Projects Day 2019
Celebrating 56 Years of the Clinic Program: 1963-2019

Tuesday, May 7
10:30 a.m.–6 p.m.

Harvey Mudd College
Clinic Program
301 Platt Boulevard, Claremont, CA 91711 | hmc.edu/clinic
Projects Day is dedicated to Jack Alford and Mack Gilkeson for their foresight and wisdom in the creation of the Harvey Mudd College Clinic Program.

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

**Harvey Mudd Clinic Outcomes**
- During the past several years, Clinic sponsors have filed 5–10 patent disclosures as a result of their projects.
- Liaisons are enthusiastic about their experience and, in 2017–2018, all of them reported that the experience had business value to their companies.
- Clinic sponsorship provides increased visibility for companies hoping to recruit HMC students.

To view Clinic videos, learn about the sponsor experience, including success stories, and for more information, see hmc.edu/clinic/, email clinic@hmc.edu or call 909.607.7015.
Harvey Mudd College's annual celebration of student achievement includes Presentation Days (May 6 and May 8, 2019), showcasing senior thesis research and class projects, as well as Projects Day (May 7, 2019), showcasing projects in the Clinic Program.
Harvey Mudd College
Clinic Advisory Committee

Industry Members
Tessa Adair '14, Laserfiche
Paul Anderson, The Aerospace Corporation
Daniel A. Borton '90, Amgen Inc.
Bob Butterfield, RDB Consulting
Carl Carrera '75/76, The Boeing Company
Frances Ferris '80, The Boeing Company
Aaron Gable '12, Google Inc.
Sharon Kwan '98, GNF
David Losyna, Optivus Proton Therapy Inc.
John Livingston, Tandem Diabetes Care
Hal Lonas, Webroot Inc.
Craig Snow, Raytheon Missile Systems

College Members
Zach Dodds, director, Computer Science Clinic
Kash Gokli, director, Engineering Clinic
Qimin Yang, associate director, Engineering Clinic
Susan Martonosi, director, Global Clinic
Weiqing Gu, director, Mathematics Clinic
Peter Saeta, director, Physics Clinic
Colleen Coxe, director, Corporate Relations
Kelly Barker, assistant director, Corporate Relations
Lorena González, coordinator, Engineering Clinic
DruAnn Thomas, coordinator, Computer Science, Global and Mathematics Clinics
Heather Clark, senior accountant for finance and grants

Acknowledgments
The College acknowledges the many alumni and parents, who assist in the recruitment, formulation and conduct of Clinic projects each year; and the Clinic Advisory Committee members, who provide valuable industry perspective and advice; their continued support is greatly appreciated. Also, many thanks to all Harvey Mudd College faculty and staff involved in the preparation of Projects Day.
Shanahan Center for Teaching and Learning
Second Floor
Projects Day | May 7, 2019

President's Office
Math Lounge
Elevator
Restrooms
Math Offices

2481
A Capella (CS)
Dassault Systèmes BIDVIA (CS)

2475
ATI Metals (ENG)
COH—AMT (ENG)

2471

2465
ATI Metals (ENG)
COH—AMT (ENG)

2421
GKN Aerospace (ENG)
Technion (CS)

2425
ServiceNow (CS)
Proofpoint (CS)

2461
COH—Raman (ENG)
Pure Storage (CS)

2460
EDR (MATH)
Tradeweb (MATH)

2450
HRL Labs (CS/PHYS)
LLNL (CS/PHYS)

2454
Meggitt (ENG)
Moog (ENG)

2444
2440
HP Inc. (ENG)
Intuitive Surgical (ENG)

49th Annual Harvey Mudd College
Projects Day Program
May 7, 2019

10:30 a.m. Registration and Poster Viewing, Platt Campus Center

1 p.m.
General Session, Shanahan Center Auditorium
Welcome – Maria Klawe, president
Remarks – Susan Martonosi, director, Global Clinic
Milestone Awards – Lisa Sullivan, vice president and R. Michael Shanahan Dean of the Faculty
Recipients:
AT&T
EDR
HP Inc.
Lawrence Livermore National Laboratory
Sandia National Laboratories

1:30–3 p.m. Project Presentations (see schedule)

3–3:30 p.m. Break, Shanahan Center, first-floor north terrace, and Thomas-Garrett Plaza

3:30–5 p.m. Project Presentations (see schedule)

5:15–6 p.m. Poster Reception for guests, faculty and students, Platt Campus Center
### Projects Day 2019 Presentation Schedule

<table>
<thead>
<tr>
<th>Presentation Times</th>
<th>Room</th>
<th>Clinic Team</th>
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<tbody>
<tr>
<td>1:30</td>
<td>Shan 2475</td>
<td>A Capella (CS)</td>
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<tr>
<td>1:30</td>
<td>Shan B-454</td>
<td>Accenture Labs (CS)</td>
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<tr>
<td>1:30</td>
<td>Shan B-445</td>
<td>Avinind (Global)</td>
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<tr>
<td>2:00</td>
<td>Galileo-Pryne</td>
<td>AT&amp;T (ENG)</td>
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<tr>
<td>3:30</td>
<td>Shan 2465</td>
<td>ATI Metals (ENG)</td>
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<tr>
<td>4:00</td>
<td>Shan 2407</td>
<td>Booz Allen Hamilton (CS)</td>
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<td>4:30</td>
<td>Shan 2465</td>
<td>COH – AMT (ENG)</td>
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<td></td>
<td>Shan 2461</td>
<td>COH – Raman (ENG)</td>
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<td></td>
<td>Shan 2475</td>
<td>Dassault Systèmes BIOVIA (CS)</td>
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<tr>
<td></td>
<td>Shan B-480</td>
<td>Doosan Bobcat (ENG)</td>
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<tr>
<td></td>
<td>Shan B-480 (Recital Hall)</td>
<td>EDR (MATH)</td>
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<tr>
<td></td>
<td>Shan 3461</td>
<td>Fluxergy (CS)</td>
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<td></td>
<td>Shan B-445</td>
<td>FMBC (ENG)</td>
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<td></td>
<td>Shan B-470</td>
<td>Georg Fischer Signet (ENG)</td>
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<td></td>
<td>Shan 2421</td>
<td>GKN Aerospace (ENG)</td>
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<tr>
<td></td>
<td>Shan 3461</td>
<td>Google (CS)</td>
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<tr>
<td></td>
<td>Shan B-442</td>
<td>HP (CS)</td>
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<tr>
<td></td>
<td>Shan 2440</td>
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<td>Shan 2450</td>
<td>HRL Labs (CS/PHYS)</td>
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<td></td>
<td>Shan 3425</td>
<td>Intel (MATH)</td>
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<tr>
<td></td>
<td>Shan B-460</td>
<td>Intuit (CS)</td>
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<td></td>
<td>Shan 2440</td>
<td>Intuitive Surgical (ENG)</td>
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<tr>
<td></td>
<td>Shan 3485</td>
<td>Jones Parking (CS)</td>
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<tr>
<td></td>
<td>Shan 1480</td>
<td>Leidos (ENG)</td>
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<td>Shan B-480 (Recital Hall)</td>
<td>LGP (ENG)</td>
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<td>Shan 2450</td>
<td>LLNL (CS/PHYS)</td>
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<td></td>
<td>Shan 1480</td>
<td>LLNL (ENG)</td>
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<tr>
<td></td>
<td>Shan 3425</td>
<td>McKay Brothers (ENG)</td>
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### Shanahan Center for Teaching and Learning
First Floor

Projects Day | May 7, 2019

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![Shanahan Center Map](image-url)
Shanahan Center for Teaching and Learning
Basement
Projects Day | May 7, 2019

![Shanahan Center Floor Plan]

<table>
<thead>
<tr>
<th>Presentation Times</th>
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<tbody>
<tr>
<td>1:30</td>
<td>Shan 2454</td>
<td>Meggitt Control Systems (ENG)</td>
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<td>2:00</td>
<td>Shan B-442</td>
<td>Mentor Graphics (CS)</td>
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<td>2:30</td>
<td>Shan 3465</td>
<td>Microsoft (CS)</td>
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<td>3:00</td>
<td>Shan B-470</td>
<td>Millennium Space Systems (E)</td>
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<td>3:30</td>
<td>Galileo-Edwards</td>
<td>MIT LL Imaging (CS)</td>
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<td>Galileo-Edwards</td>
<td>MIT LL FACECAR (CS)</td>
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<td>Shan 2454</td>
<td>Moog (ENG)</td>
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<td>Shan 3421</td>
<td>New Relic (CS)</td>
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<td>4:30</td>
<td>Galileo-McAlister</td>
<td>Niagara–Changeover (ENG)</td>
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<td>4:30</td>
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<td>Niagara–Robotic (ENG)</td>
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<td>4:30</td>
<td>Galileo-Pyne</td>
<td>Niagara–SW (ENG/MATH)</td>
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<td>Shan 2407</td>
<td>OpenX Technologies (CS)</td>
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<td>4:30</td>
<td>Shan B-454</td>
<td>Pilot City (MATH)</td>
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<td>4:30</td>
<td>Shan B-450</td>
<td>Project MUSIC (ENG)</td>
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<td>4:30</td>
<td>Shan 2425</td>
<td>Proofpoint (CS)</td>
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<td>4:30</td>
<td>Shan 2461</td>
<td>Pure Storage (CS)</td>
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<td>4:30</td>
<td>Shan 3461</td>
<td>Sandia–Cybersecurity (E)</td>
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<td>Shan 3481</td>
<td>Sandia–Measurement (E)</td>
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<td>4:30</td>
<td>Shan 2425</td>
<td>ServiceNow (CS)</td>
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<td>4:30</td>
<td>Shan 3465</td>
<td>Steelcase (CS)</td>
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<td>Shan 2421</td>
<td>Techmation (ENG)</td>
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<td>4:30</td>
<td>Shan B-450</td>
<td>Toyota (ENG)</td>
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<td>4:30</td>
<td>Shan 2460</td>
<td>Tradeweb (MATH)</td>
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<td>4:30</td>
<td>Shan B-460</td>
<td>Verkada (CS)</td>
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<td>4:30</td>
<td>Shan 1430</td>
<td>Virgin Orbit (ENG)</td>
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<td>4:30</td>
<td>Shan 1430</td>
<td>Virgin Orbit (MATH)</td>
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<tr>
<td>4:30</td>
<td>Shan 3485</td>
<td>Webroot (CS)</td>
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</tbody>
</table>
Personalized Projects Day Schedule

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

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
<th>Location</th>
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</thead>
<tbody>
<tr>
<td>10:30 a.m.</td>
<td><strong>Registration and Poster Viewing</strong></td>
<td>Platt Campus Center</td>
</tr>
<tr>
<td>1 p.m.</td>
<td><strong>General Session</strong></td>
<td>Shanahan Auditorium</td>
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<tr>
<td>1:30 p.m.</td>
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<td>2 p.m.</td>
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<td>2:30 p.m.</td>
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<tr>
<td>3–3:30 p.m.</td>
<td><strong>Break</strong></td>
<td>Shanahan Center, Thomas-Garrett Plaza; Galileo Foyer</td>
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<td>3:30 p.m.</td>
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<td>4 p.m.</td>
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<td>4:30 p.m.</td>
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<tr>
<td>5:15–6 p.m.</td>
<td><strong>Poster Reception</strong></td>
<td>Platt Campus Center</td>
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</tbody>
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**Tradeweb Markets** | Shan 2480
*Building Intelligence into Credit Bond Pricing*
Liaisons: Mike Jia, Justin Peterson '85
Advisor: Andrew J. Bernoff
Students: Herrick Fang, Hemeng “Maggie” Li (PM), Chudan “Ivy” Liu, Danny K. Liu, William X. Meng

The Harvey Mudd Tradeweb Clinic team is finding insights to systematically decompose and upgrade Tradeweb's complex, rules-based corporate bond pricing engine into a machine learning-based engine. The task of this project is to help Tradeweb to improve its corporate bond pricing accuracy by identifying and developing effective machine learning models that can automatically tune the algorithms and parameters of its pricing engine.

**Virgin Orbit** | Auditorium
*Flight Engineering Virtual Assistant*
Liaisons: Trent Basset-Parkins, Clayton Chu, Matt Gialich, Andrew Linton, Brent Lytle, JP Muncks, Farrid Zeighami
Advisor: Weiqing Gu
Students: Jonathan Hayase, Jason Ma, Joseph Nunez (PM), Adelaide Punt, Pedro Sandoval Segura, Ricky Shapley

Virgin Orbit handles large amount of sensor data from their tests as a part of their development process. However, there are no existing tools for quickly manipulating the file types VO Uses. We are developing a customized, fast, lightweight tool for slicing and defragmenting large data files to allow VO engineers to quickly manipulate their test data for easier analysis.

PM (project manager); F (fall); S (spring)
Mathematics Clinic

EDR | Shan 2460

Historical Imagery Project
Liaisons: Zachary Fisk, Paul R. Schiffer, Richard White
Advisor: Nicholas Pippenger
Students: Nathaniel Diamant, Mackenzie Kong-Sivert, Jacky Lee (PM), Vivaswat Ojha, Kinjal Shah (PM-F)

The Historical Imagery Project will develop systems to search and categorize vast collections of historical raster imagery and extract key information. The complex problems to be solved relate to search, statistical analysis, image analysis and mapping. EDR believes that a focused mathematical and computer science approach provides both a challenging problem for students and a potentially valuable product for EDR, ultimately helping to improve environmental due diligence across the United States.

Intel Corporation | Shan 3425

Creating Spatialized Audio Playback System for Mixed-Reality Application
Liaisons: Charles Johnson II, Peter Sankaghovit
Advisor: Alfonso Castro
Students: Jacob Cordeiro, Greg Derecho, Jeffrey Rutledge, Brenner Ryan, Thitaree Tanprasert (PM), Nina Thiebaut

Intel TrueView is a system for displaying realistic replays of sports scenes from all points of view in the form of mixed reality (MR). An important factor in creating a believable MR scene is to create a suitable audio replay. Our project aims to develop a system to turn dry sound into realistic, spatialized audio so each object in an MR scene sounds like it’s in the same environment as the user, and at the position displayed in the scene. We explore two approaches to this problem, which are recognition of room properties via the room impulse response (RIR) and via photos of the room or parts of the room. We are performing user testing by implementing and integrating each approach into a simple MR scene.

PilotCity | Shan B-454

Automating an Engine to Extract Educational Priorities for Workforce City Innovation
Liaison: Denick Lee
Advisor: Talithia Williams
Students: Jean Selasi Acedze, Aanya Alwani, Madison Hobbs (PM), Xuming Liang, Dominique Macias

Our Clinic team was tasked with developing software and algorithms to automate PilotCity programming. Our solutions involve creating web interfaces with which teachers, students and employers involved in the PilotCity Program can engage as well as designing recommender systems that facilitate the process of matching employers to high school classrooms. Additionally, we are using topic modeling to extract educational priorities from community college and high school syllabi in order to inform work-based learning community partnerships.

Computer Science Clinic

A Capella | Shan 2475

Telemetry and Modeling for Automatic Tuning in Apache Cassandra
Liaisons:
Advisor: Beth Trushkowsky
Students: Jonathan Cruz (PM-S), Carissa DaRanek, Lilly Liu, Jonathan Raygoza, Ashley Schmit (PM-F)

Databases—especially large-scale databases—are the “reactor core” powering today’s software services. The performance of large databases depends on many interactions between internal parameters and the varying external load they’re asked to handle. Our goal is to improve both the “sensing” and the “control” of Cassandra, a large-scale open-source database, adapting its operation based on changing conditions. The pipeline will use machine learning to guide parameter-tuning for the database, depending on operational and query patterns.

Accenture | Shan B-454

Representing and Communicating Intent in Human-Robot Teams
Liaisons: Nicholas Akiona, Alex Kass
Advisor: Jim Boerkoel
Students: Joe Esbenshade, Tre Gonzales (PM-S), Yan Yan Harris, Chen Pekker, Finn Southeterland (PM-F)

Human-Robot teams work closely in factories and warehouses. As tasks become more complicated and robots become more autonomous, Accenture sees that these robots will transition from being perceived as tools to being perceived as teammates. Thus, bridging the communication gap between humans and robots is vital to productivity, and our goal is to provide a communication platform for humans to communicate with robots clearly, fluidly and efficiently.

Booz Allen Hamilton | Shan 2407

An All-Audiences Interface for Algorithmic Data Analysis and Exploration
Liaisons: David Gerner, Aaron Ishikawa, Homan Karimi
Advisor: Christopher Stone
Students: Wynne Becker, Jackson Crewe (PM), Mary Clare Shen, Oswaldo Sosa

The team developed a web application through which users can easily explore data analysis algorithms. Users can select an algorithm along with settings and the site will fill in an online interpreter with custom starter code. Users can then alter the code to tune their algorithms for their datasets and run the code directly within the application.

Dassault Systèmes BIOVIA | Shan 2475

Improving Laboratory Outcomes Using Augmented Reality
Liaisons: Ian Kerman, Dr. Reza Sadeghi
Advisor: Eliot Bush
Students: Evan Amason, Jamie Kunzelman, Parnika Sharma (PM), Rachel Sun

The BIOVIA Clinic project is focused on improving the laboratory experience through the use of augmented reality. The team aims to improve consistency and efficiency within the lab by creating a proof-of-concept augmented reality application that combines a virtual laboratory manual with a digital laboratory notebook connected to BIOVIA's existing cloud-based electronic laboratory notebook.
Fluxergy

**Developing Robust Cell-Counting Algorithms**

Liaisons: Steve Lee, Vyai Savanur '14
Advisor: Jessica Wu
Students: Flora Gallina-Jones (PM-S), Erica Goodwin, Monee McGrady (PM-F), Jocelyn Rodriguez

Fluxergy makes medical care more accessible by bringing laboratory technology to the hands of health care providers. Fluxergy is currently adding cytometry functionality to their device, which will allow users to input a biological sample and extract information such as cell counts. Our Clinic team has built a pipeline that takes microscope-scale blood cell images as input and performs a complete blood count using machine learning and computer vision.

Google

**Reviewing Code Reviews**

Liaison: Titus Winters '02
Advisor: George Montañez
Students: Shyan Akmal, Ryan Piancetoski, Yucheng Wu (PM), Andy Zhan

Code reviews are an essential part of software engineering, but issues often arise in human code review. Automation eases the process by detecting and correcting bugs and problems before review. The Google Clinic team aims to improve automation by contributing to the clang-tidy C++ developer tool. In addition to writing C++ checks and corrections, the team aims to improve the overall clang-tidy workflow by introducing a novel tool to infer and generate checks from concrete before and after code examples.

HP Inc.

**Simulating and Fixing Visible Anomalies in Thermal Inkjet Printing with Machine Learning**

Liaisons: Steve Bauer, Perry Lieber, Aaron Rosen '16
Advisor: Lucas Bang
Students: Willis Sanchez-duPont, Collin Valleroy, Olivia Watkins (PM), Gavin Yancey, Jasmine Zhu

Through use of neural network architectures, our project aims to correct for common visible static and dynamic printing defects. Our architecture creates a simulated model of the printer hardware based on a database of printed and scanned images. The model then learns to remove future print defects via "anti-defect" patterns inserted in the image that counteract the different types of observed defects.

Intuit Inc.

**Journalized Objects, Blockchain and the External Source of Truth**

Liaison: Roger Meike
Advisor: Z Sweedyk
Students: Daksha Agarwal (PM-F), Luis Hernandez Cruz (PM-S), Nithya Deepak, Anna Geottert, Ryan Kusch

Intuit has created a new programming paradigm called Journalized Objects that allows Java Objects to store the history of object values in a system called BlackFlower. The goal of our project is to prove BlackFlower can be used to represent external data, and we have chosen to do this by connecting BlackFlower to the Bitcoin blockchain. This will show that Intuit’s new paradigm can be used to track and maintain history of data that is externally managed and updated.

Niagara Bottling LLC

**Stretch Wrapper**

Liaisons: Parker LaMascus
Advisor: Timothy Tsai
Students: Stephanie Blankley (S), Bohan Gao (TL-F), Tai Le (F), Adrian Sanchez (TL-S), Dana ShangGuan (F), Elijah Whitsett

The Niagara Stretch Wrapper Team has developed an algorithm that autonomously optimizes stretch wrapper material usage under quality constraints. The algorithm does this by safely experimenting with different machine parameters and finds recipes that either meet or surpass the goal of 20 percent material usage reduction. The algorithm is compatible with the main Data and Control Hub that operates on Niagara’s plants.

City of Hope

**Raman Spectroscopy and Laser Ablation for In-Vivo Cancer Detection and Destruction**

Liaisons: Dr. Yuman Fong, Dr. Veronica Jones, Ragini Kothari '18, Dr. Daniel Schmolze
Advisors: Steven Santana '06, Dr. Michael Storrie-Lombardi
Students: Morgan Blevins (TL), Daniel Brito (F), Kira Fawakeh (S), Dominque Mena, Qianti Min, Youkang Shon

The team created a system which can locate and diagnose an early stage breast tumor via raman spectroscopy and destroy it via laser ablation during surgery.

Global Clinic

Arvind Ltd.

**Reducing Energy Consumption in Wet Dry Cycles**

Liaisons: Harvinder Rathee, Dhruvin Savalia
Advisors: Sunil Kale (Ahmedabad University), Erik Spjut
Students: Nisha Maheshwari (TL-S), Alex Ravnik, Sithe Thiam (TL-F);
AU Team: Varshil Dalal, Anuj Pandya, Het Patel

Arvind Ltd. is a $1 billion revenue Indian textile manufacturing company. The Harvey Mudd College Global Clinic team is working to increase the energy efficiency of Arvind’s textile drying process. In the fall semester, the team recommended changes to the current drying process that will help Arvind recover 10 percent of the energy usually lost during drying. In the spring, the team modeled and prototyped novel, low-energy ways to dry fabric at an industrial level.
**Techmation | Shan 2421**

**Obstacle Detection and Tracking using mmWave Technology**

Liaisons:  Jerry Hsiung ‘16, Xin Cyrus Huang ‘16, Vaibhav Viswanathan ‘17, Jack Yang ‘17

Advisor:  Anthony Bright

Students: Kitty Belling (TL-F), Nils Godmuse (FE-F), Peter Johnson (F), Alexander Moody (S), David E. Olumese, Andrew Q. Pham (S), Shiv Seetharaman (TL-S)

Millimeter Wave (mmWave) Radar is a unique type of radar system that uses high frequency (~70-80 GHz) electromagnetic waves to detect the position and velocity of objects with high resolution. This Clinic project seeks to characterize the performance of mmWave radar technology and explore its feasibility for usage on Techmation’s industrial robotics platforms. The team’s efforts have culminated in a mobile robot demonstration that uses mmWave radar for autonomous obstacle avoidance in known, indoor environments.

**Toyota | Shan B-450**

**Design and Study of Fuel-Cell Vehicles of Different Types, Sizes, and Applications**

Liaisons:  Andrew Sata, Justin Ward, Takehito Yokoo

Advisor:  Okitsugu Furuya

Students:  John Little (S), Vicki Moran (F), Kevin Nakahara (F), Bradley Phelps (TL-S), Russell Salazar (TL-F), Aliki Sarantopoulos

Toyota has used hydrogen fuel cell technology to create zero-emission Class 8 trucks for heavy-duty trucking (Project Portal) and commercially available passenger vehicles (the Toyota Mirai). To support this effort, the 2018-2019 Toyota Clinic team generated a design map and hardware recommendations for future fuel cell systems.

**Virgin Orbit | Auditorium**

**Bulk Molded Compounds for Secondary Structures**

Liaisons:  Danielle Fallon, Chad Foroster ‘05

Advisor:  Gordon Krauss

Students:  Kaitlyn Eng (TL-F), Mariah Ewing (S), Fernando Fernandez (F), Douglas Raigoza (S), Marianna Sbordone (TL-S), Kevin Shoyer (F), Jessica Wolfe (F)

The Virgin Orbit Clinic team was challenged to reduce weight aboard the LauncherOne rocket. By replacing aluminum secondary structures with bulk molded compound (BMC) designs, the team will decrease non-value-added weight and needless emissions. The team developed BMC machining methods including drilling and tapping. Pull-through and bearing fastener allowable were tested and analyzed. The team designed their own test fixtures, conforming to industry standards. Finally, the team redesigned structures, performed analysis and created a proof of concept.

**Jones Parking Inc. | Shan 3485**

**ScreenPortal: Improving Spatial Presence Across Single-User Screens**

Liaison:  Josh Jones ‘98

Advisor:  Lisa Kaczmarczyk

Students:  Jason Dwyer (PM-S), Jonah Rubin (PM-F), Santiago Weight, Shota Yasunaga

The goal of this project is to build a prototype system that acts as a visual window into another environment. Our system uses only off-the-shelf displays and cameras to show a 3-D scene on a 2-D screen. Using a face detector, we track where the viewer is relative to the screen, and then change the perspective shown on the screen to match, creating immersive 3-D illusions.

**Mentor Graphics, a Siemens Business | Shan B-442**

**Automating Identification of Factors that Lead to Low-Yield in Semiconductor Manufacturing**

Liaisons:  Wes Smith, Janice Waterworth

Advisor:  Ben Wiedermann

Students:  Emily Kim (PM-F), Blake Larkin (PM-S), James Ren CMC ’19, Coco Smith

Mentor Graphics, a subsidiary of Siemens, is in the business of industrial data systems, and one of its areas of focus is the semiconductor industry. The semiconductor process involves building electronic devices on (usually) silicon wafers. These wafers go through a complicated production process where any step could contribute to the failure of a computer chip. We were tasked with providing an automated solution that identifies different potential sources of failure. This will allow Mentor Graphics’ customers to focus on where to improve their systems in a more efficient manner than is currently available.

**Microsoft Corporation | Shan 3485**

**Improving the Reading Experience Through Always-on Eye Tracking**

Liaison:  Rob McKaughan ‘93

Advisor:  Julie Medero

Students:  Kaylene Chan (PM-S), Teerapat “Mek” Jenungrot, Robert Linden, Devang Patel (PM-F), Leana Yearwood

The Advanced Reading Technologies team at Microsoft seeks to improve the reading experience for all. We have been working closely with the team to explore how eye-tracking systems may be used to create a better reading experience. To accomplish this goal, we created an application which tracks eye movements and eye data to generate and visualize insights about a user’s reading session.

**MIT Lincoln Laboratory | Galileo-Edwards**

**Ground-Based Localization Within Satellite Images**

Liaison:  Andrew Fishberg ’16

Advisor:  Zachary Dodds

Students:  Nupur Banerjee (PM), Arnessh Batlaw, Gary Luc, Jess Winssinger

MIT Lincoln Laboratory is interested in exploring cost-efficient, vision-based localization. This technology is orthogonal to GPS, so it can be used both in place of GPS and as an augmentation to GPS in built environments. Given commodity overhead imagery, such as satellite images from Google Maps or Bing, our team has prototyped and analyzed a system that localizes vehicles using ground-based images. Our system integrates a siamese neural network, particle filtering, and spatially-aware visual features.
MIT Lincoln Laboratory | Galileo-Edwards

RACECAR for Education
Liaison: Andrew Fishberg '16
Advisor: Zachary Dodds
Students: Parth Desai (PM), Chloe Elliott, Alasdair Johnson, Anthony Seto, Reagan Smith

In collaboration with the Beaver Works outreach program, MIT Lincoln Laboratory has developed an autonomous RC car with powerful sensors and processing. Using two of these RACECAR robots, the Clinic team has researched and developed a curriculum in which students implement a variety of robot navigation algorithms. Through an HMC seminar course, first-year students used these cars to test and refine the materials. The resulting curriculum will make the RACECAR platform accessible to a much wider audience in the future.

New Relic | Shan 3421
Host Anomaly Detection: Drawing Attention to the Needle in the Haystack
Liaisons: Merlyn Alberty-Speyer, Lukmaan Bawazer, Tray Zacharias
Advisor: Melissa O’Neill
Students: Mo Bakhiet, Grace Breckenridge (PM), Nathan Justin, Idinma Mbeledogu

When websites go down or don’t perform well, customers are frustrated and money is lost. New Relic provides monitoring services that give their customers vital insight into the performance of their systems. New Relic’s instrumentation produces detailed data that can be time-consuming for humans to fully understand. Our group is developing tools to detect anomalies in system performance monitoring data, allowing problems to be detected more quickly and easily, and potentially discover issues that would have otherwise gone unnoticed.

OpenX Technologies | Shan 2407
Applications of Deep Learning to Ad Quality
Liaisons: Chris Hallenbeck, Victor Lam, Larry Price
Advisor: Christopher Stone
Students: Monica Acosta, Diana Areoia, Adam Schulze (PM-S), Yun Zhang (PM-F)

OpenX powers the world’s largest independent ad exchange, connecting publishers and advertisers through real-time auctions. The goal of our project with OpenX is to improve advertisement labeling to provide publishers with more information during a real-time auction. Our Clinic team used computer vision and convolutional neural networks (CNNs) to detect the presence of the AdChoices logo, indicating whether advertisers follow certain privacy protocols. We also created a system to detect the brand(s) associated with an advertisement using text extraction and CNNs.

Proofpoint Inc. | Shan 2425
Associating Attacks with Actors
Liaisons: Thomas Lynam
Advisor: Ran Libeskind-Hadas
Students: Harrison Chotzen (PM-S), Tim Gaskin (PM-F), Patrick McDonough, Steve Zhong

Proofpoint identifies thousands of malicious email attachments and URLs every day. However, currently only about half of all attack threats are associated with an actor. The aim of this Clinic project is to improve this ratio, by using machine learning and heuristics to provide a proof-of-concept for the systematic association of attacks with actors and identification of new actors.

Project MUSIC | Shan B-450
Multi-Use Single Coax (MUSIC)
Liaisons:
Advisor: Matthew Spencer
Students: Geneva Ecola (TL-F), Michael Fernandez, Nico Naar (F), Rachel Perley (TL-S), Chris Strong, Samantha Ting (S)

The Project MUSIC Clinic team designed a system to reduce the number of cables in a radio frequency (RF) testing setup. Reduction from five cables to a single coaxial cable plus two printed circuit boards per test stand will save the company $600,000 in hardware for implementation of 2,000 test stands. Transmitting the signals over a single cable, requires first combining RF, digital and power signals on one side of the transmission line, and then separating them back apart with sufficient isolation and no information loss on the other side.

Sandia National Laboratories | Shan 3481
Critical Infrastructure Cybersecurity
Liaisons: Chris Abate, Zach Benz ‘98, BeiBei Chen, Trevor Hutchins
Advisor: David Harris
Students: Evan Chapman (TL-S), Chris Ferrarin (S), Laura Fleming (F), Trevor Fung (TL-F), Henry Limm (S), Francisco Munoz (F)

The Sandia National Laboratories Cybersecurity Clinic team investigated cyberphysical attacks on critical infrastructure. In the fall semester, the team reverse engineered and demonstrated SkyJack, a malware for hijacking Parrot drones. In the spring semester, the team has extended this attack with the addition of RF spoofing to commandeer a DJI Phantom drone. The team has also built methods to detect these attacks and implemented testing on an RFID system.

Sandia National Laboratories | Shan 3481
Measuring the Permittivity of Ferroelectric Nanoparticles in an Injection Molded Epoxy Composite
Liaisons: Dr. Todd Monson
Advisor: Albert Dato
Students: Deji Andrew, Evie Antholis (F), Colter Downing (TL-S), Kai Fukazawa (FE), Ali Khan (TL-F), Benjamin Lehman, Shruti Sukir (S), Meenakshi Venkataraman (F)

Barium titanate (BTO) is a ferroelectric material commonly used in capacitors because of its high bulk dielectric constant, which may be even higher in nanoparticle form. We are determining the dielectric constant of BTO nanoparticles as a function of particle size by measuring composites of BTO nanoparticles in epoxy. We're using ball-milling techniques to fabricate surfactants to reduce nanoparticle agglomeration and using finite element analysis to extract the dielectric constant of the nanoparticles.
**Moog Inc.** | Shan 2454  
*Contactless Position Sensor*  
Liaisons: Brennan Carrizales, John Holzinger, Jason Ro ’99  
Advisor: Mary Cardenas  
Students: Chance Bisquera, Brenden Brown (TL-F), Casey Gardner (TL-S), Makoto Nara (S), Richard Zhang (F)

Moog Chatsworth Operations (MCO) is a division of Moog Inc. that designs and manufactures precision space mechanisms. In order to improve the accuracy and product lifetime of MCO’s absolute rotary-position sensors, the 2018–2019 Moog Clinic team researched a variety of contactless sensing methods as well as designed and built multiple novel, cost-effective proof-of-concept devices. A final prototype was evaluated for precision and reliability, compared to current industry standards and recommended to MCO.

**Niagara Bottling LLC** | Galileo-McAlister  
*Single-Touch Changeover*  
Liaisons: Tim Ford, Richard Melanson, Manish Nagbanshi, Tony Peterson, Veronica Short, Daniel Weckstein  
Advisor: Patrick Little  
Students: Zachary Golan (TL-F), Michael Guzman (S), Valerie Kwee (TL-F), Briana Liu (TL-S), Jeni Zhu (F)

As a leading private label bottling company, Niagara Bottling produces a variety of products for different customers. In between different products, changeovers must be performed on manufacturing lines. The goal of this project is to conduct a study to identify modifications for the current manufacturing process. These modifications are expected to reduce changeover time by at least 20 seconds without increasing the number of operator-machine interactions required.

**Niagara Bottling LLC** | Galileo-McAlister  
*Biomimetic Robotic Measurement of Water Bottle Stiffness*  
Liaisons: Madhusudan Govindraju, Ian Song ’17  
Advisor: Ziyad Durón ’81  
Students: Alex Nunes, Laurel Schy, Marisa de Souza (TL-F), Jane Cho Watts (F), Kayla Yamada (TL-S)

Niagara Bottling LLC aims to reduce plastic in their bottled water products while maintaining functionality and customer satisfaction. To aid in new bottle testing, the Niagara Robotic Clinic team is developing a process to correlate data from a robotic hand programmed to grasp bottles with bottle stiffness rankings determined by student survey participants.

**Pure Storage** | Shan 2461  
*Implementing a Clustered NFS Server on a Pure Storage FlashArray*  
Liaisons: Andrew Bernat ’99, Dan King, Akif Yalcin Ozhabes  
Advisor: Mark Campe  
Students: Theodore Dubno (PM), Katie Gruenhagen, Sara McAllister, Jake Palanker  

The goal of this Clinic project is to build a Network File System server on a Pure Storage Flash Array. The Pure Storage Flash Array has users connect to with block access which requires some external medium to treat the storage as files. We will provide a highly reliable Network System server utilizing the purdy apps framework to help provide file access directly on the flash array controllers.

**ServiceNow** | Shan 2425  
*Optimizing Compression for Time Series Data*  
Liaisons: James Capaldo ’92, Magaly Drant, Vincent Seguin, Meg Sharkey  
Advisor: Ran Libeskind-Hadas  
Students: Maya Minier (PM-F), Dhruv Sawhney, Eleanor White (PM-S), Kate Woolverton

ServiceNow maintains enormous amounts of time series data on behalf of its customers and seeks a solution to achieve lossless compression in a real-time system. The solution will be evaluated on the basis of compression ratio and read/write speed. We will discuss our process of implementing and evaluating various compression algorithms and our findings regarding their performance.

**Steelcase** | Shan 3465  
*Wood Veneer Classification and Cataloging for Finished Product*  
Liaisons: Joe Noto, Mark Schilt, Ed Vander Bilt  
Advisor: Katherine Breeden  
Students: Christoph Gaebier, Israel Jones, Annalise Ko (PM), Charleen Tan, Kanishk Tantia

This Clinic project applies a classification system on finished wood veneer panels as a means of quality control. The image classification algorithm detects color differences between a given sample of finished wood veneer and its “master” (expected veneer color). The algorithm rates the degree of agreement between these two colors and provides a grade to express whether these differences are likely acceptable.

**Verkada** | Shan B-460  
*Interpreting Image Streams in Multi-Camera Systems*  
Liaisons: Martin Hunt ’08, Filip Kaliszanz  
Advisor: Jeho Park, Elizabeth Sweeney  
Students: Morgan Frisby, Matt Guillery (PM-F), Ziyuan Shang, Gabriel Womark (PM-S)

Verkada presents customers with an easy-to-setup surveillance camera system with an intuitive web interface to review footage. In order to provide more useful information to their customers, Verkada wants to leverage computer vision. Over the last two semesters, our Clinic team has focused on solving two problems with computer vision: identifying abandoned objects within footage and searching for people in footage based on the colors of their clothing.
Webroot Inc. | Shan 3485

Analyzing The Web for HTTPS Certificate Reputation
Liaisons: Michael Balloni ’98, Yuanhang Huang, Dave Krich, Hal Lounas, Trung Tran, Cathy Yang
Advisor: Lisa Kaczmareczyk
Students: Fabio Amendola, Natalie Kadonaga, Maeve Murphy, Aaron Ong (PM), Britanny Wang

Internet users increasingly rely on secure web connections marked by web site certificates for encrypted HTTP traffic. A 2018 F5 study conducted with Webroot data determined that 68 percent of active malicious sites used https. A big driver for phishing sites in particular to adopt web certificates is that the displayed green lock can give phishing sites false credibility. This project investigates if it is possible to detect suspicious connections by inspecting certificate fields. This process could establish a reputation for each certificate, which would greatly enhance threat intelligence for encrypted connections.

Computer Science/Physics Clinic

HRL Laboratories LLC | Shan 2450

Using Machine Learning to Automate the Tuning of Electrostatically Defined Quantum Dots
Liaisons: Seán Meenehan ’08, Emily Pritchett
Advisor: Peter Saeta
Students: Corbin Bethurem (PM-F), Evan Hubinger, John Jeang, Vivian Phun (PM-S)

HRL Laboratories wants to use electrostatically defined quantum dots in order to build qubits for quantum computers. Specifically, HRL Laboratories wants to use a three-dot system with a configuration of one electron per dot. However, the process of tuning up the dots is labor-intensive and extremely slow to do by hand. The goal is to automate the process via machine learning techniques; we use deep reinforcement learning as our machine learning technique.

Lawrence Livermore National Laboratory | Shan 2450

Finding the “Right” Balance for Asymmetric Lipid Bilayers
Liaisons: Drew Bennett, Tim Carpenter, Helgi Ingólfsson
Advisor: Peter Saeta
Students: Madison Blumer (PM-S), Sophia Harris (PM-F), Mengzhe Li, Luis Martinez, Michael Untersiner

Lawrence Livermore National Lab's Biochemical and Biophysical Systems Group uses molecular dynamics simulations to study how lipid bilayers interact with drugs. The two leaflets of bilayers in real cells have different composition, but most simulations have used symmetric bilayers to avoid unrealistic stresses in the bilayer. Our project aims to develop a method to determine how many lipids to include in each leaflet of an asymmetric bilayer simulation to produce stress-free membranes.

McKay Brothers | Shan 3425

Characterization of HF Radio Use in the Financial Markets
Liaison: Daylan Benner ’00
Advisor: Qinmin Yang
Students: Jonah Cartwright (S), Ryan Haughton (TL-F), Kai Kaneshina, Aaron Lutzker (TL-S), Jesus Solano, Reynaldo Farias Zorrilla (F)

In order to design a system to record and analyze radio transmissions in the HF band, the team will use a software-defined radio in conjunction with GNU Radio to develop a modular and automated program to identify and characterize interesting signals and record pertinent information in real time. The team will build out a robust signal processing flow in GNU Radio to help classify and correlate signals coming from the same transmitter.

Meggitt Control Systems | Shan 2454

Pressure Regulator Redesign
Liaisons: Mark Abrams, Leo Leyanna
Advisor: Mary Cardenas
Students: Maggie Gelber (TL-S), Danielle Michaud (F), Kyle Miller (S), Reese Peterson (F), Bella Puentes (TL-F), William Teav, Flora Xia (S)

Meggitt Control Systems designs and develops aerospace components such as pressure-regulating valves for aircraft systems. The Meggitt Clinic team was tasked with redesigning an environmental control system pressure regulator subassembly to address known failure modes. The team was encouraged to pursue novel designs, and three promising alternatives were built utilizing innovative configurations of bellows, levers and diaphragms to regulate pressure. The team evaluated designs based on test data and metric performance, and recommended a final design for Meggitt to pursue.

Millennium Space Systems, a Boeing Company | Shan B-470

3-D Satellite Missions Visualizer
Liaisons: Tom Chrien, Ari Stern
Advisor: Ruyu Wang
Students: Ankoor Apte (TL-S), Russell Bingham (S), Charles Dawson (TL-F), Spencer Rosen (F), Curtis Shinn

Millennium Space Systems is an end-to-end space mission solutions provider, and they use visualization tools at every stage of a program to communicate their ideas to their customers. To supplement existing two-dimensional visualization tools, we will design a three-dimensional display for rendering complex satellite operations in Earth’s orbit, helping Millennium better communicate their mission proposals to their customers.
**Lawrence Livermore National Laboratory | Shan 1480**

**Ubiquitous Nuclear Threat Detection Campaigns**

Liaisons: Simon Labov, Mateusz Monterial
Advisors: Ziyad Duron ’81
Students: Richie Harris (S), David Linn (F), Juliette Martin (F), Scott Montague (TL-S), Josh Morgan (F), Tim Player (S), Lydia Sylla (TL-F)

The Clinic team is challenged with designing, building and testing a measurement campaign procedure to create data sets for ubiquitous nuclear detection performance analysis. The team has completed this goal by implementing a scavenger/puzzle hunt event run using an Android app that was developed to support deployments. The team has run several deployments in the local area that have generated data sets that contain precise location data, simulated unknown radioactive sources, and large area coverage.

**Leidos | Shan 1480**

**System on Chip Development for Future Embedded Systems**

Liaisons: Alric Altop, Trevor Gile ’03
Advisors: David Harris
Students: Jordan Abrahams, Noah Boorstin (S), Derrick Chun (TL), Veronica Cortes (F), Will McDonald (F), Jonathan Schallert (S)

The Leidos Clinic team built a character recognition neural network application on Leidos’ prototype System on Chip (SoC) device. The application was tested for accuracy and performance on an FPGA-based prototype system. The application showcases the processing capabilities and reprogrammability of the SoC, which are both important features for potential customers. The team demonstrated SoC performance by processing 28x28 pixel grayscale images at a rate of more than 1,270 megapixels per second. Additionally, lessons learned during the team’s development process informed Leidos on how to facilitate future application development.

**Locally Grown Power | Shan B-480**

**Local Factory Startup**

Liaisons: Mike Caldwell, Devon Hartman, Kent Kernahan
Advisors: Kash Gokli
Students: Jacquelyn Aguileras (TL-F), Giulia Castelberg, Priscilla Chu, Christopher McElroy, Nate Smith (TL-S)

Locally Grown Power (LGP) is a start-up creating replicable, non-profit solar panel factories. The pilot factory will open in Pomona, California, and aims to promote economic and environmental change by installing 6,000 solar systems on low- to mid-level-income households. The team is tasked to design a world-class solar panel factory by producing an optimal plant layout, outlining detailed workstations, and determining specific machines, tools and equipment.

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**Engineering Clinic**

**AT&T | Galileo-Pyne**

**Perceptual Video Quality Measurement and Analysis**

Liaisons: Ross Castillo, Harrison L. Hays V, Peshala V. Pahalawatta
Advisors: Timothy Tsai
Students: Alex Chang (S), Kanca Gilliland (F), Anant Kandori (S), Tianyi Ma (TL-F), Sati Smyth (TL-S), Emmanuel Solom (FE-F), Rebecca Wroblewski (F)

AT&T currently determines video streaming quality through expert opinion. The project streamlines this process with a data collection application and analysis tool. These applications allow AT&T experts to collect data from consumer-level users and analyze this information to determine optimal streaming parameters that maximize perceptual video quality while reducing cost. In building the analysis tool, the team investigated the connection between consumer-level preferences and objective video data to predict optimal streaming parameters based solely on objective metrics.

**ATI Metals | Shan 2465**

**Classification of Metal Powders for 3-D Printing**

Liaisons: Dr. Nicholas Cunningham, Dr. Noah Phillips ’03
Advisors: Leah Mendelson
Students: Lukas DeSimone, Matthew Huerta (TL-S), Mario Jurand (F), Lisa Mattson (TL-F), Max Tepermeister (S), Andrea Vasquez

ATI Metals is a premier manufacturer of specialty metal alloys and components. The ATI Metals Clinic team was tasked with designing, building and testing a laboratory scale inert gas classifier to remove fine particles less than 25 μm from their metal powders that ultimately will be used to 3-D print metal components. The design of the device relies on the Coandă effect to separate particles at a specified cut point.

**City of Hope | Shan 2465**

**Arm Movement Sensing Device for Tele-Rehabilitation (Solving Disparity of Care Through Technology)**

Liaisons: Yuman Fong, Jennifer Hayter, Sherry Hite, Lily Lau Lau, Sorena Nadaf, Amy Polverini, Katharine Schulz-Costello
Advisors: Leah Mendelson
Students: Ronak Bhatia (TL-S), Siddharth Chandra (S), Marisol Guzman, Wilson Ives (S), Darien Joso (TL-F), Josephine King (F), Ewan de la Musse (FE)

Rehabilitation following breast cancer surgery aims to increase the functional progress of patients and avoid long-term disability. However, financial and logistical obstacles limit patients’ access to rehabilitation services. The City of Hope Arm Movement Tele-rehabilitation team (COH-AMT) is creating a wearable system and companion mobile application to better connect patients to their medical professionals thereby increasing access to therapy for patients.

PM (project manager); TL (team leader); F (fall); S (spring); FE (foreign exchange student)
Doosan Bobcat | Shan B-480 (Recital Hall)  
**GPS-Denied Localization and Navigation**  
Liaisons: John Pfaff, Jonathan Roehr  
Advisor: Yize Chang  
Students: Felipe Borja, Skipper Gonzalez (TL-S), John Lee, Max Maleno (F), Aom Pongpiriyakarn (S), Jingnan Shi (TL-F)  

Doosan Bobcat's R&D group has taken focus in recent years on developing an autonomous loader. Due to a reliance on GPS, the current system is restricted to the outdoors. To extend indoors, our Clinic team has designed and implemented a system for both localizing and navigating a mobile loader in a GPS-denied environment. Our work focused primarily on finding an alternate means of positioning as well as finding techniques for path-planning and object detection for both the indoor and outdoor systems.

**Fresno Metro Black Chamber of Commerce (FMBCC) | Shan B-445**  
**Fresno Air Quality Monitoring and Mapping**  
Liaisons: Tara Lynn Gray, Kaya Herron  
Advisors: Leila Hawkins, Tanja Srebrotak  
Students: Sidney Cozier (TL-F), Eliana Goehring, Simone Griffith (TL-S), Jakim Johnson, Kaitlyn Loop

Fresno is one of the most polluted and underserved communities in California. The Fresno Metro Black Chamber of Commerce is partnering with local organizations and the Transform Fresno Climate Communities Collaborative to clean the air in downtown, Chinatown and southwest Fresno with new infrastructure. Our Clinic team is implementing low-cost sensors throughout the area, visualizing the fine particulate pollutant concentration and publishing our findings so the community can understand where problem areas still exist and how infrastructure is changing their air.

**Georg Fischer Signet | Shan B-470**  
**Non-Contact Level Sensors: Benchmarking Methods and Developing Prototypes**  
Liaisons: Kamran Afshari, Chuck Gerner, David Kwan '18, Steven Wells  
Advisor: Ruye Wang  
Students: Sabrina Chang, Eric Contee II (TL-S), Benjamin Iten, Elizabeth Poss, Gabriel Quiroz (TL-F)

The Georg Fischer Signet Clinic team has implemented a prototype for a low-cost noncontacting level sensor with Bluetooth capability to augment Georg Fischer's current sensor suite. The prototype utilizes frequency-modulated continuous wave radar to conduct range measurements and is robust to obstructions that may be present in the industrial tank environment. The team benchmarked competitor's sensors to quantify performance of the prototype as well as measurement quality relative to devices already in the field.

**GKN Aerospace | Shan 2421**  
**Modeling Resistivity Grading on Aircraft Transparencies**  
Liaisons: Kintesh Patel, Philip Sturman  
Advisor: Anthony Bright  
Students: Hanna Ching (TL-F), Nicholas Draper (TL-S), Roger Hooper, Gregory Pagani (S), Andrew Pham (F)

The GKN Aerospace Clinic team at Harvey Mudd College has been tasked with developing a thickness variation calculation software to aid in the manufacturing of conductive films on aircraft transparencies. This software will help GKN Aerospace determine the relationship between the thickness of these conductive films and how much heat they produce when a voltage is applied to them.

**HP Inc. | Shan 2440**  
**Improving LFA and ELISA Workflow with Printing**  
Liaisons: Beverly Chou, Brian Keefe, Anita Rogacs, Adam Weisman  
Advisor: Elizabeth Orwin ’95  
Students: Celeste Cerna (F), Matthew Crane (F), Solhee Kim (S), Bethany Reim, Taylor Sloop (S), Melissa Spangler (TL-F), Angela Sun (TL-S)

Immunodiagnostic assays are a collection of techniques designed for detecting and quantifying biological molecules such as, proteins, peptides, hormones, etc. In immunodiagnostics, immunoglobulins (antibodies) are used to selectively bind specific biological markers that are indicative of a biological state or condition. The goal of this project is to determine if the dispensing of reagents can speed up and simplify the preparation and workflow of customized immunodiagnostics, focusing specifically on enzyme-linked immunoabsorbent assays (ELISAs) and lateral flow assays (LFAs).

**Intuitive Surgical | Shan 2440**  
**Laparoscopic Camera Test Fixture**  
Liaisons: Diana Friedman ’04, Krithika Muralidharan  
Advisor: Angela Lee  
Students: Jacob Garcia, Sabrine Griffith (F), Ice Lim Chantra (TL), Victoria Marino (S), Greg Murphy (S), Ellie Naudzius (F), Hiroki Ohara (FE-S), Freddie Simental (F)

Laparoscopic cameras are used to visually aid surgeons during minimally invasive robotic surgeries. The Clinic team designed and built an automated life-test system for a third party laparoscopic camera. The final designs for testing each subsystem of the camera were integrated into one overall system that conducts adaptive tests. This automated system aims to decrease technician involvement and reduce human error in determining failure metrics.