Seattle University

ScholarWorks @ SeattleU

2021

2021 Projects Day Booklet

Seattle University
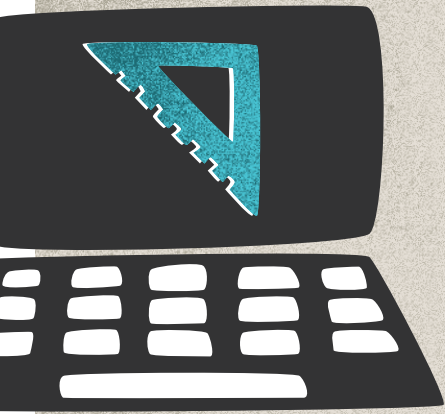
PROJECTS

2021 DAY
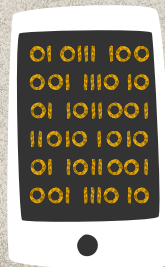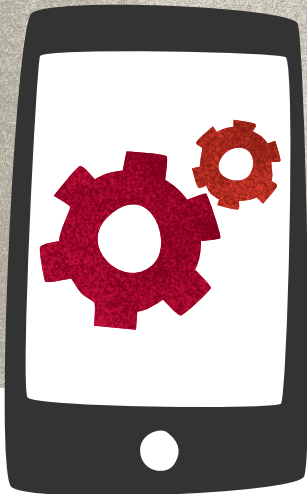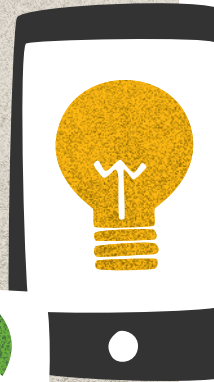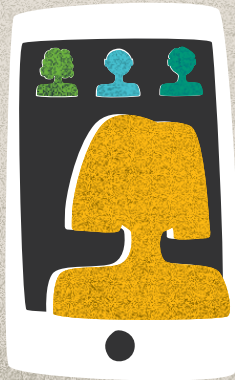
"**Together we are preparing a new generation of engineers and scientists who are uniquely equipped to face unprecedented global challenges with the support of leading external partners**"

Welcome to Projects Day 2021! We are pleased that you can participate in this important end-of-year celebration. In September, each student team received a challenging, real-world assignment from a local external partner. As the students worked throughout the year on their projects, they applied the technical knowledge gained in their coursework and gained skills in project management, teamwork, budgeting, technical writing, and oral communications. Projects Day is the culmination of their experience.

This year, our students faced the challenge of conducting their projects remotely due to COVID-19 restrictions that prevented them from working on campus together and with their sponsors. The resilience and creativity of these student teams demonstrates their ability to apply their educational experiences in a professional context and their formation as responsible engineers and scientists. At this second virtual Projects Day, you will see more than 160 students from 41 teams present their amazing projects. You will have the opportunity to interact with them after their presentations and during the networking sessions that follow.

We are grateful to the companies, government agencies, and non-profits who partner with us to make possible this important, award-winning educational experience. As we end the 34th year of the Project Center in the midst of disruptions due to the pandemic, we would like to give special thanks to the sponsor liaisons, faculty advisors, and staff who provided unfailing support to the student teams in the completion of their projects.

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

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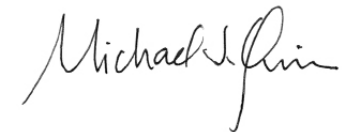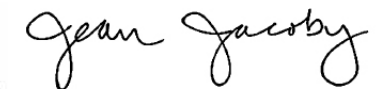Associate Dean and Project Center Director
College of Science and Engineering

PROJECTS
2021 DAY

FRIDAY, JUNE 4

EVENT SCHEDULE

⇉ ENGINEERING, ENVIRONMENTAL SCIENCE,
AND COMPUTER SCIENCE VIRTUAL PRESENTATIONS

12:45 P.M. – 1:45 P.M. PRESENTATION SESSION 1
ROOM 1
- CEE 21.1 **City of Bellevue** Kelsey Creek Bridge Approach Repair
- CEE 21.5 **Snohomish County** Trout Creek Bridge #494 Replacement

ROOM 2
- ECE 21.2 **The Boeing Company** Indoor Navigation System
- INT 21.1 **Jonathan Patten** Ambient Earbuds

ROOM 3
- ME 21.6 **Puget Sound Energy** COVID-19 Building Ventilation Energy Impacts
- ME 21.7 **Sound Transit** Light Rail Overhead Catenary System Tension Weight Replacement Program

ROOM 4
- CS 21.3 **Baus Systems** DSD Office Utilities Web Version
- CS 21.4 **Computer Life Skills LLC** E-Commerce Educational Website for A Start-Up Company

ROOM 5
- CS 21.19 **Snowflake ITM, Inc.** ABAC (Attribute-Based Access Control)
- CS 21.13 **The Postman** Postman App

ROOM 6
- CS 21.9 **Kenworth Truck Company** Mobile Metrics
- CS 21.8 **Kenworth Truck Company** Chassis Optimization

1:45 P.M. – 2:00 P.M. BREAK

2:00 P.M. – 3:00 P.M. PRESENTATION SESSION 2
ROOM 1
- CEE 21.4 **Seattle City Light** Assessment of Steel Structures in South Seattle Substation
- CEE 21.3 **KPFF-Fundacion Poder Joven** Home for Underprivileged Children in Medellin Colombia

ROOM 2
- ECE 21.1 **Black Farmers Collective** Off-Grid Electrical System for Urban Greenhouse
- ECE 21.3 **KiloWatts for Humanity** Energy Kiosk Design and Simulation Tool

ROOM 3
- ME 21.1 **The Boeing Company** Optimal Structural Design Accounting for Changes in Loading and Boundary Conditions
- ME 21.4 **NASA Psyche Mission** Mission to 16 Psyche: Sampling System

ROOM 4
- CS 21.20 **Votegrity Inc.** Votegrity
- CS 21.1 **1KM Agency** Marketing Data Mapping

ROOM 5
- CS 21.10 **Mercer Island Telecom** Collaborative Calculus
- CS 21.14 **Tuneme.co** Realtime AI Voice Coach

ROOM 6
- CS 21.11 **Our Fabric Stash** Inventory and Consignor Management System for Our Fabric Stash
- CS 21.12 **The Perfect Push** Birth and Lactation Outcomes Database

3:00 P.M. – 3:15 P.M. BREAK

3:15 P.M. – 4:15 P.M. PRESENTATION SESSION 3
ROOM 1
- ENSC 21.1 **USFS** Evaluating the Feasibility of Using Large Wood in Duwamish River Restoration
- CEE 21.2 **King County** Green Stormwater Infrastructure Development

ROOM 2
- ECE 21.4 **Panthera** Project Spot Check
- ECE 21.5 **Schweitzer Laboratories** Mobile Application with AMS Functionality

ROOM 3
- ME 21.2 **Kenworth Truck Company** Turn Prediction and Compensation from Environmental Effects
- ME 21.3 **MODICA Microindustries** MODICA MicroFAB Cooling Solution
- ME 21.5 **NIC Global** Vision System for Silkscreen Inspection

ROOM 4
- CS 21.5 **F5 Networks** Service Automation (Chatbot/Guided Wizard) & Issue Identification
- CS 21.6 **F5 Networks** Datadog Automation
- CS 21.7 **F5 Networks** Modernization of F5 iHealth

ROOM 5
- CS 21.16 **SU College of Science and Engineering** Faculty Review Process Automation
- CS 21.17 **SU Facilities and Center for Environmental Justice and Sustainability (CEJS)** RenewSU
- CS 21.18 **SU Information Technology Services** SU ITS Identity Management Automation

ROOM 6
- CS 21.2 **Amazon Sustainability** Zero Waste: Image Analysis of Care Labels
- CS 21.15 **SDI Engineering** GearSim UI and UX Design

4:15 P.M. – 5:30 P.M. NETWORKING SESSIONS

KELSEY CREEK BRIDGE APPROACH REPAIR CEE 21.1

SPONSOR: City of Bellevue
SPONSOR LIAISON: Kyle Potuzak, PE, PTOE
FACULTY ADVISOR: Michael Wright, PE, SE
STUDENTS: Audrey Hansen, Mike Kwispond, Connor McCoy, Bivek Rana, Anthony Woolley

The City of Bellevue asked the team to investigate worsening settlement at the south approach of Kelsey Creek Bridge on 134th Ave NE and evaluate possible solutions. The settlement has resulted in a vertical discontinuity in the pavement where the south approach meets the bridge superstructure, as well as a vertical gap between the pile cap that supports the superstructure and the riprap below. As part of the investigation, the City of Bellevue requested that the team perform a scour analysis and evaluate transportation infrastructure including pavement, guardrails, and pedestrian railing. The team created a decision matrix to determine the optimal approach based on cost, time, constructability, environmental risk, and design life. The team also produced plans for transportation enhancements pertaining to paving and guardrails, as well as a scour monitoring plan.
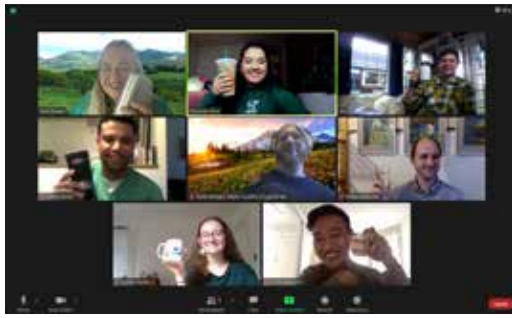
GREEN STORMWATER INFRASTRUCTURE DEVELOPMENT CEE 21.2

SPONSOR: King County Department of Natural Resources and Parks
SPONSOR LIAISONS: Jon Polka, PE, Matt McNair, PE, Denise Di Santo
FACULTY ADVISOR: Michael Marsolek, PhD, PE
**STUDENTS:** Collin Bond, Priyanka Devi, Sara Kessel, Hinh Nguyen, Emma Rusin

King County is improving stormwater infrastructure throughout the Bostic Creek subbasin of Bear Creek watershed, including the implementation of green stormwater infrastructure (GSI). The projects aim to improve flow control and runoff water quality while protecting downstream salmon habitat. As part of this effort, King County is working with Seattle University to conduct an alternatives analysis for GSI at Sunrise Elementary School in Redmond, Washington. The team completed a site characterization, engaged the community through a survey, analyzed three design alternatives for improvements to flow control, water quality, environmental benefits, and cost. The preferred alternative, a terraced bioretention facility that also serves as an outdoor education platform, was designed to 30% completion.

HOME FOR UNDERPRIVILEGED CHILDREN IN MEDELLIN COLOMBIA CEE 21.3

SPONSOR: KPFF, Poder Joven Foundation (PJF)
SPONSOR LIAISONS: Clared Patricia Jaramillo (PJF), Sean Story, PE (KPFF), Scott Stainer, PE (KPFF)
FACULTY ADVISOR: Jhon P. Smith, PhD, PE, SE
STUDENTS: Per Anderson, Ryan Larsen, Nicholas Paduano, Shawn Schaub, Lance Slichko

Poder Joven Foundation is a nonprofit organization dedicated to providing disadvantaged children in Medellin Colombia with a safe environment to grow and learn. Currently, Poder Joven is operating out of two daytime facilities and is looking to expand their outreach through a new, third full-time/overnight facility. The team was tasked with the structural and architectural design of a 13,000 square foot, two-story reinforced concrete building. The building was designed in accordance with the local Colombian code, NSR-10, and further verified with American standards such as ASCE 7-16, ACI 318-19, and IBC 2018. Deliverables for the project included architectural and structural drawings as well as a calculation package, material quantities, and a final report.
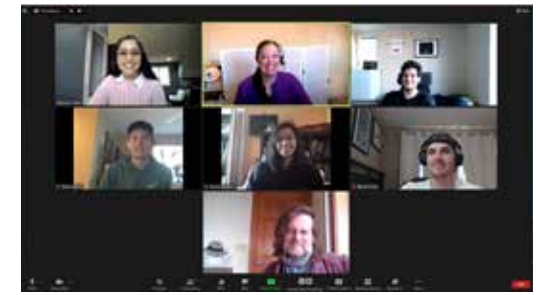
ASSESSMENT OF STEEL STRUCTURES IN SOUTH SEATTLE SUBSTATION CEE 21.4

SPONSOR: Seattle City Light
SPONSOR LIAISON: Robert Cochran, PE, SE
FACULTY ADVISOR: Jordan Jarrett, PhD, PE
STUDENTS: Ethan Crout, Luka Dzipkovic, Ryan Gilmer, Navneet Johal, Alyssa Toledo

A Seattle City Light substation provides electricity to industrial, commercial, residential, and municipal buildings. The substation is located in an area of high seismicity and liquefaction potential. Seattle City Light has estimated that a high seismic event in the Puget Sound region would cause outages for roughly 10 to 40 days, with repairs of electrical equipment taking over a year to complete. The resilience of Seattle City Light's substations is essential for a fast recovery of the societal framework. The team used a Performance Based Design approach to assess the resiliency of the South Seattle Substation. The team analyzed the behavior of 10 steel structures supporting electrical equipment in the substation for Immediate Occupancy and Life Safety performance levels for the Design Earthquake and Maximum Considered Earthquake, respectively. The provision of ASCE 7-16, ASCE 41-17, and AISC 360-16 govern the structural analysis for this project. An assessment report was provided for each structure including a visual inspection checklist, SAP2000 modeling results, analysis summary, and structural and non-structural mitigation recommendations. A corresponding assessment manual was also developed that will be used by Seattle City Light to assess the substations that provide energy to the Puget Sound region.

TROUT CREEK BRIDGE 494 REPLACEMENT
CEE 21.5

SPONSOR: Snohomish County Public Works
SPONSOR LIAISONS: Tim Tipton, PE, SE, Darrell Ash, PE, SE, Martin Jackson, EIT
FACULTY ADVISOR: Mark Siegenthaler, PE, PLS
STUDENTS: Michiko Aizawa-Smith, Nicholas Harris, Sing Cheong Kam, Korey Miyakawa, Samantha Mutoni

Snohomish County Public Works Department requested that the team develop a Type, Size, and Location (TS&L) Report for the replacement of Trout Creek Bridge 494. The bridge is located on Index-Galena Road, six miles northeast from the town of Index. Bridge 494 is classified as functionally obsolete due to its insufficient lane and bridge deck width. In addition, portions of the bridge need replacement. Design alternatives to replace the bridge included superstructure, substructure, guardrails, drainage, and alignment. The team created an evaluation matrix to select the preferred alternative, which was subsequently developed to 30% design. The bridge replacement features single-span, steel-plate girders with concrete deck and approach slabs, a spread footing foundation supported by a Mechanically Stabilized Earth (MSE) wall, Glulam beam guardrails, bioswales to treat stormwater runoff, and roadway approach realignment to meet design speed guidelines. The road realignment design required excavation into the existing hillside. The bridge was designed to improve resistance to stream scour, protect fish habitat, address challenging foundation conditions, and maintain traffic during construction. The design follows Snohomish County standards, professional standards, and state guidelines to provide satisfactory structural performance, minimal maintenance costs, vehicle and driver safety, and reduced environmental impacts.

"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** PE/SE,
Senior Civil Engineer, Structural Engineering Group, Seattle City Light

MARKETING DATA MAPPING CS 21.1

SPONSOR: 1KM.Agency
SPONSOR LIAISON: Sidney Wambach
FACULTY ADVISOR: Hidy Kong, PhD
STUDENTS: Alexander Erickson, Dang Nguyen, Tuan Phan, Adama Sanoh

1KM.Agency is a digital marketing firm working primarily with small businesses to enhance their online presence. 1KM uses a diverse set of communication and analytics software that provides a variety of benefits to their clients, but they lack integration between the various platforms. Project Managers (PMs) often repeated work or completed many mundane tasks to meet a client's needs such as providing up-to-date information on project progress. The workflow was inefficient and was not conducive to an easy flow of information between clients and PMs causing extra work for PMs and leaving clients less satisfied. 1KM has partnered with our team to decrease redundancies and build an interface to ease communication between external parties and PMs. We approached the problem by integrating all the software that was used by 1KM into one combined system, which will decrease the PM's workload. In addition, our team developed a web application that streamlines communication between 1KM and their clients by providing enhanced data visualization and improving the client experience. The main tools used in our project were Zapier, WordPress, Google Sheets, and ClickUp. The tools were integrated and built into the website to allow end-users to easily track project progress and understand the impact that 1KM's work has on their business. The integrated system and client-side web application helped us to achieve our goal of increasing the productivity of the internal parties and improving the experience of clients.
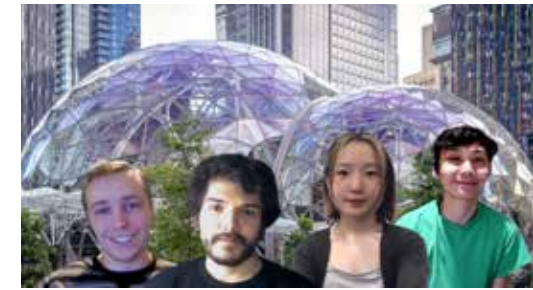
ZERO WASTE: IMAGE ANALYSIS OF CARE LABELS
CS 21.2

SPONSOR: Amazon Sustainability
SPONSOR LIAISONS: Daphne Chong, Rob Jellinek, Rich Meyer
FACULTY ADVISOR: Sheila Oh
STUDENTS: Heriberto Avendaño, Sam Firnhaber, Megan Gao, Ryan Nakatani

Amazon has set ambitious goals to make its business more sustainable on behalf of customers. From thousands of Amazon-branded products to millions of retail and third-party items sold on Amazon, they are working to reduce the environmental impact of the products they manufacture and provide customers with more information about the sustainability attributes associated with the items they sell. Amazon aims to be Earth's most customer-centric company, which means giving their customers access to the sustainable products they want. Sustainable products cover a range of attributes intended to preserve the natural world, and they strive to help Amazon customers easily discover and shop products that exceed the environmental benefits of comparable products.

Our sponsors within Amazon Sustainability requested an application to extract clothing care information from product images on a large scale. This tool could help Amazon learn more about the variation of clothing care instructions within the vast assortment of apparel products sold on its website. These instructions could then either be used to help customers care for these products longer or provide additional accuracy to lifecycle models that depend on a product's use phase.

To meet this need, our team built a machine learning model that identifies care instructions from images of clothing care labels. We compiled a dataset of over 400 images and preprocessed them to train the model. We worked closely with Amazon Sustainability and documented our process so that the model's accuracy can continue to be improved upon.

DSD OFFICE UTILITIES WEB VERSION CS 21.3

Baus Systems

SPONSOR: Baus Systems
SPONSOR LIAISONS: Steve Baus, Mark Baus, Mark Nielson, William Lewis
FACULTY ADVISOR: Israel Hilerio, PhD
STUDENTS: Aidan Bossio, Joshua Mora, Thong Nguyen, Ahmed Ugas

Baus Systems is a small business that provides route accounting solutions for Direct Store Delivery (DSD) distributors. Developed in the 1990s, their proprietary route accounting software DSD Office Utilities is a desktop application that acts as a middleware between a delivery driver's handheld device and a distributor's backend accounting software. It allows DSD distributors to manage their existing accounting information, such as customer and product details and price scheduling. Originally designed as an Access desktop application for a single user administrator, the software can only be used by one user at a time. To overcome this single user usage pattern and improve serviceability, Baus Systems requested that the project team build a multi-user web application to transition the DSD Office Utilities from the desktop to the cloud. Building upon the AWS backend implementation completed by last year's project team, the project team created an AWS hosted Angular web application that uses ASP.NET Web APIs to communicate with a MySQL cloud database. This web application delivers on the company's vision of providing distributors the capability to manage their existing accounting information by multiple users in the organization from anywhere.

Baus Systems
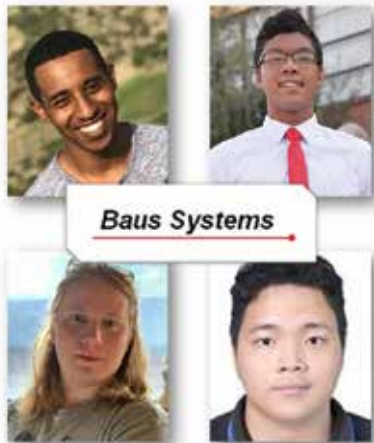
E-COMMERCE EDUCATIONAL WEBSITE FOR A START-UP COMPANY CS 21.4
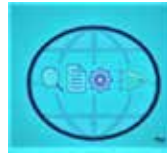
SPONSOR: Computer Life Skills LLC
SPONSOR LIAISON: Kory Srock
FACULTY ADVISOR: Susan Reeder
STUDENTS: Fuyuan Geng, Tuan Lo, Emma Tamura, Jietao Zhan

Computer Life Skills LLC is a start-up company that provides people resources and materials that teach basic technology skills and usage. Founded in 2019 by Kory Srock, the company started as a personal platform for learning after he started teaching and training Microsoft employees on tools to overcome learning disabilities. The goal of the Computer Life Skills LLC is to provide practical understanding and help build confidence in the use of technology. The team created a user-friendly and simply designed e-commerce educational website for the company that helps students to focus on the content, accessible for all students anytime anywhere, and provides the following functionalities:
• Technology skills courses with a dynamic and interactive webpage for students
• Subscriptions feature to the webpage
• Quiz games to refresh and review learned materials.

SERVICE AUTOMATION (CHATBOT/GUIDED WIZARD) & ISSUE IDENTIFICATION CS 21.5

SPONSOR: F5 Networks
SPONSOR LIAISONS: Nicholas Ferguson, Ron Runyon, Jordan Zhao
FACULTY ADVISOR: Steven Hanks, PhD
STUDENTS: Andrea Callista, Stephan Crum-Futch, Grace Mondry, Marco Rodriguez

F5 Networks receives hundreds of customer support tickets a day regarding issues or questions about their products. These support tickets are then resolved by an F5 support engineer. However, some of these support tickets do not require any human intervention to be resolved. To reduce the number of customer support tickets that need to be resolved by a support engineer, we have built a chatbot using Salesforce's Einstein Bot that assists the customer in resolving their issue without the help of a support engineer. Our goal with the chatbot is that some issues get resolved by an automated solution, and some get routed to an F5 support article. We analyzed the past year's support tickets and built a dialog tree that powers the chatbot to present customers with an automated solution, an F5 support article, or creates a support ticket for a support engineer to address if the chatbot fails to solve the issue on its own. This chatbot serves as proof of concept that an automated system can both effectively address customers' issues and be integrated into F5's system for handling customer support tickets.
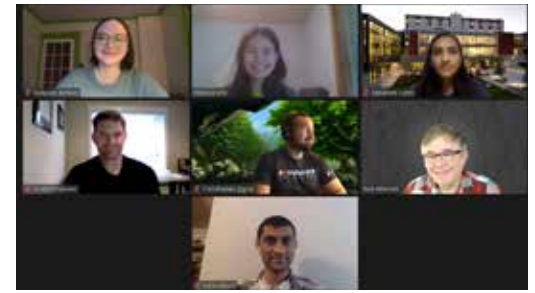
DATADOG AUTOMATION CS 21.6

SPONSOR: F5 Networks
SPONSOR LIAISON: Rick Mitchell
FACULTY ADVISOR: Scott McMaster
STUDENTS: Greyson Berkley, Patricia Ishii, Devanshi Lohri, Arjun Misra

The Common Engineering Development and Infrastructure (CEDI) Team at F5 works across all F5 services, using Datadog to monitor and maintain common internal systems. Our team worked with the CEDI Team to manage these monitors as code. This project involved designing an automated system for F5's CEDI Team to update, modify, and create Datadog monitors without reliance on Datadog's UI. Creating monitors through the UI makes them more difficult to track and manage, risks allowing unwanted or untracked changes, and makes it challenging to do batch-creation of monitors upon standing up a new service. To solve this problem, our team created a tool to manage monitors, push changes, lessen the manual UI dashboard workload, and batch-create/deploy new monitors. We achieved this using a Gitlab CI/CD pipeline to run scripts and a web service to allow codified access by F5's internal systems. The pipeline executes scripts to pull monitor files via the Datadog API, lint monitor files after changes, create monitors from templates given a basic set of parameters, and redeploy monitors to Datadog via Terraform. This combined with the web service allows the F5 team to easily change monitors and define and deploy sets of monitors when standing up new services. This solution meets F5's criteria that the use of Datadog's UI for changes should be minimal, monitors should be version controlled, the system's automation should make template-driven monitors easier to make and deploy, and F5 should be able to define a standardized set of monitors for each new service.

MODERNIZATION OF F5 IHEALTH CS 21.7

SPONSOR: F5 Networks
SPONSOR LIAISON: Jon Gross
FACULTY ADVISOR: Wan Bae, PhD
STUDENTS: Joel Davidson, Suchith Ramyasri, Benaja (Ben) Tchamba, Blake Werner

F5 networks manages and maintains the health of client networks across the globe and, naturally, this poses a diverse array of challenges. Chief among those is the challenge of providing top-tier technical support while simultaneously affording clients the ability to seek solutions independently from F5 staff. Thus, F5 created iHealth, a heuristic analysis tool that caters to both employees and clients alike. If a problem occurs on a client network, iHealth is the first line of defense in its resolution. However, iHealth's current technology stack is over 10 years old and lacks the capabilities offered by modern web applications. As such, F5 is committed to bringing this integral part of their support system into the current decade. Our team was entrusted with creating a scalable, interactive, and fully tooled graphing utility that takes advantage of modern languages and frameworks, including React, Node.js, and Typescript. Leveraging those technologies alongside Amcharts4, a powerful graphing library we adopted to satisfy F5's needs, our team delivered an application capable of passing gigabyte-scale network data to a front-end graphing solution. Our focus was to create an application that provides for the easy rendering of many datasets, smooth integration with existing F5 technical standards, and fast backend data-handling.

CHASSIS OPTIMIZATION CS 21.8

SPONSOR: Kenworth Truck Company
SPONSOR LIAISONS: Nick Grant, Thomas Lee
FACULTY ADVISOR: Richard LeBlanc, PhD
STUDENTS: Nayif Alhomoud, Kai Hirose, Gavin Limchayseng, Arjun Srikureja

Kenworth Truck Company is a subsidiary of PACCAR that specializes in the production of heavy-duty and medium-duty commercial vehicles. Additionally, each Kenworth truck that is ordered is customized specifically for the client. Due to this, the weight of each truck is unique and heavily reliant on which parts are chosen for each truck. Kenworth must give a predicted weight to the client that is within 2% of what the actual weight of the truck will be before building it. Currently, Kenworth has a process to manually double check and audit the predicted weight of the truck to make sure it is accurate. This process takes many hours a week from sales engineers, therefore automating the process would save Kenworth both time and money. However, due to the importance of weight, the automation process must be precise. Our team elected to take a machine-learning approach to do this. We used Kenworth's truck history data comprised of more than 50,000 trucks to train our Random Forest model to accurately produce a weight prediction within this 2% uncertainty specification. Using our algorithm, Kenworth is able to reduce the need for manual intervention significantly, thus speeding up the process and allowing sales engineers to more efficiently allocate their time.

MOBILE METRICS CS 21.9

SPONSOR: Kenworth Truck Company
SPONSOR LIAISONS: Alex Russell, Martin Valiquette
FACULTY ADVISOR: Michael McKee
STUDENTS: Albert Abes, Cheng Loong Kong, Nicholas Nguyen, Andrew Saputra

Kenworth Truck Company is an industry leader in the design and manufacturing of medium- and heavy-duty trucks. Each production plant has local metrics known as Key Performance Indicators (KPI) that indicate a measure of plant performance for the day. Currently, these KPI values are only viewable while being physically on site via large TV monitors at set locations above the assembly line. This method cannot be scaled to meet business and employee needs at or away from the facility. Our team has worked closely with Kenworth's software development team to develop a progressive web application so that production managers and workers can access mainline metrics through their PC or mobile devices while off-site. We also developed the required background services using .NET Core, integrating with Kenworth's current architecture. There are two significant components that our team has built in this project. The first is an Administrative Dashboard and the second is a Mainline Dashboard. A user with administrative privileges can decide which specific metrics are to be displayed and set alert values for any of the metrics on the Mainline Dashboard. The Mainline Dashboard contains a display based on which metrics are enabled. The values shown on this dashboard are refreshed and updated seamlessly. Anyone accessing the solution can see the status of a metric based on its color and its current value that it holds.

COLLABORATIVE CALCULUS CS 21.10

SPONSOR: Mercer Island Telecom
SPONSOR LIAISON: Carlos Luis Obando
FACULTY ADVISOR: Aditya Mishra, PhD
STUDENTS: Nicholas Doubrovsky, Bryn Lasher, John Munar, Bailey Thompson

The difficulty of math curriculums has been a significant factor in turning students away from STEM-based careers. Since the pandemic, math has only become more challenging to learn due to limited interaction opportunities between students and teachers in most online education platforms. As a result, students are becoming more and more disengaged. Dr. Jo Boaler, Professor of Mathematics Education at the Stanford Graduate School of Education, in her book "Limitless Mind," advocates that one of the keys for people to learn math better is by learning with other people. Based on Dr. Boaler's work, Mercer Island Telecom has requested the team to create a platform that facilitates users to learn Calculus collaboratively. Using WordPress plugin solutions, the team has created a website with specialized courses on various Calculus topics. The website offers collaborative features such as text and video chat with other students interested in taking the lessons collectively. This platform enables users to learn math by engaging with other people in a simplified, fun way.

INVENTORY AND CONSIGNOR MANAGEMENT SYSTEM FOR OUR FABRIC STASH CS 21.11

SPONSOR: Our Fabric Stash
SPONSOR LIAISON: Deborah Boone
FACULTY ADVISOR: Lisa Milkowski, PhD
STUDENTS: Matthew Grebert, Sam Hesler, Patrick Morton, Jasmine Vinoya

Our Fabric Stash is a one-of-a-kind fabric and craft consignment store located in historic Pike Place Market. Because of the uniqueness of Our Fabric Stash's business model, they struggled to find one system that met all of their complicated inventory and consignor management needs. Their previous dissonant tooling resulted in a great deal of manual overhead in the transportation of information between systems. To remedy this, we aimed to create a custom tool that matched the uniqueness of their business. Our tool is made up of two components, a database and web application. The database, which is hosted on Azure, contains information on the business's inventory, consignors, transactions, and vendors. The web application, which is a Razor Pages .NET Core web application, allows users to interact with the database to track and update the aforementioned information as well as other tasks such as receiving transaction information and emailing relevant information to new consignors. By providing one cohesive management system, we were able to reduce most of the manual overhead while automating some additional day-to-day tasks for Our Fabric Stash staff.

BIRTH AND LACTATION OUTCOMES DATABASE CS 21.12

SPONSOR: The Perfect Push
SPONSOR LIAISON: Jen Hamilton
FACULTY ADVISOR: Jason Wong
STUDENTS: Michael Brown, Alexa Fisher, Alyssa Gaston, Emma Zucati

The Perfect Push is a doula and lactation consultant service provider that utilizes the product IntakeQ to manage their patient information. IntakeQ was not able to compare patients, generate trends, and identify areas of interest. The Perfect Push wants to leverage their historical data and identify trends to instruct better outcomes; the student project consisted of creating a database, transferring historical data, and connecting the data to maintainable, easy to use tools. The student project team has built a relational database that allows the users to store and view their data in a HIPAA-compliant manner. Using a MariaDB hosted on Azure, the sponsors will be able to access and maintain their data after project completion. The project team has created a continuous ETL tool that will update the database with new client data automatically to ensure that the product has continuous, maintainable growth. By connecting this database to PowerBI, the Perfect Push can view and query their data easily without having technical expertise. By creating a tool to run queries, generate reports, and make predictions based on their data, The Perfect Push and their clients will be able to have more successful birth events, personalized care, and lactation outcomes.

POSTMAN APP 21.13 CS 21.13

SPONSOR: The Postman Seattle
SPONSOR LIAISON: Keanna Rose Pickett
FACULTY ADVISOR: Jason Wong
STUDENTS: Hailey Dice, Grant Weikel, Jack Witt, Karen Wong

The Postman is a third-party authorized mail and business center, located in the Central District in Seattle. They provide shipping and business services to members of the local community, as well as micro and small businesses. These services include daily shipping and package pickup through established carriers such as FedEx, DHL, UPS, USPS as well as printing, faxing, notary appointments, and private mailboxes with a professional street address. The main goal of the team was to build a functioning mobile app for The Postman, which would provide customers remote access to The Postman's in-store services, with an emphasis on shipping and appointment scheduling. The team also built a basic backend for the app to be secure and provide users the ability to create accounts and save and track important shipping information. This app will help accommodate the growth of The Postman and be a foundation for future development. The Postman app users will be able to make and use a secure account where they can store addresses in an address book, purchase and generate shipping labels, and access new business services that The Postman will offer in the future.
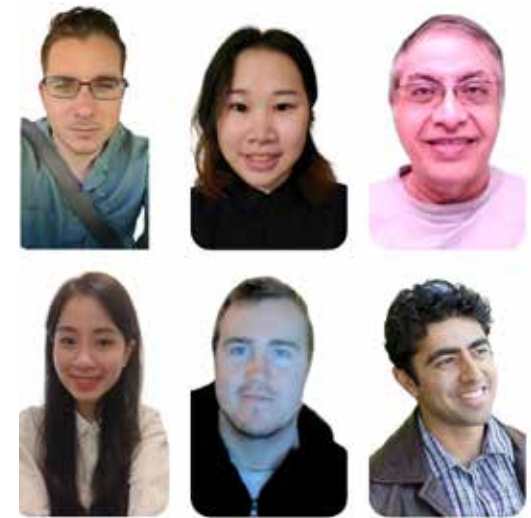
REALTIME AI VOICE COACH CS 21.14

SPONSOR: Tuneme.co
SPONSOR LIAISON: Rahber Thariani, PhD
FACULTY ADVISOR: Shadrokh Samavi, PhD, PE
STUDENTS: Benjamin Agrelius, Yinhui Li, Andrew Roach, My Tran

The Realtime AI Voice Coach is an essential tool for business professionals, web conferencing, and virtual presentation skills. Entrepreneur Rahber Thariani noticed the ever-developing virtual work environment and sought to develop a product to aid in the adaptation that work-from-home employees would need to adjust to. He looked to the team to do the market research and software development necessary to develop a design that would best suit the professional world. The product seeks to develop public speaking skills by measuring the rate of speech of users in real-time and displays notifications if users are talking too fast or too slow. The voice coach also gives a visual representation of these data to better articulate how one can improve their speech patterns. After completing the thorough testing phase, the product was launched for commercial use, with several of the team members staying on to maintain its growth.

GEARSIM UI AND UX DESIGN CS 21.15

SPONSOR: SDI Engineering
SPONSOR LIAISONS: Dennis Fredell,
Phillip Richards, PhD
FACULTY ADVISOR: Michael McKee
STUDENTS: Chris Fong, Oleg Kovalenko,
Patrick Manacorda, Jack Moss

SDI Engineering is a small, local business in the Seattle area that has been providing services to major aircraft component manufacturers and suppliers for over 25 years. The primary services rendered range through applied modeling of aircraft, simulation and analysis of aircraft, and specialized niche aviation engineering consulting. SDI Engineering is looking to improve the user experience of their proprietary GearSim software. The main design goals were a fresh and intuitive linear workflow, and modern software design principles for maintainability. We began by wireframing different ideas of how a typical user would interact with GearSim and presented our wireframes to SDI Engineering. Based on SDI Engineering's feedback, we produced a UI using C++ and Qt for GearSim. Our UI uses a standard file format and makes use of an MVC model for the front end to work towards SDI's design goals. It also lays the ground-work for extending the current functionality using the fundamental abstractions and idioms found in the specific domains of Qt and C++ UI development.

FACULTY REVIEW PROCESS AUTOMATION CS 21.16

SEATTLE UNIVERSITY.

SPONSOR: Seattle University College of Science and Engineering
SPONSOR LIAISONS: Pejman Khadivi, PhD, Michael Quinn, PhD, Donna Sylvester, PhD, Cheryl Wotus, PhD
FACULTY ADVISOR: Eric Larson, PhD
STUDENTS: Malav Dipankar, Richard Pallangyo, Quinn Wass, Amanda Zheng

The Seattle University College of Science and Engineering Faculty Annual Performance Review (APR) senior capstone team has engineered an annual performance review system that creates a streamlined review process for the Seattle University College of Science and Engineering. Currently, the APR process is a paper-based process that requires several cumbersome and inefficient methods such as the manual calculation of Student Perception of Teaching (SPOT) scores and requiring faculty to reference of past forms for reflection, which were difficult to locate as they are not stored in a centralized location. Furthermore, there are different forms for different faculty positions, increasing the overhead of the system. The team has created an online service that aims to address these concerns. On a high level, the system is able to follow the same basic review workflow that the paper-based system does while augmenting the system with additional features. These features include the automatic processing of SPOT scores, the ability to easily reference past forms, and built-in selection of the correct form based on faculty position. This new service aims to reduce the amount of time the faculty members have to spend on this review process by optimizing the parts of the process prone to user error, and allowing the faculty members to focus on the content of the review.

RENEWSU CS 21.17

SEATTLE UNIVERSITY.

SPONSOR: Seattle University Facilities and Center for Environmental Justice and Sustainability (CEJS)
SPONSOR LIAISONS: Yolanda Cieters (CEJS), Richard Moyer (Facilities)
FACULTY ADVISOR: James Obare
STUDENTS: Carolina Angelica, Anais Barja, Yinying Liang, Ajer Lodhi

With the goal of reaching zero waste by 2025, Seattle University's Center for Environmental Justice and Sustainability (CEJS) and Facilities Department teamed up to sponsor a platform that would further advance sustainable practices on campus. Seattle University community members do not currently have a platform for getting unwanted items into the hands of others who can use them. The goal of this project is to build a website that is accessible on both desktop and mobile where students and employees can easily post and request unwanted items for free. From textbooks to furniture, the RenewSU website will help students, employees, and the university save money and keep items circulating on campus rather than sending them to a landfill. The website has three separate views for personal items, university-owned items, and administrative access. Students can post and request personal items, while employees can post and request university-owned items as well as person-al ones. Administrators can track website activity, col-lect statistics, and keep the website safe and inclusive by managing flagged items and users. All users can receive notifications on item requests and activity. The team is excited that our project will be used by the Seattle University community to contribute to our campus sustainability. By encouraging the circulation of items on campus, RenewSU seeks to conserve resources, build community, and achieve Seattle University's zero waste goals.

> "Working with the Center of Environmental Justice and Sustainability and SU facility has been a great educational experience! Besides learning new technical skills, we were also able to develop professional communication skills. We are glad that our project will make a valuable contribution to our university's sustainability goals."
> **CS 21-17** Capstone Project Team

IDENTITY MANAGEMENT AUTOMATION CS 21.18

SEATTLE UNIVERSITY.

SPONSOR: Seattle University Information Technology Services
SPONSOR LIAISON: David Abney
FACULTY ADVISOR: Yingwu Zhu, PhD
STUDENTS: Katherine McLane, Jou-Chun Pan, Cameron Quinn, Yibo Sheng

Seattle University's IT Department oversees account management for every university affiliate. Many of the processes for provisioning and de-provisioning accounts are manual and, as a result, are extremely time consuming and error prone. Our team was tasked with automating this system and enabling it to connect to a front-end GUI in the future. Leveraging the existing PowerShell scripts, our team has re-implemented them in C# to enhance consistency, efficiency, and extensibility. We have also added extensive logging within the new codebase to improve traceability. Finally, we have provided a suite of APIs for ITS to easily and seamlessly incorporate their future front-end GUI to the back end we have built in this project.

ABAC (ATTRIBUTE-BASED ACCESS CONTROL) CS 21.19

SPONSOR: Snowflake ITM
SPONSOR LIAISON: Steven Johnson
FACULTY ADVISOR: Michaeljon Miller
STUDENTS: Joe Fedden, Ethan Guttman, Saif Sheikh, Rajiv Singireddy

Access control is at the core of computing system security. Access control includes Authentication (AuthN) of the "User" and checking if the User is Authorized (AuthZ) to perform the requested activity. Snowflake ITM has been issued a patent covering core functionality of the Attribute Based Access Control (ABAC) Authorization method. The method overcomes problems with other Authorization methods by enabling a dynamic/real-time Authorization solution that is efficient, granular, and low maintenance. Snowflake ITM asked our team to build the patented core functionality into an Authorization service. We began by first researching different authorization schemes from companies such as Amazon, Google, and Microsoft. We saw the differences in their authorization set up compared to ABAC's. We then implemented a Node JS framework that takes a HTTP header request, routes it to our internal API and evaluates policy associated with the requested activity to determine if the requested activity is allowed to be performed on the target resource by the requesting "User". The team was able to deliver a working prototype of the patented ABAC functionality. The prototype has a functional API that parses the request and provides real-time evaluation of a "dummy" request using mock policy and attribute data.

VOTEGRITY CS 21.20

SPONSOR: Votegrity Inc.
SPONSOR LIAISON: Tom Thomas
FACULTY ADVISOR: Kevin Lundeen
STUDENTS: Kelsey Bates, Emily Blitman, Jordan Jue, Shaun Lee

Votegrity, Inc. is a Seattle-based startup that delivers state-of-the-art online election services. Votegrity brings the ballot box to the voter and manages the election process end-to-end. Their SaaS platform removes wasted paper, postage, and time from the voting process while increasing accessibility, verifiability, and scalability for their customers. While Votegrity currently works with companies in the private sector, the long-term goal of the company is to move into the public election space. The pre-existing voting platform was built over 10 years ago and needed to be upgraded to meet current demands of potential customers. Our team updated and modernized the user interface and added key features such as write-in voting, without compromising the security and integrity of the online elections. After early completion of the original project goals, we moved on to upgrade and modernize the election administrator web portal. Votegrity is now preparing to turn the platform into a self-service engine for customers to create and host secure online elections from anywhere globally.

> " 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

OFF-GRID ELECTRICAL SYSTEM FOR URBAN GREENHOUSE ECE 21.1

SPONSOR: The Black Farmers Collective
SPONSOR LIAISON: Ray Williams
FACULTY ADVISOR: Henry Louie, PhD
STUDENTS: Nabin Kc, Ian Paulo Santiago, Christiana Tembo, Yen Tran

The Black Farmers Collective requested the team to design a renewable off-grid electrical system to power loads such as fans, water pumps and security lights in their Yes Farm greenhouse. Currently, the farm is not connected to the electrical grid, which is a significant limitation to fully utilizing the greenhouse. With an off-grid electrical system for the greenhouse, the Black Farmers Collective will be able to grow quality produce at a faster rate. After careful consideration of different energy sources, a solar photovoltaic array was selected to power the greenhouse. A load profile detailing the average daily energy consumption of each load was developed. This load profile was implemented in HOMER Pro software for system component sizing, cost, and scenario analysis. System Advisor Model (SAM) software was used to perform a shading analysis. AutoCAD was used to show the physical location of the solar array, charge controller, batteries, cables, and other components. The design takes into consideration the shading from nearby buildings and trees, reduces the risk of theft, and meets the required electrical codes in the region. The design is within the given budget of $15,000, including installation and maintenance costs. The off-grid solar system uses a backup generator and batteries to support any unmet electrical load.
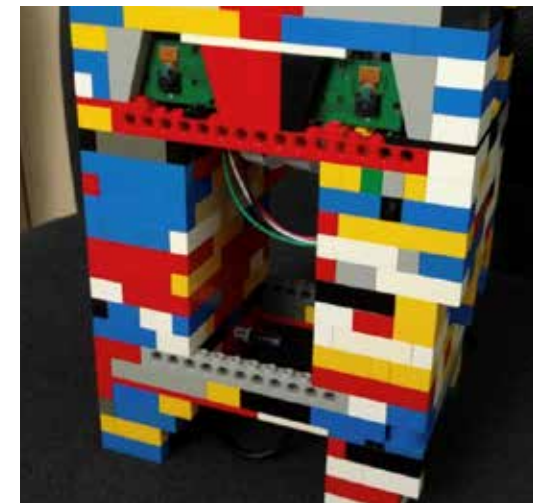
INDOOR NAVIGATION SYSTEM ECE 21.2

SPONSOR: The Boeing Company
SPONSOR LIAISONS: Chris Esposito, James Fadenrecht, Katherine Meza, Rohan Rana, Jim Troy
FACULTY ADVISOR: Al Moser, PhD
**STUDENTS:** Ari Adusumilli, William Lambrecht, Carmen Olmedo, Sid Teske

The Boeing Company is the world's largest aerospace company. They create and manufacture commercial jetliners, defense, space, and security systems. For environments that are too far removed from a traditional GPS signal or for those that GPS proves to be too unreliable, a user should still be able to identify their position, path, and bearing. In the event that a small component in an airplane breaks down, the user should be able to quickly arrive at its location. The project's aim is to find a solution to the problem of navigating through an indoor area without the use of GPS services, instead relying on visual odometry and sensor fusion using sensors integrated in a hand-held device. The scale of indoor environments is much smaller than those outdoors, thus this solution needs a higher level of precision and accuracy than GPS. The team created an indoor positioning system (IPS) that uses a visual Simultaneous Localization and Mapping (vSLAM) algorithm on a Raspberry Pi 4 with the aid of an inertial measurement unit and a stereoscopic camera. The portable solution uses real-time localization and mapping with precise location measurements as well as transfers position and location data through a WebSocket data interface.

ENERGY KIOSK DESIGN AND SIMULATION TOOL
ECE 21.3

SPONSOR: KiloWatts for Humanity
SPONSOR LIAISON: Daniel Nausner
FACULTY ADVISOR: Shiny Abraham, PhD
STUDENTS: Anh (Justin) Duong, Ann Marie Jawili, Pualilia (Lily) Kahale, Scott O'Shea

KiloWatts for Humanity (KWH) is a nonprofit organization that implements off-grid solar-powered energy kiosks that provide limited electricity to villages in sub-Saharan Africa. KWH has tasked the team with creating an energy kiosk design simulation application. KWH currently uses an application called HOMER to run their simulations. The new desktop application will replace HOMER and is tailored specifically to KWH's workflow. The application allows the user to input the location of a future energy kiosk as well the specifications of the battery and photovoltaic array they will use. The user will also input the hourly load profile and the desired reliability for the system. The application will process the inputs and display the energy that will be produced by the solar array, the hourly state of charge of the battery, feasibility of the project, and a cost estimation. The application is only available on Windows 10 and is written in the programming language C. KWH will use the application to help design future energy kiosk projects.
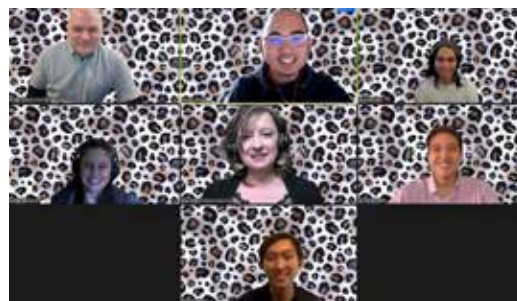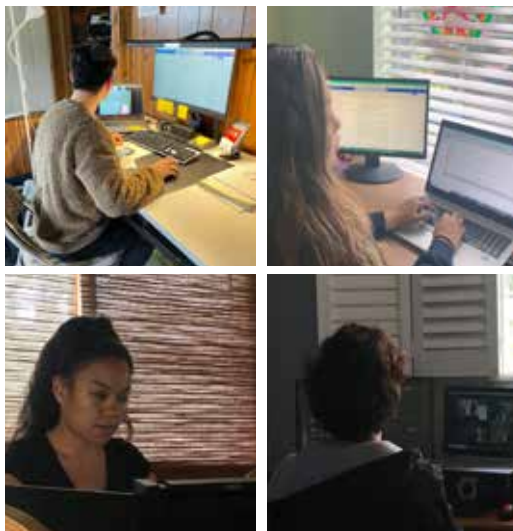
PROJECT SPOT CHECK ECE 21.4

SPONSOR: Panthera
SPONSOR LIAISONS: Rana Bayrakçismith, Devin DeWitt, Agnieszka Miguel, PhD
FACULTY ADVISOR: Mehmet Vurkaç, PhD
STUDENTS: Dustin Pham, Edward Gao, Neil Sadaoka, Calien Somlak

Panthera is a non-profit organization devoted to protecting all 40 species of wild cats through research and conservation. Panthera uses camera traps to photograph cats in their natural habitat. Panthera requested software that identifies cats in their snow leopard database by automatically grouping photos of the same cat in their respective directories. The team improved the previous year's software to exponentially reduce runtime. The software was also completely rewritten to improve readability, compartmentalization, and polymorphism. The image processing techniques were maintained from previous years. The main image processing methods applied to this project are Mask-R CNN and SIFT (Scale Invariant Feature Transform). This year Mask R-CNN and SIFT was fully tested on Panthera's database of 2,000 snow leopard images. The software now takes into account more metadata to match snow leopards. The software output provides information on the number of unique snow leopards in the database of images and informs the user when there are certain images that need to be inspected and identified manually.

MOBILE APPLICATION WITH AMS
FUNCTIONALITY ECE 21.5

SPONSOR: Schweitzer Engineering Laboratories
SPONSOR LIAISON: Steve Szablya, PE
FACULTY ADVISOR: Margarita Takach, PhD
STUDENTS: Pamela Ferraz, Isaac Parker, Dinh Tran, Kiet Trinh

Schweitzer Engineering Laboratories (SEL) uses an adaptive multichannel source (AMS) to demonstrate, test, and calibrate meters and other SEL devices such as relays. The AMS can provide many signals simultaneously to a device to simulate realistic voltage and current waveforms as seen in utility and industrial applications. SEL requested the development of an iOS mobile application that creates a pair of realistic voltage and current waveforms to be transmitted to the SEL-735 power quality and revenue meter via the iPhone audio jack. This final product will greatly assist sales engineers who demonstrate SEL's products to potential clients because the AMS device is cumbersome to travel with, in addition to being an expensive piece of equipment. Replacing the heavy AMS with the mobile application will make travel much easier with a mobile application providing similar functionality. The company also reduces the risks involved with travelling with the AMS. The mobile application can provide voltage and current signals through two separate channels to the iPhone audio jack. Each channel provides the selection of waveform type, harmonics, amplitude, frequency, and phase shifts. Additionally, it contains a feature where industry-standard-standard COMTRADE files can be downloaded to the phone, displayed on the application, and shown on the meter screen.

> " SU students can compete on the big stage. They have the tool kit, information, abilities, experiences to do that."
> **JOHN HOOPER** '81,
> Magnusson Klemencic Associates

EVALUATING THE FEASIBILITY OF USING LARGE WOOD IN DUWAMISH RIVER RESTORATION ENSC 21.1

SPONSOR: United States Forest Service (USFS)
SPONSOR LIAISONS: Robert Deal, PhD, Monika Derrien, PhD
FACULTY ADVISOR: Se-Yeun Lee, PhD
STUDENTS: Piper Klinger, Darren Lui, Zach Stephens

The Environmental Science team, sponsored by the USFS, evaluated the feasibility of using large wood for restoration in the Lower Duwamish River. In upstream rivers, knowledge about how natural large wood functions has informed the placement of large wood for restoration purposes. Many successful restorations have been reported in upstream rivers but there are fewer studies of how large wood functions in estuaries such as the Lower Duwamish River. For restorations to be successful, the natural function of large wood in large rivers must be known. Thus, the team inventoried existing large wood in the Lower Duwamish River. The data included the size, location, placement, and elevation of natural and restoration-site-placed wood. This information can inform the placement of large wood in future restoration projects so that they may better mimic how wood naturally functions in an estuary. In addition, to learn about stakeholder perspectives about the feasibility of using large wood in restoration projects in the Lower Duwamish River, the team conducted a survey and follow-up one-on-one meetings with stakeholders. When planning restoration projects, it is vital to also understand the perspectives of stakeholders as well as the ecological functions of the site.

AMBIENT EARBUDS INT 21.1

SPONSOR: Jonathan Patten
SPONSOR LIAISON: Jonathan Patten
FACULTY ADVISOR: Alvin Moser, PhD
STUDENTS: Ragan Crowe, Julian Hirsch, Nathan Rablee, Matthew Rutigliano

Jonathan Patten's use of modern hearing aids has given him an appreciation for the ability to seamlessly switch between listening to Bluetooth audio and his surroundings. Seeing market potential, he patented a concept for multifunctional earbuds with the same features. These would allow any user to control what they hear with the push of a button. The team was tasked with developing this concept into a physical prototype. Mechanical and electrical engineering students worked in tandem to develop hardware and the casing to contain it. An embedded Bluetooth platform was selected, microphone drivers were developed, and both mockup and functional cases were designed.

> "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

OPTIMAL STRUCTURAL DESIGN ACCOUNTING FOR CHANGES IN LOADING AND BOUNDARY CONDITIONS ME 21.1

SPONSOR: The Boeing Company
SPONSOR LIAISON: Vladimir Balabanov, PhD
FACULTY ADVISOR: Josh Hamel, PhD
STUDENTS: Quinton Borseth, Brandon Morgan, Coby Pudiquet, Gurkirat Somal

Boeing is the world's largest aerospace company and a leader in the design and manufacture of commercial jetliners, defense, space, and security systems. Aircraft structural components must be both lightweight and durable. This requires design trade-offs that can be addressed by optimizing the structural design. However, structural optimization presents a challenge. It is an iterative procedure that uses finite element analysis that is a time-consuming and computationally intensive process. As a result, the dependency on finite element analysis makes structural optimization difficult in real-life applications with varying boundary conditions. Boeing asked the team to develop and study a methodology that would allow the company to efficiently account for varying boundary conditions when performing structural optimization. The team developed a method to create a simple mathematical approximation of a structural design parameter that can then be used as a surrogate model during optimization. This method had four steps: 1) Perform finite element analysis for a limited set of boundary conditions and record the design parameter at selected control points; 2) Use machine-learning to create a model for each control point; 3) Create approximation for design parameter by interpolating between control point models; and 4) Perform optimization using the design parameter approximations. The method was validated by experimenting with various sets of boundary conditions on a fixed cantilever plate and by analyzing a practical design case utilizing a component of an aircraft wing.

TURN PREDICTION AND COMPENSATION FROM ENVIRONMENTAL EFFECTS ME 21.2

SPONSOR: Kenworth Truck Company
SPONSOR LIAISON: Stan DeLizo
FACULTY ADVISOR: Yen-Lin Han, PhD
STUDENTS: Stafford Cary, Meghan Decker, Ryan Mann, Mohammed Muthanna

Kenworth, an industry leader in the design and manufacture of heavy-duty trucks, is preparing for significant change to their industry with the development of driver automation and assist technology. Kenworth tasked the team with developing an automated system that can accurately predict the minimum turn radius of a Kenworth T680 tractor-trailer in varying weather conditions. Turning radius is affected by road conditions and the vehicle's loading, tire-wear, suspension stiffness, geometry, and speed. These factors combine to make the radius of each turn unique and hard to replicate. Our design solution predicts the ideal minimum turning radius for the known conditions at the entrance to a turn, provides real-time feedback for the vehicle's progress relative to the minimum turning radius during the turn, and recommends any necessary course corrections. This is achieved through our mathematical model, which uses the known attributes of the vehicle to predict the minimum-radius turn-path in each direction. An optical sensor network uses image recognition and edge detection to inform the model of the vehicle's actual location along the turn-path. This allows our system to compensate for any unknown factors that impact the accuracy of our mathematical prediction model in real-time. Due to COVID-19 restrictions, we were only able to test on a small scale. However, the system was designed to be scaled and applied to Kenworth trucks in the future. The reactionary system developed may first be implemented as a driver assistance tool on current Kenworth models, and has the potential to be used in future higher-level automation projects.

MODICA MICROFAB COOLING SOLUTION ME 21.3

SPONSOR: MODICA Microindustries
SPONSOR LIAISON: Will Gibbs
FACULTY ADVISOR: Bob Cornwell, PhD, PE
STUDENTS: Cody Blaschka, Hao Chen, Max Chinowsky, Zach Larson, Justin Verniest

MODICA Microindustries is developing a modular fabrication system called a MicroFAB. A MicroFAB is comprised of an array of Pods which each contain a small machine tool. Pods are mounted on a central wall, called the "Core", which controls and distributes utilities to each Pod. Pods may contain tools such as a 3D printer or a miniature CNC mill/router, all of which typically generate heat during operation. Additionally, Pods require ventilation and filtration of particulates in the circulated air. The team was asked to evaluate the thermal management and filtration needs of the system and to design a compact, cost-effective method to keep each process tool within its operating temperature range. Airflow requirements for individual Pods and the Core were calculated using the physical dimension of each tool, their power requirements, and engineering assumptions based upon a literature review and physical testing. The worst-case scenario for airflow was found by iterating all possible Pod configurations with an optimization program to determine the maximum required volumetric airflow. The design for the thermal management system including the placement of fans, blowers, filters, and air routing was determined for the worst-case scenario. The final design was validated using principles of fluid dynamics while the physical layout was validated using SolidWorks.

MISSION TO 16 PSYCHE: SAMPLING SYSTEM
ME 21.4

SPONSOR: Arizona State University and NASA Psyche Mission
SPONSOR LIAISON: Cassie Bowman, EdD
FACULTY ADVISOR: Mohsen Dadfarnia, PhD
STUDENTS: Cameron Aest, Logan Kamla, Luke Ogoshi, Brandon Vongpitunmanachai

16 Psyche is an asteroid that orbits the sun between Mars and Jupiter. Unlike other asteroids, Psyche is hypothesized to be made of metals like iron and nickel. Scientists have pondered whether Psyche could be the core of an early planet whose outer layers were stripped away by a violent collision billions of years ago. Understanding how Psyche came to be will also help researchers learn more about our own planet's core. To learn more about Psyche, physical samples must be extracted from the asteroid's surface. This project, in collaboration with Arizona State University and NASA's student involvement program, asks teams of students to design a sampling system for a hypothetical future mission. The system must include a method for collecting and for storing samples from Psyche's surface. The Seattle University team developed two sampling solutions that take metal and rock samples from Psyche's surface to be examined back on Earth. The two proposed sampling systems include: The Ultrasonic Assisted Rotary Percussive Hammer Drill which uses a piezo-electric transducer combined with the rotational motion of a traditional power drill, and The Ultrasonic Assisted Abrasion Tool which uses an ultrasonic transducer with an amplification horn, allowing a free-mass abrasion bit to resonate. Both designs were verified with mathematical models that predict power usage, and forces to fracture metal and rock; additionally, finite element analysis was conducted to verify that the designs can withstand extreme environments on Psyche.

VISION SYSTEM FOR SILKSCREEN INSPECTION
ME 21.5

SPONSOR: NIC Global
SPONSOR LIAISONS: Spencer Morse, Ted Wirsching
FACULTY ADVISOR: Greg Mason, PhD, PE
STUDENTS: Matthew Gimpelevich, Linh Ngo, David Schulman, Robert Wheeler

NIC Global is a tier one manufacturer that specializes in sheet metal fabrication and production, as well as global sourcing and product assembly. NIC Global asked the team to design and build a system to inspect lines, text, and symbols that are screen printed on metal parts. The current inspection method relies on the operator performing visual inspection however, operators are unable to reliably detect minute errors in small lettering on the panels, resulting in approximately 5% of parts having defects after passing visual inspection. NIC's goal is to achieve six sigma quality levels for their customers and a less than 0.5% internal reject rate. The team developed an automated inspection system that uses a computer vision to scan the silk screen prints for defects. The inspection system automatically loads satisfactory prints into a curing oven and returns failed parts back to the operator for review and rework. By detecting errors prior to curing, NIC Global can easily rework parts with printing mistakes, thus reducing labor lost in reproducing materials. The inspection system includes a computer vision system, a two-axis gantry that positions the camera over the silk screen panel and a motorized mechanism that transfers good parts to the curing oven. Development entailed construction and programming design of the system frame, design, fabrication, and assembly of the inspection system, as well as programming interactions between the camera, gantry, ejection system, and camera software.

COVID-19 BUILDING VENTILATION ENERGY IMPACTS ME 21.6

SPONSOR: Puget Sound Energy
SPONSOR LIAISON: Austin Doutre, MBA
FACULTY ADVISOR: Claire Strebinger, PhD
**STUDENTS:** Eli Brown-Martin, Alula Kalayu, Hans Ardianto Sutardi, Wei Tang

Puget Sound Energy (PSE) is an energy utility company that serves customers in Washington State. PSE provides incentives to customers that implement energy saving measures to reduce the stress on the energy grid. However, the coronavirus pandemic has changed the way buildings are operated and managed, including changing outdoor air ventilation rates and occupancy. These changes impact the energy consumption of a building and PSE is unsure if the energy savings estimates it provides to customers are still valid. Therefore, PSE wished to assess commercial baseline energy usage changes in relation to the pandemic to better predict the impact of the energy saving measures and inform program development. To do this, they tasked the team to create energy models of selected building types and use these models to assess energy consumption before and during the pandemic. Using the local building codes, standards, existing building drawings and utility data history, the team was able to create and calibrate the energy models for the period before the pandemic with about 95% accuracy in EnergyPlus and OpenStudio by modifying standard models from the Department of Energy (DOE). For the models representing the energy consumption during the pandemic, the team used building operating guidelines from the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), the Center for Disease Control and Prevention (CDC) and the Washington Department of Health. The results from this study were compiled into a report to PSE that includes the resulting year-to-year and month-to-month comparisons in commercial building energy usage before and during the pandemic.

LIGHT RAIL OVERHEAD CATENARY SYSTEM TENSION WEIGHT REPLACEMENT PROGRAM
ME 21.7

SPONSOR: Sound Transit
SPONSOR LIAISON: Craig DeLalla
FACULTY ADVISOR: Eric Gilbertson
STUDENTS: Alison Cordano, Rachel Kastama, Richard Royer, Thanh-Thuy Truong

Sound Transit is a public transit agency in the Seattle metropolitan area. They require testing for a new tensioning system for the overhead wires that deliver power for light rail trains. There are two overhead wires that must be maintained at a constant tension. Currently, tension is maintained using a 3500 lb. counterweight system. Sound Transit plans to replace the counterweight with a spring-tensioning device. This provides a safe alternative with lower maintenance costs. Sound Transit asked the team to identify the specific tensioning device and verify that the device can supply the required tension under different weather conditions. The team developed mathematical models of the spring-tensioning device to evaluate its performance under dynamic loading. Analysis included the spring-tensioning device as a simplified mass-spring-damper system, and a force analysis of the cable during thermal expansion. An installation guide for the spring-tensioning device was created for the proposed pilot site at the SODO Transit Station. This guide will be used to aid in contractor bidding. The team designed a monitoring system using a sensor array measuring the force provided by the spring-tensioning device, rotation angle of the spring-tensioning device, and wire temperature to ensure the spring-tensioning device meets all operational requirements. The system uses a sensor array for measuring the force provided by the spring-tensioning device vs. temperature of the wire, force vs. angle of the wire, and length vs. temperature of the wire.
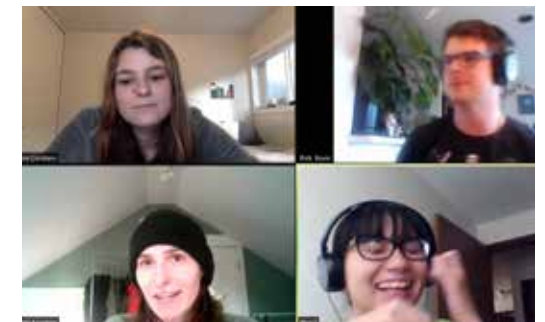
REFINING THE BILIMETRIX WEBSITE TO ADVANCE THE FIGHT AGAINST KERNICTERUS
MSCS 21.1

SPONSOR: Bilimetrix
SPONSOR LIAISON: Richard Wennberg, PhD
FACULTY ADVISOR: Michael Koenig
STUDENTS: Jaewon Jeong, Laura Larson, Kasidit Nusitchaiyakan, Pongpichit Poonpiriyasup

Bilimetrix-USA is developing digital-based products to prevent kernicterus-induced brain damage in jaundiced newborns in low-income countries. The company has partnered with Seattle University's Computer Science department to develop a smartphone app and a "Stop Kernicterus International" website to support this effort. The smartphone application measures plasma bilirubin levels by analyzing a photograph of a test strip invented by Dr. Wennberg. Our involvement in the project was to make significant improvements to the website that accompanies the app. The website aggregates data from the app to allow for further analysis and research about jaundice and kernicterus, but there were issues with the website's performance and usability as it was largely designed for use by developers and not end users. Our specific aim through our involvement was to make improvements to target these issues. We made great progress in both performance improvements, through the addition of pagination features, as well as user experience improvements, where we were able to tailor the website to the different needs of the different types of end users to make it more pleasant and easy to use. Specifically, we achieved this through the addition of features to assist our sponsor with his research, dashboard features which target each separate user group, filtering on aggregate data, and the consolidation of old data through migration to a unified format.

"During this project, our team developed the ability to work towards a common vision and contribute to various aspects of the project."
MSCS 21.2 Puget Sound Energy

ROBOTICS PROCESS AUTOMATION (RPA)
MSCS 21.2

SPONSOR: Puget Sound Energy
SPONSOR LIAISONS: Bryan Amstrup, Eric Tanaka
FACULTY ADVISOR: Michael Koenig
STUDENTS: Edward Lam, Jacob Miller, Harshal Vadnere, Heetae Yang

Puget Sound Energy (PSE) is an energy utility provider that services approximately 1.1 million electric and 840,000 natural gas connections across 6,000 square miles, primarily in Puget Sound region of Western Washington. The Automation Factory Department of PSE is working to automate business processes using Blue Prism Robotics Process Automation (RPA) platform. PSE requested that we automate the Billing reports for the Finance team. It took two members of the Finance team eight hours each month to complete two Billing reports. Business processes required these reports to be completed within the first week of each month. PSE's Finance team spent most of the time on creating the report template in MS Excel. Using Blue Prism platform, the team developed two bots that automated excel operations required for creating the report template. With the help of these bots, the Finance team was able to save four business hours per person each month. The automation reduced input errors and helped ease resourcing bottlenecks created during the busy first week of each month.

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