Paul M. Khoury

A personal engineering portfolio webpage inspired by Wikipedia, the free encyclopedia.

Contents

Paul Khoury a fourth-year Mechanical Engineering student at RPI with a passion for developing technologies that have a meaningful, positive impact on people's lives.

Focus areas:

- Surgical Robotics
- EMG-controlled robotic prosthetics
- Assistive Tech
- Medical device automation manufacturing

This desire to develop life-enhancing technologies as an engineer has guided and continues to guide his career trajectory.

Paul Khoury

Born: 2004 (age 21)

Hometown: Brooklyn, NY

Education:
Rensselaer Polytechnic Institute (B.S. Mechanical Engineering, Cognitive Science minor)

Website:
khourypaul.com

Experience

- **R&D Intern – Limbitless Solutions** – Designed wearable vibrotactile arrays for pediatric prosthetics; wrote human-subjects protocol and presented findings.
- **Co-op Engineer – Medline (NAMIC Division)** – Built custom automation systems, improved cleanroom compliance, enhanced safety, and resolved product performance issues.
- **Undergraduate Researcher – RPI LACEs Lab** – Modeled pelvic fractures to evaluate efficacy of surgical screw fixtures in collaboration with a phhysician.

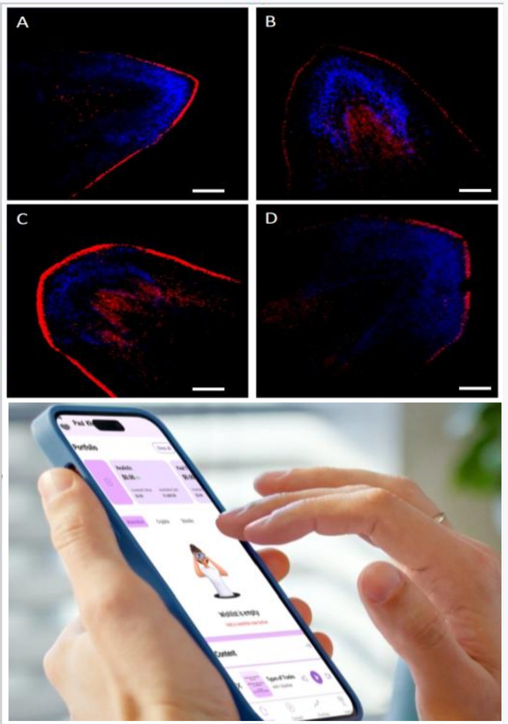
Image Sources: Limbitless (top), Medline Namic (bottom).

Experience

- **Laboratory Intern – NYS Institute for Basic Research** – Automated assays with Arduino and studied neurodevelopmental impacts of toxins and psychoactive compounds.

- **Product Team Lead – Zalpha** – Directed UX design and testing for an investing education mobile app.

- **Student Research Participant – Weill Cornell Medicine** – Supported genomic research on Covid-19 and Alzheimer's, analyzing disparities in carcinogen exposure.



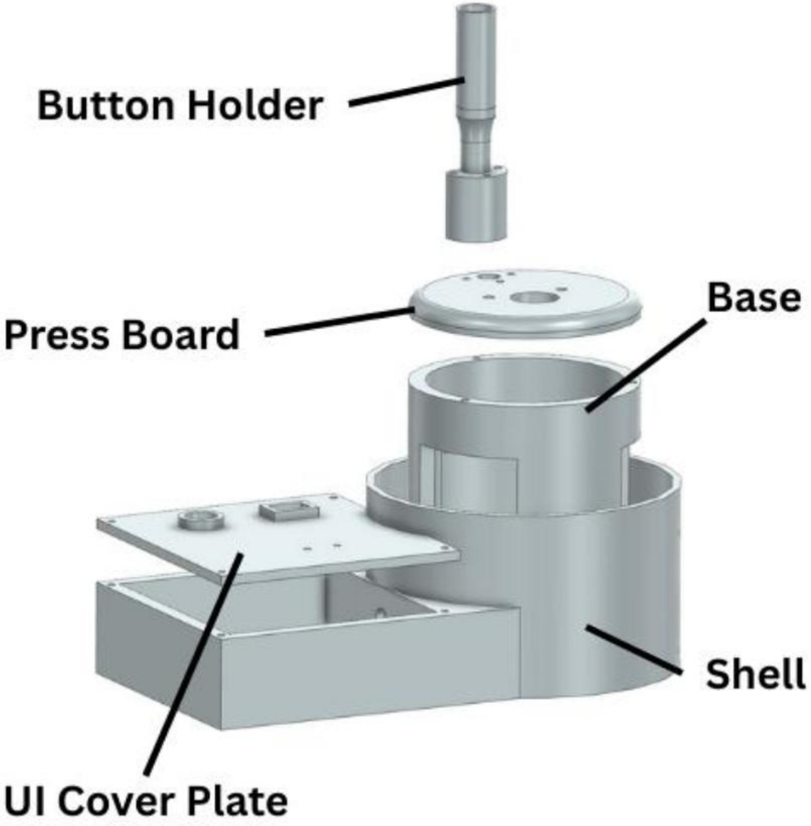
From top to bottom: Confocal microscope imaging reveals elevated neural activation in planarian worms after exposure to novel social stimulae; mockup of app including real screenshot of homepage.

This presentation's styling and layout were inspired by Wikipedia. This portfolio is intended as a tongue-in-cheek homage and is not affiliated with Wikipedia or the Wikimedia Foundation.

Projects

Mechanical Design + CAD with SolidWorks/NX (1 of 4)

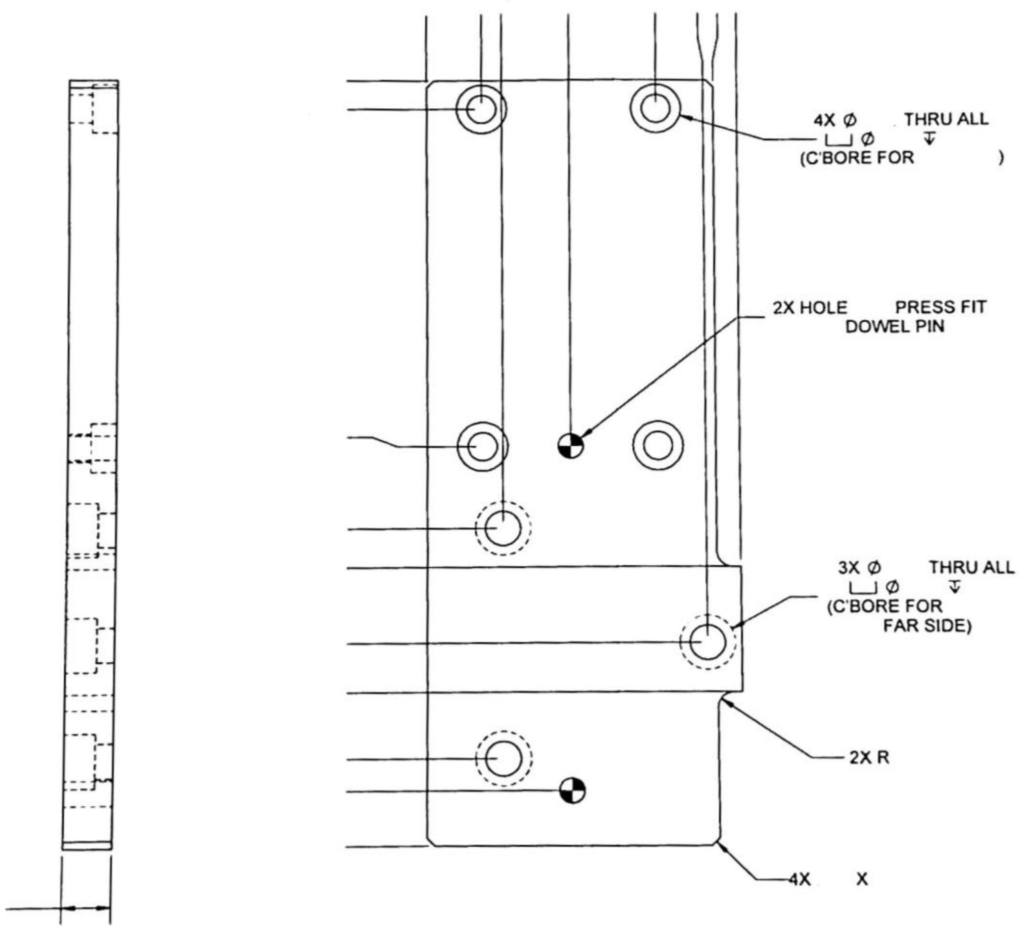
- Automated brush system for removing debris from inside of silicone mask
- CAD model (right) and physical prototype (left)



Projects

Mechanical Design + CAD with SolidWorks/NX (2 of 4)

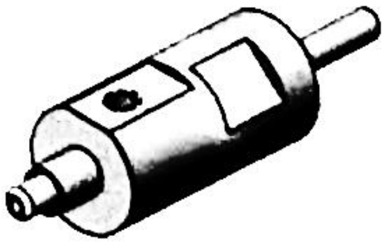
- Plate Fixture
- Sensitive dimensions and drawing template have been omitted

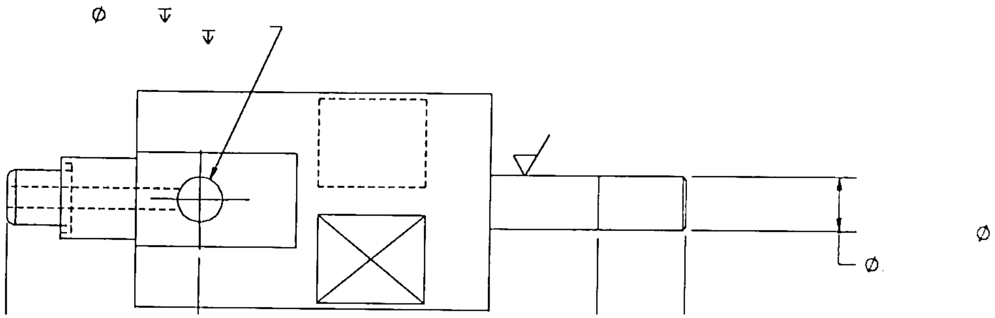


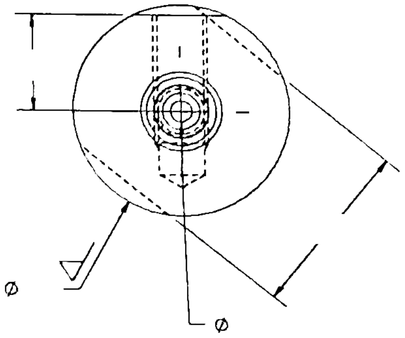
Projects

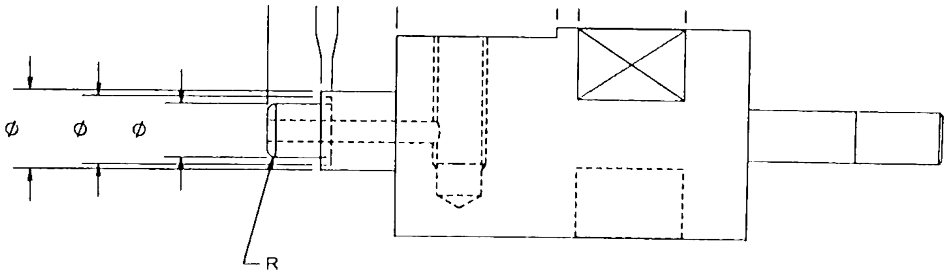
Mechanical Design + CAD with SolidWorks/NX (3 of 4)

- Attention to Design for manufacturing principles
- Machine part reverse-engineering + redesign





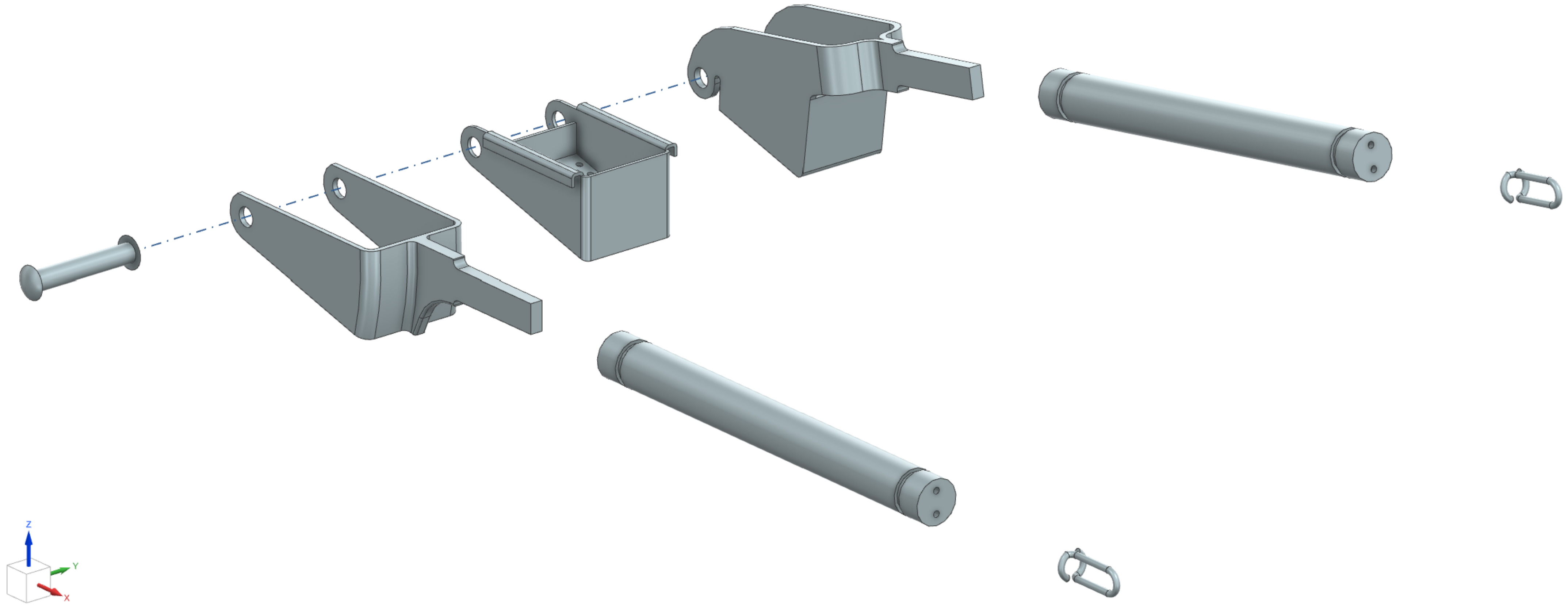




Projects

Mechanical Design + CAD with SolidWorks/NX (4 of 4)

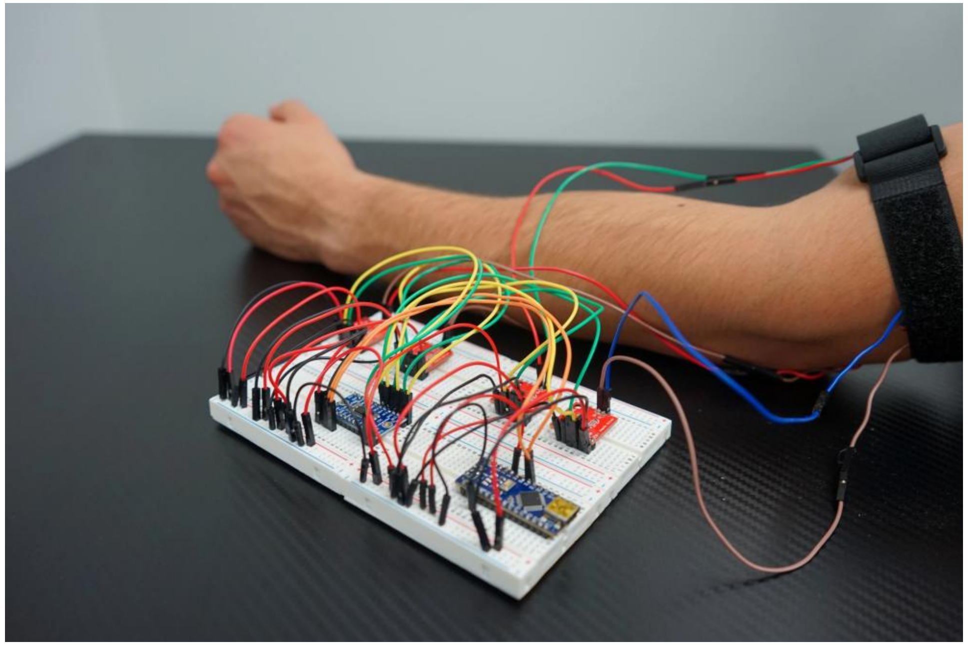
- Garlic press assembly

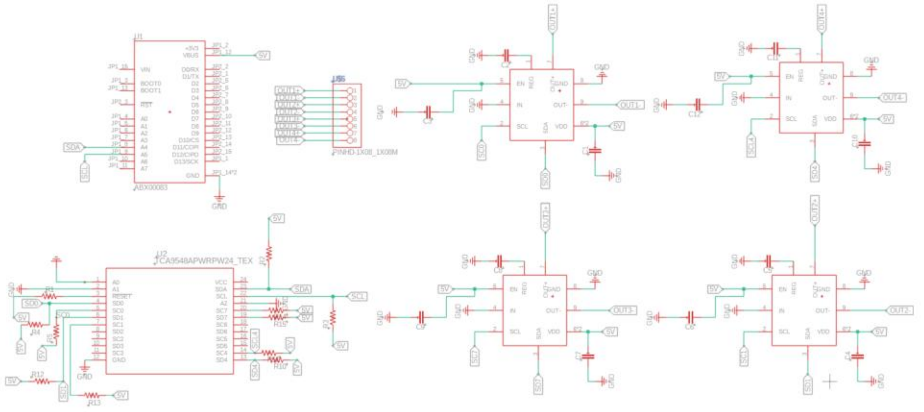


Projects

Haptics Project (1 of 3)

- Designed a vibrotactile feedback armband for pediatric prosthetic users to convey touch and contact events.
- event-driven control using motor current data to trigger spatially mapped vibration cues.
- Evaluated signal localization and mapping accuracy to improve intuitiveness and user awareness.





Projects

Haptics Project (2 of 3)

Design of a Haptic System for Sensory Feedback in Pediatric Prostheses

Paul Khoury
Limbitless Solutions Inc.
University of Central Florida, Orlando, FL

Abstract

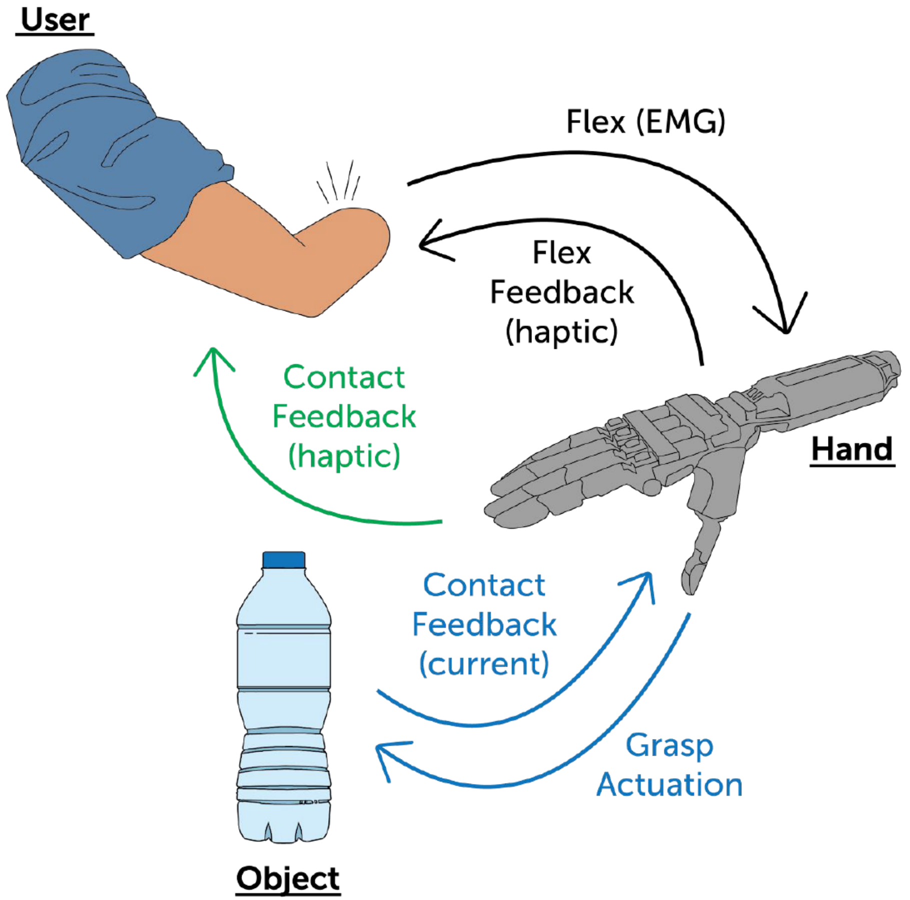
Children with congenital limb differences often experience high prosthesis rejection rates due to limited functionality and lack of sensory feedback. Additionally, they often face difficulties interacting with their environment, particularly dexterous object manipulation and touch-based exploration. This creates a need for prosthetic systems that provide tactile information. This project proposes a vibrotactile array that provides intuitive sensory feedback to users of the Limbitless prosthetic arm. The design aims to communicate to the user when the fingers of their prosthetic arm make contact with an object or surface. The system circumvents the need for additional sensor hardware by inferring contact from the motors' current draw. Upon contact, the system delivers brief vibrotactile cues to the user, adhering to an event-driven sensory feedback control (DESC) paradigm. Vibrations are produced by an array of four vibration motors arranged circumferentially around the upper arm, preserving the spatial dimensionality of the information. Testing will consist of a two-part study evaluating participants' ability to (I) localize haptic signals—identifying which motors on the armband are active at a given time—and (II) interpret vibratory stimulation on the arm as corresponding to stimulation of predefined regions of the hand. These assessments will gauge the prototype's effectiveness in delivering intuitive sensory feedback for prosthetic applications and inform future design iterations. High accuracy in distinguishing signals is anticipated, consistent with findings reported in related studies. However, successful interpretation of the spatial mapping may require cognitive restructuring and training.

Table 1: Summary of Relevant Haptic Feedback Studies

Reference	Modality	Info Conveyed	Array Dim.	Config.	Location	Relevant Findings
Witteveen et al., 2012 [20]	Vibrotactile	Grasping Force/Slip (Progressive Spatial Encoding Scheme)	1×8	Circumferential	Forearm	Improved performance in virtual object holding task.
Van der Riet et al., 2013 [6]	Vibrotactile	Intensity, Modality	1×4	Circumferential	Upper Arm	High spatial and intensity discrimination; lower accuracy with more channels.
Witteveen et al., 2015a [21]	Vibrotactile	Grasping Force	1×1	Single Actuator	Residual limb	No significant difference compared to circumferential linear array.
Witteveen et al., 2015b [21]	Vibrotactile	Grasping Force/Hand Aperture	1×8	Circumferential	Forearm	Improved grasping performance vs. no-feedback.
Kerdegari et al., 2016 [19]	Vibrotactile	Directional (Progressive Spatial Encoding)	1×7	Horizontal	Forehead	Head-mounted displays intuitive for navigation; high accuracy.
Clemente et al., 2015 [5]	Vibrotactile	Contact	1×2	Effectively single motor	Upper Arm	Useful for fragile object manipulation; stimulation site may not be important.
Guemann et al., 2019 [22]	Vibrotactile	Unmapped	1×6	Circumferential vs. Longitudinal	Upper Arm	Circumferential config. w/ prop. spacing best for discrimination; shorter pulses reduce discomfort.
Antfolk et al., 2013 [23]	Vibro vs. Mechanotactile	Force, Spatial	1×5	U-shape	Forearm	Mechanotactile outperformed vibrotactile in spatial discrimination.
Erbas & Guclu, 2024 [24]	Vibrotactile	Intensity, Modality	Dual 1×2	Horizontal	Upper Arms	14 discrete events recognized with low-medium accuracy.
Besharatzad et al., 2024 [25]	Vibrotactile	Force	1×2	Multi-motor (nominal)	Upper Arm	Amputee reached 93.3% accurate force control with training.
Xu et al., 2024 [26]	Vibrotactile	Pressure, Spatial, Symbolic	1×5	Circumferential	Upper Arm	High accuracy in dynamic/static discrimination; rolling motion conveyed.
Choi & Kim, 2019 [27]	Vibrotactile	Intensity, Spatial	6×8	2D Array	Touch Panel	Beat-phenomenon-based haptics effective for simulating textures.
Jones et al., 2006 [28]	Vibrotactile	Symbolic Navigation Commands	4×4	2D Array	Torso vs. Forearm	Patterns recognized with near-perfect accuracy on torso (forearm).
Jones et al., 2009 [29]	Vibrotactile	Symbolic Navigation Commands	3×3	2D Array	Torso vs. Forearm	Military signals mapped to torso had up to 98% recognition.
Kim et al., 2010 [12]	Multimodal	Contact, Pressure, Vibration, Shear	N/A	Multifunction Device	Not Wearable	Effective texture discrimination; shear increased confusion.
Kyung et al., 2007a [30]	Vibrotactile	Texture	1×1	Single Actuator	Handheld	Reasonably effective in texture display.

Projects

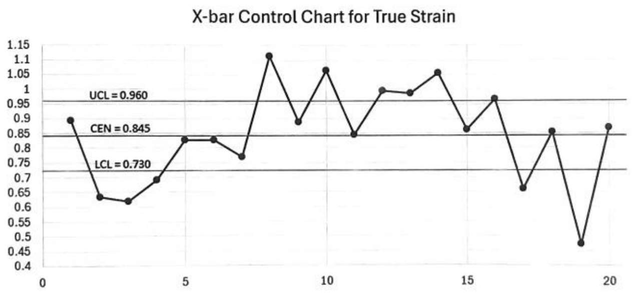
Haptics Project (3 of 3)

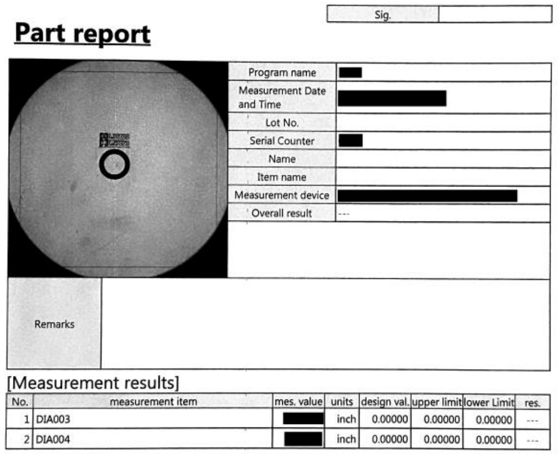


Projects

Six Sigma O-Ring Failure Investigation (proprietary data redacted for confidentiality)

- Tensile testing: extension vs. load, failure strength
- X-bar and normal distribution analysis
- Uncertainty modeling
- Part metrology
- Root-cause identification within Six Sigma framework




Part report

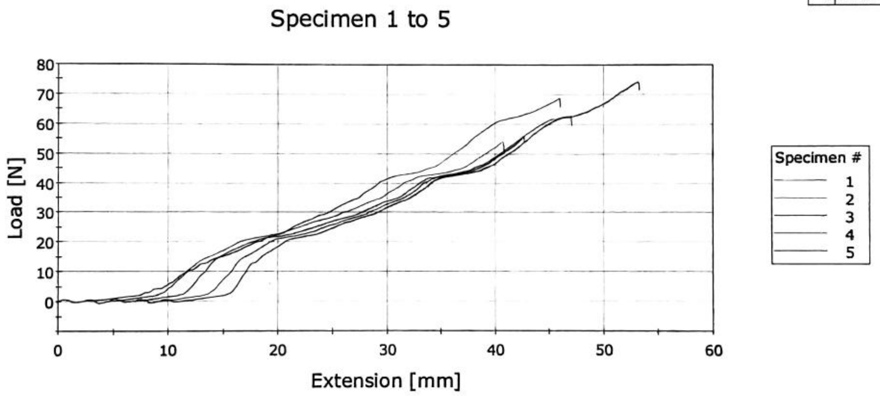
Sig.

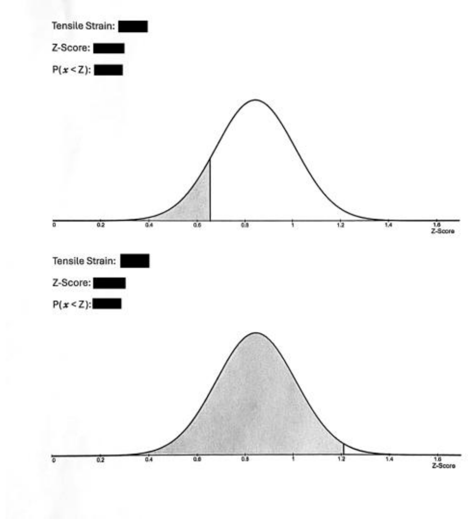
Program name	[redacted]
Measurement Date and Time	[redacted]
Lot No.	
Serial Counter	[redacted]
Name	
Item name	
Measurement device	[redacted]
Overall result	---

Remarks

[Measurement results]

No.	measurement item	mes. value	units	design val.	upper limit	lower Limit	res.
1	DIA003	[redacted]	inch	0.00000	0.00000	0.00000	---
2	DIA004	[redacted]	inch	0.00000	0.00000	0.00000	---

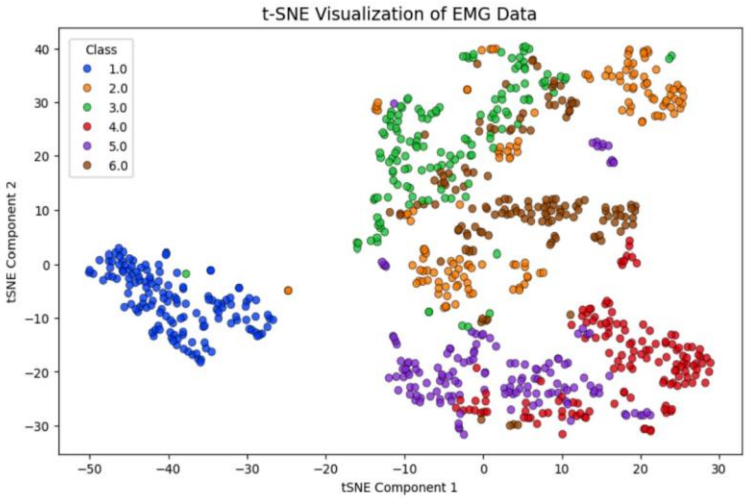


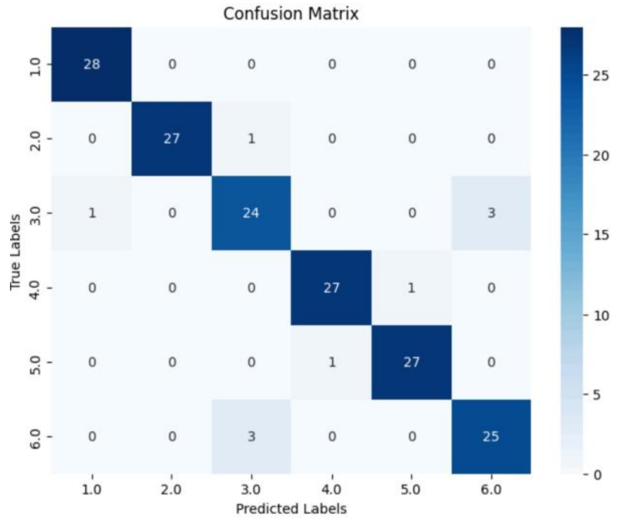


Projects

Predicting User Intent from EMG Signals

- Developed a machine learning system to classify hand gestures from surface EMG data for next-gen prosthetic control
- Processed EMG signals using RMS, MAV, and SSC feature extraction and normalization
- Achieved 94% gesture-recognition accuracy

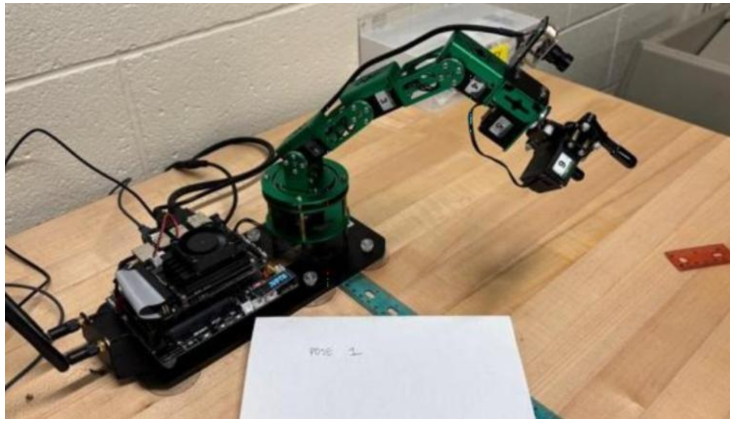




Projects

"Threading the Loop" –
Surgical Skill with Robot Arm

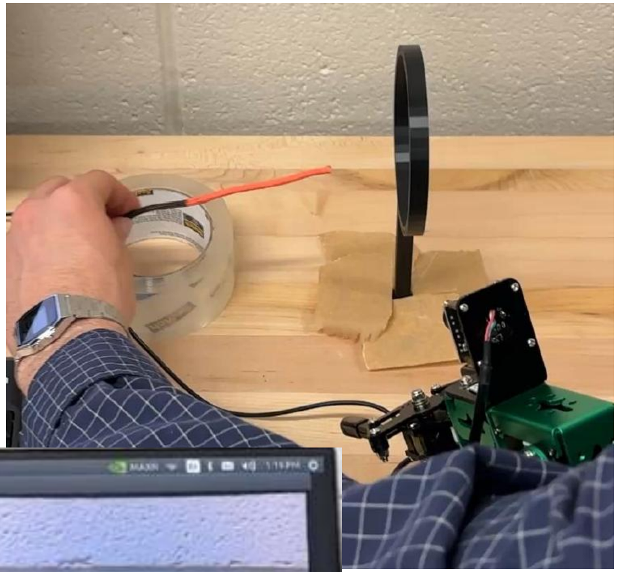
- Programmed a 6-DOF DOFBOT robotic arm to replicate a laparoscopic threading task
- Computer vision enabled thread detection & IK path planning
- Maintained laparoscopic field of view via visual servoing (following string as it moves)



Projects

“Threading the Loop” (Continued)

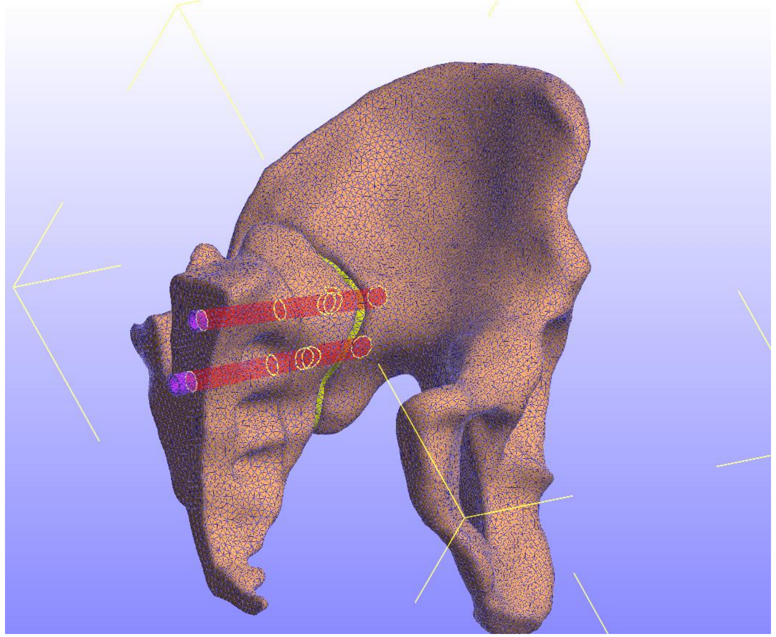
- Spoke to surgical robotics industry professionals to identify identified user needs
  - Assist operation goals by maintaining visualization and providing static retraction
  - Offload low-risk, supportive tasks while keeping all high-stakes decisions for the surgeon
- Used camera calibration, HSV color-based string detection and visual servoing to continuously track and follow the thread in real time
- Confronted hurdles including lens distortion and lighting sensitivity, jerky motion
- Depth perception robustness was the primary performance bottleneck

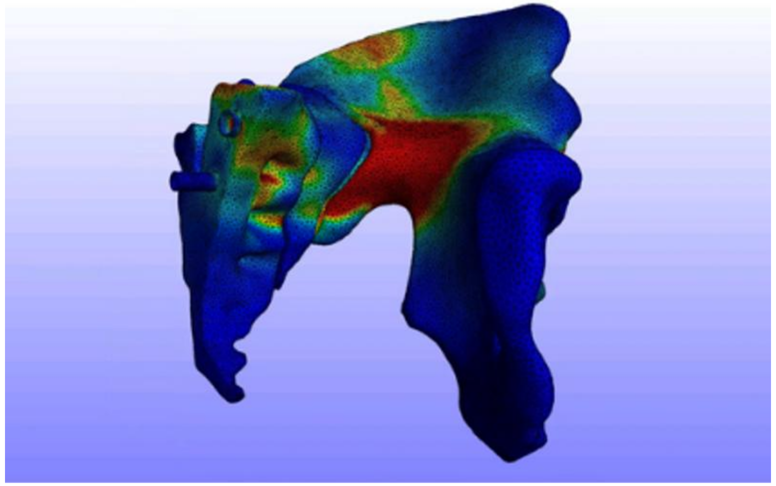


Projects

Finite Element Modeling of Pelvic Fracture Fixation

- Simulated vertical shear fracture stabilization with screws for study
- Collaborated with orthopedic surgeon
- Modeled cortical vs cancellous bone
- Analyzed stress and displacement fields under simulated walking
- Explored effects of screw diameter and placement

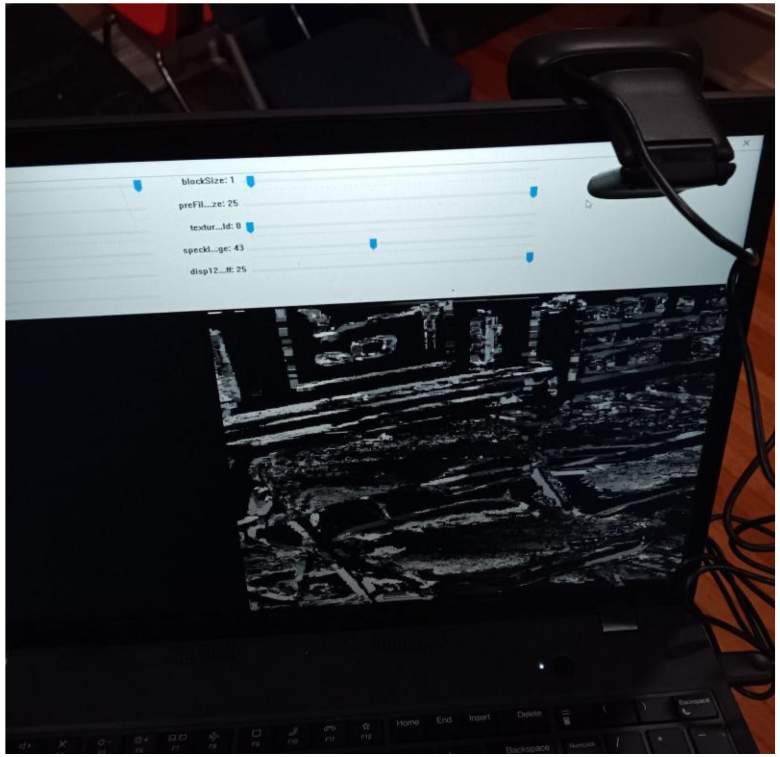




Projects

Project "Read the Room"

- Ambient Feedback Glove for visually impaired
- Mapped stereo vision depth data to a vibrotactile array
- Built with OpenCV, microcontrollers, and dual cameras; performance limited by lighting and surface color
- Explored use of LIDAR
- Submitted to NIH Debut Competition

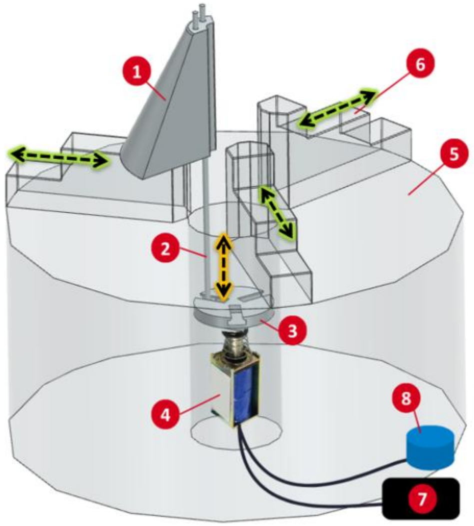


Projects

Senior Capstone: Redesigning VHC Assembly to Eliminate Foreign Object Debris

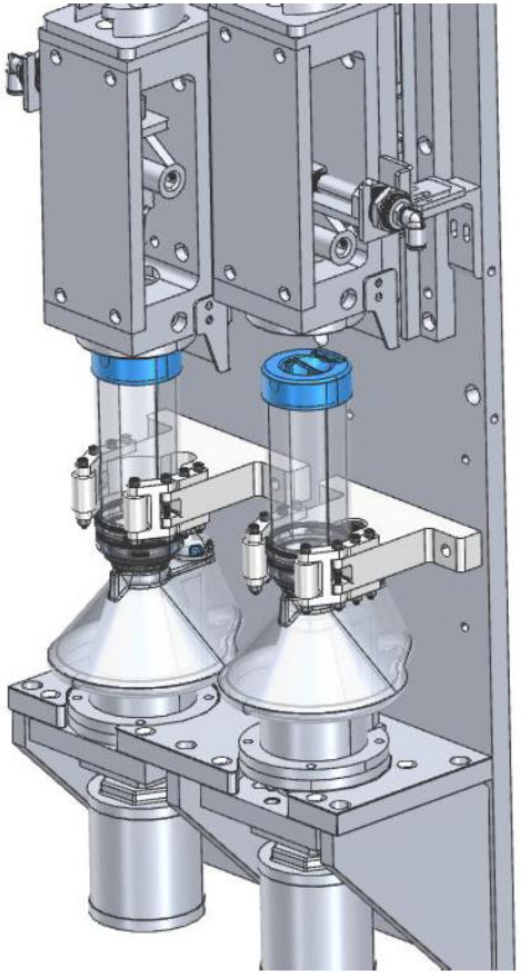
- Problem during pneumatic press-fit assembly of valved holding chambers for asthma inhalers
- Silicone flash sheared off
- Designed and prototyped a multi-layered solution
    - Poka-yoke alignment fixtures
    - Multi-finger Mask expander
    - Suction-based FOD removal as a failsafe

Sponsor: monaghan



Mechanical
1 Fixture Finger Base (3x)
2 Retractable Prong (3x)
3 Track Platform
5 Chuck
6 Chuck Jaw (3x)

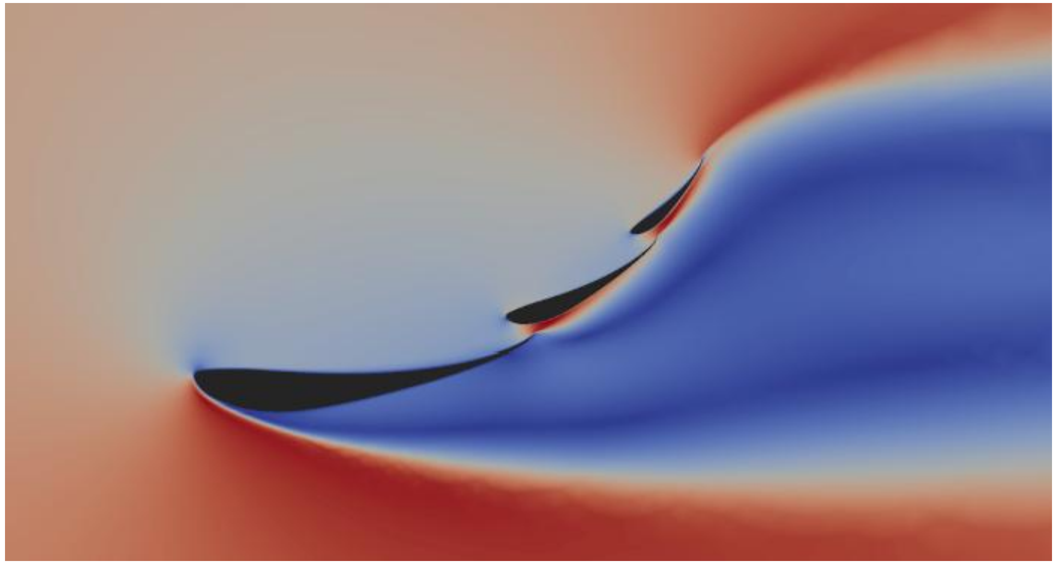
Electrical
4 Push-Pull Solenoid
7 Power Supply
8 Pushbutton

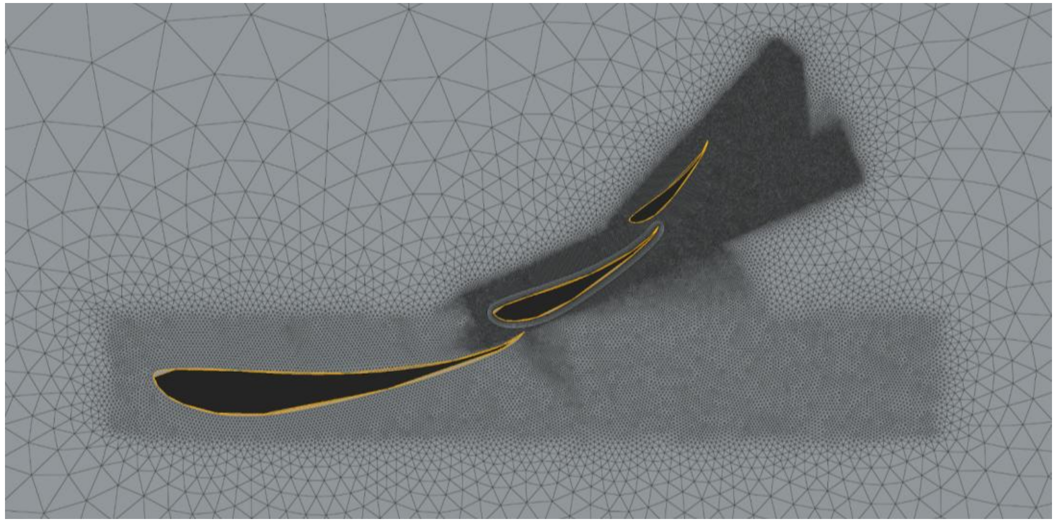


Projects

CFD Analysis of Airfoil

- Simulated airflow over a high-camber Selig S1223 airfoil to evaluate lift and drag characteristics for automotive downforce applications
- Modeled in Altair HyperMesh/AcuSolve
- Achieved converged results consistent with literature values
- Mesh refinement





Art/Just For Fun

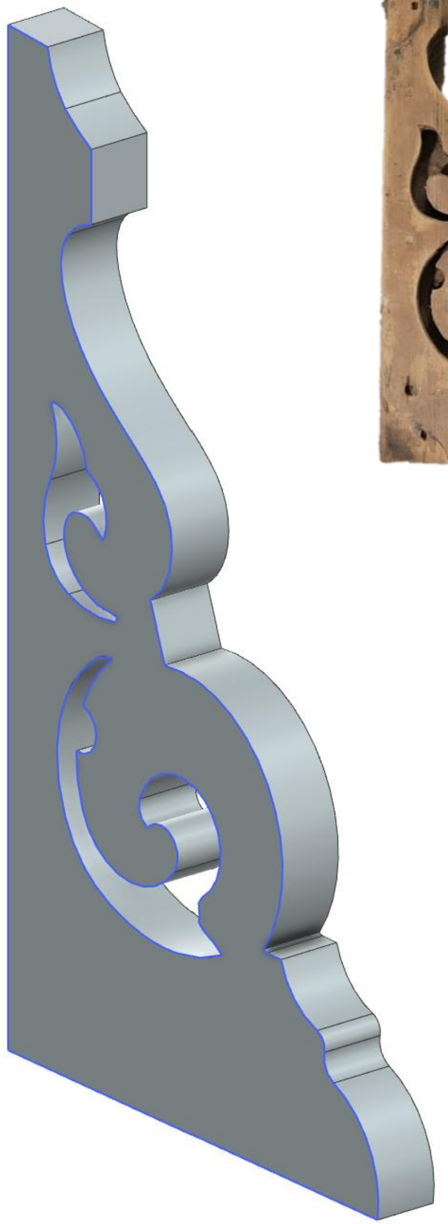
Custom Bronze Medallion

- Medal featured a friend’s likeness and was presented to MVP of our rec league basketball team
- Created the medal from a 3D scan of a human face using open-source photogrammetry software
- Refined model in Meshmixer and CAD
- Prepared mold geometry and cast in bronze to create physical artifact

Art/Just For Fun

Historic Façade Restoration

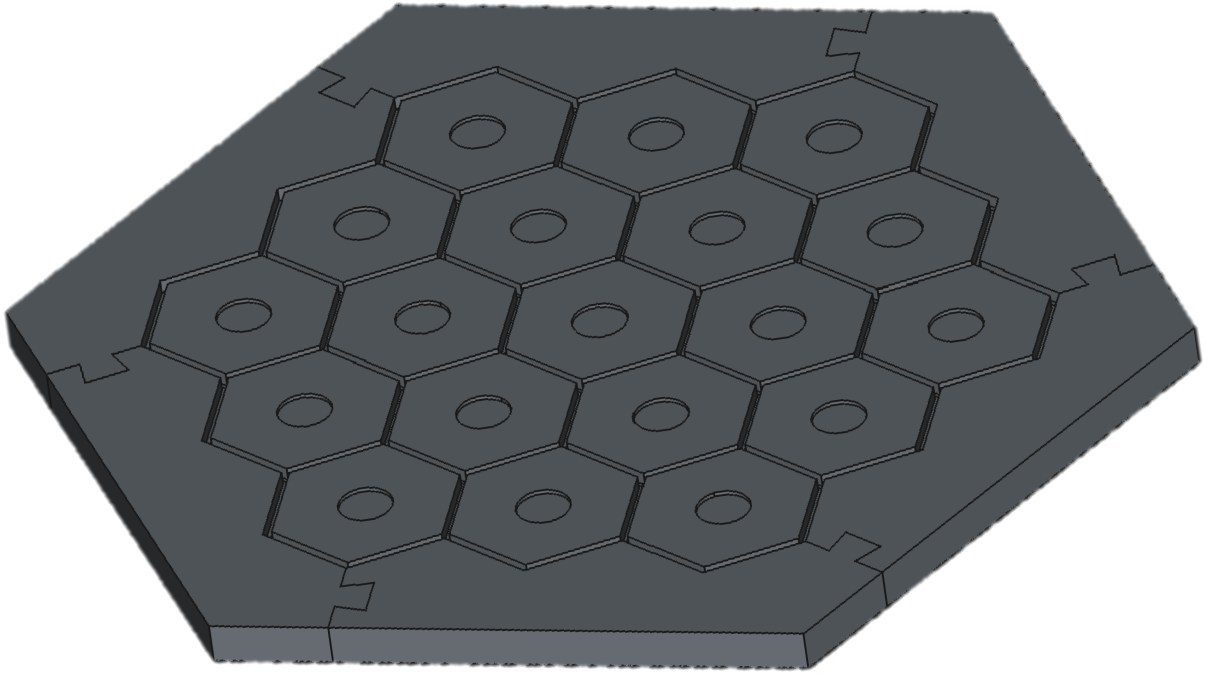
- Historical building in Troy, NY burned in a fire; ornamental wooden brackets supporting the bay windows were partially destroyed
- Used CAD to faithfully recreate the original geometry and CNC-milled replacement brackets from wood
- Preserved local history and vernacular architectural culture



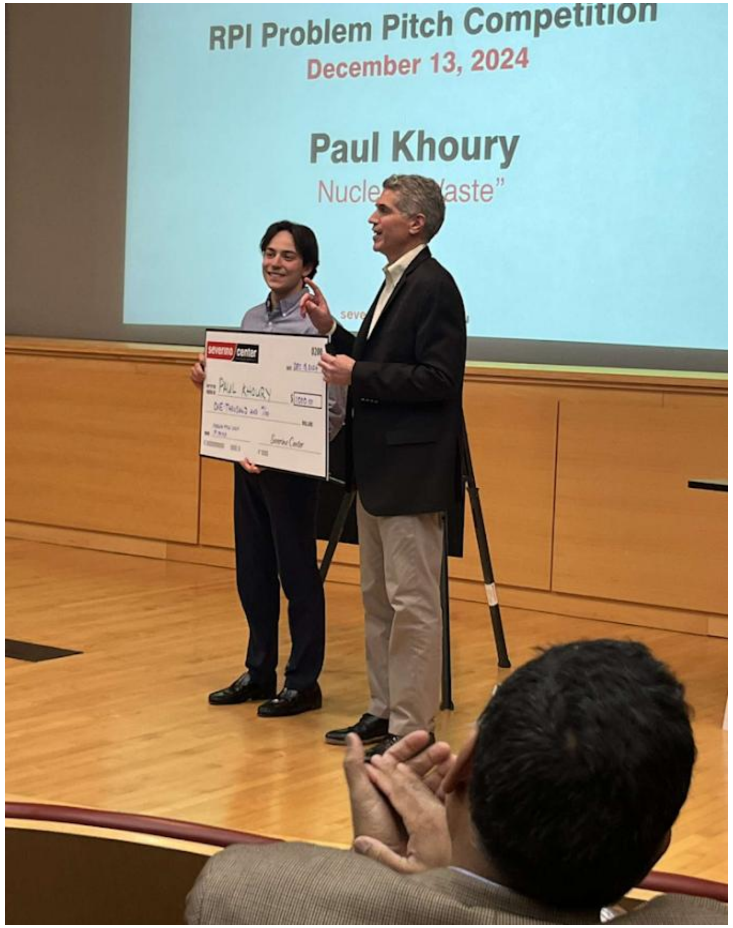
Art/Just For Fun

Catan Board

- Redesigned the *Settlers of Catan* game board
  - Thicker and more rigid tiles
  - Interlocking geometry
  - Roads and settlement pieces click into place, improving stability during play
  - Iterated on tolerances and edge geometry to achieve a snug fit when assembled



Public Speaking



Summary

Paul has worked in settings ranging from medical device manufacturing to computational biomechanics research to haptic system development for EMG-controlled pediatric prosthetics. These roles reflect his focus on patient-centered innovation and advancing healthcare.

EEG Headset in RPI Cognitive Science Dept.

His minor in Cognitive Science—initially a way to explore a secondary interest in linguistics—sparked a deeper curiosity about human-machine interaction and how people perceive, adapt to, and benefit from technologies.

Overall, Paul thrives on learning new tools, software, and hands-on skills, and embraces any opportunity for growth. Beyond engineering, he enjoys mentoring fellow engineers, studying foreign languages, cooking for his roommates, film photography, swimming, and lifting.