Welcome

SCOPE Senior Capstone Projects

Amazon Robotics
Arthur G Russell
Boeing
Boston Scientific
CUAHSI
Ford Motor Company
GE Healthcare
Microsoft Corporation
Pfizer
Santos Family Foundation / Volpe Center
Sonos
Toyota Motor North America
Valve Corporation
Watts Water Technologies, Inc.
Welcome to Scope Summit!

Today we gather to celebrate the 64 Olin seniors who are presenting their Senior Capstone Program in Engineering (SCOPE) projects. Before I say anything else, I would be remiss if I didn’t lead off with an acknowledgment that we’re living and operating in a different world today than when these student teams launched into their project work in September of last year. On March 10th, Olin made the announcement that we would move to 100% virtual instruction for the remainder of the year, which dramatically shifted the nature of the work—and in some cases the endpoints—for these SCOPE projects. What ensued was a period of rapid planning for adaptation during what would normally have been Spring Break, and then hitting the ground sprinting to figure out how to learn, adapt, and function in a virtual space for the final 7 weeks of the semester. This was a tall order to say the least.

We were unsurprised that our students rose to the occasion and were wildly successful in creating value for sponsors in such an uncertain and tumultuous time. Olin students are exceptionally driven, curious, and committed people. I am also confident that Olin’s unique curriculum had bearing on their ability to adapt. Seniors will recall (hopefully with fondness) their first semester at Olin, taking courses like Modeling and Simulation of the Physical World, Design Nature, and Products and Markets - all courses where they were told up front that they should expect to arrive at answers that they can put a box around, but that they should expect to teach themselves new skills and content in response to evolving project needs. These themes of open-endedness, self-direction, and a mandate to adapt to real-world problem solving deepen throughout the next three years—all leading to the complex and significantly challenging projects our students tackle in SCOPE. It’s no surprise that they were ready to take the unexpected challenge of a COVID-19 shutdown in stride. Today we’ll all witness the culmination of our students’ Olin experience together. This year in particular, we think that’s worthy of our most heartfelt celebration.
SCOPE would not exist without the 14 sponsors who worked with us to propose projects and then support teams in executing those projects. They brought us projects that varied widely in disciplinary domain, developmental stage, and desired project endpoints. They trusted our students with autonomy to tackle problems that have a real opportunity to create substantial value for the sponsors—and in many cases the world more broadly. I have personally found each of these projects to be fascinating in its own right - whether focused on developing networked, wireless sensing systems or designing and prototyping new tooling and processes to make manufacturing more efficient and better for workers. Thank you to our sponsors for partnering with us in your innovation.

Thanks to all of you for experimenting with us as we attempt the first ever Virtual SCOPE Summit. And thank you so much to the individuals who made these projects possible: again, to the sponsors who enabled the projects, the liaisons who mentored teams throughout the year, the Olin faculty who coached teams toward success, and to the entire SCOPE leadership team. I’m so grateful to work with such thoughtful and brilliant colleagues at Olin and to play even a small role in the innovation that our sponsors and students achieve together through SCOPE.

Thank you, thank you, thank you.

Scott Hersey

SCOPE Leadership and Teaching Team:

Scott Hersey
Director of SCOPE, Assistant Professor of Chemical and Environmental Engineering

Ruth Levine
Director of Business Development

Jessica McCarthy
SCOPE Program Manager

Alessandra Ferzoco
Visiting Assistant Professor of Measurement Science

Alisha Sarang-Sieminski
Associate Dean, Associate Professor of Bioengineering

Lynn Andrea Stein
Professor of Computer & Cognitive Science
SCHEDULE OF EVENTS

1:00–1:15 PM  Welcome from Olin Leadership
1:15–2:15 PM  Snapshot Presentations by SCOPE Teams
2:15–2:30 PM  Break
2:30–2:45 PM  Breakout Session 1
2:45–3:00 PM  Breakout Session 2
3:00–3:15 PM  Breakout Session 3
3:15–3:30 PM  Breakout Session 4
Amazon Robotics is a subsidiary company of Amazon that specializes in manufacturing leading technology for future fulfillment centers. When Amazon orders are placed, a fast, smart, and consistent customer experience is critical. Amazon Robotics is looking to increase the throughput of fulfillment centers by augmenting their existing capabilities with machine learning. The Amazon Robotics SCOPE team researched and developed a software system that explores new possibilities in fulfillment centers.

The team started by creating a development platform that would allow them to efficiently work in parallel and integrate their work. They researched existing machine learning algorithms and used proof-of-concept experiments to demonstrate the usefulness of selected algorithms. Their work led to insights in how to improve the efficiency of a number of stages of a fulfillment center, including how movement through a fulfillment center is organized.
The Arthur G. Russell Company designs and delivers high-volume and ultra-high-volume assembly systems. An integral part of these systems is vibratory parts feeding. Because vibratory parts feeding is governed by chaotic and unpredictable dynamics, experimental testing and validation is necessary to build systems with optimized part feeding efficiency.

The Olin AGR SCOPE team designed and analyzed a vibratory test platform that can be configured to experimentally test multiple vibratory characteristics. They used computer simulations and physical sketch models to explore design possibilities, and explain why existing designs would fail to withstand the forces of the more powerful vibratory platforms needed to increase part feeding rate. The team did mathematical analysis and preliminary experiments on a proof-of-concept platform and actuation scheme to specify the physical parameters needed to drive their prototype. Through analysis and design iteration, they settled on a prototype that balances usability and trade-offs between a number of physical parameters. This tool will help the company’s R&D department test and optimize feeding characteristics quantitatively.
Boeing planes comprise more than half of the entire world’s air fleet, and the growing demand requires faster, more efficient production. In modern airplanes, there are miles of wiring that supply power, run communication, and ensure safe operation and flight in exceptionally harsh conditions. These wire assemblies, which are largely assembled by hand, represent some of the most intricate and difficult operations in the entire manufacturing process. Thus, finding ways to support assembly technicians to increase their efficiency of fabricating these wire bundles is a key area of interest.

Over the past several years, Boeing has been systematically investigating the use of reelettes, small plastic disks that hold cut wires, for storing, sorting, and moving wire around the manufacturing floor. This year’s Boeing SCOPE team was tasked with creating a reelette sorting device. The final product is a design that efficiently sorts stacks of randomly ordered reelettes into the desired order for a given wire bundle. Once implemented on the manufacturing floor, it will be part of overall improvements to the wire bundle production process.
Endoscopy is a medical procedure in which surgical tools are inserted into a patient’s gastrointestinal tract using an endoscope to reach the site of interest. Once positioned, tools are threaded down the endoscope to perform minimally invasive surgeries. Endoscopic retrograde cholangio-pancreatography (ERCP) is a specialized form of endoscopy dealing with procedures in the pancreatic and biliary ducts via the duodenum. Physicians performing ERCP use a specialized endoscope known as a duodenoscope. Current clinical procedures involve reusable endoscopes, which are cleaned to sterilize them between patients. However, cross contamination, which can lead to infection and even death, remains a major concern.

Boston Scientific is a leader in the medical device industry, and currently makes a wide variety of the disposable tools that are inserted down the working channels of endoscopes to perform procedures. Recently, Boston Scientific has made strides towards addressing potential issues of cross contamination by designing a disposable duodenoscope, the ExaltTM Model D Single Use Duodenoscope. Boston Scientific asked the 2019-2020 SCOPE team to help improve future generations of the duodenoscope design by reducing the waste of using a disposable duodenoscope without compromising infection prevention or physician operation. The team developed a modular design with both disposable components and reusable components that can be more effectively cleaned than current devices and provides a simple assembly procedure for medical technicians. The team presented Boston Scientific with a design for a next generation duodenoscope that reduces the waste profile while maintaining function and physical experience.
The Consortium of Universities for the Advancement of Hydrologic Science, Inc. (CUAHSI) develops and maintains an assortment of cloud-based tools for the hydrologic science community. CUAHSI is looking to further empower their users by improving the user experience for CUAHSI Compute, a cloud-based platform for analyzing water data. CUAHSI Compute, a JupyterHub platform, is a web-based environment for executing Python and R code. The team worked to improve CUAHSI Compute’s usability, make the platform more accessible, and streamline its integration with HydroShare, which is CUAHSI’s online repository for sharing hydrologic data and models. They did this by building a React web app that allowed for integration and syncing between files that a user is editing in JupyterHub and files that are saved to their HydroShare account.
Autonomous vehicles (AVs) are cars that can drive themselves using a combination of sensors and software to control steering, acceleration, and braking. The Society of Automotive Engineers has defined 6 different levels of autonomy, ranging from 0 to 5 based on the car’s autonomous capabilities. Level 0 would be a completely manual vehicle such as Ford’s Model T. Most cars we own today are Level 1: the driver controls most aspects of the vehicle, but a specific function (e.g., cruise control) can be done by the car. Level 3 autonomy is conditional autonomy: the vehicle is driving itself until conditions change such that the driver must take control. It is important for the driver to know their responsibility and for the vehicle to validate that the driver is ready to step in.

When a car is in autonomous mode, we believe that there is potential for a range of new experiences and possibilities. Conditional autonomy might, for example, offer a unique opportunity for users to spend their time however they prefer. As we are moving towards an increasingly more autonomous world, it is essential for designers to deeply understand the relationship between driver and vehicle. This understanding will enable them to create AVs that will be impactful, trustworthy, and enjoyable. Ford is already a household name, but as it transitions into a new mobility era, its aspiration is to become not only the world’s most trusted car company but the world’s most trusted company period. Ford believes that freedom of movement drives human progress, and it aspires to design smart vehicles for a smart world.

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Sabrina Tamames
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Faculty Advisor
Alisha Sarang-Sieminski
The Olin SCOPE team worked alongside Ford to reimagine the driving and riding experience in a vehicle with Level 3 capability. To do this, our team conducted research and interviews to deeply understand users and their needs, while trying to help them envision a future they had not yet experienced, and generated numerous insights and scenarios that captured the opportunities for decreasing the “lows” of driving while increasing the “highs” of driving. The work culminated in a number of prototypes and hypotheses that offer Ford a vision of a Level 3 autonomous vehicle designed from the ground up.
GE HEALTHCARE

Adjustable PET/CT Scanner Accessory for Improving Patient Comfort

GE Healthcare provides the global medical community with a wide array of Computed Tomography (CT) and Positron Emission Tomography (PET) devices, which help diagnose and monitor myriad serious illnesses. During PET/CT scans, maintaining patient positioning and comfort is paramount for generating the highest quality scan possible. In particular, it is difficult for patients to maintain a steady arm and head position during cardiac and thoracic scans which can take up to 30 minutes. This is especially challenging for patients with limited mobility. Currently, radiology technicians craft their own improvised set-ups which are not robust enough to accommodate all sizes and abilities of patients. Any movement can corrupt the scan, which takes up unnecessary and costly patient, technician, and facility time. To tackle this challenge, the team designed an adjustable, integrable, and user-friendly armrest to aid technicians and patients during the PET/CT scanning process and set a new industry standard.

Team Members
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Onur Talu

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Technology is growing faster than we have ever seen, but it is not always accessible to people in overlooked communities, such as people who are blind or have low vision. Building on the foundational insights, research, and prototype made by last year’s SCOPE team, the Microsoft team leveraged open data sets and Microsoft Cognitive Services to address some of the challenges these individuals face when navigating in a city. The team designed a new application for and with the blind and visually impaired community, allowing users to explore areas virtually and get information relevant to them, before visiting in person.
Pfizer’s patient-first culture drives their mission of delivering reliable, life-changing medicines to patients and their families all over the world. In many cases they manufacture and store the world’s supply of innovative life changing research medications. Product losses stemming from adverse environmental exposure, or any other disruption, can impair Pfizer’s ability to extend clinical trials to those patients where no other treatment options may exist.

An interdisciplinary Olin SCOPE team worked to support the quality of Pfizer’s drugs by developing a wireless system of devices and interfaces to monitor environmental conditions in the supply chain. Their work involved making a benchtop analog of Pfizer storage sites to test and calibrate sensors; design custom hardware, firmware, software, and mechanical infrastructure to wirelessly network environmental sensors; and design of a data path and user interface for Pfizer to be able to manage and take action based on information coming from the sensors. Their work has resulted in a proof-of-concept package that proves a pathway for improving the reliability of Pfizer’s supply chain.

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This project has studied the vehicle crash reporting ecosystem, from its stakeholders to its pain points. From this, we’ve found that the ecosystem struggles with data standardization and data relevance, which is best addressed through improvements of the data collection process. To this end, our team has designed and assembled a mobile toolkit for reporting officers, in the form of a mobile application. This novel solution will automate and standardize data collection, enhance officers’ experience, increase data relevance, and improve overall road safety.

The Volpe National Transportation Systems Center improves transportation by anticipating and addressing emerging issues and advancing technical, operational, and institutional innovations across all modes. The Santos Foundation is a non-profit organization dedicated to improving transportation safety.
Sonos is reinventing home audio for today and tomorrow through its variety of home audio systems. As part of the manufacturing process, a large suite of tests is performed on each device in order to ensure the highest product quality. Audio files are generated at multiple testing steps for each device, leading to potential inefficiencies through redundancy. Further, some tests require a human to listen to audio test files in an enclosed audio booth to detect any suboptimal audio performance, leading to worker fatigue. This year, the Sonos SCOPE team employed tools from data science and machine learning to explore data from the speaker testing process, with the goal of providing insights into optimizing testing to increase manufacturing efficiency and reduce the burden on human speaker testers.

SONOS
Sonos Product Manufacturing Test Optimization

Team Members
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Scott Hersey
Currently, 1 in 5 persons in the United States are living with a disability, and in the coming decades, populations of persons with ambulatory disabilities are likely to continue to increase. Toyota Motor North America seeks to make a difference in the mobility space by working with users for a people-first approach.

Throughout the year, the Olin SCOPE team worked to improve the mobility experience for people with ambulatory disabilities. By leaning on insights and technical developments from last year’s SCOPE team, this year’s team folded together elements from the fields of user interface design, sensing and control, and mechanical design. More importantly, by working closely with power wheelchair users all design decisions were able to be made with the user in the forefront, and the result is a comprehensive design for expanding the perception capabilities of power wheelchair operators.
VALVE CORPORATION

Video Game Playtesting with Physiological Data Acquisition

During video game playtests, feedback is collected via manual observations by playtest managers and retrospective evaluations from the playtesters. While this information is invaluable for game designers to optimize gameplay experiences, humans often cannot observe internal states and subtle emotional and physiological responses in real-time. This project validated the viability of using facial electromyography (fEMG) and subsequent data analysis methods to flag notable events during gameplay. The team delivered a system consisting of a well-documented experimental setup, an algorithm for feature extraction and statistical analysis, and a comprehensive report of findings with fEMG and other sensors investigated. This system will augment, rather than replace, the current playtesting system employed by Valve.

Team Members
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Faculty Advisor
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Legionnaires’ disease is a severe and often lethal form of pneumonia that is particularly prevalent in hospitals, hotels and other facilities. The disease is caused by legionella, an opportunistic waterborne pathogen that finds its ideal habitat in warm and humid environments. Because legionella thrives at elevated temperatures and is resistant to most common biocides, it frequently colonizes in hot water plumbing systems. Legionella can be effectively managed by ensuring that the water temperature stays within a tightly controlled range. Unfortunately this can be difficult to achieve in practice, since many plumbing systems contain sections of pipe where water cannot circulate - known as dead legs. These dead legs are usually created unintentionally when buildings are expanded or renovated. Once in place, dead legs are not easily identified and can become prime breeding ground for legionella. This project focused on developing a scalable prototype for a networked sensor system aimed at monitoring water temperature in plumbing systems in order to identify high-risk areas for legionella growth. This enables building managers to make data informed decisions about how to best mitigate the risk of legionella contaminating the plumbing system.

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