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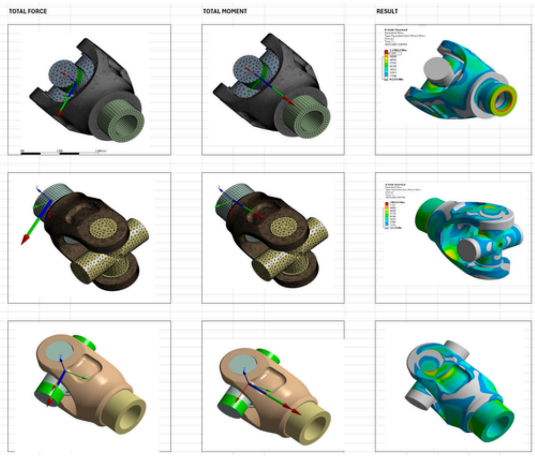
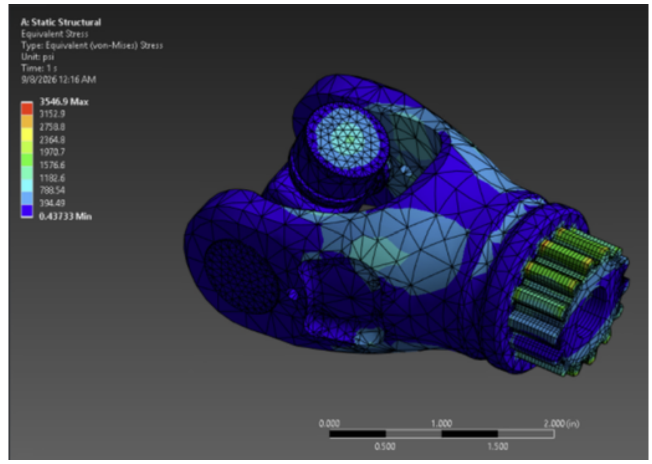
PURDUE BAJA SAE – REAR DRIVETRAIN YOKE REDESIGN & FEA





What?

- Redesigning the rear drivetrain yokes to accommodate an increased spline size and updated packaging constraints.
- Maintaining compatibility with the existing U-joint while ensuring the new geometry can withstand expected vehicle loads.

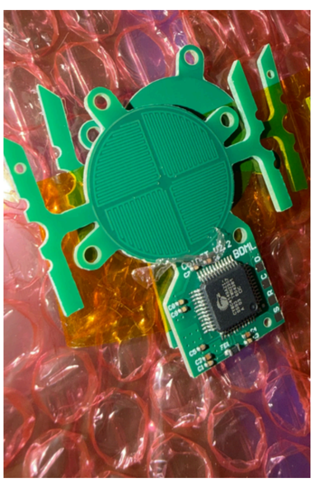
How?

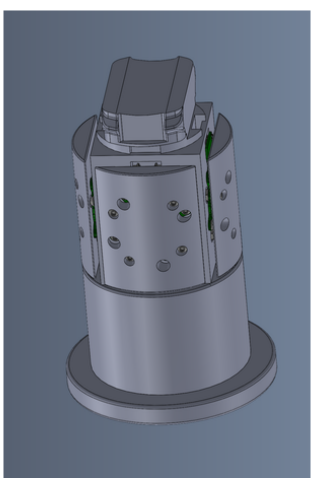
- Created an Excel load-case calculator to document different failure scenarios and determine the forces and moments acting on the yokes.
- Applied those load cases in ANSYS to evaluate stress concentrations, deformation, and factor of safety while iterating the design.

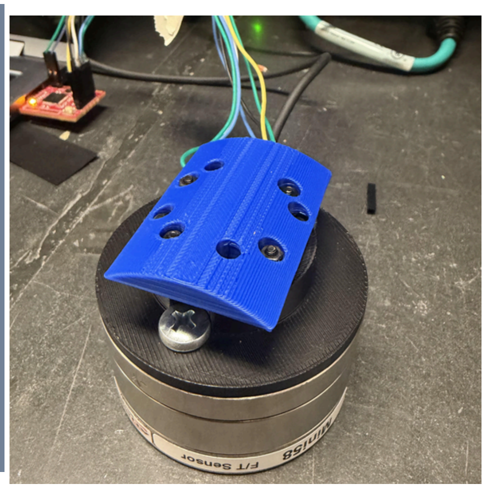
Results

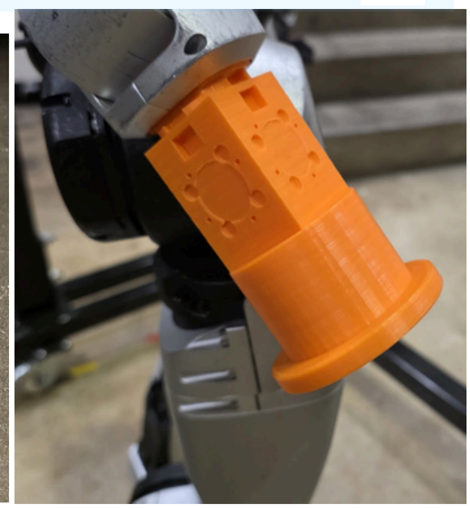
- Used FEA results to identify critical regions and guide geometry changes in the redesigned yokes.
- Validating the final design to a minimum factor of safety of 1.4 before manufacturing.

TRACE ROBOTICS LAB – HUMANOID FORCE & CONTROL SENSING









What?

- Fabricated and integrated CoinFT force sensors onto a Unitree G1 humanoid robot to measure contact forces during physical interaction tasks.
- Designed mounting hardware and the sensing setup to collect repeatable force measurements directly from the robot.

How?

- Wrote calibration code to convert CoinFT sensor readings into force measurements and compare them with an ATI reference sensor.
- Designed calibration and mounting fixtures in SolidWorks to keep the sensor setup consistent during testing.
- Created repeatable ETPs defining how the sensors are mounted, tared, loaded, and tested.

Results

- Integrated the calibrated CoinFT sensors onto the Unitree G1 humanoid robot to measure contact forces during physical interaction.
- Used teleoperated demonstrations with Ψ_0 to collect force and motion data for training a residual control policy.

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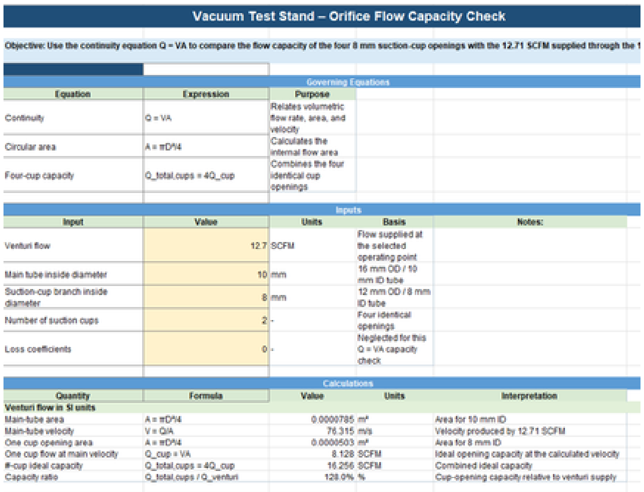
TOYOTA AUTOMATED LOGISTICS – EOAT VACUUM TEST STAND



Vacuum Test Stand – Orifice Flow Capacity Check

Objective: Use the continuity equation Q = VA to compare the flow capacity of the four 8 mm suction-cup openings with the 12.71 SCFM supplied through the 1

Governing Equations

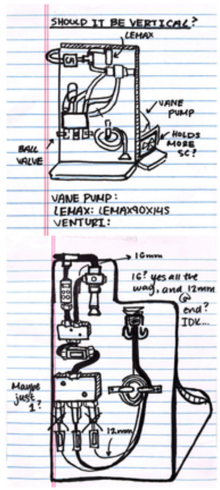
Equation	Expression	Purpose
Continuity	Q = VA	Relates volumetric flow rate, area, and velocity
Circular area	A = πD²/4	Calculates the internal flow area
Four-cup capacity	Q_total,cups = 4Q_cup	Combines the four identical cup openings

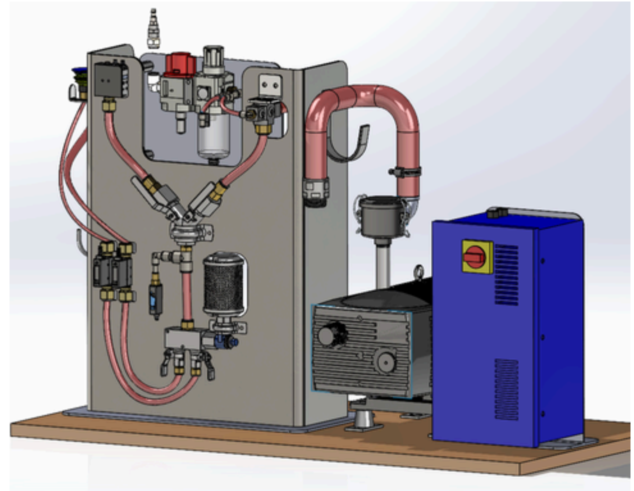
Inputs

Input	Value	Units	Basis	Notes:
Venturi flow	12.7	SCFM	Flow supplied at the selected operating point	
Main tube inside diameter	10	mm	16 mm OD / 10 mm ID tube	
Suction-cup branch inside diameter	8	mm	12 mm OD / 8 mm ID tube	
Number of suction cups	2	-	Four identical openings	
Loss coefficients	0	-	Neglected for this Q = VA capacity check	

Calculations

Quantity	Formula	Value	Units	Interpretation
Venturi flow in SI units				
Main-tube area	A = πD²/4	0.0000785	m²	Area for 10 mm ID
Main-tube velocity	V = Q/A	76.315	m/s	Velocity produced by 12.71 SCFM
One cup opening area	A = πD²/4	0.0000503	m²	Area for 8 mm ID
One cup flow at main velocity	Q_cup = VA	8.128	SCFM	Ideal opening capacity at the calculated velocity
#-cup ideal capacity	Q_total,cups = 4Q_cup	16.256	SCFM	Combined ideal capacity
Capacity ratio	Q_total,cups / Q_venturi	128.0%	%	Cup-opening capacity relative to venturi supply





What?

- Designed a modular test stand to evaluate product porosity, suction-cup performance, and vacuum-system restrictions before EOAT design.
- Supported Venturi, LeMax, and vane-pump configurations with interchangeable cups and fittings.

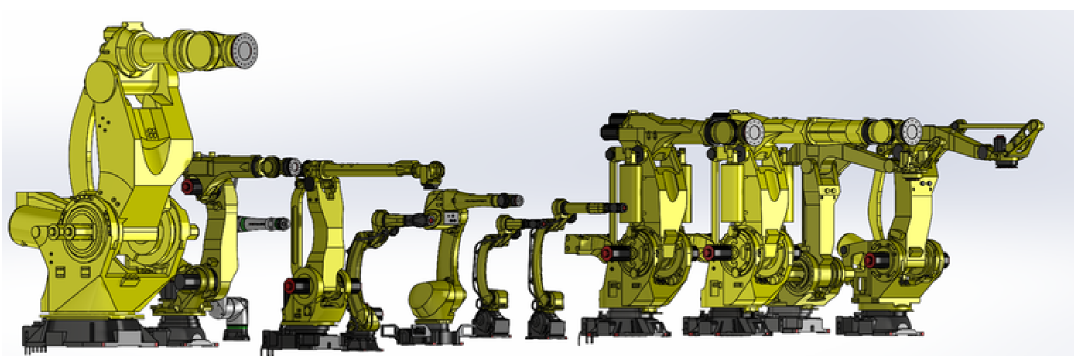
How?

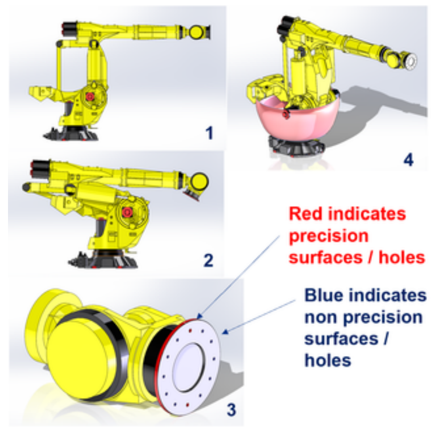
- Built an Excel calculator using first-principles fluid mechanics, including (Q=VA), orifice sizing, and pressure/head-loss calculations.
- Documented assumptions and compared results with vendor data to drive tubing size, component selection, and system layout.

Results

- Reduced typical testing time by ~2 hours and created a repeatable lab setup.
- Used the analysis to identify excessive restriction and increase tubing from 12 mm to 16 mm.

TOYOTA AUTOMATED LOGISTICS – FANUC CAD STANDARDIZATION





What?

- Completely revamped and standardized 12 FANUC robot models for reuse across layouts, EOAT design, simulations, and future engineering projects.
- Converted inconsistent legacy models into a common internal robot design standard.

How?

- Thoroughly reviewed FANUC manuals and specifications to rebuild configurations, interfaces, motion limits, precision surfaces, metadata, and design documentation.
- Updated the PLM system, creating ECOs and standardizing CAD, BOM, and design-journal information for controlled release and future reuse.

Results

- Created a consistent, documented robot library that engineers can confidently reuse across new projects.
- Reduced repeated manual research by embedding key manufacturer and design information directly into the standardized models.

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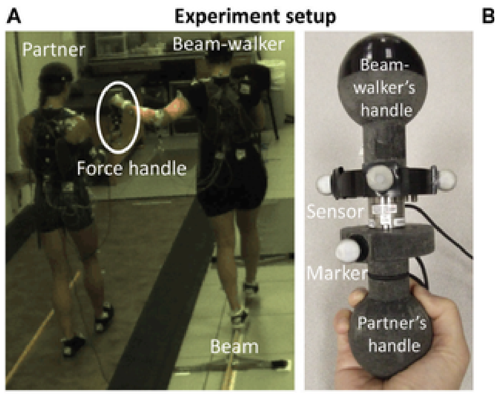
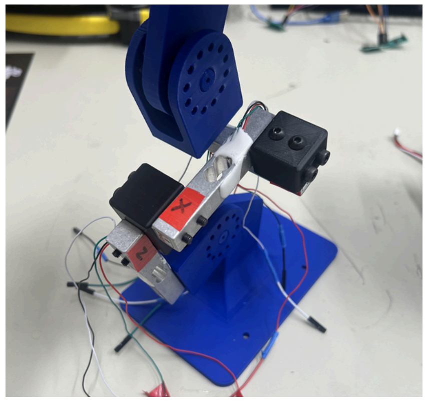
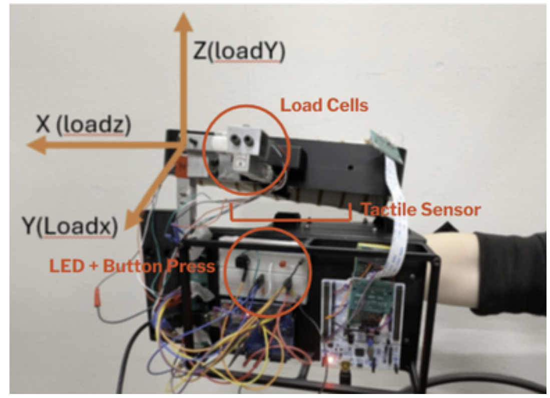
TRACE ROBOTICS LAB – ROBOTICS FORCE-SENSING PLATFORM







What?

- Developed a custom experimental setup inspired by prior research exploring haptic feedback in assistive robotics.
- Aims to evaluate whether haptic cues improve user control and perception more effectively than direct assistive force application.

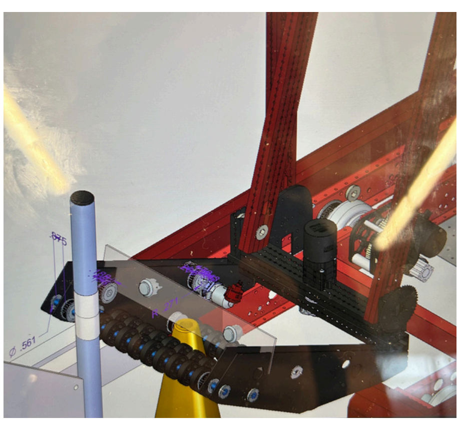
How?

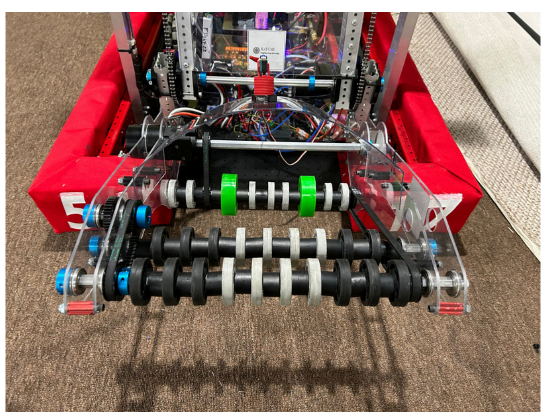
- Utilized three load cells using precision reference masses and custom Arduino-based scripts to gain 3D force data.
- Implemented synchronized data logging with a button-controlled start/stop trigger, ensuring all sensors record simultaneously.
- Integrated tactile sensor to gain grip force data from beam walker needing assistance

Results

- Produced reliable, high-resolution measurements of applied forces across three axes with 95% accuracy across all forces
- Created an automated, replicable platform for future experiments.
- Enabled direct data import into Excel for real-time visualization, modeling, and validation against existing literature.

FIRST ROBOTICS – HEAD OF COMPETITION ROBOT DESIGN





What?

- Designed/built a competition-ready FRC robot for 3 different seasons.
- Developed and tested self made custom intake and manipulation systems using rapid prototyping methods.
- Led a team in CAD modeling, fabrication, and electronics integration.

How?

- Created 3D CAD models and fabricated parts using CNC, 3D printing, laser cutting and welding.
- Optimized design through stress analysis and iterative prototyping.
- Managed robot testing, debugging, and performance tuning.

Results

- Improved robot efficiency, speed, and task accuracy in competitions.
- Designed a modular system for quick adaptability between matches.
- Helped lead the team to multiple competition wins and awards.

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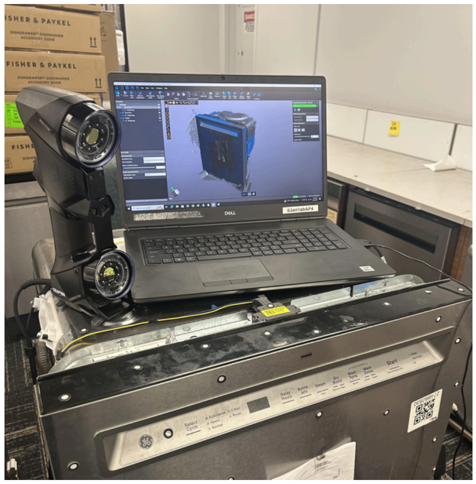
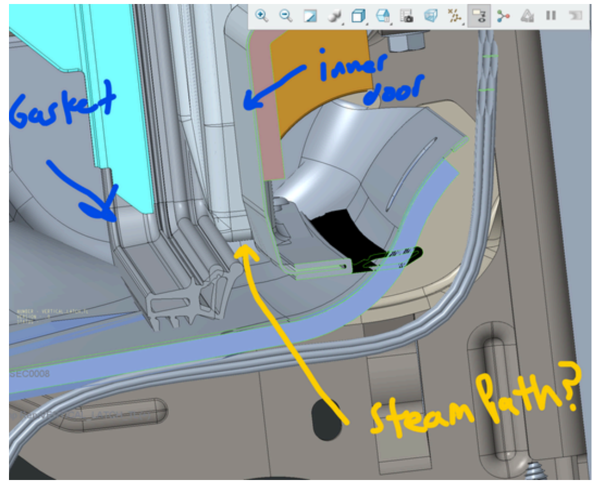
GE APPLIANCES – CONDENSATION ROOT-CAUSE ANALYSIS





What?

- Identified a 10% condensation-related failure rate, costing over $1M in repairs.
- Tested 7-10 units to pinpoint contributing factors.
- Developed an Excel tracker for systematic data logging.

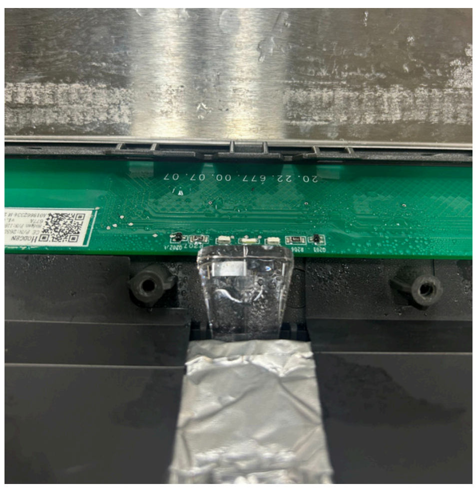
How?

- Used VXelements & PolyWorks for 3D scanning of gasket engagement.
- Analyzed failure trends from GoPro-recorded condensation tests.
- Validated factors like upper rack protrusion, pressure differences, and gasket fit.

Results

- Identified failure causes and worked with supply chain for short- & long-term fixes.
- Created Engineering Test Procedures to improve troubleshooting.
- Reduced failure rates, saving $9 Million in projected costs.

GE APPLIANCES – DISHWASHER UI STEAM FAILURE MITIGATION



What?

- Investigated excessive steam exposure causing erratic UI behavior.
- Diagnosed failures under worst-case steam conditions.
- Developed a short-term insulation fix without factory redesigns.

How?

- Designed & tested custom insulation cutouts for toe kick, middle, & sides.
- Performed circuit diagnostics showing short and open circuits to detect component degradation
- Worked with manufacturing & supply chain to ensure seamless production integration.

Results

- Reduced UI steam failures saving a projected $3 Million while maintaining factory workflow.
- Delivered a deployable short-term fix within a month for major retailer sales.
- Proposed modifications to circuit board housing and configurations for better long term performance

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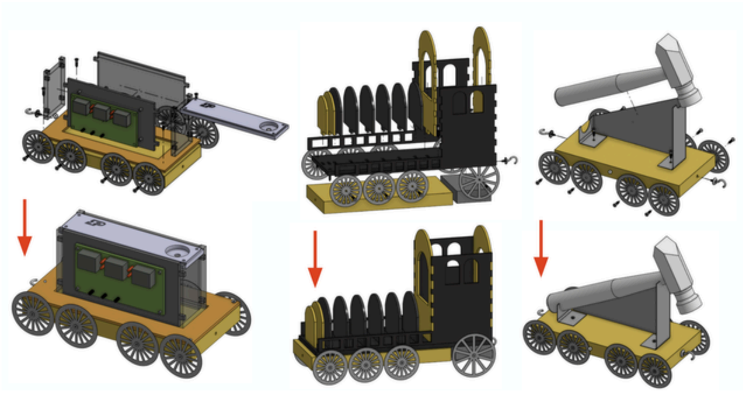
PURDUE ME264 – DESK ORGANIZER DESIGN & MANUFACTURING



What?

- Designed and manufactured Purdue-themed desk organizer
- Created over 40 custom parts using wood, plywood, acrylic, sheet metal, and PLA.
- Developed all CAD models, assembly drawings, DFA evaluations, and manufacturing plans.

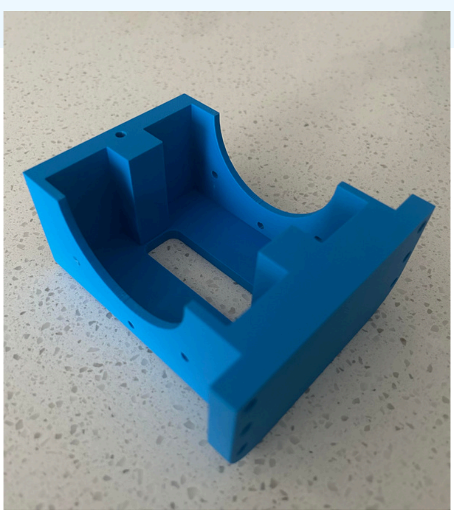
How?

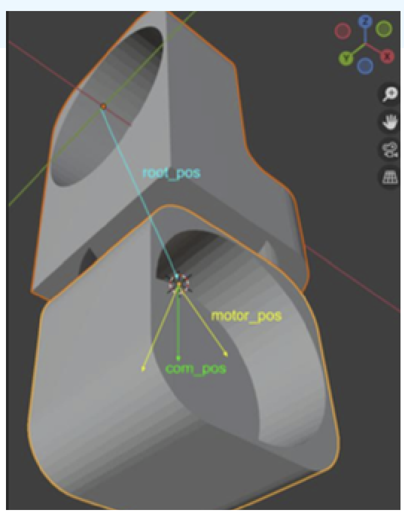
- Designed a complete CAD assembly in OnShape, including tolerances, GD&T, exploded views, and detailed drawing sheets.
- Manufactured components using woodworking tools, CO_2 laser cutters, metal laser cutters, and sheet-metal bending equipment.

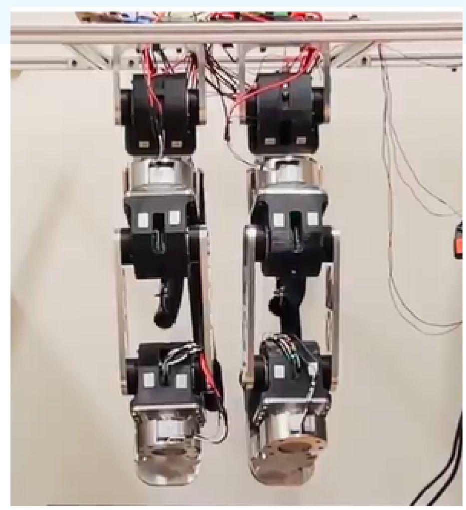
Results

- Produced a fully functional, multi-car desk organizer that demonstrated manufacturing skills across five materials and four fabrication methods.
- Gained significant experience with manufacturing limitations, real-world tolerances, and adapting CAD designs for practical assembly that directly improved the final build quality.

PURDUE HUMANOID ROBOT CLUB – HIP JOINT DESIGN & VALIDATION







What?

- Designed a hip joint for a small-scale humanoid robot.
- Simulated center of mass, motor forces, and joint performance in MuJoCo.
- Optimized leg structure through Finite Element Analysis (FEA) in ANSYS.

How?

- Modeled and refined 3D CAD components for prototyping.
- Conducted force and stress analysis to validate design durability.
- Led manufacturing efforts, machining and assembling aluminum parts.

Results

- Developed a functional prototype ready for software integration and testing.
- Improved motor efficiency and joint articulation for better mobility.
- Contributed to the club's first humanoid robot prototype.

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NASA L'SPACE – MARS ROVER COMMAND & DATA HANDLING SYSTEM

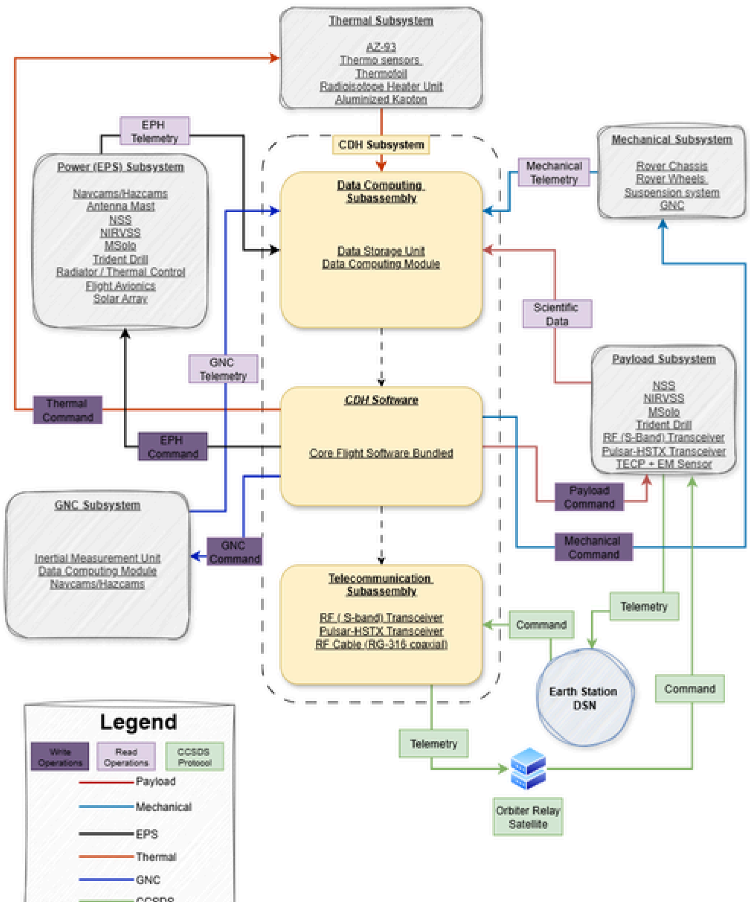

Table 2.1.3.2.2. Subcomponent Overview

Sub-Component	Subassembly	TRL	Justification
GomSpace NanoMind A3200	Onboard Computer (OBC)	6	Proven in LEO CubeSat missions; validated in relevant environments but not on Mars. NASA TRL 6 = "Prototype demonstration in relevant environment."
Software (NASA cFS + C++/Python logic)	Software	6	cFS has flown (e.g., Artemis), so if unmodified core → TRL 6. If significant new logic or untested configuration, stays at TRL 5.
Data Storage (e.g., SpaceCube Mini SSDR)	Data Storage Module	6	NASA-built SpaceCube Mini SSDRs used in space-based operations (e.g., STP-H6), tested in space and high-fidelity labs. TRL 6.
Pulsar-HSTX Transceiver	Transceiver/Transmitter (Comms)	6	Qualified for deep-space CubeSats, TRL 6 as it's been flight-tested and is commercially space-rated.
S-band Patch Antenna (ISIS)	Antenna	6	ISIS antennas have flown on LEO and lunar missions. Proven integration and test heritage = TRL 6.
RF Cable (RG-316 coaxial)	RF (S-band)	9	Space heritage in Mars missions (used on CubeSats and mainframes). TRL 9 = actual flight use in final form.
Power Wiring (MIL-W-16878)	Power Wiring	9	NASA heritage cable used across Mars and deep-space platforms (e.g., Perseverance). TRL 9 = flight heritage.
Data Wiring (Twisted Pair CAN/UART)	Data (CAN/UART)	9	Used on Mars rovers (CAN on Perseverance and Curiosity). TRL 9 = proven in final form on operational mission.

What?

- Designed the Command & Data Handling (CDH) subsystem for a simulated NASA Mars rover mission
- Ensured reliable communication between onboard processors, sensors, and flight software
- Developed fault recovery strategies to maintain data integrity during failures.
- Conducted TRL assessments to identify suitable processors, memory, and data interfaces for space environments.

How?

- Created subsystem architecture diagrams and data flow pathways connecting CDH with Power, Payload, and Comms subsystems.
- Analyzed trade-offs in processor performance, radiation tolerance, mass, and power draw to guide component selection.
- Collaborated with systems, thermal, and power teams to influence CDH choices

Results

- Delivered full CDH subsystem design, architecture, and verification plan for NASA PDR.
- Improved overall mission data reliability and synchronization efficiency across multiple onboard subsystems.
- Strengthened technical communication through NASA-format reports and subsystem presentations to mentor engineers, with final presentation being rated "Technical Expert"