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SEATTLEU
COLLEGE OF
SCIENCE AND ENGINEERING



9

PROJECTS

DAY



1

WELCOME TO COMING



“For 32 years, we have enjoyed the support of leading external partners. We continue to witness tremendous professional growth among the students as they complete their projects each year.”

You are about to meet an impressive group of students. In September, each student team received an assignment from a local industry partner. These are real-world challenges faced by the sponsoring companies. The sponsors expected results, and, as you'll see, the students delivered!

For our students, these year-long projects are about much more than the deliverable. As they have worked together to solve the challenges put before them, the students have learned about project management, team leadership, budgeting, technical writing, and oral communication. These are all crucial skills—and they put our students ahead of the curve when they begin their careers.

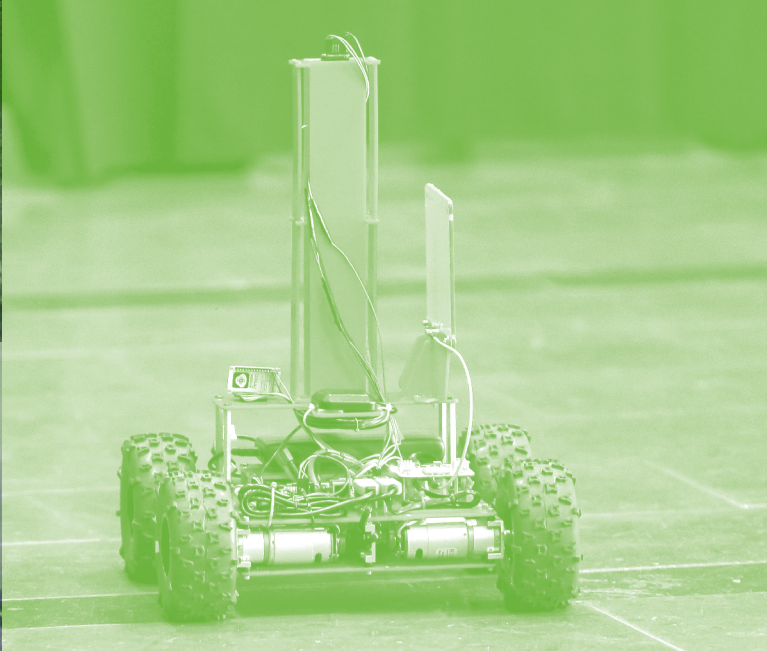
We encourage you to look through this booklet and identify the projects that interest you. Attend the team presentations and ask questions. Talk to the students and their industry liaisons during the poster sessions. We're confident you'll find their work fascinating, and you'll be impressed with the students' ability to think on their feet and discuss technical issues.

We are grateful to the companies, government agencies and non-profits who partner with us to make this important, award-winning educational experience possible. We also want to thank the industry liaisons and the faculty advisors who have worked with the teams throughout this academic year. Together, we are preparing a new generation of scientists, engineers and computer scientists who will make an impact throughout the Puget Sound region—and beyond.

Michael J. Quinn, PhD
Dean
College of Science and Engineering

Jean Jacoby, PhD
Associate Dean and Project Center Director
College of Science and Engineering





SCHEDULE ————— 4

CIVIL & ENVIRONMENTAL ENGINEERING ————— 6

COMPUTER SCIENCE ————— 9

ELECTRICAL & COMPUTER ENGINEERING ————— 16

ENVIRONMENTAL SCIENCE ————— 21

INTERDISCIPLINARY ————— 22

MECHANICAL ENGINEERING ————— 24

PROJECTS DAY 2019

EVENT SCHEDULE

ENGINEERING, ENVIRONMENTAL SCIENCE, AND COMPUTER SCIENCE PRESENTATIONS

FRIDAY, JUNE 7

SULLIVAN HALL, LAW SCHOOL

11:45 A.M. - 12:30 P.M. Check-in and Registration

12:30 P.M. - 12:40 P.M. Welcome to Projects Day 2019
Father Stephen Sundborg, S.J., President
Dean Michael Quinn, College of Science and Engineering

12:45 P.M. - 1:45 P.M. PRESENTATION SESSION 1

ROOM C5

- **SNOHOMISH COUNTY PUBLIC WORKS** South Machias Road/Dubuque Road Intersection Improvements / CEE 19.4
- **CKC** Probable Maximum Loss (PML) Analysis and Seismic Retrofit of a Building / CEE 19.1
- **SEATTLE CITY LIGHT** Ross Powerhouse Seismic Evaluation and Retrofit / CEE 19.3

ROOM C6

- **T-MOBILE** Automated Durability Evaluation Platform / INT 19.3
- **T-MOBILE** Post-Hoc Failure Analysis / CS 19.13

ROOM 109

- **PANTHERA** Project Spot Check / ECE 19.7
- **OUTBACK POWER** Battery Monitoring System / ECE 19.5
- **KILOWATTS FOR HUMANITY** Improving the KiloWatts for Humanity Data Logger / ECE 19.4

ROOM 110

- **BILIMETRIX USA** BiliPic / CS 19.4
- **NOISEOUT** NoiseOut NoSnore / CS 19.10
- **STARBUCKS** Project Kasandra / CS 19.12

1:45 P.M. - 2:00 P.M. BREAK

2:00 P.M. - 3:00 P.M. PRESENTATION SESSION 2

ROOM C5

- **KING COUNTY** White Center Regional Retention/Detention Facility Retrofit / CEE 19.2
- **US FOREST SERVICE** Desimone Oxbow River Restoration / CEE 19.5
- **WISErg** Assessment of Recycled Food Fertilizer Amendment for Soil and Plant Health / ENSC 19.1

ROOM C6

- **VITA INCLINATA** Cable Attachment Mechanism / ME 19.5
- **SEATTLE UNIVERSITY** Collegiate Wind Competition 2019 / INT 19.1
- **THE LIGHTHOUSE FOR THE BLIND** Visual Inspection of the Multipurpose Hydration System Bladder Radio Frequency Weld / ME 19.3

ROOM 109

- **KENWORTH TRUCK COMPANY** Fuel Tank Weld Repair Tracker / CS 19.8
- **KENWORTH TRUCK COMPANY** Supplier Collaboration Interface / CS 19.9
- **PACCAR INC** Industry 4.0 Knowledge Sharing / CS 19.11

ROOM 110

- **SEATTLE CITY LIGHT** Generator-Circuit Breaker Coordination Study / ECE 19.8
- **HOLDEN VILLAGE** Holden Village Generator Controls Upgrade / ECE 19.3
- **CHELAN COUNTY PUD** Hydroelectric Unit Data Acquisition and Transmission System / ECE 19.2

3:00 P.M. - 3:15 P.M. BREAK

3:15 P.M. - 4:15 P.M. PRESENTATION SESSION 3

ROOM C5

- **AMAZON** Amazon Asha Project / CS 19.1
- **AMAZON** Visualizing Footprint / CS 19.2
- **AMAZON** Amazon Sustainability Question Bank Editor / CS 19.3

ROOM C6

- **DIMENSIONAL MECHANICS** Automating the Curation and Preparation of Training Data for Machine Learning / CS 19.5
- **F5 NETWORKS** Cloud Analytics Framework / CS 19.6
- **F5 NETWORKS** Upgrade Hero / CS 19.7

ROOM 109

- **KENWORTH TRUCK COMPANY** Gladhand Connector Automation / ME 19.2
- **KENWORTH TRUCK COMPANY** Machine Learning for Weight Audits / ECE 19.6
- **BOEING** Development of Power Quality Test Data Processing Software / ECE 19.1

ROOM 110

- **SOUND TRANSIT** Building an Interactive Noise Map Application for Customer Access to Light Rail Noise Data / INT 19.2
- **INGERSOLL RAND** Pneumatic Gearmotor Performance Enhancement / ME 19.1
- **NIC GLOBAL** Press Brake Lift Assist / ME 19.4

4:15 P.M. - 5:00 P.M. POSTER SESSION

5:00 P.M. - 6:00 P.M. RECEPTION

PROBABLE MAXIMUM LOSS (PML) ANALYSIS AND SEISMIC RETROFIT OF A BUILDING CEE 19.1



SPONSOR: CKC Structural Engineers
SPONSOR LIAISON: Zohrah Ali, PE
FACULTY ADVISOR: Michael Wright, PE, SE
STUDENTS: Ryan Holt, Nick Luckman, Jordan Seiler, Duy Tran



The 3400 Phinney Avenue North is a historic unreinforced masonry (URM) bearing wall building with a flexible wood roof diaphragm. Historically, earthquakes have shown that URM buildings perform poorly in seismic events, with the primary concern being the failure of the roof to wall connections, which can result in the partial collapse of the structure. CKC Structural Engineers tasked the team with performing a Probable Maximum Loss Analysis (PML), ASCE Tier 1 seismic evaluation, and seismic retrofit for the building. The PML Analysis was conducted using ST-RISK software and the seismic upgrade was developed using ASCE 41-17 Seismic Evaluation and Rehabilitation of Existing Buildings. After analysis, the team concluded that various roof elements are deficient and the brace frames throughout the building require seismic improvements. The team developed upgrades to the preexisting roof elements, as well as several retrofit design options including improvements to the brace frames and complete replacement of several of the frames.

WHITE CENTER REGIONAL RETENTION/DETENTION FACILITY RETROFIT CEE 19.2



SPONSOR: King County Department of Natural Resources and Parks
SPONSOR LIAISONS: Jon Polka, EIT, Wes Kameda, PE
FACULTY ADVISOR: Michael Marsolek, PhD, PE
STUDENTS: Kori Chun, Ariella Dean, Johnny Esteban, Lian Ephraim Salvan

The King County Department of Natural Resources and Parks worked with the team to develop alternative retrofit designs for the White Center Regional Retention/ Detention Facility. King County sought improved flow control and water quality through three stormwater detention cells in White Center, as well as aesthetic enhancements of the cells to increase public use of the area. To achieve these goals, the team developed a Storm Water Management Model (SWMM) calibrated against stage gage and pumping data, created three alternative designs by altering cell volumes, flow control structures, and community amenities, and developed SWMM models for each alternative. The team and King County selected a preferred alternative via decision matrix and designed the preferred alternative to 30% including a cost estimate, plan and profile views of modified cells, and cross-sectional views of retrofitted control structures.



“Our passion for structural engineering keeps us driving forward. Even when it gets hard, we feed into each other’s excitement. This project has made me certain that I want to study structural engineering in graduate school.”
KALEI SUR '19 CEE

ROSS POWERHOUSE SEISMIC EVALUATION AND RETROFIT CEE 19.3



SPONSOR: Seattle City Light
SPONSOR LIAISONS: Robert Cochran, PE, SE, Owen Kohashi, PE, SE
FACULTY ADVISOR: Jhon Paul Smith, PhD, PE, SE
STUDENTS: Jorge Lara Alvarado, Romina Guibao, Ryoya Sano, Kalei Sur

The Ross Dam and Powerhouse produce the most power out of the three major generation facilities in the Skagit River Hydroelectric Project, making it highly essential to the Seattle area. Built in 1952, the Ross Powerhouse was constructed when seismic provisions were underdeveloped. Due to the significant seismic risk in the area and the building’s age, there are concerns about the structure’s resiliency and capacity to withstand a seismic event. Seattle City Light asked the team to conduct a seismic evaluation to diagnose deficiencies and design retrofit options in accordance with ASCE 41-17: Seismic Evaluation and Retrofit of Existing Buildings. Upon completion of our analysis, the team delivered a final report to Seattle City Light, which included a list of deficiencies, supporting calculations, retrofitting options, and cost estimates.

SOUTH MACHIAS ROAD/DUBUQUE ROAD INTERSECTION IMPROVEMENTS CEE 19.4



SPONSOR: Snohomish County Public Works Department
SPONSOR LIAISON: Polly Brooks, PE, Sam Chi, Matthew Feeley, PE, Brian Larmore, PE
FACULTY ADVISOR: Mark Siegenthaler, PE, PLS
STUDENTS: Christine Cabanas, Martin Jackson, Janet Lo, Benj Parrilla

Snohomish County requested the team to provide an intersection improvement plan for the unsignalized T intersection of South Machias Road and Dubuque Road near the Lake Stevens/Machias area. Improvements are required to reduce delays and improve traffic and trail user operations of the Centennial Trail. The goal of the design was to improve the level of service (LOS) and safety to all users of the intersection. Factors considered in designing intersection improvements included heavy trail usage, projected population growth, and current traffic delays. The team designed and analyzed five different alternatives: a roundabout, re-channelization, signalization, an underpass, and a no-build option. Each design included a cost estimate, LOS and safety analysis, preliminary channelization plan, preliminary roadway cross-sections, and horizontal and vertical alignments done with Synchro and AutoCAD Civil 3D. Based on the decision matrix results, a recommended design alternative was selected. The full plan set for the recommended alternative is comprised of the geometric layout of the selected alternative, preliminary finish grade design and sizing of storm water flow control, a traffic control plan, and an erosion and sedimentation control plan.

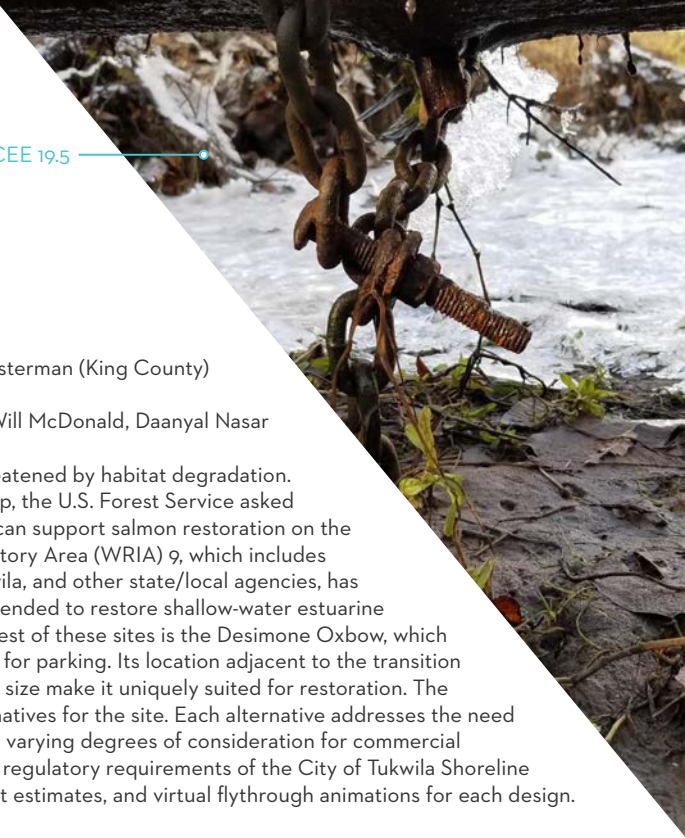


DESIMONE OXBOW RIVER RESTORATION CEE 19.5



SPONSOR: U.S. Forest Service
SPONSOR LIAISONS: Bob Deal, PhD, Doug Osterman (King County)
FACULTY ADVISOR: Wes Lauer, PhD, PE
STUDENTS: Randall DeJarlais, Russell Lynch, Will McDonald, Daanyal Nasar

Chinook salmon in the Duwamish River are threatened by habitat degradation. As part of the Urban Waters Federal Partnership, the U.S. Forest Service asked the team to evaluate how green infrastructure can support salmon restoration on the Duwamish. Washington's Water Resource Inventory Area (WRIA) 9, which includes representatives from King County, City of Tukwila, and other state/local agencies, has developed a master list of potential projects intended to restore shallow-water estuarine habitat on the Duwamish. At ~45 acres, the largest of these sites is the Desimone Oxbow, which is privately owned and presently used primarily for parking. Its location adjacent to the transition zone (where fresh and salt water mix) and large size make it uniquely suited for restoration. The team developed three conceptual design alternatives for the site. Each alternative addresses the need for shallow-water tidally inundated habitat, with varying degrees of consideration for commercial development. Proposed alternatives satisfy the regulatory requirements of the City of Tukwila Shoreline Master Program. The team produced plans, cost estimates, and virtual flythrough animations for each design.



AMAZON ASHA PROJECT CS 19.1



SPONSOR: Amazon
SPONSOR LIAISONS: Pat Ahlberg, Jordan Lee, Xin Wang
FACULTY ADVISOR: Sheila Oh
STUDENTS: Brian Le, Hansen Liman, Jonathon Roscoe, Ian Suwandi

Amazon Sustainability manages Amazon's social and environmental impacts globally, and drives solutions that enable Amazon's customers and business to become more sustainable. The Asha Platform collects product data from suppliers to mitigate safety, sustainability, and social risk to Amazon's customers and employees. One method of collecting data from Amazon's suppliers is via a Safety Data Sheet (SDS) exemption sheet, which is an Excel template produced by Amazon. These sheets are populated, submitted by suppliers, and reviewed by Amazon's compliance operations staff to validate information provided. Our project delivered automation to reduce manual effort and increase efficiency for compliance operations staff. We provided new insight on data validity by delivering a pipeline utilizing data scraping and machine learning to parse and analyze product data. The end product was an MVP proof-of-concept that showcases pipeline capabilities while supporting future Amazon extensibility.



VISUALIZING FOOTPRINT CS 19.2



SPONSOR: Amazon
SPONSOR LIAISONS: Jessica Blat, Graham Coomer, Wei Ji, Derek Singer
FACULTY ADVISOR: Kevin Lundeen
STUDENTS: George Chen, Henry Dihardjo, Nick Hjelle, Tiffany Hsu

Amazon provides customers with a huge variety of goods, including perishable food products that can be delivered to the customer's doorstep in days. Amazon tasked us with analyzing the impact of food waste in the fulfillment centers, where Amazon warehouses and fulfills customer orders. We are organizing and visualizing inventory data to produce actionable information on the environmental impact of inventory-handling decisions for soon-to-expire products. The tool we developed provides a breakdown of the emissions generated by food group and by product group in order to provide context on which products have the greatest impact. Emissions impact is determined by product-specific emission weights for production and disposal. We provided a serverless solution that leverages AWS services such as S3, Athena, and QuickSight. Our service is triggered automatically by the upload of new inventory data. Then, it extracts and transforms the input data into a format that provides the necessary data points for visualization. The resulting data are aggregated in QuickSight dashboards to provide business insights.

AMAZON SUSTAINABILITY QUESTION BANK EDITOR CS 19.3



SPONSOR: Amazon
SPONSOR LIAISON: Emir Barucija-Hodzic
FACULTY ADVISOR: Pejman Khadivi, PhD
STUDENTS: Victor Erickson, Vance Kuikahi, Steven Phan, John-Paul Vetter, Tyler Yamashiro

Amazon currently has a Sustainability Question Bank service that allows users to find answers to commonly asked questions about how Amazon departments are dealing with Sustainable Services. One limitation is that it takes up to four development days a month to manually update the content, add new questions and answers, and update or remove existing questions and answers. Our job was to streamline this process and create a question bank editor. This editor will be used by several different Amazon teams so that they can post and update their own questions and answers. Our product will reduce the amount of time spent by Amazon teams, improve agility and efficiency of the business teams, and provide important information on product sustainability to Amazon customers and investors.



BILIPIC CS 19.4

BILIMETRIX-USA
Eradicating Kernicterus from the World

SPONSOR: Bilimetrix USA
SPONSOR LIAISON: Richard Wennberg, MD
FACULTY ADVISOR: Lin Li, PhD
STUDENTS: Anna Gassen, Connor Noblat, Alex Runciman, Max Werner

About 50% of newborn babies develop jaundice during the first week of life until liver enzymes needed to excrete bilirubin are activated. Newborns can sometimes develop dangerously high levels of bilirubin resulting in irreversible hearing loss, brain damage (kernicterus), or death. Bilirubin levels can easily be reduced by exposing newborns to phototherapy. In developed countries, the amount of bilirubin is easy to measure, but many developing countries cannot measure serum bilirubin readily and thus have no guideline for medical intervention. Our application enables medical workers to use an Android smartphone camera to estimate serum bilirubin levels. A drop of blood is applied to a test strip that separates out the yellow plasma. By comparing the color of the plasma to known bilirubin concentrations, our application provides immediate "point of care" results to determine the need for referral to a treatment facility. By providing an affordable and accessible way to identify dangerous levels of bilirubin, our application facilitates Bilimetrix USA's vision that no child's life should be permanently changed by neonatal jaundice.



"Working with the Project Center is a collaborative way to make headway on evaluating our structures. By utilizing student teams, Seattle City Light furthers our knowledge base on the structures while the students learn seismic analysis and perform the heavy number crunching under our supervision."

ROBERT COCHRAN SENIOR CIVIL ENGINEER, SEATTLE CITY LIGHT

AUTOMATING THE CURATION OF TRAINING DATA FOR MACHINE LEARNING CS 19.5



DIMENSIONAL MECHANICS

SPONSOR: Dimensional Mechanics
SPONSOR LIAISON: Rajeev Dutt
FACULTY ADVISOR: Steven Hanks, PhD
STUDENTS: PJ Doerner, Ari Eisips, Thomas Ficca, Bridger Zoske

The team was tasked with improving the usability of Dimensional Mechanics's product, AI Studio. This product allows users of any experience level to quickly deploy machine learning solutions for their business or organization. Despite being a very powerful tool that is capable of tackling almost any task in any industry, AI Studio still required a large amount of upfront work by clients. Training data had to be sorted, validated, and balanced by hand - a time consuming and error-prone task. We automated this process, streamlining Dimensional Mechanics workflow and dramatically reduced the barrier to getting a useful model from AI Studio.



CLOUD ANALYTICS FRAMEWORK CS 19.6



SPONSOR: F5 Networks

SPONSOR LIAISONS: Blake Cizek, Nicholas Fusaro, Prashant Pandey, Tom Thomas

FACULTY ADVISOR: Steven Hanks, PhD

STUDENTS: Kenny Joshua, Scott Little, Samantha Metevier, Adam O'Connell

F5 Networks, Inc. has developed a new, cloud-based Application Delivery Controller (ADC). This product will provide services such as load balancing and offloading. The product is in the development process and is not contingent upon analytics. The idea behind analytics on telemetry is to gain advanced insight on how the product is built and maintained, and ultimately on how the customer buys/interacts with the product. F5 asked the team to develop an ETL pipeline that will continuously extract, transform, and load telemetry data produced from the Cloud IP product, and apply machine learning algorithms to forecast meaningful outcomes to refine the product launch period. The student team transformed the telemetry data, conducted exploratory data analysis, designed a schema for data warehouse, and applied machine learning algorithms to forecast the deployment of resources that F5 should consider when further developing this product. The team implemented triggers that will allow the collection, processing, and aggregation of telemetry instances over an extended period of time. This system was designed for high maintainability that allows future employees to view and aggregate past instances.

UPGRADE HERO CS 19.7



SPONSOR: F5 Networks

SPONSOR LIAISONS: Rekha Choudhary, Jyo Fanidam, Kin Lane, Nancy Mariano, Tom Perez, Scott Peters

FACULTY ADVISOR: David Lillethun, PhD

STUDENTS: Ryan Frasheski, Jeyte Hagaley, Nolan Smith, Zibin Su, Shang-Yi Yang

The student team worked with F5 Networks to create an automated test system for F5's BIG-IP API. The developed system can generate and run tests, verifying F5's API specification against its endpoints, as well as store and display telemetry produced by the test runs. All of this was achieved through the combination of open source products including Dredd, Prometheus, Grafana, and GitLab CI. With this system in place, F5 will be able to more easily detect errors or discrepancies that occur during updates to the API and greatly reduce customer's friction when upgrading their BIG-IP software.

KENWORTH FUEL TANK WELD REPAIR TRACKER CS 19.8



A **PACCAR** COMPANY

SPONSOR: Kenworth Truck Company

SPONSOR LIAISONS: Jason Hutchinson, Blaise Reader, Sherry Sheline, and Scott Welch

FACULTY ADVISOR: Mike Koenig

STUDENTS: Jonathan Kuc, Ryder Roedel, Patrick Shipley, Xiaomei Xie

Kenworth Truck Company and the Seattle University team have worked closely on the development of a simplified weld repair tracking system. The web application replaces the existing Fuel Tank Defect Tracker application, and it will serve the fabrication welders and business managers in Kenworth's Chillicothe, Ohio manufacturing plant. The web application offers a dashboard interface for managers and welders to stay up-to-date on the status of the manufacturing floor. The application provides fabrication welders with a robust data management experience with the ability to add, view, update, and delete weld repairs in their system. In addition, the application empowers managers with more metrics that they can control to help cater the application to the needs of the manufacturing plant. This functionality is offered in a sleek web application that will be added to Kenworth's growing list of web applications available exclusively to employees of PACCAR and its subsidiaries.



KENWORTH SUPPLIER COLLABORATION INTERFACE CS 19.9



A **PACCAR** COMPANY

SPONSOR: Kenworth Truck Company

SPONSOR LIAISONS: Walt Brewer, Ramji Gupta

FACULTY ADVISOR: Mike Koenig

STUDENTS: Jared Alonzo, Rose Kolb, Ian Samuraj, Duc Vu

The PACCAR Supplier Collaboration system facilitates temporary and permanent design document changes for parts manufactured by PACCAR and their suppliers. The team was tasked with updating the workflow and user interface of select features of the system to improve usability, throughput, and user efficiency. The students developed new designs and implementations for Change Request creation, managing approval workflow participants, and managing individual change request line items within the system. The solution, developed in an Internet of Things tool called PTC Thingworx, is integrated with the current system to provide the easiest accessibility for the current users.

NOISEOUT NOSNORE CS 19.10



SPONSOR: NoiseOut

SPONSOR LIAISONS: Fernando Hernandez, Bonnie Schnitta, PhD

FACULTY ADVISOR: Israel Hilerio, PhD

STUDENTS: Jeffrey Atwood, Christopher Go, Tian Mai, Quinn Obenauf, Carter Scofield

The goal of this project is to create a mobile application that can provide active noise cancelling. A user will be able to create a profile with their basic health information and be able to update it over time as necessary. The app will then receive and store background environment sounds to create a noise-cancelling baseline. Once this baseline has been established, the app will recognize a signal event, such as a snore, and be stored on the device. A reverse phase signal will be sent to provide the active noise cancelling. The reverse phase signal will be updated over time to better improve the noise cancelling process. We built the app on the Android platform, leveraging Microsoft's Azure cloud services for storing users and statistics. We gathered requirements and conducted research before moving onto designing the system architecture and developing an Android prototype. The app can interact with the Azure web server and database. Another major milestone features the ability to detect sound and respond.

“Getting involved with a company such as PACCAR Inc was a great opportunity to be exposed to the real world. My Computer Science capstone project helped me secure my current job at SABIC, one of the top chemical companies in the world, and get offers from two other great companies.”

YOUSEF ALTURAIFI '17 CS

PACCAR INDUSTRY 4.0 KNOWLEDGE SHARING CS 19.11



SPONSOR: PACCAR Inc

SPONSOR LIAISON: Ken D. Faith, PE, PMP, CQE

FACULTY ADVISOR: Michael McKee

STUDENTS: Keegan Fisher, Cynthia Hsieh, Christopher Ross, Jacqueline Wong

PACCAR is a publicly owned company that produces premium commercial vehicles. PACCAR supplier partners provide a significant amount of vehicle content. Component defects have a substantial impact on customer satisfaction and contribute to the Cost of Poor Quality (COPQ). For this project, the team worked on implementing a scalable web-based and mobile application for capturing best practices and lessons learned. Functionality includes read-across capability so that PACCAR can efficiently deploy and manage best practices. Benefits include a structured process for capturing, deploying and managing standardized best practices reducing supplier defective parts.

PROJECT KASANDRA CS 19.12



SPONSOR: Starbucks

SPONSOR LIAISONS: Tyler Duke, Grace Goodwin, Kara Widhalm

FACULTY ADVISOR: Richard LeBlanc, PhD

STUDENTS: Trong Do, Shannon King, Jared Mead, Linh Nguyen

The project is a continuation of a student team's work (Project Kasandra) for Starbucks in 2018. That team built a forecast algorithm to calculate the global stability of nations around the world using internationally reported data. This year, the objective of our project was to automate the data pulling and data scrubbing process. This will minimize the dependency on traditional manual data processing methodology, while attempting to increase usability, providing a more seamless end-to-end user experience. By allowing last year's algorithm to analyze and update from a much larger dataset, we improved the model's accuracy. Our software will be used to complement Starbucks' analysts' research by reducing analytical bias and allowing the company to do analysis at scale. We applied machine learning and data science to empower Starbucks leaders in their future business decisions.

POST-HOC FAILURE ANALYSIS CS 19.13



SPONSOR: T-Mobile

SPONSOR LIAISONS: Toaha Ahmad, David Jenkinson, Zach Powers, Grant Taylor

FACULTY ADVISOR: Jason Wong

STUDENTS: Gigi Davidson, Jeff Dille, Tom Gleitsmann, Ciara Goetze, Tommy Zumstein

The team designed, developed, and deployed a full stack video analysis application that runs on top of the existing testing platform in T-Mobile's handheld device testing laboratory. Previously, T-Mobile relied on engineers to analyze and bucketize each test video. Using image recognition, the team built a solution that groups like failures together, drastically reducing the number of videos that require manual analysis. Lab Engineers are given the option to have the data autonomously analyzed either in real time or as a batch process. Viewing a single video is all that is now required to perform root cause analysis for the group. The purpose of this project was to reduce time spent watching videos, and we achieved a minimum reduction of at least fifty percent in the number of videos watched.



DEVELOPMENT OF POWER QUALITY TEST DATA PROCESSING SOFTWARE ECE 19.1



SPONSOR: The Boeing Company

SPONSOR LIAISONS: Kamiar Karimi, PhD, Evelyn Matheson, Eugene Solodovnik, PhD

FACULTY ADVISOR: Richard Bankhead

STUDENTS: Jeremiah Kalmus, Rasmus Nystroem, Kadrian Rickman, Huy Vu

The Boeing Company requested that the team develop a power quality data analysis tool to easily and accurately analyze the power quality data recorded from an airplane's electrical power system. The tool was developed in MATLAB and consists of a graphical user interface (GUI) along with an integrated graphical data display (GDD) and data processing algorithms. The GUI provides the user convenient interaction with several types of analysis, and the GDD graphs the sampled data based on chosen analysis type. The types of analysis that the tool supports include; min, max, mean, RMS, real power, reactive power, power factor, individual harmonics, total harmonic distortion, crest factor, DC content, modulation and waveform envelope, plotting of waveform frequency, peak-to-peak ripple, and frequency spectrum analysis of ripple.

HYDROELECTRIC UNIT DATA ACQUISITION AND TRANSMISSION SYSTEM ECE 19.2



CHELAN COUNTY

SPONSOR: Chelan County PUD

SPONSOR LIAISON: John Yale, PE

FACULTY ADVISOR: Shiny Abraham, PhD

STUDENTS: Abraham Hutauruk, Mirka Mandich, Austin Shardo, Nassuel Valera

Since 1947, Chelan County PUD has been providing electric service through the operation of multiple sets of hydroelectric generators stationed at three dam facilities across the county. Understanding the conditions of these large electromechanical devices is key to effective management of the assets. However, Chelan County PUD currently has no efficient means of collecting data on the condition of rotating generator parts. The team was requested to develop a data acquisition and transmission system to monitor the performance and component condition of a hydroelectric generator. This system, called the Hydroelectric Monitoring System (HMS), is composed of two subsystems: a rugged, generator-mounted component and a stationary, externally-mounted component. The monitoring process begins as generator performance data are collected from a variety of sensors measuring temperature, conductivity, strain, and rotational speed. These data are centralized and packaged within the generator-mounted component, then transmitted in real-time to the stationary component for uploading to the Chelan County PUD cloud servers. Chelan County PUD specified that the design solution be sensor agnostic for maximum user adaptability. To meet this criterion, the HMS can receive analog and digital signals and is compatible with Bluetooth and Wi-Fi sensor connections. Another project specification, to perform reliably despite magnetic field interference, has been tested in both off-site and on-site conditions.

HOLDEN VILLAGE GENERATOR CONTROLS UPGRADE ECE 19.3



SPONSOR: Holden Village

SPONSOR LIAISON: Chris Shultz, PE

FACULTY ADVISOR: Kirk MacLearnsberry, PE

STUDENTS: Diego Carregha, Balchetan Grewal, Greg Hirose, Elias Smith

Holden Village is a community located on the shores of Lake Chelan that is powered by an islanded 500 kW hydroelectric plant with control panels that were built around 1940. Holden Village asked the team to design a new generator control system for their hydroelectric power plant using state-of-the-art technology. The team designed automated systems for voltage control with UL listed devices, and flow regulation through automated control of the needle valves. Additionally, the team implemented a new relay protection scheme to better protect the generators, including an automated emergency function to protect both the operators and generators in the event of governor failure. Finally, the team designed new control panel layouts and wiring diagrams, which included implementation of data storage and remote monitoring capabilities. To verify the system upgrades would work as intended in the designs, the team conducted testing of the automated voltage regulation scheme and programmed all equipment for use in Holden Village. The final product that the team delivered to Holden Village included: one-line diagrams, control panel wiring diagrams, material list, equipment data sheets and manuals for all material, test reports from lab testing, and documentation for programs and relay setting files. The team provided Holden Village with a complete electrical design that can be used to build the new controls for the Holden Village hydroelectric power plant.



IMPROVING THE KILOWATTS FOR HUMANITY DATA LOGGER ECE 19.4



KILOWATTS
FOR HUMANITY

SPONSOR: KiloWatts for Humanity
SPONSOR LIAISONS: Dave Goldsmith, Alex Kvenvolden, Carrie Smith
FACULTY ADVISOR: Shiny Abraham, PhD
STUDENTS: Dominic Burgi, Chau Huynh, Joshua Ohara

KiloWatts for Humanity (KWH) is a non-profit organization that specializes in providing off-grid power solutions to remote communities lacking access to electricity. KWH asked the team to improve the capabilities of their data logger design, which is intended for implementation within a microgrid power system. The specific areas of improvement include redesigning the printed circuit board, data storage and transmission software updates, and designing the device enclosure. The team redesigned the printed circuit board to incorporate additional functionality and introduce protective circuitry. MySQL databases were utilized to store configuration and sensor data, and a retransmission protocol was introduced to resolve transmissions unacknowledged from the server-side. The device's Protocase enclosure was developed to provide sturdy mounting for all components, as well as external port access to all sensor channels and device I/O. The team wrote documentation detailing the construction and use of the data logger, enabling KWH to replicate the design for future implementation projects. As part of an upcoming microgrid implementation in summer 2019, this data logger will be installed in a remote village located in the Southern Province of Zambia.

BATTERY MONITORING SYSTEM ECE 19.5

**OutBack
POWER™**

SPONSOR: Outback Power
SPONSOR LIAISON: Matt Rust
FACULTY ADVISOR: Paul Kostek
STUDENTS: Abdulaziz Alrakaf, Gurjit Dhesi, Reid Furton, Usman Jamil

Outback Power's battery monitoring system product is 15 years old and needs updating. They tasked the team with designing a new battery monitor. The battery monitor will be used in conjunction with other Outback Power devices, such as their charge controllers and inverters, to efficiently use batteries on and off the grid. The system monitors up to three battery banks simultaneously, measuring voltage, bidirectional current, and temperature. The data are stored onboard and used to find daily averages including total power charged and discharged, as well as accumulated energy and instantaneous power. The data can be sent to other systems via CAN bus and RS485. The battery monitor was designed to be powered by and draw minimal power from the first of up to three batteries. After testing initial prototypes, the team delivered a fully functioning system on a PCB and documentation of both hardware and software.



MACHINE LEARNING FOR WEIGHT AUDITS ECE 19.6



A PACCAR COMPANY

SPONSOR: Kenworth Truck Company
SPONSOR LIAISON: Brandon Singh
FACULTY ADVISOR: Mehmet Vurkaç, PhD
STUDENTS: Ariel Harris, Edie Mei, Paul-Franklin Okomba, Sean Wright

PACCAR Inc is among the world leaders in truck manufacturing. They provide custom-made trucks with weight estimates for customer orders. PACCAR Inc has been experiencing significant differences between the expected and actual weight, so the team was given the task to design a program based on machine learning that provides an accurate weight estimate for every truck. The team broke the system into two sections, the back-end and front-end. The back-end holds the machine learning algorithm, while the front-end provides PACCAR associates with a user interface to enter truck specifications and receive an accurate weight estimate. The team began by analyzing every truck record and creating a database of previous truck specifications and formatted them to feed into the machine learning algorithm. From the initial data analysis and visualization, the team was able to identify a series of machine learning algorithms that could provide improved weight estimates. The team then built and trained the algorithm to achieve accurate weight estimates, while simultaneously developing the front-end user interface using Flask. PACCAR Inc will now be able to give customers accurate weight estimates for trucks.

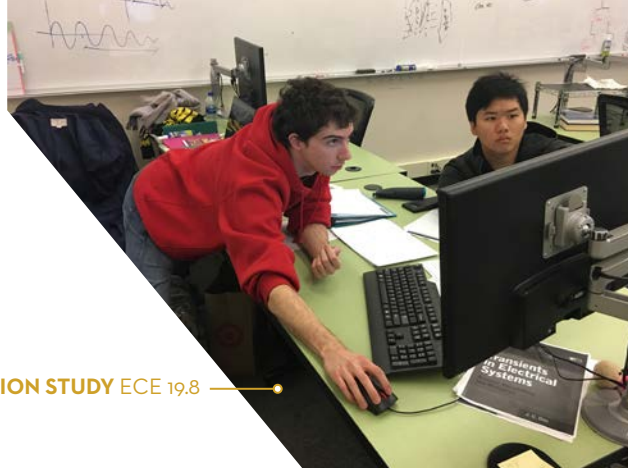
PROJECT SPOT CHECK ECE 19.7



SPONSOR: Panthera Corporation
SPONSOR LIAISON: Rana Bayrakçismith
FACULTY ADVISOR: Agnieszka Miguel, PhD
STUDENTS: Mai Dang, Devin DeWitt, Jack Gularte, Long Pham



The Panthera organization asked the student team to continue developing a software program that aids in the research and conservation of two wild cat species: snow leopards and African leopards. Currently, Panthera biologists must manually sort through images captured by camera traps to identify individual cats, but the process is very time intensive. For this reason, Panthera tasked the team to help create efficient automated software to aid their biologists. The team has modified an existing Python program that utilizes image recognition and machine learning to facilitate this process. Using the computer vision program OpenCV, the program finds identifying markers such as the leopard's spots and labels each leopard image with a numerical value. Utilizing machine learning processes such as K-means clustering and neural nets, the label values are then used to group images by the individual leopard. This allows Panthera to estimate the total number of leopards in a study area.



GENERATOR-CIRCUIT BREAKER COORDINATION STUDY ECE 19.8



SPONSOR: Seattle City Light
SPONSOR LIAISON: Shane Repking, PE
FACULTY ADVISOR: Kevin Lybarger, PE
STUDENTS: Alexander Antoku, Matthew Horn, Mahaed Mohamud, Mahalia Polk

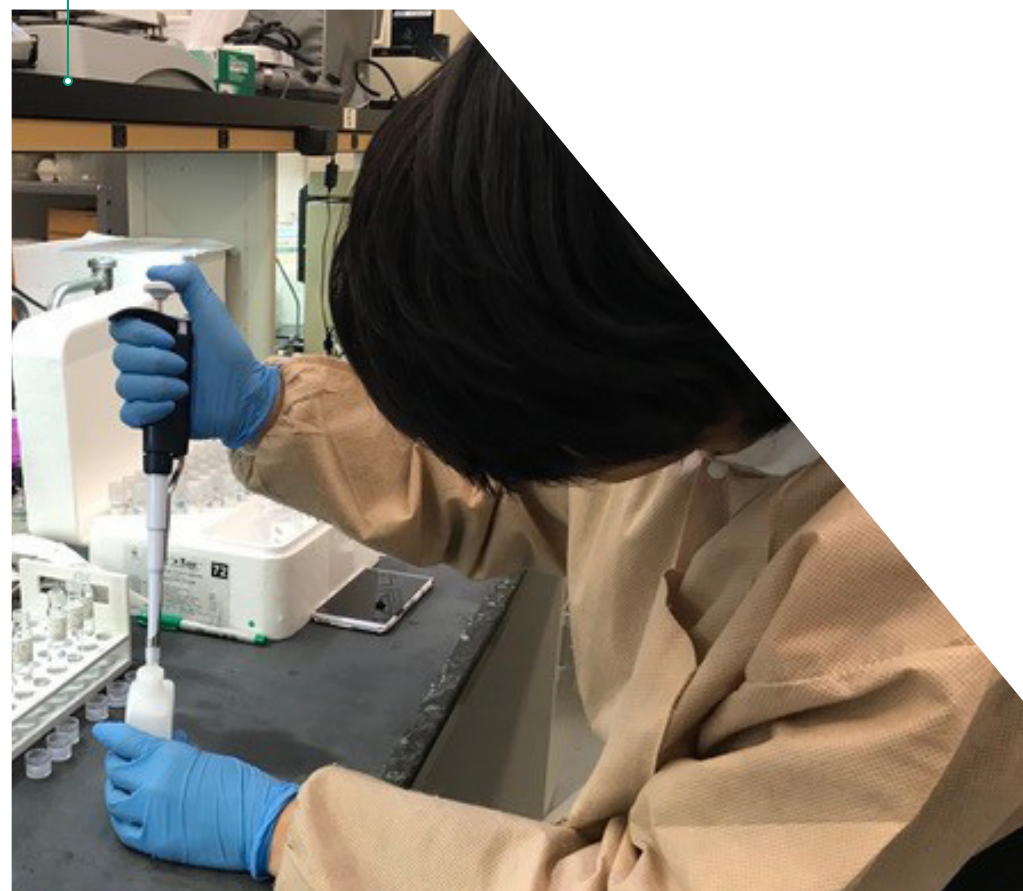
In 2018, Seattle City Light replaced existing load interrupters with new circuit breakers as fault protection equipment. Seattle City Light requested that the team complete a generator-circuit breaker coordination study for their newly installed circuit breakers at the Diablo Power Plant. The circuit breakers at the Diablo Power Plant have a manufacturer's rated time for clearing a fault. The team performed simulations and documented the duration of various fault types to ensure that faults were cleared within the rated time. Faults that occur near generation stations produce a high DC offset in the fault current. This DC offset can make it difficult for the current to reach a zero crossing within the rated time of the circuit breaker which can make a delay in the tripping of the circuit breaker time necessary. The team performed simulations of a model circuit representing Diablo's physical components and documented the occurrence of zero crossings for various fault types to ensure that faults were cleared within the rated time of the circuit breaker. The transient analysis program, Electromagnetic Transient Program Restructured Version (EMTP-RV), was used to simulate the range of fault conditions to determine the timing of the current zero crossings. The results include the range of fault conditions, accounting for physical fault types and location of fault, and the corresponding graphs of current. The worst-case fault was used to determine the recommended time for the circuit breakers to trip.

ASSESSMENT OF RECYCLED FOOD FERTILIZER AMENDMENT FOR SOIL AND PLANT HEALTH ENSC 19.1



SPONSOR: WISErg Corporation
SPONSOR LIAISON: Renee Harkins
FACULTY ADVISOR: Phillip Thompson PhD, PE
STUDENTS: Maria Ilioukhov, Noel Kim, Vincent Mai, Naod Sebhat, Erin Thomas

WISErg Corporation asked the team to determine how its fertilizer amendment, Synergy, affected overall soil health and plant growth. An additional goal was to determine if Synergy could reduce negative environmental effects of nutrient movement associated with traditional fertilization practices. The team designed and conducted experiments to model how nutrient retention and movement differed in field soils. These experiments had four treatment groups; 1) no fertilizer, 2) traditional fertilizer alone, 3) Synergy alone, and 4) traditional fertilizer amended with Synergy. Nutrient material balances were performed for nitrogen, phosphorus, potassium, iron, calcium, and magnesium. In addition, traditional fertilizer alone and with Synergy were evaluated for the growth of hybrid poplar (*Populus deltoides* x *nigra*, DN34). Student's t-tests were used to determine differences in shoot height, microbial abundance, and total biomass.



COLLEGIATE WIND COMPETITION 2019 INT 19.1

SEATTLE UNIVERSITY

SPONSOR: Seattle University
SPONSOR LIAISONS: Tim McCoy, Matt Malkin
FACULTY ADVISOR: Yen-Lin Han, PhD
STUDENTS: Nicole Kahasha (ME), James Lamont (ME), Thanh Nguyen (ECE), Kees Westra (ME), Benjamin (Jeremy) Yarborough (ECE), Emily Zaretsky (ME)

The U.S. Department of Energy-sponsored Collegiate Wind Competition (CWC) challenges students from various engineering and business disciplines to offer solutions to a complex wind energy project. Along with 11 other teams from around the country, Seattle University was invited to compete in the 2019 CWC. The team was asked to design and fabricate a small-scale wind turbine that fits in a 45 cm x 45 cm x 45 cm cube. The electrical engineering members designed and implemented the power generation and the control system for the turbine, while the mechanical engineering members designed and built the blades, pitching system, nacelle, and tower of the turbine. The team used open-source blade design and CAD software to computationally study the performance of the designed turbine. The designed turbine was tested in a small-scale wind tunnel on Seattle University's campus and finally in a large-scale wind tunnel off-campus. The 2019 CWC was held in Denver, Colorado in May. During the competition, the wind turbine was subjected to five tests that simulated important elements of full-scale wind turbines to evaluate the turbine's ability to control rated power under variable wind speeds and wind directions.



“I am honored that our sponsor trusted us with this project. It has helped me see myself as an environmental scientist.”
ERIN THOMAS '19 ENSC



BUILDING AN INTERACTIVE NOISE MAP APPLICATION (INMA) FOR CUSTOMER ACCESS TO LIGHT RAIL NOISE DATA INT 19.2



SPONSOR: Sound Transit
SPONSOR LIAISONS: Craig DeLalla, PE, Shankar Rajaram, PhD
FACULTY ADVISOR: Alvin Moser, PhD, PE
STUDENTS: Abdulrahman Alsammahi (ECE), Raghad Ashoor (CE), Don Dang (ECE), Emily Graham (CE), Kirsten Hooper (CE)

Noise from new train projects is a concern for communities residing along Sound Transit's future Link extension alignments. Sound Transit requested that the team design a web application displaying Link Light Rail project noise information in a format that is easily accessible to communities. Sound Transit performs detailed environmental noise impact assessments during the project development phases and shares the information with the communities using traditional Community Outreach formats such as open houses, door-to-door campaigning, and online publication of PDF reports. To help connect with more community members, Sound Transit is seeking additional platforms that use technology-based solutions. As a pilot project, INT 19.2 created a map of the Lynnwood Link Expansion project displaying noise data in a clear and intuitive format and built a website to display noise data from a web address that will be accessible using smartphones, tablets or computers. The map has an interactive feature that will allow community members to search for their individual home or business address and get detailed noise information specific to their location. This feature improves the efficiency of accessing noise information for community members and Sound Transit staff. The website that the team is providing Sound Transit is also scalable for other Link Light Rail projects to insert new noise data into a database, which will then update the noise map. The team provided Sound Transit with the designed website, a detailed technical report of the chosen design approach and a user manual for future updates and improvements.

AUTOMATED DURABILITY EVALUATION PLATFORM INT 19.3



SPONSOR: T-Mobile
SPONSOR LIAISON: Eric Christie
FACULTY ADVISORS: Yen-Lin Han, PhD, Eric Gilbertson, PhD
STUDENTS: Angela Flores-Marcus (ECE), Shubham Jain (ECE), Levon Markossian (ME), Spencer Morse (ME), Jerry Winata (ME), Nathan Yasuda (ME and ECE)

In addition to providing mobile data and cellular service, T-Mobile resells mobile devices purchased from original equipment manufacturers. To improve customer satisfaction and reduce device return rates, T-Mobile performs testing to ensure that the functionality, usability, and durability of these devices meets their standards. The team designed, built, and tested an automated robotic platform that was integrated with an existing system to test the durability of mobile devices. The team's design uses a modified four degree of freedom uniplanar robotic arm mounted to two linear actuators. This platform uses open source Dorna robot software and line tracing computer vision software to locate the dropped mobile device, check the device for cracks, and remount the device on the evaluation system. The team's design allows for increased testing operator ease, additional durability tests, and enhanced evaluation capabilities. T-Mobile, the T logo and the magenta color are registered trademarks of Deutsche Telekom AG.

PNEUMATIC GEARMOTOR PERFORMANCE ENHANCEMENT ME 19.1



SPONSOR: Ingersoll Rand

SPONSOR LIAISONS: Christopher Home, Stephen Snider, PE, Aaron Williamson, PE

FACULTY ADVISOR: Mohsen Dadfarnia, PhD

STUDENTS: Amro Algethmi, Tomas Geisler, Robert Moore, Roseann Njunge

Ingersoll Rand Material Handling designs industrial equipment such as winches and pneumatic motors. One of the company's products is a winch driven by an air-powered gear motor. While the theory behind their operation has been analyzed in the past, Ingersoll Rand has requested the team further investigate how the pneumatic gear motor functions. Additionally, Ingersoll Rand tasked the students with identifying potential areas where the motor design might be improved, and then testing these improvements on an existing motor. The goal is to not only improve the motor performance, but also better understand the underlying theory behind the original design. The team identified and implemented several modifications designed to improve airflow inside of the motor housing. Performance of the modified motor was compared to the unmodified motor using a custom testing apparatus. Results of the modifications help to establish a physical relationship between the housing geometry and the performance of the motor. This was coupled with an analytical model to validate the test results.

GLADHAND CONNECTOR AUTOMATION ME 19.2



A PACCAR COMPANY

SPONSOR: Kenworth Truck Company

SPONSOR LIAISON: Stan DeLizo, PE

FACULTY ADVISOR: Yen-Lin Han, PhD

STUDENTS: Brian Celustka, EenSeung Kwak, Charles Lyford, Mark Taylor

Kenworth is a technology leader in the design and manufacture of medium- and heavy-duty trucks. Self-driving vehicles are poised to revolutionize the freight industry, and as a supplier to the semi-truck market it is in Kenworth's interests to be at the forefront of the development of self-driving technology. Along with the technical challenges inherent to any self-driving application, semi-trucks have additional maintenance and operational requirements, including but not limited to the connection of air-lines between tractor and trailer during the hitching process. The student team was tasked with designing a prototype system capable of autonomously connecting the emergency brake gladhand connectors that supply air to the trailer braking system. The autonomous system utilizes a custom designed end-effector attached to a three-dimensional gantry robot mounted on the chassis of the truck. During operation, a computer vision system identifies the location of the gladhand on the trailer and controls the motion of the robot, completing the air circuit and allowing the release of the trailer emergency brake.

VISUAL INSPECTION OF THE MULTIPURPOSE HYDRATION SYSTEM (MPHS)

BLADDER RADIO FREQUENCY WELD ME 19.3



The Lighthouse for the Blind, Inc.

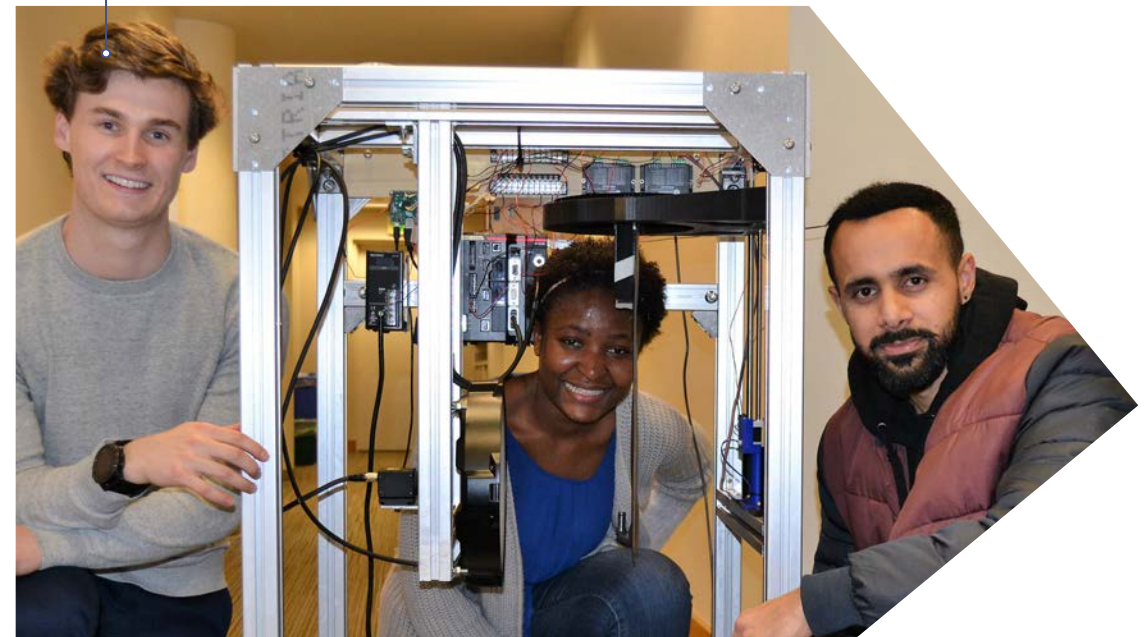
SPONSOR: The Lighthouse for the Blind, Inc.

SPONSOR LIAISONS: Doug Hintz, Brent Weichers

FACULTY ADVISOR: Eric Gilbertson, PhD

STUDENTS: Garrett Modersohn, Matthew Moe, Leticia Ndagang, Karandeep Sran, Yu-Hsuan (Johnson) Tso

The Lighthouse for the Blind, Inc., is a non-profit organization that provides employment and training opportunities for people who are blind, DeafBlind, and blind with other disabilities. They currently have a contract with the federal government to assemble a multipurpose hydration system (MPHS) for the military. The focus of this project was the inspection of the radiofrequency weld on the MPHS bladder. This inspection is currently done visually by an employee at the Lighthouse for the Blind. The student team was tasked with designing and building an inspection system that could be operated by an employee who is blind or DeafBlind. The team designed and built a device that utilizes a computer vision system to inspect the welds. While the inspection is performed automatically, the process still requires one employee to carefully load the bladder into the inspection device. After inspection, the device alerts the operator of any defects via sound and tactile vibration, while also logging the total number of failures to a database. This new system can inspect 1300 bladders a day with zero failure acceptance, reduces the possibility of human error in the failure detection process, and provides an employment opportunity to a person who is blind, DeafBlind, or blind with other disabilities.



PRESS BRAKE LIFT ASSIST ME 19.4

NIC Global**Manufacturing Solutions****SPONSOR:** NIC Global**SPONSOR LIAISON:** Ted Wirsching**FACULTY ADVISOR:** Greg Mason, PhD, PE**STUDENTS:** Sean Bayless, Brittany Dale, Ryan Sargent, Shane Serns

NIC Global is a custom sheet metal manufacturing company specializing in the fabrication of electrical boxes. Many of these boxes start as a flat piece of sheet metal and are bent to shape using a hydraulic press brake. Currently, this manufacturing process requires two press brake operators to support the sheet metal throughout the fabrication process. To reduce the physical strain and number of operators, NIC Global tasked the team with designing a sheet metal lift assist system to be used in conjunction with their custom press brake. The lift assist system needed to reduce the number of press brake operators, reduce operator fatigue, be detachable from the press brake, and be non-intrusive to operations. The team designed, built and tested a system that supports the sheet metal without the assistance of an operator. The system automatically tracks the position of the press brake and adjusts the lifting angles throughout the bending process. The design uses a linear actuator driven by a servomotor, an optical encoder to track the position of the press brake, and a programmable logic controller (PLC).

“We have had eight months of exposure to the structured process that is part of every engineering design solution.”

BRITTANY DALE '19 ME

CABLE ATTACHMENT MECHANISM (CAM) ME 19.5

**SPONSOR:** Vita Inclinata**SPONSOR LIAISONS:** Caleb Carr, Jon Chung, Alex Popoff, Derek Sikora**FACULTY ADVISOR:** Joshua Hamel, PhD, PE**STUDENTS:** Bilegt Bayaraa, Andrew Lenart, Jamal Marshall, John Reinke

Vita Inclinata designs and builds devices that control the motion of cable-suspended loads. One important application is that of stabilizing the load in helicopter hoist rescue missions. These missions are aborted for safety reasons if the load swings past 25 degrees from vertical. Vita Inclinata's Load Stability System (LSS) is designed to expand the operational envelope of rescue and sling load missions by using a series of turbines to counteract the swinging motion of the load. The independently powered LSS is designed for quick deployment and removal from the hoist cable via a direct mechanical attachment. The team was asked to design and fabricate a Cable Attachment Mechanism (CAM) prototype to connect the LSS to a helicopter-grade cable. The CAM was designed for rapid deployment while maintaining cable integrity. It can attach and detach the LSS to a helicopter cable in less than 15 seconds. The CAM housing is designed to interface with various Vita Inclinata technologies in addition to the LSS HR-Hoist Rescue.

“The student engineering team had a totally fresh perspective and looked at all kinds of solutions. They contributed energy and ideas that invigorated our engineering team. And they came up with a solution that we believe will work.”

BRIDGET BREWER '88 President, NIC Global Solutions



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