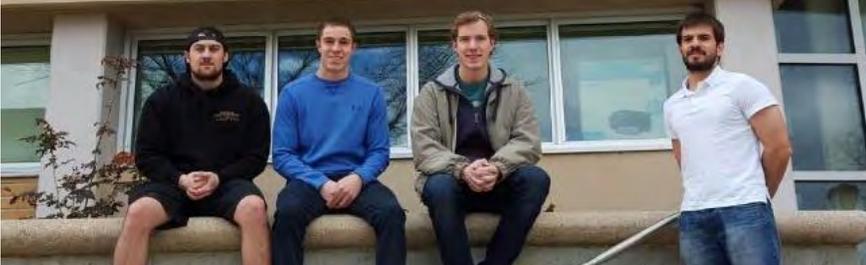
HVAC Base Design team redesigned a HVAC base for Haakon Industries line of custom HVAC units. The 2015-2016 team was asked to create a more cost effective design and decrease assembly complexity. Based on these requirements, team ENSC 36 has designed a sheet metal base that uses self drilling/tapping screws instead of welding, has standardized members for ease of assembly and design, and reduces cost by up to 35%. The design eliminates unnecessary material, decreases the overall part count, and reduces the labor and material costs. The concept allows the base parts to be designed using Haakon's parametric modelling programming, which allows for adaptability based on a client's specific needs. Overall, the new HVAC base design allows for easier assembly, many cost reductions, and increased customization ability for individual customers.

HUGHES HALL

ENSC 37, Hughes Performance Audit

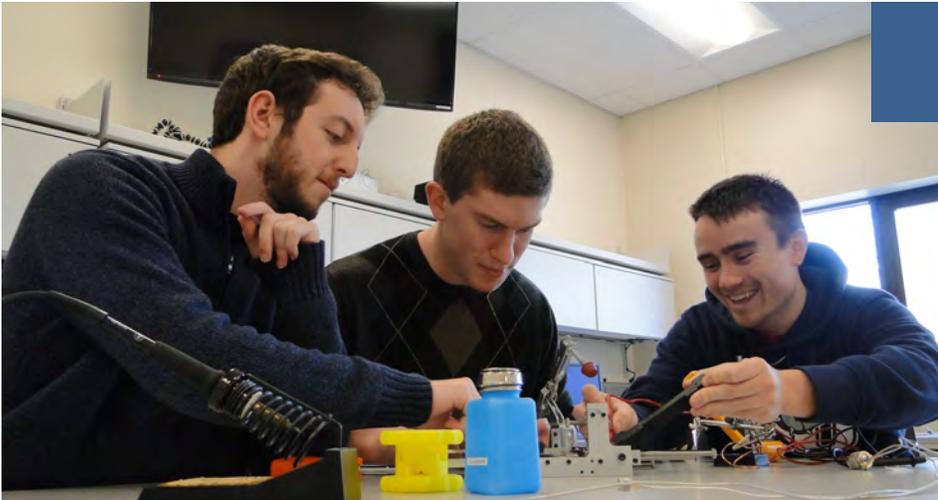
Lawrence Walkley
Connor Smith
Gregg Davidson
Leon Galhardo

Advisor: Colleen Nolting
Sponsor: McKinstry
Liaison: Jayson Schmidt



The goal of this project was to develop an Investment Grade Audit (IGA) for Hughes Hall. Hughes is a building on Gonzaga's campus, originally built in 1961 and renovated in 2002, which is primarily used for biology and chemistry coursework. Being an older building, our task in creating an Investment Grade Audit was to analyze the building and develop opportunities for energy savings, which would then be presented to the school. Through this process, our team interviewed building operators, walked and observed the facilities, logged system performance, identified possible improvement opportunities, engineered systems to 50% design specifications, produced written detailed scopes of work, completed energy engineering and delivered a final report to the client. Our final report, given to Gonzaga in the form of an Investment Grade Audit, identifies all criteria of the project, including detailed scopes of work, project schedule, Guaranteed Maximum Project (GMP) cost, guaranteed energy savings and more.

Engineering Projects



ENSC 38, Antenna Element Fabrication

Stuart Lauer
Anthony Arkoosh
Colter Mahlum

Advisor: Steven Zemke
Sponsor: LHC2 Inc
Liaison: Bob Conley

We are the Antenna Element Fabrication team. We were tasked with examining the process used by a local company to manufacture a part critical to the operation of the antennas they build and finding a way to build them more reliably and efficiently. To accomplish this, we examined a multitude of different processes to determine which ones would be able to make the part cost effectively and in a highly repeatable fashion. Simultaneously, we built a custom die set that gave our sponsors the ability to create the part themselves, "in house." Finally, we created a financial report that compared all of the different options that will aid our sponsor in making their final decision.

ENSC 39, NIOSH Baghouse

Cameron Falkenburg
Richard Moore
Ben Muyres
Carlie Mantel

Advisor: Cristy McKinney
Sponsor: NIOSH
Liaison: Art Miller



The NIOSH Baghouse project is a filtration project for limiting the amount of respirable silica particles in the air during frac sand moving process. The product is a filter housing that attaches to the openings of the sand moving tanks and uses filters to entrap dangerous silica particles before they can escape. NIOSH is funding this project to limit the occupational hazard to workers around silica frac sand and reduce the rates of silicosis in said workers.

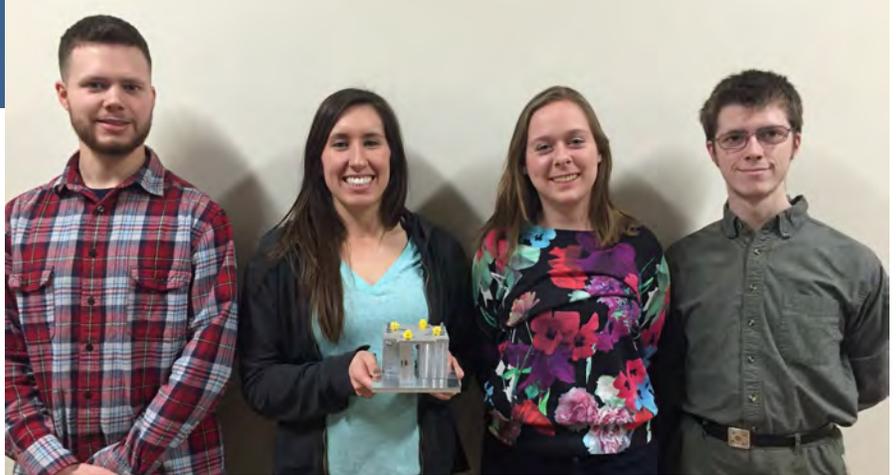
The project included two prototypes, both utilizing the same pleated cartridge filters and jet pulse style cleaning systems. The housings are welded sheet metal, however the second prototype has a multi-piece body to facilitate easy loading and unloading. The project included testing and data analysis for each prototype.

Engineering Projects

ENSC 40, RANDL

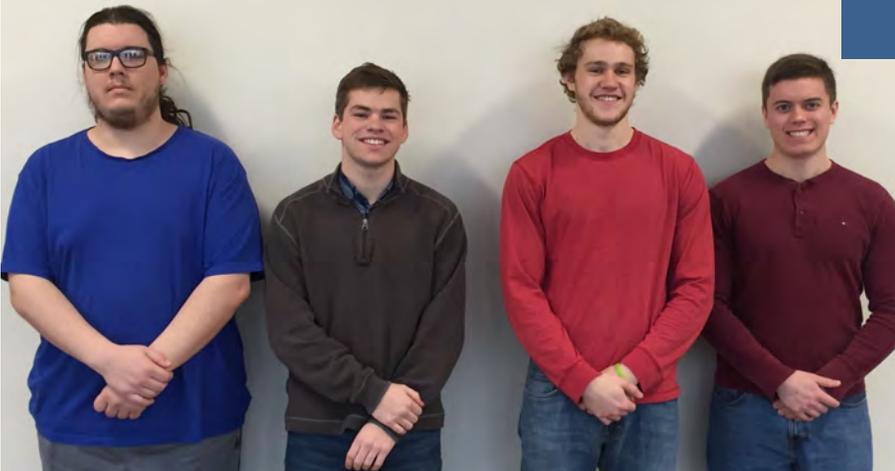
Tyler Wales
Lauren Joseph
Kirsten Solders
David Wesinger

Advisor: Steven Zemke
Sponsor RANDL Industries
Liaison: Bob Hagarty



RANDL is an electrical box manufacturing company located in Spokane, WA. Our original goal was to design and create an automated machine, which inserts cable managers into an electrical box. After due consideration, a decision was made to tighten the focus on the locating and locking mechanism of this device. Our revised goal was to create a proof of concept device that would demonstrate how the cable managers would be precisely located and locked. To that end, we designed, fabricated, and tested a spring loaded locating head comprised of four aluminum cavities. The cavities precisely locate and insert the cable managers into RANDL's 5 Square electrical box. This completed proof of concept may be used in the future as a component of a fully automated assembly line.

ENSC 41, Silica Sampling Cassette



Ryan Rackham
Michael Sedor
Peter Siderius
Jacob Adams

Advisor: Art Miller
Sponsor: NIOSH
Liaison: Art Miller

The goal of our project was to create a Silica Sampling Cassette capable of portable FTIR analysis without removing the filter. We were also tasked with designing a cassette holding fixture that is compatible with the current FTIR platform. To fulfill this goal meant multiple iterations of prototypes were necessary in order to learn what features provided the most accurate readings and were the most user friendly. Accurate readings required a consistent Silica deposition, negligible filter blow by, and utilizing air tight seals. Features such as threaded caps and removable filter support fins were some concepts which factored into our chosen user friendly features. By utilizing the data and analysis of our prototypes, we created a final portable Silica Sampling Cassette that represents the best combination of our prototypes' successes. We worked to develop a holding fixture for this cassette which is compatible with the current FTIR platform.

Engineering Projects

ENSC 42, Sterling Assembly Line

Daniel Llerana
Renee Wahlman
Lucas Schneidmiller
Brian Drummey

Advisor: Brent Fales
Sponsor: Sterling International
Liaison: Steve Klemp

The client, Sterling International, is seeking to redesign their fly tape manufacturing process. The current process is unreliable and uses material inefficiently. Our project team has proposed and partially constructed a design that will seek to minimize errors and increase the production rate significantly. With our sponsor we have worked on project specifications that our machine will be able to meet. We have also provided our sponsor a brief, high level outline of the specifications of the machine, models and drawings, and sub assembly prototypes that can be used in the final machine.

ENSC 43, Universal Robot Safety

Elise LaRussa
Daniel Vimmerstedt
Garrett Mathews
Luke Sackschewsky

Advisor: Andy Johnston
Sponsor: HP Inc.
Liaisons: Daniel Ellis,
Hans Leidenfrost



HP Inc. asked us to develop a safety system that will protect both their employees and the robots used for printer testing. The testing robots have a wide range of motion and move at various speeds, causing a potential risk to any one passing by. Requirements for this project include: easy setup, easy use, and the ability to protect an area up to 8 feet by 8 feet. They also asked that this safety system has the ability to pause the testing robots as people approach, and shut down the robots completely if they get too close. The final safety system we have created uses ultrasonic sensors and a web camera. The sensors are used for the warning zone; if someone is approaching the printers, the sensors will detect them, pause the machine and trigger an alarm so the person knows they are too close. If that person continues to approach the printer the web camera will find them in the shutoff zone and turn the robot off completely.

Engineering Projects

ENSC 44, Archimedes Testing System

Royce Mapes
Joseph Talbot
Troy Odstrcil
Mary-Elizabeth Sierra Ianham

Advisor: Gabe Achenbach
Sponsor: UTC Aerospace Systems
Liaison: Lynn Spivey

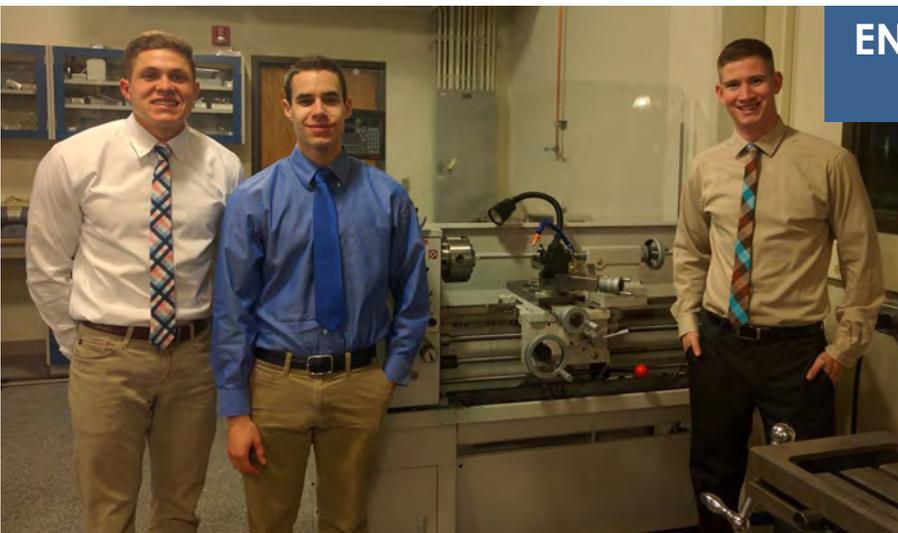


As a team, we have worked closely with UTC Aerospace Systems to redesign their Archimedes Testing System. UTC is the leading manufacturer for carbon disc brakes used in the aerospace industry and their Archimedes Testing System measures the density of these disk brakes. We have worked hard to successfully improve the system by easing both use and maneuverability along with increasing efficiency and accuracy for safer operations. This was accomplished by restructuring how the disks were removed from the system. Our new design also eliminated an unneeded step in the long process saving time and money.

ENSC 45, Directional Width Control Systems

Taylor Johnson
Kevin Featherstone
Matt Riso

Advisor: J. McCall
Sponsor: UTC Aerospace Systems
Liaison: Isaiah Ratliff



Our project was initially targeting to design, assemble, and test an automated control system for a manufacturing process using SERVOs and PLCs for United Technologies Aerospace Systems. This process needed to control the overall width and location of a material similar to felt. We designed a system that utilized a banana bar and a tilt bar to stretch/unstretch or slide the material one way or the other. However, in early February the requirements from UTAS changed and we were then requested to design a mechanical control system to be controlled by operators. We were fortunate that we could still utilize some of our previous design and still were able to control the width and location with the banana and tilt bars. We designed a new system and because of concerns with tolerances provided drawings and assemblies to UTAS for potential installation.

Engineering Projects



ENSC 46, Helical D Pole Antenna SFM

Igor Vegner
Caleb Archer
Ryan Lum

Advisor: Steven Zemke
Sponsor: Eigen Wireless
Liaison: Steve Schennum

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.



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| Bill Fees | WA Dept. of Ecology | Bob Turner | City of Spokane |
| Brent Barr | f5 | Brian Auer | Keytronic EMS |
| Bruce Worobec | Worobec Consultant | Chris Sharman | Soft Development Syst. |
| Dan Lenz | Quad Graphics | Dave Duncan | Dept. of Ecology |
| David Knaggs | Telect | David Moss | Spokane County |
| Doug Pooler | Empire Lab Automation | | |
| Gary Holmesmith | Kaiser Aluminum | | |
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| | | Scott Ratterman | Eclipse Engineering |
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Thank you to our Sponsors!

The design projects and resources required to implement the many engineering and computer science projects during the 2015-2016 academic year were generously provided and supported by the following sponsors:

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CEDE Senior Design, Final Presentations
Wednesday, April 27, 2016
10 am—2 pm Display Tables in Herak Atrium
3—6 pm Final Presentations, Various Classrooms
6—8 pm Senior Social, Hemmingson Ballroom

PACCAR 107— Computer Science

DAB: Melissa Migliuri, Dan Lenz
 Chris Sharman, Ron Riel
 Bruce Worobec, Mike Herzog
 Rob Bryant

CPSC 1 Automated Ag System
 CPSC 2 Form Cycle
 CPSC 3 GPS Tracking App
 CPSC 4 Digital RPT Binders
 CPSC 5 English Lang. Web App
 CPSC 6 Sleep Improvement App
 CPSC 7 Wayfinding App

3:10 p.m.
 3:35 p.m.
 4:00 p.m.
 4:25 p.m.
 4:50 p.m.
 5:15 p.m.
 5:40 p.m.

Herak 245— Mixed Disciplines

Structural Projects
 DAB: Tim Graybeal
 Kevin Cary, Jim Roletto
 Jerry Tombari, Scott Ratterman

ENSC 13 Hardened Connex
 ENSC 09 Little Falls Rehab
 ENSC 19 Bldg. 15 – SFCC
 ENSC 10 Benin Risk Assessment
 ENSC 22 Martin Center Energy Audit

3:10 p.m.
 3:40 p.m.
 4:10 p.m.
 4:40 p.m.
 5:10 p.m.

Herak 237 -Civil Engineering

Hydrology Projects
 DAB: Katy Allen, Troy Gibbs
 Bill Fees, Scott Marshall
 Matt Zarecor, Joel Lee

ENSC 14 Cle Elum Surface Water
 ENSC 15 Moctileme Creek
 ENSC 17 Permeable Pvmt Water Quality
 ENSC 18 Stormwater Bio-Infiltration

3:10 p.m.
 3:40 p.m.
 4:10 p.m.
 4:40 p.m.

Herak 244— Civil Engineering

DAB: Dave Duncan, Dave Moss
 Phil Pintor, Lindsay Gilbert
 Bob Turner, James Simon

ENSC 11 Tanzania Community Center
 ENSC 12 EPA Kitchen Technology
 ENSC 21 EPA Fire Resistant Housing
 ENSC 16 Permeable Pvmt Monitoring
 ENSC 20 Campus Circulation & Safety

3:10 p.m.
 3:40 p.m.
 4:10 p.m.
 4:40 p.m.
 5:10 p.m.

Presentation Schedule, Continued

Hughes 130- ME & EE Eng.

DAB: Ron Oscarson, David Knaggs
Paul Robertson, Gary Holmesmith
Brian Auer

| | |
|-------------------------------------|-----------|
| ENSC 29 Prosthetic Devices | 3:10 p.m. |
| ENSC 26 Braille Printer | 3:40 p.m. |
| ENSC 38 Universal Safety Robot | 4:10 p.m. |
| ENSC 46 Helical D-Pole Antenna | 4:40 p.m. |
| ENSC 43 Antenna Element Fabrication | 5:10 p.m. |

Herak 301-Mechanical Eng.

DAB: Sam Shoemaker,
Les Bohush, George Coleman
Kevin Oldenburg, Ryan Leahy

| | |
|--|-----------|
| ENSC31 Truck Bed Extender | 3:10 p.m. |
| ENSC 36 HVAC Base Design | 3:40 p.m. |
| ENSC 39 NIOSH Baghouse | 4:10 p.m. |
| ENSC 41 NIOSH Silica Sampling Cassette | 4:40 p.m. |
| ENSC 32 Cathead Guard | 5:10 p.m. |

College Hall 101-Mechanical Eng.

DAB: Jim McCall, Nick Questad
Michael Maffeo, Tom Zysk

| | |
|-----------------------------------|-----------|
| ENSC 35 Boeing Firewall Seal | 3:10 p.m. |
| ENSC 37 Hughes Energy Audit | 3:40 p.m. |
| ENSC 44 Archimedes Testing System | 4:10 p.m. |
| ENSC 45 Directional Width Control | 4:40 p.m. |

Herak 123 -Mechanical Eng.

DAB: John Olsulfka, Alek Marinos
Doug Pooler, J. McCall
Jim Weston

| | |
|-------------------------------------|----------|
| ENSC 40 Randl Manufacturing Process | 3:10p.m. |
| ENSC34 FLSmidth Takeup Fixture | 3:40p.m. |
| ENSC42 Sterling Assembly Line | 4:10p.m. |
| ENSC33 Diesel Heat Pump | 4:40p.m. |

Hemmingson 314-EE/CPEN

DAB: Jeff Owen, Brent Barr
Mike Perrin, Michael Santora
John Gibson, Kaitlyn Helsing

| | |
|--------------------------------|-----------|
| ENSC 27 Braille Refresh Reader | 3:10 p.m. |
| ENSC 24 AVISTA Relay Lab | 3:40p.m. |
| ENSC 30 Somnutech Bread Board | 4:10p.m. |
| ENSC 28 GPS Tracking System | 4:40p.m. |
| ENSC 08 Automated Ag System | 5:10p.m. |





Center for Engineering Design & Entrepreneurship Student Learning Outcomes

1. Design & develop solutions for multi-dimensional problems
2. Communicate project information
3. Manage project tasks, resources, and schedules
4. Collaborate and contribute as a team member



Congratulations to team ENSC 21 on winning the 1st place Vitruvian Award from Organic Architect!

The team competed against 38 other university teams on April 16 & 17th in Washington D.C at the 13th Annual National Student Design Competition for Sustainability, Focusing on People, Prosperity and the Planet. In March, they submitted their project to the EPA in hopes of being recipients of the EPA P3 Phase II Grant and will know the results in July.

Congratulations and best of luck!