

# Projects Day 2023

**Celebrating 60 Years of Solving Real-world  
Problems in the Clinic Program, 1963–2023**

The logo for Harvey Mudd College, featuring the text "HARVEY MUDD COLLEGE" in a bold, sans-serif font. The text is white on a black rectangular background, which is itself set within a white rounded-corner box in the bottom right corner of the poster.

**HARVEY  
MUDD  
COLLEGE**

## **College Mission Statement**

Harvey Mudd College seeks to educate engineers, scientists, and mathematicians well versed in all of these areas and in the humanities, social sciences and the arts so that they may assume leadership in their fields with a clear understanding of the impact of their work on society.

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## 2022–2023 Clinic by the Numbers



41

PROJECTS



40

SPONSORS



243

STUDENTS

## Acknowledgements

The College acknowledges the alumni and parents who assist in the recruitment, formulation and implementation of Clinic projects each year. Also, many thanks to all Harvey Mudd College faculty and staff involved in the administration of the program, which touches more than a quarter of our student population.

The Harvey Mudd College Computer Science, Engineering, Mathematics and Physics Clinic faculty are pleased to present the work of their students.

Katherine Breeden  
Capstone Program Director—Computer Science

Zach Dodds  
Clinic Relations Director—Computer Science

Steven Santana '06  
Clinic Director—Engineering

Talithia Williams  
Clinic Director—Mathematics

Peter Saeta  
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The Global Clinic Program is supported by an endowment bequeathed by Robert and Joan Vickery, parents of John Vickery '91. Global Clinic prepares students for the future challenges of practicing engineering, science and mathematics in a global context.

# **Annual Harvey Mudd College Projects Day Program**

May 2, 2023

<b>9 a.m.</b>	Registration and Breakfast
<b>9:45–10:55 a.m.</b>	Session 1 Project Presentations
<b>11:15 a.m.–12:25 p.m.</b>	Session 2 Project Presentations
<b>12:30–1:30 p.m.</b>	Clinic Team Luncheon Welcome – Maria Klawe, president Milestone Awards – Tom Donnelly, R. Michael Shanahan Dean of the Faculty Remarks – Talithia Williams
<b>1:45–2:55 p.m.</b>	Session 3 Project Presentations
<b>3–3:45 p.m.</b>	Poster Session 1
<b>3:45–4:30 p.m.</b>	Poster Session 2

# Projects Day 2023

## Presentation Schedule

### **Session 1** 9:45–10:55 a.m.

<b>Shanahan Auditorium</b>	Lawrence Livermore National Lab IMC Trading Proofpoint
<b>Shan B480 (Recital Hall)</b>	Quantcast FedEx: Autonomous Vehicle Deliverability Toyota
<b>Shan B460</b>	NASA/JPL Sandia National Laboratories MIT Lincoln Laboratory
<b>Galileo-Pryne</b>	Doosan Bobcat Cai Lab Caltech Microsoft
<b>Galileo-Edwards</b>	Boston College Tesla eBay

### **Session 2** 11:15 a.m.–12:25 p.m.

<b>Shanahan Auditorium</b>	Georg Fischer Signet Silvus Technologies Tradeweb
<b>Shan B480 (Recital Hall)</b>	Center for Strategic and International Studies ClareNom Parker Meggitt Engine Systems
<b>Shan B460</b>	Nininger Medical Inc. FedEx: Economic Insights Harvard Center for Computational Biomedicine
<b>Galileo-Pryne</b>	Project Pyramid Juniper Networks N Consulting Engineers
<b>Galileo-Edwards</b>	Project Metal Inspection Aprovecho Research Center DIRECTV

### **Session 3** 1:45–2:55 p.m.

<b>Shanahan Auditorium</b>	Crowdstrike HRL Laboratories Shopify
<b>Shan B480 (Recital Hall)</b>	Clean Power Research Memorial Sloan Kettering Cancer Center UNITE HERE
<b>Shan B460</b>	Amazon Lab126 WePackItAll
<b>Galileo-McAlister</b>	City of Hope Nordstrom Casa Herrera

# Personalized Projects Day Schedule

Please fill in the empty slots below with the presentations you would like to attend.

Time	Event	Location
9 a.m.	Registration and Breakfast	Thomas-Garrett Plaza
9:45–10:55 a.m.	Session 1	
11:15 a.m.–12:25 p.m.	Session 2	
12:30–1:30 p.m.	Clinic Team and Liaison Lunch	Liquidambar Mall Tent
1:45–2:55 p.m.	Session 3	
3–3:45 p.m.	Poster Session 1	Strauss Plaza
3:45–4:30 p.m.	Poster Session 2	Strauss Plaza



## Milestone Awards

The College celebrates returning Clinic sponsors with the Milestone Award for every five projects.

**35 projects**



**Sandia  
National  
Laboratories**

**10 projects**

**proofpoint®**

**Five projects**

**JUNIPER**  
NETWORKS



**Tradeweb**

# 2022-2023 Clinic Program Sponsors



MEGGITT



Memorial Sloan Kettering  
Cancer Center



Microsoft



LINCOLN LABORATORY  
MASSACHUSETTS INSTITUTE OF TECHNOLOGY



NORDSTROM



Project  
Pyramid

proofpoint.

Quantcast



Sandia  
National  
Laboratories



shopify

SILVUS  
TECHNOLOGIES

T E S L A



TOYOTA



Tradeweb

UNITE  
HERE!



WePackItAll.

# Computer Science Clinic

## Caltech Cai Lab

### *Visualizing Spatial Genomics for Biology and Translational Medicine*

Liaisons: Jonathan White, Henry Amrhein

Advisor: Katherine Breeden

Students: Toby Frank (PM-S), Cade Kritsch (PM-F), Trenton Wesley, Xoaquin Baca, Kamarion Porter

Caltech's Cai Lab is pioneering the field of spatial genomics, which uses novel probe-based assays to obtain high-resolution, location-specific gene expression data within tissue samples. However, these data are multidimensional and difficult to visualize. We improved upon the 2021–2022 Clinic team's efforts to develop an efficient data storage, access and visualization pipeline for the lab's spatial genomic data. In particular, we have prioritized efficient data storage and access and worked with Cai Lab scientists to build interactive visualization tools to drive scientific discovery.

## ClareNom

### *Personalized 5C Dining Web App*

Liaison: Geoff Kuenning

Advisor: Geoff Kuenning

Students: Adam Beckwith (PM-F), Noah Nevens (PM-S), Phoebe Chen, Danica Du, Olivia Owen, Harry Weale

Choosing a 5C dining hall is complex due to varying menus and personal needs. Existing resources can be hard to use in practice. We are building an application that will consider food preferences and restrictions, proximity to various halls and probable line lengths in order to suggest where to get your next meal.

## Clean Power Research

### *Generalized, Deployable, Insolation Forecasts*

Liaisons: Thomas Haley POM '02, Alex Kubinieć

Advisor: Julie Medero

Students: Kendah Abughararh, Max Hui (PM-S), Malia Morgan (PM-F), Hallie Seay

Solar utilities rely on accurate sunlight forecasts to determine how much power they will produce on a given day. Clean Power Research provides these forecasts, but existing methods take too much time and computation to forecast for a given location immediately. To explore machine learning solutions, our Clinic team constructed a pipeline to retrieve and transform data, train predictive models and evaluate their performance. We used this to investigate new data sources and the viability of two different machine learning approaches.

## **CrowdStrike**

### *Designing Algorithms and Infrastructure for Improved Kubernetes Autoscaling*

Liaisons: Luke Hunter '03, Julius Lauw '20, Thomas Fleming '22,  
Jonathan Fuentes

Advisor: Lucas Bang

Students: Rex Asabor, Andrea Chen (PM-S), Miles Christensen, Annika Khare,  
Celine Wang (PM-F)

CrowdStrike is a cybersecurity company that provides cloud-native endpoint protection. They process trillions of messages every week in order to detect malicious behavior and would like to automatically scale their server resources in response to the volume of messages they receive. To do so, the CrowdStrike Clinic team has worked on developing a robust testing framework and improving the existing autoscaling algorithms to best serve CrowdStrike and their customers' needs.

## **DIRECTV**

### *Automatic Video Scene Extraction and Annotation Tool for Customer Experience Enhancement*

Liaisons: Peshala Pahalawatta, Rudy Lowenstein

Advisor: Calden Wloka

Students: Marcos Acosta, Aldrin Feliciano, Isabel MacGinnitie, Ruth Mekonnen,  
Alina Saratova, Daniela Sechen (PM-S)

DIRECTV offers streaming and satellite TV services that curate content for its viewers. DIRECTV aims to automate generation of personalized football highlight reels, so fans who miss a game should be able to keep up-to-date with their favorite teams and players in real time without the need for manually curated content. To achieve this, the Clinic team created a dataset, which pairs a full-length game with highlight scenes, and applied machine learning models to label football plays as either highlight or non-highlight.

## **eBay**

### *Clustering, Analysis and Prediction on eBay M2M Messaging*

Liaisons: Rahul Agarwal, Kishore Paul, Raphael Tsow

Advisor: Melissa O'Neill

Students: Amy Tam (PM), Wyatt Chang, David Garcia, Cynthia Hom, Andy Liu,  
Amani Maina-Kilaas

The eBay Clinic team is training model(s) on member-to-member (M2M) messaging data, which makes up a majority of users' interactions, for sentiment analysis and topic modeling to improve existing eBay models and identify new opportunities. By leveraging machine learning and natural language processing techniques on eBay's M2M data, eBay can better understand user behavior in order to better facilitate the sale of goods and services between buyers and sellers globally. eBay is a leading online marketplace for consumers worldwide.

## **FedEx**

### ***Identifying Economic Insights in FedEx's Shipping Data***

Liaisons: Sam Shojaei, Bryan Bunker, Clayton Clouse

Advisor: Zachary Dodds

Students: Justin Jiang (PM), Hannah Kyme, Henry Pick, Jessica Chavez, Nick Grisanti

Because of its broad reach with businesses and individuals, FedEx has long been considered a leading economic indicator. Our team has developed a correlation-based predictive model using FedEx's logistics data. We first identified a set of signals that hold predictive power with respect to economic target variables. We then combined those features into a single "FedEx Index," akin to the Dow Jones and S&P 500 indices, providing insight about the state and trends of the overall economy.

## **Harvard Center for Computational Biomedicine**

### ***Leveraging Relational Databases for Spatial Transcriptomics***

Liaisons: Ludwig Geistlinger, Robert Gentleman, Rafael Goncalves, Tyrone Lee, Nathan Palmer, Sunil Poudel; Sam Pullman

Advisor: Christopher A. Stone

Students: Chris Couto (PM-F), Alicia Lu, Elizabeth Lucas-Foley (PM-S), Mads Mansfield

Harvard's Center for Computational Biomedicine supports experimental labs to analyze their data computationally. This project focuses on high-resolution microscopy data, particularly images of tissue. Spatial omics aim to identify single molecules within microscopic images. These large datasets are challenging to analyze using R or Python alone. Modern relational databases directly support spatial data types and are designed for working with large data. This project explores whether database queries are a more scalable alternative for processing and analysis of cellular maps.

## **Juniper Networks**

### ***Assessing Health and Trust in the Border Gateway Protocol***

Liaison: Ron Bonica

Advisor: Arthi Padmanabhan

Students: Aoi Yasuda (PM-F), Olivia Russell (PM-S), Ian de Marcellus, Jennifer Li, Nestor Coria

The Border Gateway Protocol (BGP) is a crucial component of the internet routing process, and its security is essential to the integrity of the internet. An industry leader in computer networking, Juniper Networks is very invested in ensuring the trust in and health of the internet. Our team aims to investigate the weaknesses of BGP and the barriers that have prevented the widespread adoption of the security measure BGP-sec, like computational cost and lack of peer adoption.

## **Memorial Sloan Kettering Cancer Center**

### *Querying Latent Structure in Single-cell RNA-seq Data*

Liaison: Dr. Roshan Sharma

Advisors: Dr. Naim Matasci, Jim Boerkoel

Students: Sonia Bliss, Austin Froelich, Kate Phillips (PM-F), Brian Simpkins (PM-S)

Memorial Sloan Kettering Cancer Center (MSKCC) is a private cancer research and treatment facility located in New York City. Within MSKCC, the Dana Pe'er lab has developed a novel single-cell analysis tool called SPECTRA for identifying meaningful biological factors in a single-cell RNA-seq data. This project, in collaboration with the SAIL (Single-Cell Analytics Innovation Lab) at MSKCC (directed by Dana Pe'er), intends to create a graphical user interface (GUI) for SPECTRA, modify the source code to support GPU computation, and explore potential integration with other single-cell analytics tools.

## **N Consulting Engineers**

### *Improving NCE's Internal Task Management System*

Liaisons: Ross Anderson, Dmitry Chechuy, Steve Lew, Kyle Matthes

Advisor: Mark Kampe

Students: Valentina Vallalta (PM-F), Kobe Lin (PM-S), Arisa Cowe, Jose Liera, Christian Valdovinos

N Consulting Engineers is a company that supports civil engineering projects by managing and supervising complex, large technical projects and handling permissions and compliance forms. Thus, they created a custom task management and timekeeping tool, TimeSheets, to provide the level of detail and specificity required for their clients. However, many employees have a negative experience using TimeSheets. Our Clinic project focused on improving the user experience of TimeSheets by adding new functionality and improving upon the existing ones.

## **Nordstrom**

### *Measuring Query Relevance of Visual Attributes in Fashion Search*

Liaisons: Shawn Rutledge, Adam Cappio, Yvonne Rankin

Advisor: Xanda Schofield '13

Students: Michelle Lum (PM-F), April Zhao (PM-S), Saatvik Sejpal, Waverly Wang, Lauren West

Nordstrom is an American department store chain whose search engine is a key venue for product discovery. Nordstrom seeks to move beyond user clicks to evaluate the relevance of its search results compared to those of its competitors. This year, the team has developed an automated end-to-end system to pull search queries from an AWS database, execute them on retailers' websites and generate relevance scores with respect to color and aesthetics.

## **Proofpoint Inc.**

### ***Developing Tools for Testing Adversarial Attacks Against Natural Language Classifiers***

Liaisons: Cameron Malloy, Adam Starr POM '18, Dana Harris CMC '22

Advisor: Blake Jackson

Students: David Pitt (PM-S), Katie Johnson (PM-F), James Lucassen, Nanako Noda, Ingrid Wu

Proofpoint uses natural language processing systems to classify and filter out malicious or fraudulent emails. The Proofpoint Clinic team is improving existing tools to test the ways in which malicious content can evade Proofpoint's models while remaining human-readable. The team is also researching attacks that switch between multiple languages to confuse language models and defenses against these attacks.

## **Quantcast**

### ***Creating a Layer 6 Load Balancer***

Liaisons: Scott McCoy, Theo Bayard de Volo PZ '22

Advisor: Mark Kampe

Students: Anshul Kamath (PM), Jacinda Chen, Evan Coulson, Jean Pierre Nizeyumukiza, Max Szostak

Quantcast uses load balancers to distribute the load among its clusters of real-time bidding services, a system that receives millions of requests per second during normal operations. Due to the volume of this workload, they have experienced bottlenecks when using traditional load-balancing solutions. They have asked our Clinic team to develop a novel solution for distributing this load, optimized for their particular case.

## **Shopify Inc.**

### ***Next-generation Retail Experiences for Bridging In-person and Online Commerce***

Liaisons: Kathi Taylor, Joe Doyle, Chris Landry, Angela Chen CMC '21, Frank Liu '14

Advisor: George Montañez

Students: Olina Wong (PM-S), Alekz Grijalva-Moreno (PM-F), Roman Herrera, Angie Gagnon, Lucas Ewing, Henry Sojico

Shopify's primary product is an e-commerce platform for online stores and retail point-of-sale systems. In order to adapt to the recent increase in desire for in-person shopping experiences, the team explored various ideas for a next-generation retail experience that can bridge in-person and online shopping. The team focused on researching many concepts but honed in on building an application that facilitates in-store try-ons of items curated online, with the ability to be extended to in-store kiosks.



## **Tradeweb**

### ***Sweep Matching Engine Algorithm Development***

Liaisons: Dr. Justin Peterson '85, Jeremy Jess PZ '20

Advisor: Jim Boerkoel

Students: Anirudh Satish (PM), Rhea Zaverchand, Thaxter Shaw, Aditya Bhargava, Alina Hu

Sweep is a Tradeweb platform that facilitates dealer-to-dealer trade in the wholesale, fixed-income market place. Our project's goal is to more deeply understand the current matching engine and design new algorithms to make optimizations to improve matching results. Particularly, we are focusing on individual trader happiness, while still aiming to maximize the volume of trade.

## **UNITE HERE**

### ***Data-Organizing for Labor Action***

Liaisons: John Lessandrini, Jen Kim, Doug Reich '07

Advisor: Erin Talvitie

Students: Zoe Tokheim (PM), Megan Maley, Cooper Nissenbaum, Vera Reséndez, Nathan Roche

UNITE HERE is a labor union representing 300,000 workers across the United States and Canada. Although the union has extensive experience in labor organizing, it recognizes the potential for improved data infrastructure to strengthen the decision-making processes of labor campaigns. The team aims to expand UNITE HERE's data-organizing capabilities through the development of a centralized, accessible data visualization tool that will allow a wide range of users to make data-informed decisions.

## **Engineering Clinic**

### **Amazon Lab126**

#### ***Ultrasonic Head-Pose Estimation***

Liaisons: Trausti Kristjansson, Patrick Hegarty, Krishna Kamath

Advisor: Philip Cha

Students: Alec Vercruysse (TL-F), Jeremy Bakken (TL-S), Declan O'Neill, Cole Nagata, Kevin Wan, Tristan Huang, Eli Rejto

Many traditional head-tracking methods require a clean visual environment or a physical IMU device, which can limit commercial head tracking applications. The Amazon Lab126 Clinic team is working to solve the head-tracking problem with ultrasonic sensing. We have developed a platform where ultrasound is emitted from a device, reflected off surfaces and received by on-board microphones. The signals are then input into an ML model that can predict the position and rotation angle of the head.

## Aprovecho Research Center

*Advancing the Design of Aprovecho's Clean Cooking Accessory, the Jet-Flame*

Liaisons: David Evitt, Chenkai Wang

Advisor: Leah Mendelson

Students: Melissa Bruno (TL), Bryn Schoen, Ashley Cheung, Liza Gull, Heather Fuentes, Eli Schwarz, Gabriel Zwilling, Felix Murphy



Aprovecho Research Center is a nonprofit organization working toward clean biomass cooking and heating solutions around the world. Their Jet-Flame stove accessory for wood-burning cook stoves improves fuel efficiency and reduces harmful emissions by injecting jets of air from under the fire to enhance combustion. The HMC Aprovecho Clinic team has been tasked with improving the durability, modularity, ease of maintenance and cost efficiency of the current Jet-Flame design through a series of prototypes, testing and performance analysis.

## Casa Herrera

*Eliminating Downtime on Corn Dough Sheeters*

Liaison: Michael Herrera

Advisor: Okitsugu Furuya

Students: Dan Tan (TL-S), Cristian Gonzalez (TL-F), Katheryn Wang, Brayden Hedrick, Aidan Nettekoven, Andres Sanchez, Saachi Patel, Simon Woodside

Casa Herrera is an industry-leading designer and manufacturer of custom flatbread production machinery, with a global client base within the food industry. The Casa Herrera Clinic Team has been engaged to design, build and test a novel solution to eliminate the primary source of downtime on one of the company's major products—the corn dough sheeter. The project's final deliverable is a proof-of-concept, physical prototype that demonstrates desired functionality without the need for commercial viability.

## City of Hope

*A "Smart" Chemotherapy Port*

Liaisons: Dr. Virginia Sun, Dr. Aaron Lewis, Dr. Jonathan Yamzon

Advisor: Steven Santana '06

Students: Kaanthi Pandhigunta (TL-S), Luke Rodley (TL-F), Kai Dettman, Noah Limpert, Sydney Riley, Xander Fries, Julia Du, Claudia Nanez

It is well-documented that a cancer patient's post-surgery activity level highly correlates with their surgical outcomes. Medical professionals at City of Hope currently monitor patient activity with activity-monitoring watches, but patient compliance with them is low, which interrupts the continuous data collection needed to assess the patient's recovery. To circumvent this problem, the HMC City of Hope Clinic team aims to prototype an implantable remote patient monitoring device that monitors patient activity and augments the patient's implanted chemotherapy port.



Global Clinic



Social Justice Clinic

## **Doosan Bobcat**

### ***Autonomous Mower Path Planning***

Liaisons: Mike Schmidt, Dylan Stokosa

Advisor: Victor Shia

Students: Kevin Kong (TL-S), Sean Wu (TL-F), Zoe Kedzierski, Amber Hughes, Anthony Kang, Holly Chen, Jeremy Kim

The team equipped a Bobcat zero-turn mower with mapping and obstacle avoidance. This project implemented full-coverage path planning and area mapping while utilizing some of the previous Bobcat Clinic team's mapping algorithms. The team developed algorithms to partition a defined area and optimize the mower's route to mow the area in a clean back-and-forth striped pattern.

## **Georg Fischer Signet**

### ***Prediction of pH Probe Failure***

Liaisons: Chuck Gerner, Betty Lessmueller, Colter Downing '19, Calin Ciobanu, Leila Wiberg '22, Jose Salcedo, Iuliana Sendroiu

Advisor: Daniel Contreras

Students: Aaron Murdock (TL-F), Yoselin Prado (TL-S), Kaya Lane, Penny Hernandez, Henry Lee, Brittany Pan, Itzel Hernandez

Georg Fischer Signet manufactures pH testing devices, and has asked the Clinic team to study and model the decay of glass pH electrodes to predict device failure to provide more value to the customers who use these devices. These electrodes are tested in extreme pH and temperatures to capture a range of device failures. The final deliverable is an algorithm that predicts the failure of GF Signet's devices and gives customers a timeline indicating when to replace their products.

## **HRL Laboratories**

### ***Improving Quantum Computing Devices with Ferroelectrics***

Liaison: Paul Jerger '15

Advisor: Peter Saeta

Students: Sidney Chenevert (TL), Ruby Foxall, Gracey Heibert, Mason Wray

HRL Laboratories is developing a quantum computing platform that uses electrons trapped in a thin silicon layer to form qubits. To trap individual electrons in potential wells, voltages are applied to gate electrodes on the surface of the structure and manipulated by appropriate pulses applied to the electrodes. These potential wells are susceptible to noise from outside voltage sources. To address this issue, we developed a COMSOL model to assess whether a ferroelectric material could reduce the voltage needed to trap and manipulate the electrons.

## **MIT Lincoln Laboratory**

### ***Finding Radio Transmissions with Drones***

Liaisons: Joey Botero, Alexia Schulz, Sage Trudeau, Richard Gentile, Kent Lundberg  
Advisor: Matthew Spencer (S), David Harris (F)  
Students: Ava Fascetti (TL-S), Kip Macsai-Goren (TL-F), Melis Baltan-Brunet, Miles Cook, Martin Susanto, Diego Herrera Vicioso

The MIT Lincoln Laboratory Clinic team is designing, building and testing a drone carrying a software-defined radio to detect and characterize radio-frequency signals that would otherwise be undetectable from the ground. The end goal is a flight test in which a drone autonomously determines the position of one or more radio transmitters on the ground. This work builds on a Clinic project from last year, extending work on hardware and algorithm selection.

## **NASA/JPL**

### ***Planetary Protection Biological Safety Assurance Case for Mars Sample Return (MSR)***

Liaisons: Dr. Todd Paulos '90, Brian Clement, Lisa Guan  
Advisor: Ziyad Durón '81  
Students: Alexander Schlegel (TL-S), Julianne Ho (TL-F), Nick Zemtzov, Kylee Graper, Devon Overbey, Javier Perez, Leah McGregor, Johnny Yang

The Mars Sample Return Mission will mark the first time in history that humanity brings back material from a celestial body theoretically capable of nurturing life. It is important to JPL and NASA that they and the public have a clear idea of the potential risks associated with returning Mars material. To that end, this Clinic team has built a "safety case" that diagnoses the severity of a range of possible threats to Earth from the returned samples.

## **Nininger Medical Inc.**

### ***Delivery System for Transcatheter Heart Valve Replacement***

Liaisons: Daniel Anderson '99, Andrew Schombs, Dr. Lowie Van Assche  
Advisor: Angela Lee '05  
Students: George Wang (TL-F), Isabel West (TL-S), Sydney Cornell, Arya Mididaddi, Elijah Adamson

The Nininger Medical Clinic team is developing a transcatheter tricuspid valve replacement (TTVR) device for pre-clinical studies. As a grant-funded start-up, Nininger Medical Inc. is designing a delivery system to remedy tricuspid heart valve disease. This semester, the team has constructed and integrated the new mechanical stops, valve insertion mechanism and catheter-to-valve frame connection that were designed during the fall semester. The team has used various 3D printing technologies as well as the HMC shop facilities to prototype these designs and conduct strength and durability tests.

## **Parker Meggitt Engine Systems**

### ***Carbon Material Replacement***

Liaisons: Mark Abrams, Roupin Arabian

Advisor: Mark Gale

Students: Arpita Bhutani (TL), Lilliy Johnson, Jonty Solomon, Will Hegstrom,  
Cheyenne Foo, Raja Batra, Clay Rasmussen

Parker Meggitt, a leader in global aerospace, aims to create more efficient airframe and engine technologies. A key company objective is to extend the lifetime and operating temperature of their inner engine components, which contributes to reduced fuel burn. Currently, a carbon-based mechanical seal is used in their engine valves, tolerating temperatures from -65°F to over 800°F. However, harsher conditions can significantly reduce their lifespan. After rigorous experimentation and analysis, the Parker Meggitt Clinic team recommends an alternative material for further investigation.

## **Project Metal Inspection**

### ***Identification and Classification of Defects in Aluminum Strips***

Liaisons: Jeff Foutch, Andrew Donelick '15

Advisor: Nancy Lape

Students: Nick Casañas (TL-S), Sidney Taylor (TL-F), Olivia Tuffli, Viviane Solomon,  
Madeleine Masser-Frye, Brandon Bonifacio, Carlos Sanchez

One of the leading aluminum manufacturers in the nation has requested that the Clinic team develop a system to identify any potential defects on the surface of aluminum coils. The team designed an image-collection system to collect images of the product as it passes through the manufacturing line. With those images, the goal of the project is to develop a machine learning computer vision system that can detect and flag potential defects in real-time during the manufacturing process.

## **Project Pyramid**

### ***Recommended Improvements to an Isothermal Calibration Station***

Liaison: N/A

Advisor: Erik Spjut

Students: Jenny Wathanakulchat (TL-S), Jonathan Lo, Cindy Wang (TL-F), Allison Tsai,  
Cecilia Li, Ayman Abdellatif, Rafael Burger, Zoë Gomez-So

The Project Pyramid Clinic team aims to optimize an isothermal calibration procedure for precise temperature-sensing electronic devices. The project investigates a fluidized bed to replace the current water bath to minimize hazards in the testing environment and improve the throughput of the calibration process. The final deliverable will be a fluidized-bed prototype, an evaluation of its performance and a method of integrating the bed in an operation line.

## **Sandia National Laboratories**

### ***A Computational Investigation of Barium Titanate's Surface Properties***

Liaison: Todd Monson

Advisor: Whitney Fowler

Students: Jessica Marvin (TL-S), Cedar Turek (TL-F), Erina Iwasa, James Nicholson, Nilay Pangrekar

Sandia National Laboratories is researching barium titanate (BTO), a ceramic material with many applications in electronics due to its ferroelectric properties. The Clinic team will use density functional theory to perform a computational study on BTO and its interaction with ligands, such as hydrogen, water and tert-butylphosphonic acid. The objectives are to explore the interactions specifically on the titanium dioxide-terminated surface of BTO and to explain their effect on the ferroelectric properties of the material as a whole.

## **Silvus Technologies**

### ***Radio Frequency Source Localization***

Liaisons: Eric Contee II '19, Dr. Matthew Hayes, Ivan Aguilar

Advisor: Josh Brake

Students: Liam Chalk (TL-S), Arya Goutam, Joe Zales (TL-F), Alec Candidato, James Clinton, Zeneve Jacotin, Alexa Wright

The Silvus Technologies Clinic project aims to pinpoint the location of a radio frequency signal. The final deliverable is a Python neural network that uses data collected from Silvus radios to locate the source in environments with varied terrain. The neural network is designed using simulated data and validated using real experimental data.

## **Tesla**

### ***Manufacturing Repair Diagnostic Tool***

Liaisons: Nate Smith '19, Rob Dunn

Advisor: Gordon G. Krauss

Students: Diana Contreras (TL-F), Alessandro Maiuolo (TL-S), Amy Qian, Bela Quintas, Tjaard Van Loben Sels, James Barrett, Nic Lucio, Steven Huang

Tesla is a global leader in the manufacturing of electric vehicles with a vision for a more sustainable future. During assembly, tests are run on the vehicle to ensure all components are functioning correctly. When tests fail, technicians must identify and resolve issues. The Tesla Clinic team will develop a diagnostic tool that incorporates previous repair data to assess test failures and reduce repair costs.

## Toyota

### *Fuel Cell Powered “Bottomless” Uninterruptible Power Supply*

Liaisons: Daniel Folick, Justin Ward

Advisor: Okitsugu Furuya

Students: Manuel Mendoza (TL-S), JT Griffin (TL-F), Cora Payne, Clay Briggs, Allison Marten, Lawrence Nelson, Sarah Covey, Peyton TenEyck

During grid outages, data centers receive backup power from diesel generators, which are polluting and increasingly difficult to permit. This multiyear project aims to integrate a Toyota Mirai hydrogen fuel cell into an existing uninterruptible power supply (UPS) and test the system under various operating conditions. Currently, the Clinic team is designing and installing an initial test setup to draw power from the fuel cell.

## WePackItAll

### *Automation of Gummy Supplement Sachet Filling*

Liaisons: Greg Pagani '20, Natan Bershtel '01, Vanessa Jimenez, Patrick Green

Advisor: Lori Bassman

Students: Elena Anderson (TL-S), Meredith Bloss (TL-F), Izzy Jackson, Annie Elliott, Jordan Stone, Kevin Box, Ruth Mueller

The WePackItAll Clinic team has designed a system to fill sachet packages with small counts of one to 10 gummy supplements. Due to the stickiness of gummies and high-accuracy needs, sachet filling is currently done by hand, which introduces inconsistencies, tedious work and potential safety hazards. The team has designed and built a system that interfaces with a horizontal form fill seal machine to fill gummies into sachets. The final product is an automated prototype that singulates, counts, groups and accurately dispenses gummies into sachets.

## Engineering/Mathematics Clinic

### Center for Strategic and International Studies

#### *Modeling Green Hydrogen Production and Trade*

Liaisons: Dr. Joseph Majkut '06, Dr. Douglas Arent '82

Advisor: Jon Jacobsen

Students: Raj Sawhney (PM), Ross Hibbett, Khaya Kingston, Makenna Parkinson, John Hearn



If green hydrogen, hydrogen produced via electrolysis of water using renewable energy, were to be widely available and cheap to produce, it could be key to decarbonizing industrial production and other end uses. Countries around the world are making investments to become green hydrogen producers and exporters. We aim to develop a production model that incorporates relevant energy, electrolysis and hydrogen resource and technology costs to allow us to estimate the levelized cost of hydrogen and the feasibility of hydrogen trade between geographically separated nations.



Social Justice Clinic

# Mathematics Clinic

## Boston College

*Advancing Methods in Infectious Disease Models: Incorporating Structural Causes*



Liaison: Dr. Nadia Abuelezam '09

Advisor: Lisette de Pillis

Students: Anna Ding (PM-F), Claire Chang (PM-S), Anna Krutsinger (PM-S),  
Hena Ahmed, Georgia Witchel

The Abuelezam Lab at Boston College seeks to advance mathematical modeling methods to account for structural determinants of infectious disease transmission, including racism. Our Clinic project examines interventions targeting environmental and social determinants of COVID-19 dynamics. We add functionality to an existing transmission model, called Covasim, to provide policy recommendations aimed at reducing racial and socioeconomic disparities in COVID-19 health outcomes.

## FedEx

*Modeling Autonomous Vehicle Deliverability*

Liaisons: David Weaver, Kevin Smith, Nik Pande

Advisor: Susan Martonosi

Students: Nathan Nabal (PM-S), Raffa Gonzalez (PM-S), Shifa Somji (PM-F),  
Jennifer Granados, and Andrew Yu

As a global market leader in delivery and logistics, FedEx oversees research to make cargo-transport simultaneously more sustainable, more efficient and more responsive to customer needs. The team designed and created a dynamic model in Python to determine which FedEx packages are deliverable using autonomous vehicles (AV). Additionally, the model prioritizes which FedEx packages should be delivered by AVs when AV capacity is limited.

## IMC Trading

*Numerical Integration of Parabolic PDEs*

Liaisons: Jonathan Ross, Marquis Wong '11

Advisor: Weiqing Gu

Students: Myles Fabre, Jordan Hunt, Sidhant Rastogi (PM), Tarush Sharma,  
Hector Tierno

IMC Trading is a proprietary trading firm and market maker for various financial instruments listed on exchanges throughout the world. IMC would like to improve the performance and accuracy of their model for determining the price of options. Their current method employs a finite difference method to numerically approximate the analytical solution to the Black-Scholes parabolic PDE. The team designed an adaptive mesh algorithm to reduce the computational effort required to achieve the same accuracy.



Social Justice Clinic



## Microsoft

### *Creating an Interactive Metric Authoring Experience for Microsoft's Experimentation Platform*

Liaisons: Dr. Jonathan Litz '09, Dr. David Hall

Advisor: Talithia Williams

Students: Katie Wu (PM), Amber Means, Julianna Schalkwyk, Qing Yang, Justin Yeh

The Experimentation Platform (ExP) team at Microsoft runs A/B tests for Microsoft's products and uses metrics definition language (MDL) to define statistics calculated on their datasets. The goal of the Clinic team was to create an interactive metric authoring web application to teach MDL to entry-level software engineers, product managers and data scientists. The team's project will aid users in learning and using MDL at a faster pace and help them write more accurate expressions.

## Mathematics/Physics Clinic

### Lawrence Livermore National Laboratory

#### *When is Enough Enough?: Estimating Sampling Convergence in Molecular Dynamics Simulations*

Liaisons: Dr. Helgi I. Ingólfsson, Dr. Tim Carpenter

Advisor: Alfonso Castro

Students: Anya Porter (PM), Shaheen Cullen-Baratloo, Kelvin Jamison, Mihira Sogal

A project at Lawrence Livermore National Lab (LLNL) uses molecular dynamics simulations to study lipid membranes and RAS, a key protein in cancer development. The goal of our Clinic project was to use LLNL's simulation data to determine when the variation from changing the lipid composition outweighs the inherent stochastic error for some representative properties. Through this analysis, we aim to provide guidance on how to efficiently use computing resources.

# Poster Presentation Strauss Plaza

Projects Day | May 2, 2023

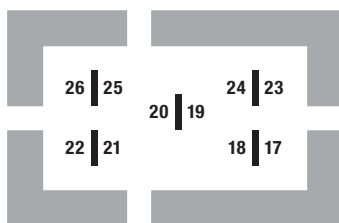
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|---|---|
| <b>1.</b> Amazon Lab126                                   | <b>21.</b> Lawrence Livermore National Lab        |
| <b>2.</b> Aprovecho Research Center                       | <b>22.</b> Memorial Sloan Kettering Cancer Center |
| <b>3.</b> Boston College                                  | <b>23.</b> Microsoft                              |
| <b>4.</b> Cai Lab Caltech                                 | <b>24.</b> MIT Lincoln Laboratory                 |
| <b>5.</b> Casa Herrera                                    | <b>25.</b> N Consulting Engineers                 |
| <b>6.</b> City of Hope                                    | <b>26.</b> NASA/JPL                               |
| <b>7.</b> ClareNom  | <b>27.</b> Nininger Medical Inc.                  |
| <b>8.</b> Clean Power Research                            | <b>28.</b> Nordstrom                              |
| <b>9.</b> Crowdstrike                                     | <b>29.</b> Parker Meggitt Engine Systems          |
| <b>10.</b> Center for Strategic and International Studies | <b>30.</b> Project Metal Inspection               |
| <b>11.</b> DIRECTV  | <b>31.</b> Project Pyramid                        |
| <b>12.</b> Doosan Bobcat                                  | <b>32.</b> Proofpoint                             |
| <b>13.</b> eBay   | <b>33.</b> Quantcast                              |
| <b>14.</b> FedEx: Autonomous Vehicle Deliverability       | <b>34.</b> Sandia National Laboratories           |
| <b>15.</b> FedEx: Economic Insights                       | <b>35.</b> Shopify                                |
| <b>16.</b> Georg Fischer Signet                           | <b>36.</b> Silvus Technologies                    |
| <b>17.</b> Harvard Center for Computational Biomedicine   | <b>37.</b> Tesla                                  |
| <b>18.</b> HRL Laboratories                               | <b>38.</b> Toyota                                 |
| <b>19.</b> IMC Trading                                    | <b>39.</b> Tradeweb                               |
| <b>20.</b> Juniper Networks                               | <b>40.</b> UNITE HERE                             |
|   | <b>41.</b> WePackItAll                            |



41 40 39 38 37

**Parsons**

36 35 34 33 32 31 30 29 28 27



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**Sprague**

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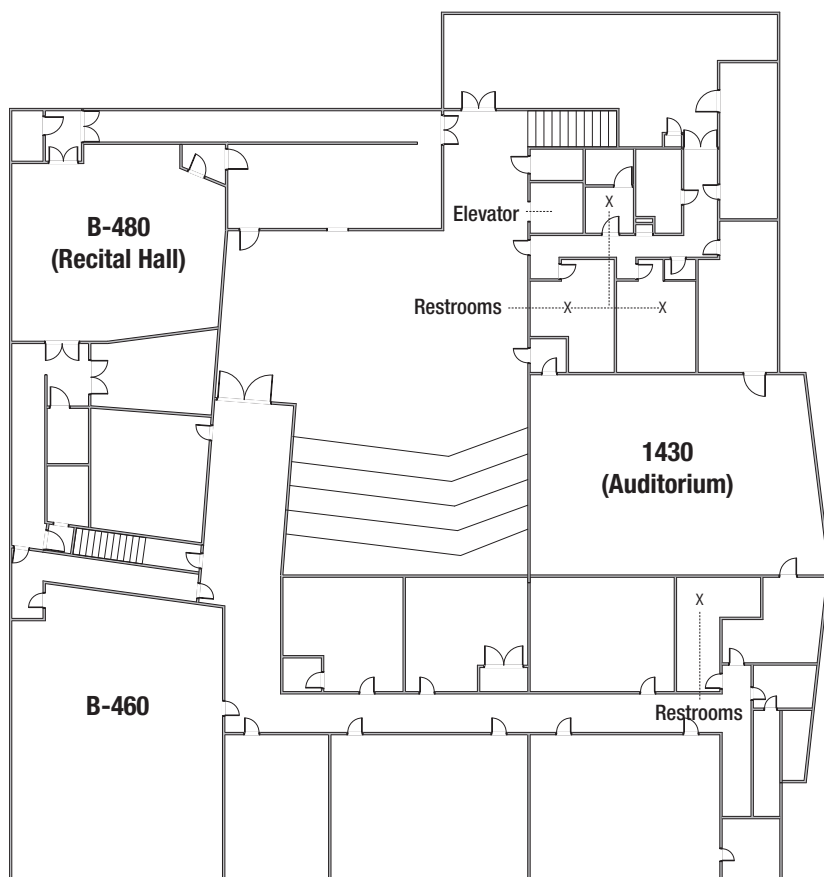
**Keck**



**Jacobs**

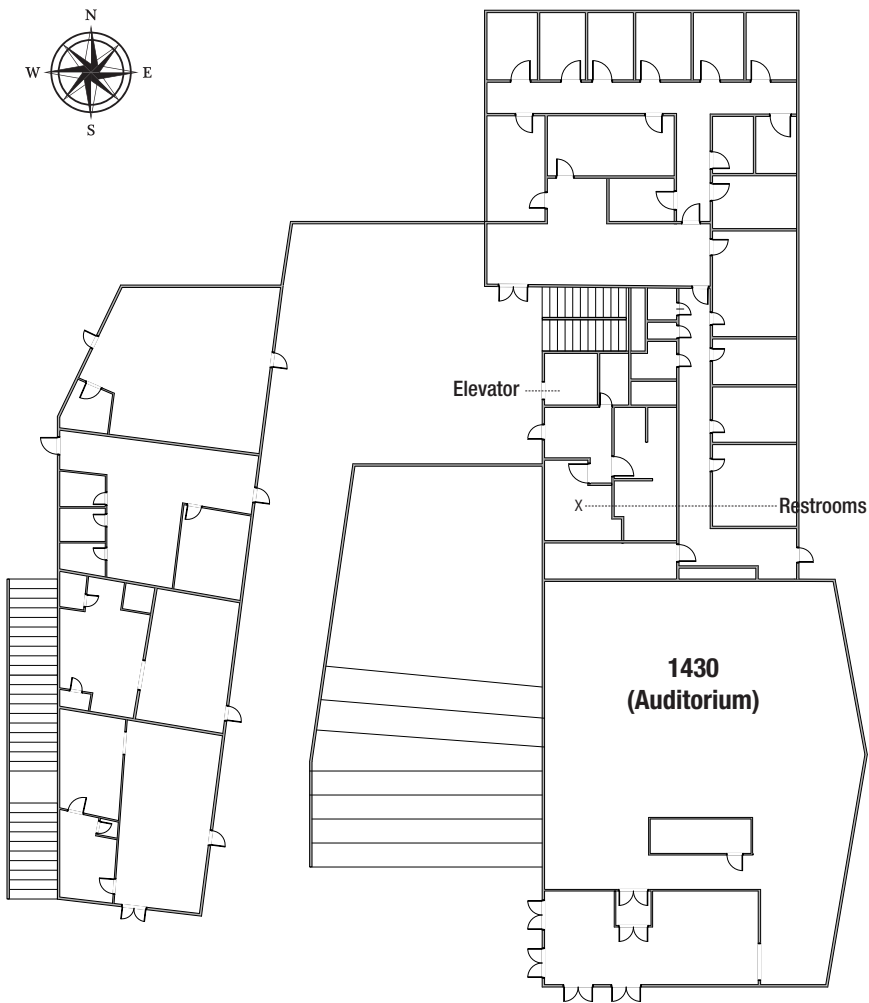
# Shanahan Center for Teaching and Learning Basement

Projects Day | May 2, 2023



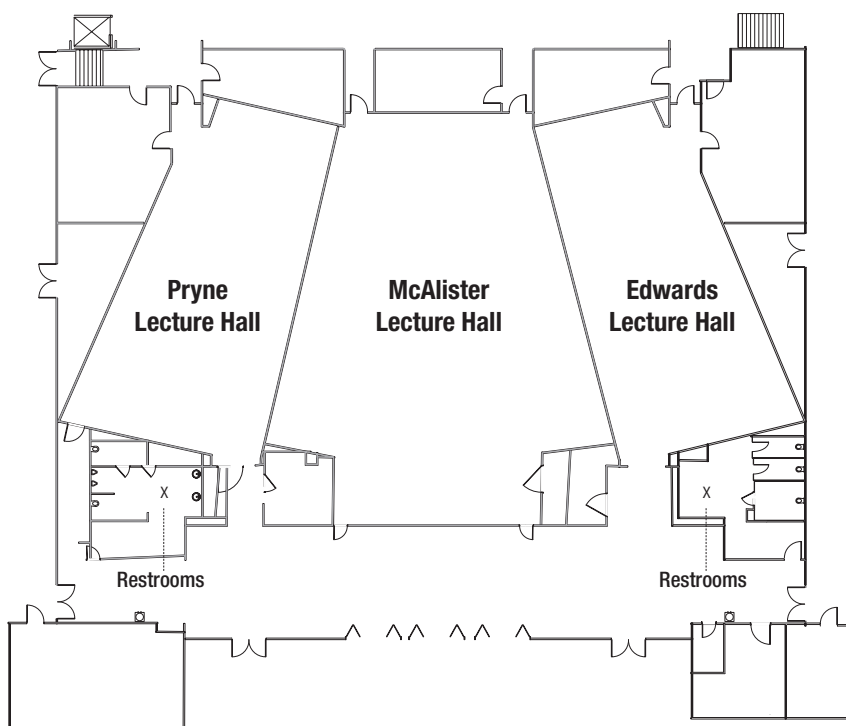
# Shanahan Center for Teaching and Learning First Floor

Projects Day | May 2, 2023



# Galileo Auditorium

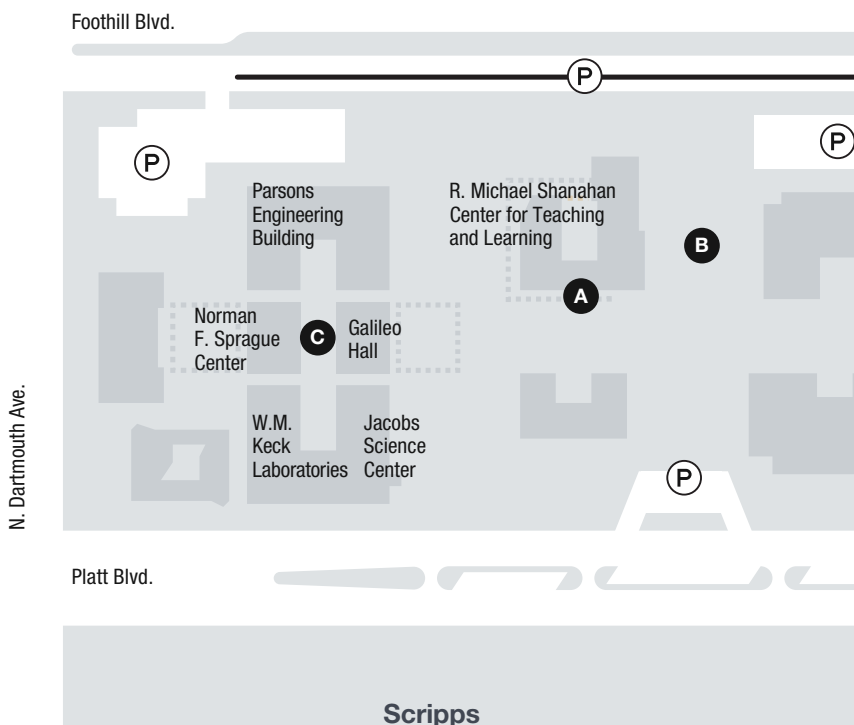
Projects Day | May 2, 2023



## **Harvey Mudd Clinic Outcomes**

- On average, Clinic sponsors have filed an average of five patent disclosures as a result of their projects.
- Each year, more than 90% of sponsors say their projects are successful.
- Clinic sponsorship provides increased visibility for companies hoping to recruit HMC students.

For more information, see [hmc.edu/clinic](http://hmc.edu/clinic); email [clinic@hmc.edu](mailto:clinic@hmc.edu).



## Map Legend

- A** Registration
- B** Liquidambar Mall Tent
- C** Jon C. and Jean A.S. Strauss Plaza
- P** HMC community parking and visitor parking with permit.  
Public parking available on Platt Blvd. and Foothill Blvd.

