



# Andrew Randell

Personal Portfolio

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B.E.Sc Mechatronics Engineering  
University of Western Ontario 2021



# Western Formula Racing: Formula-SAE



*Four years of Electronics Design,  
System Integration, and Rapid  
Troubleshooting Experience*



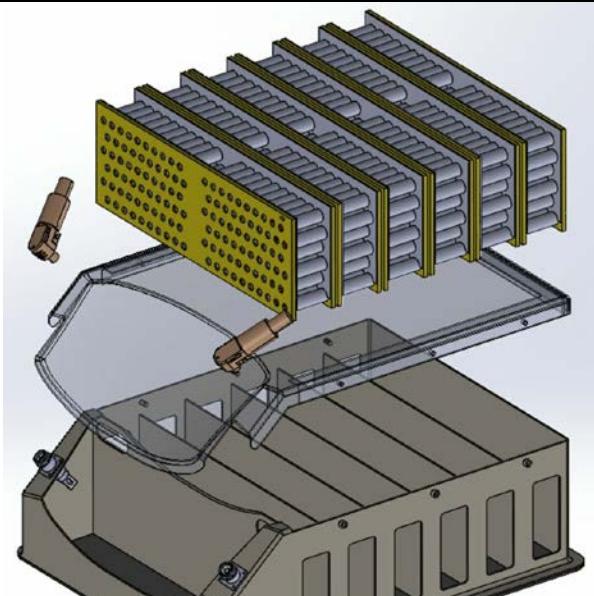
# 2021 WFR Electrical Director

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- One of three team leaders responsible for 50+ team members and 10 subsection leads who design, build, and race a 504-volt, \$160,000 electric vehicle at international SAE competitions
- Administered vehicle propulsion system design from the ground up for the 2021 vehicle. Increased the system efficiency by 30% with accumulator cell arrangement optimizations, and integrating an all-new motor controller
- Designed a Bespoke Battery Management System with hardware and control algorithms to manage 720 Lithium-ion battery cells arranged in a 6P120S configuration
- Managed cross-functional meetings and workgroups for team members. Mentored junior team members

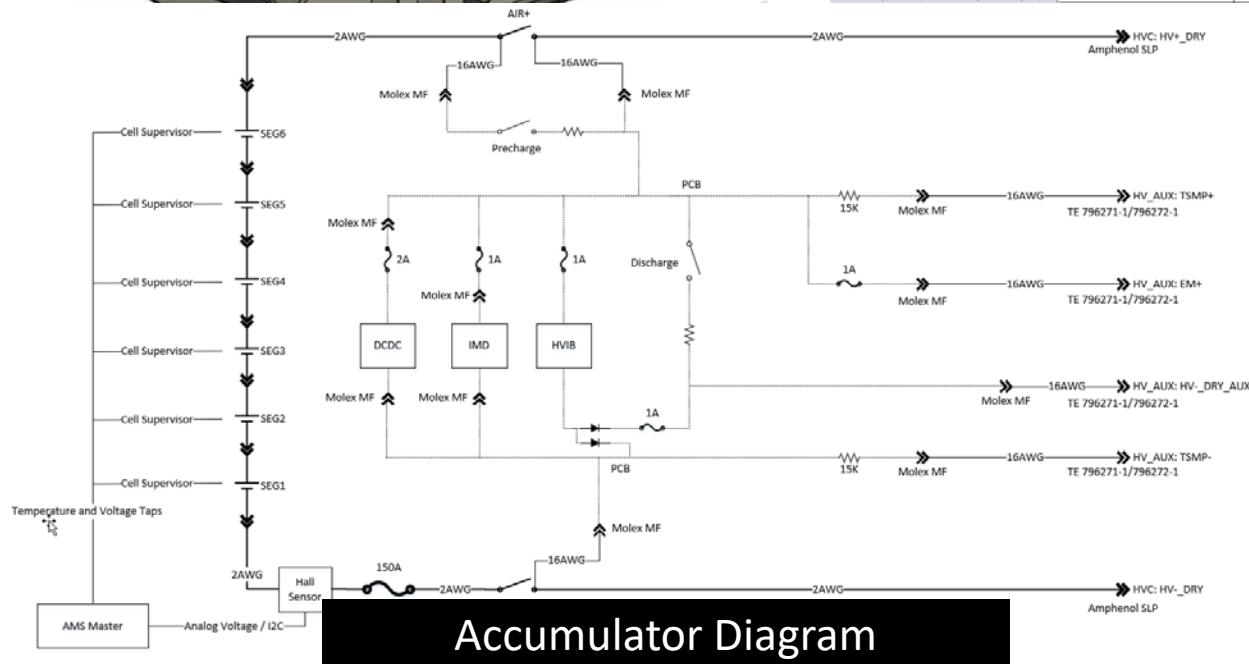


## 2021 Preliminary Accumulator



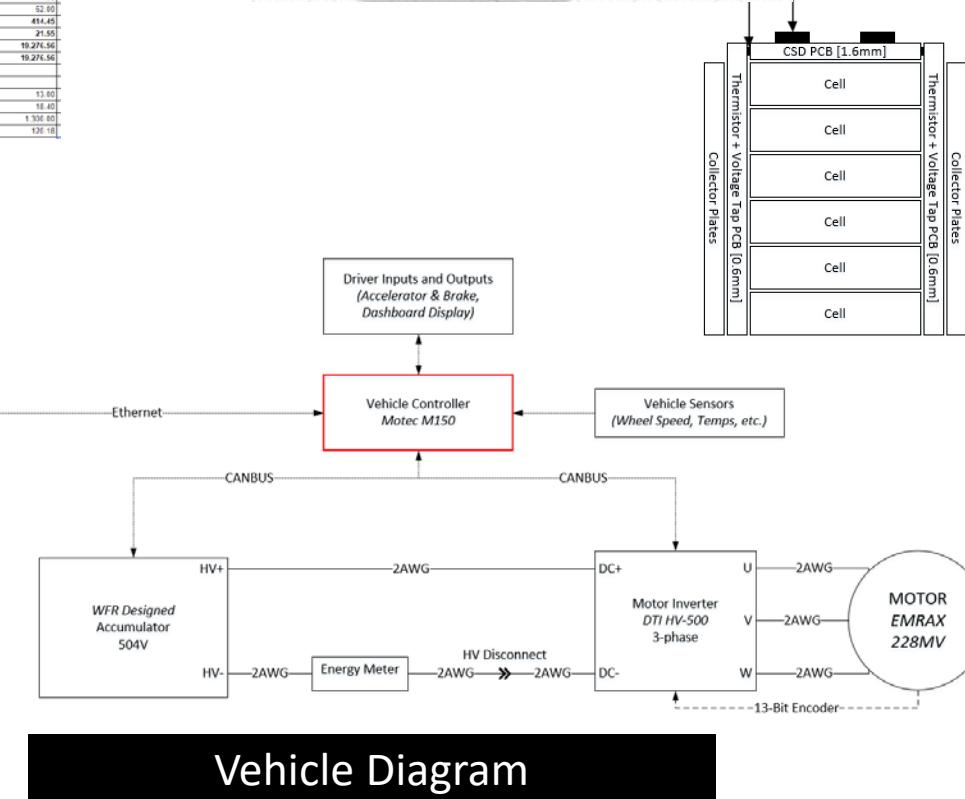
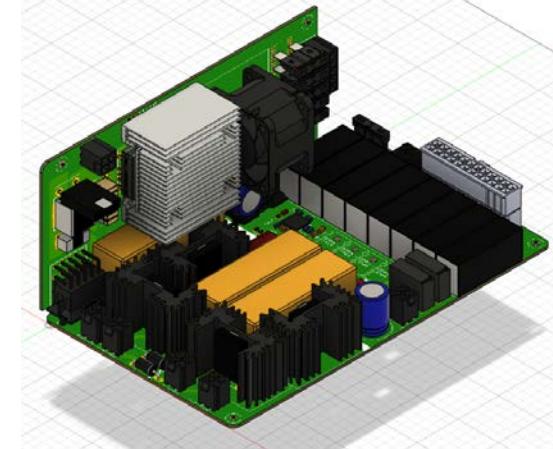
## Preliminary System Specifications

Nor LTS Input	Nickname	2019/2020	6 Module Wide 6P 500V DTI	7 Module Wide 7P 450V ScMo
ACCUMULATOR P_Count		7	6	7
Module S_Count		19	20	18
Module Count		5	6	6
Cell Count		695	729	755
Cell Selection		LG HG2 +	Sony VTC6 +	Sony VTC6 +
Cell Nominal Capacity (mAh)		3.008	3.120	3.120
Cell Rated Current A		29	30	30
Cell Peak Voltage		4.29	4.20	4.20
Cell ESR @0m		30.09	21.88	21.88
Module Peak Voltage		79.8	84.0	75.6
Module Energy (J)		6.832E+00	5.846E+00	5.945E+00
Pack Peak Voltage		149.4	160.0	154.4
Pack Peak Discharge Current A		140.00	180.00	216.00
Pack Energy (kWh)		5.43	7.49	7.66
Fractional Acc Case Mass Delta		1.09	1.20	
INVERTER		RMS PM100DXR +	GTI HV-500 +	SolMo [SC1 (2x) + Encoder]
Inverter Position Sensor Interface		Resolver Native	Resolver + Adapter	
Inverter Input Voltage Vol		400.00	360.00	600.00
Inverter Current Limit Arms		40.00	360.00	56.00
Inverter Mass Kg		7.50	6.70	5.00
Inverter Cost \$		\$7,500.00	\$4,360.00	\$16,024.00
MOTOR		Emrax 228 MV +	Emrax 228 MV +	2x SolMo SY31 +
Motor		340.09	340.00	106.00
Motor Current Arms		500.00	500.00	456.00
Motor Voltage @ MaxRPM		11.50	11.00	46.51
Motor Specific Load Speed RPM/Vd:		14.00	14.00	14.00
Motor Mass Kg		12.00	12.00	11.00
Motor Peak Torque Nm		240.00	240.00	102.00
Motor Max Speed RPM		6,500.00	5,500.00	20,000.00
Motor Cost \$		400.00	500.00	456.00
Maximum Accumulator Voltage Permitted		500.00	500.00	20,000.00
Motor Max Speed (RPM) (Assuming 50% SoC 4.2V/cell)		4,389.00	5,544.00	20,000.00
Motor Max Speed (RPM) (100% SoC 4.2V/cell)		5,500.00	6,500.00	20,000.00
MOTOR SPEED		Idle Cell Voltage (4.2V - 10% FeC)	4.00	4.00
ESTIMATION		Accumulator Load Current A (Study State)	60.00	60.00
		Loaded Accumulator Voltage (DCIR Dreq)	459.87	414.45
DRIVETRAIN		DC Bus Power kW	21.33	21.15
		Motor Max Speed Loaded RPM (DCIR Dreq)	3,911.29	5,358.57
		Motor Max Speed Idle RPM (DCIR Dreq)	4,978.00	6,138.19
		Double Reduction	Double Reduction	
		Final Drive	Optimized	
		Final Drive Ratio	3.05	4.30
		Wheel Diameter in	18.00	18.40
		Max Wheel Torque Nm	934.00	1,312.00
		Max Vehicle Speed km/h (8% Loss from Spastic Idle Speed)	504.79	121.35
				126.10



Accumulator Diagram

## Controls Platform



Vehicle Diagram

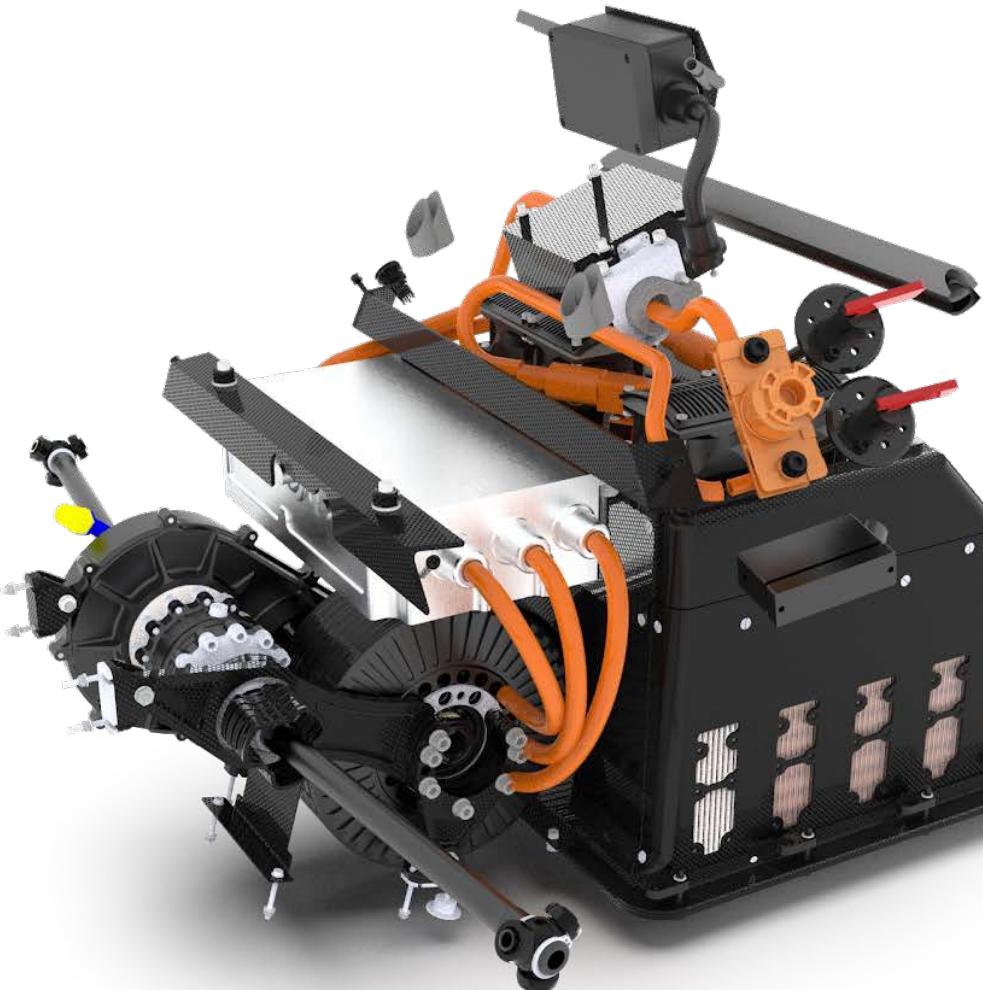


## 2020 WFR Energy Accumulator Lead

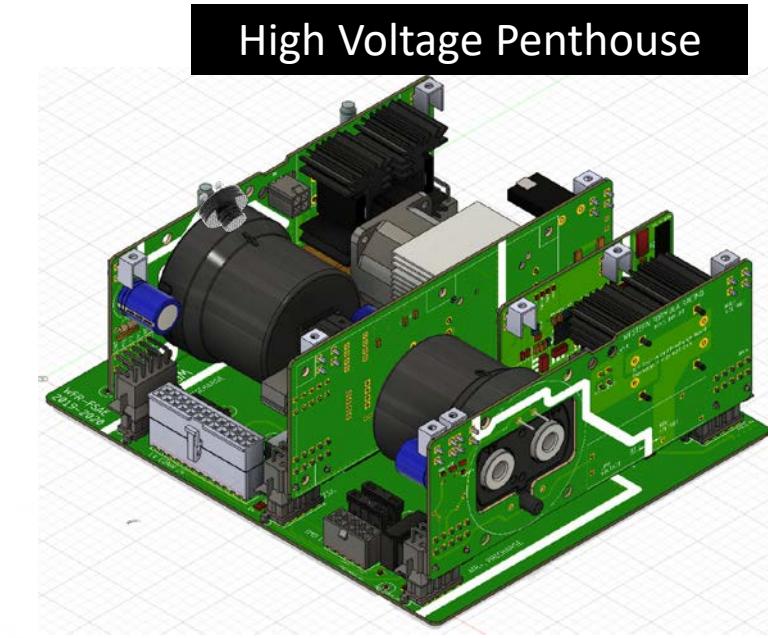
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- Lead electrical system design and assembly for a 400-volt energy Accumulator. Incorporated all discrete control components to a modular PCB assembly, resulting with stellar accumulator reliability and serviceability allowing the vehicle to complete the season with no serious faults
- Assembled and tuned a Cascadia PM100DXR inverter and Emrax 228MV motor used in the propulsion system
- Designed a 400V to 12V DCDC converter based on Vicor DCM modules to power the vehicle's low-voltage systems

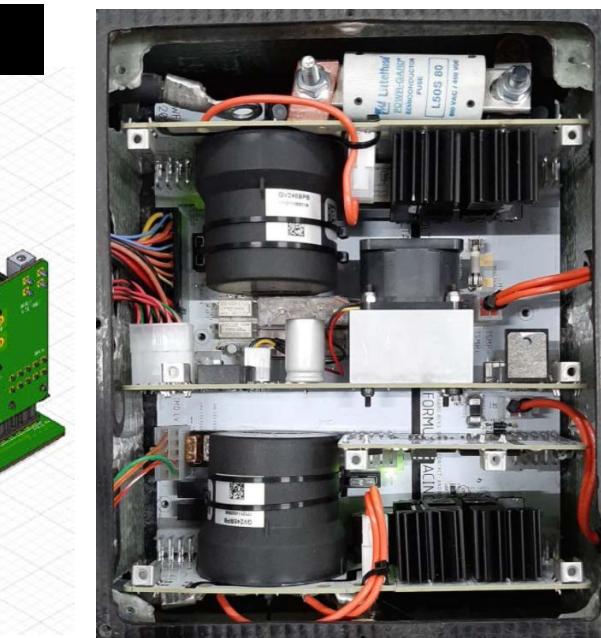




Propulsion System Rendering

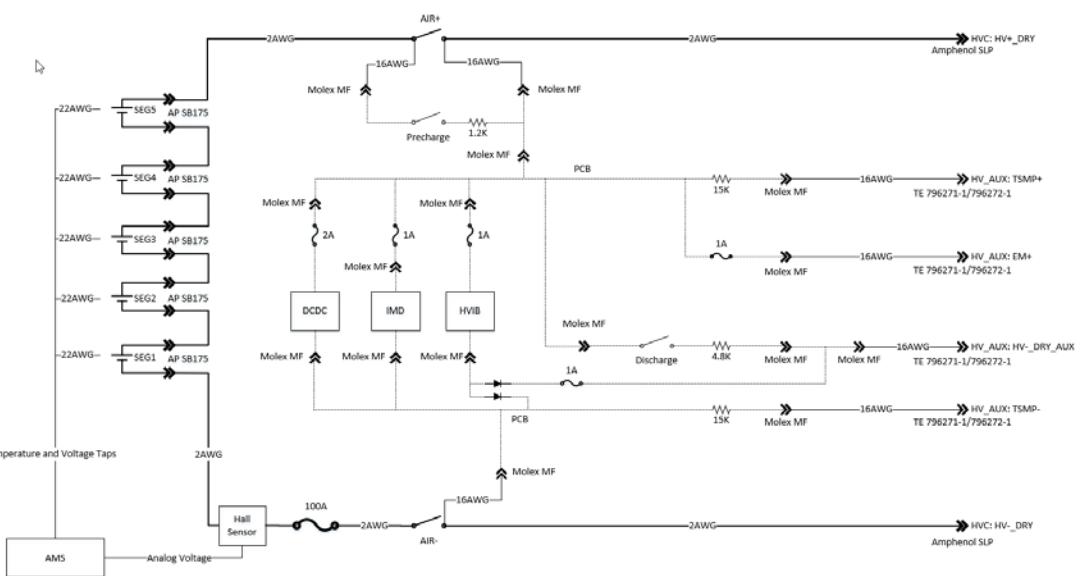
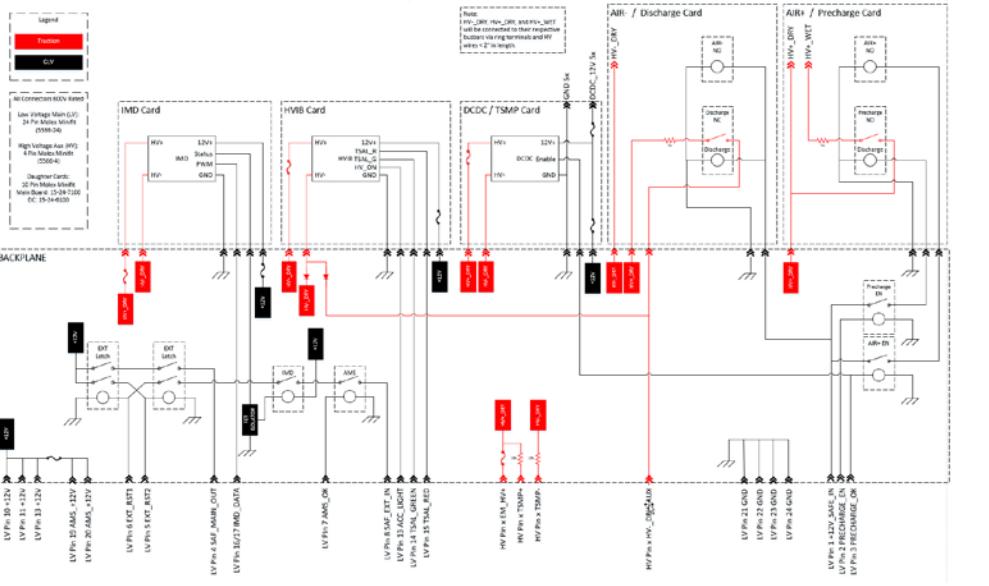


High Voltage Penthouse

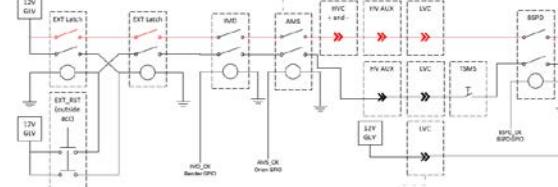
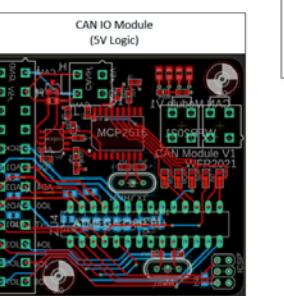
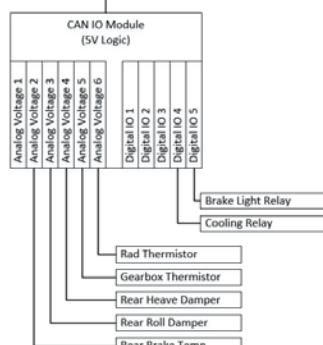
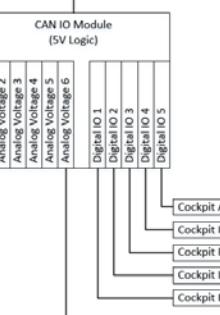
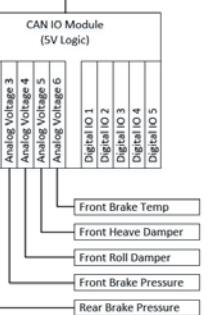


Printed Circuit Boards

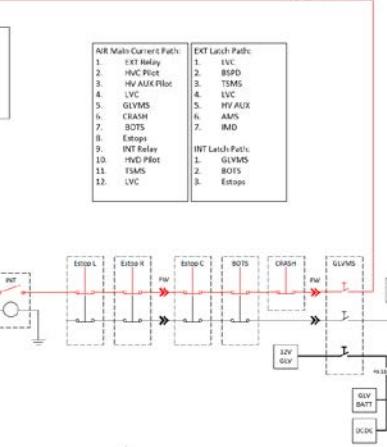
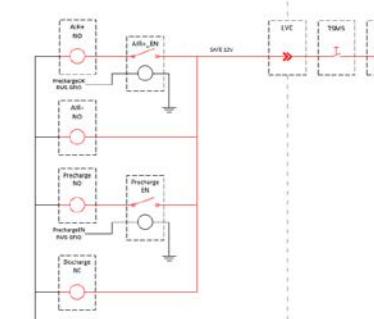
[See my WFR20-E Marketing Content](#)



## Design Synthesis, Documentation, & Knowledge Transfer



AIR Main Current Path:	1. EXT Relay 2. HV Plot 3. TSMS
LVC Main Current Path:	4. LVC
GLVMS Main Current Path:	5. GLVMS
CRASH BOTS Main Current Path:	6. CRASH BOTS
Estope Main Current Path:	7. Estope
INT Relay Path:	8. INT Relay
HVD Plot Path:	9. HVD Plot
TSMS Path:	10. TSMS
LVC Path:	11. LVC
GLVMS Path:	12. GLVMS





## WFR20-E Glamour Shots





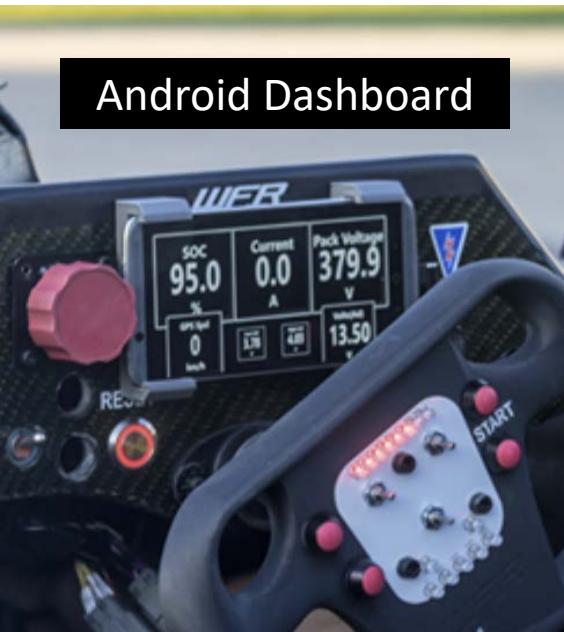
## 2019 WFR Low-Voltage & Data Acquisition Lead

- Acted as the Certified High Voltage Electrical Safety Officer for the \$150,000 vehicle and 55+ member team
- Lead low-voltage harness design and assembly utilizing a bespoke Power Distribution Module with telemetry, an Android-based dashboard display with OBDII, and a Motec M150 engine controller and DAQ

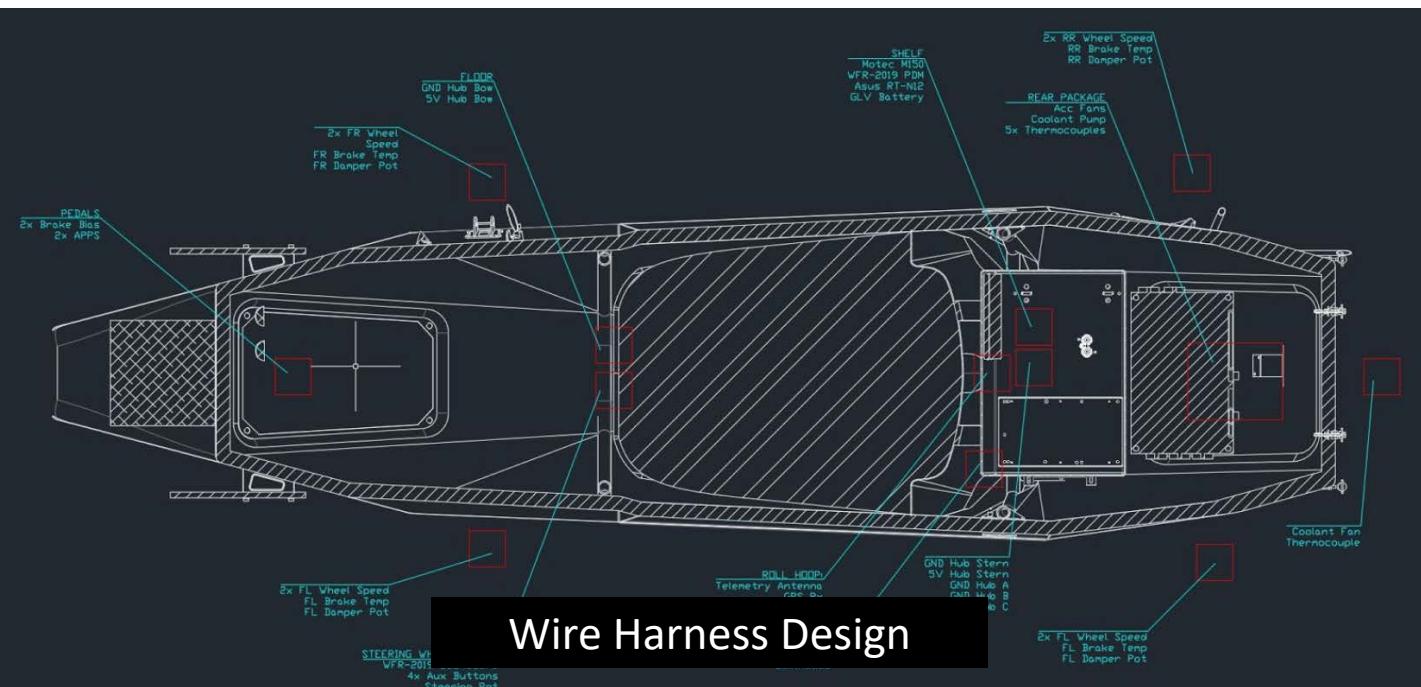




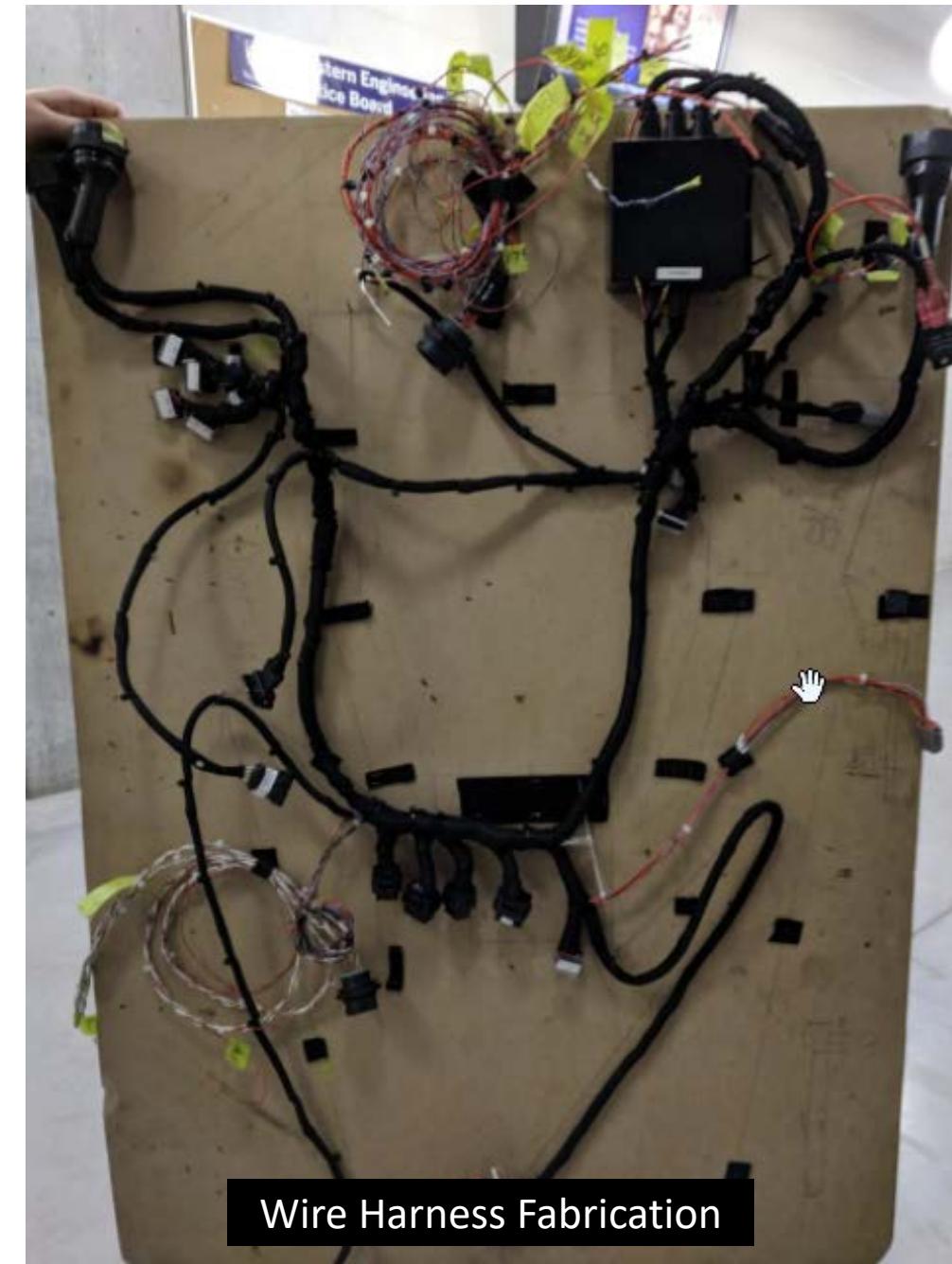
4<sup>th</sup> Place FSAE North



Android Dashboard



Wire Harness Design



Wire Harness Fabrication



## WFR19-E Glamour Shots

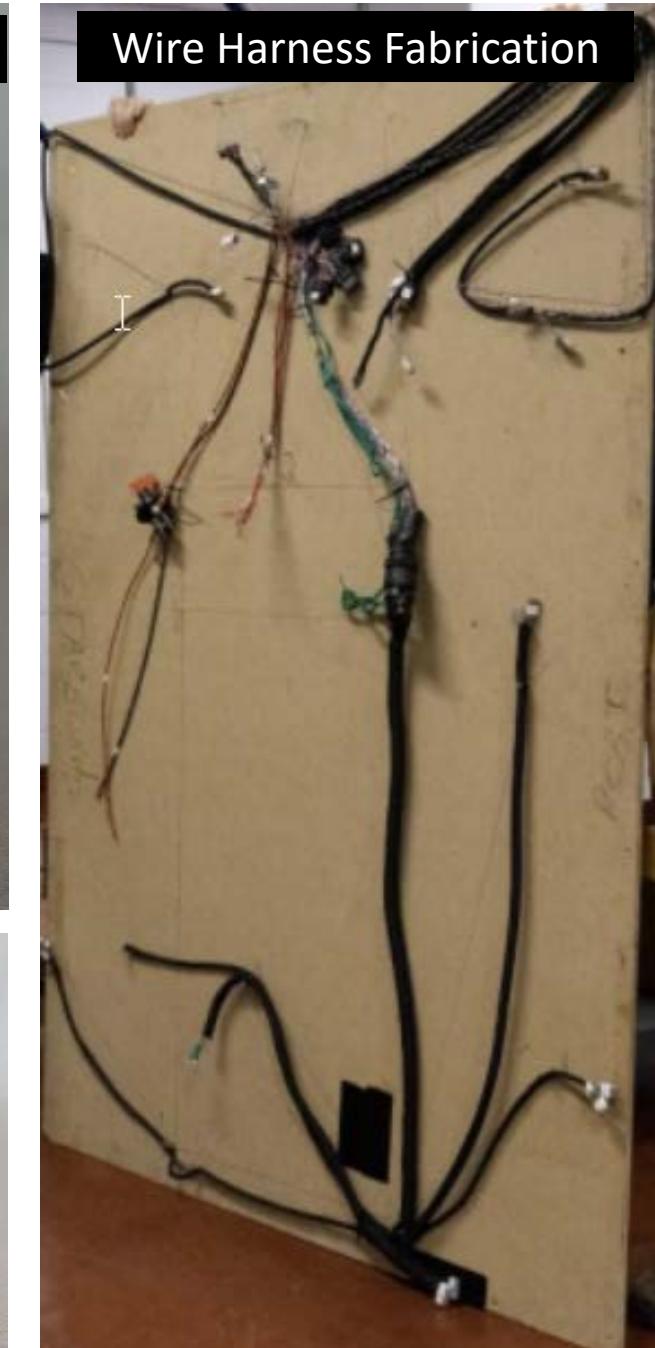
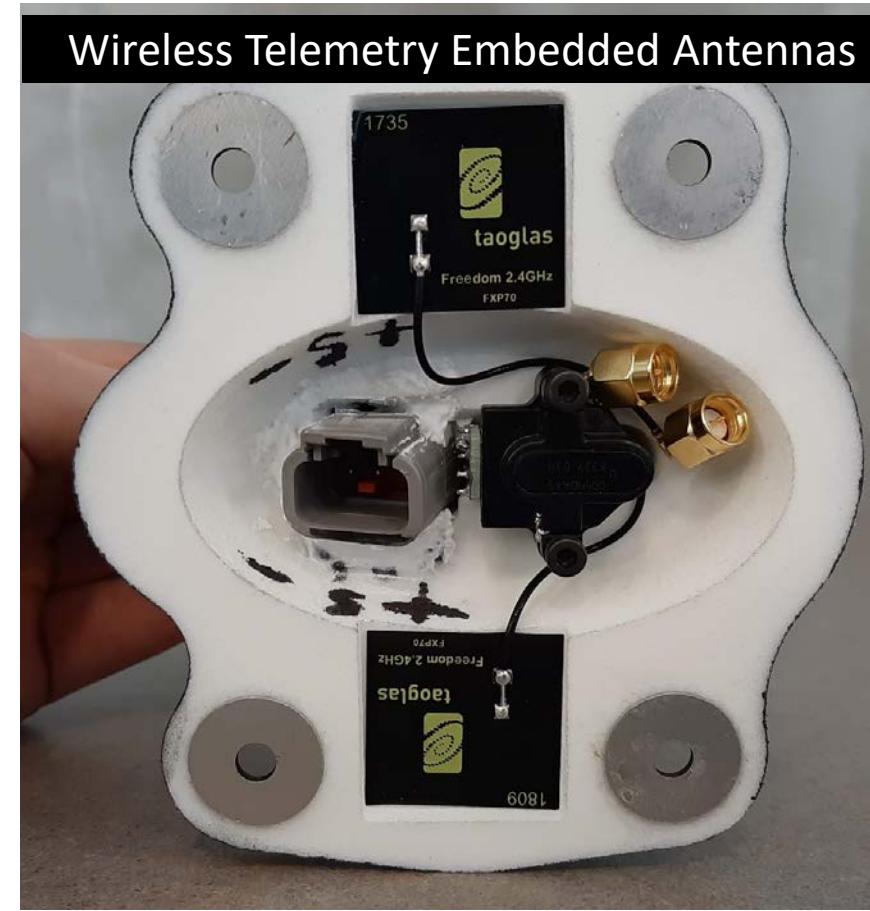
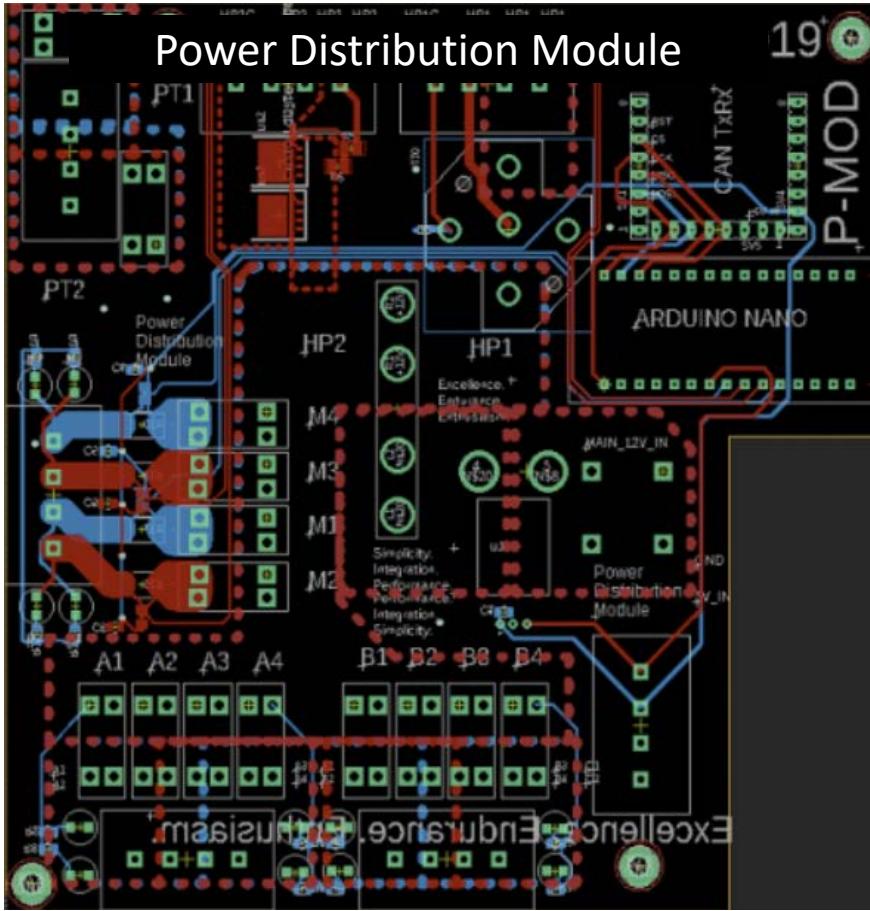




## 2018 WFR Electrical Member

- Incorporated wireless telemetry based on a generic 802.11n local area network with a router running OpenWRT
- Supported the electrical team with duties including: system design, wire harness assembly, and troubleshooting







## Product Marketing, Drone Photography, and Creative Content

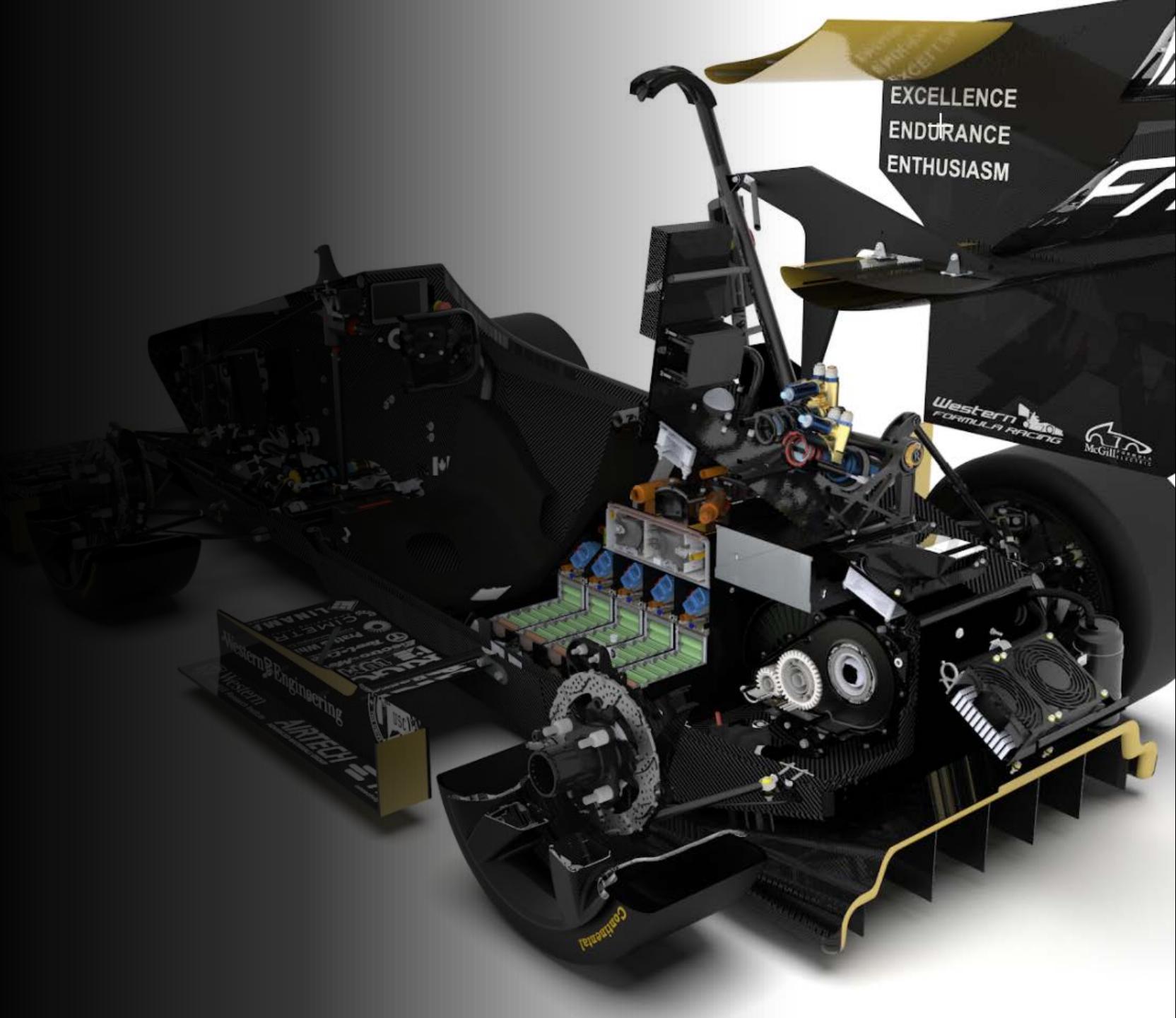
Photorealistic renderings of  
Solidworks models via Keyshot

Tunable and spherical product renders

- [Spherical Interactive Render](#)
- [Section View Interactive Render](#)

Video editing and production

- [WFR20-E Year in Review Video](#)
- [WFR20-E Testing Montage Video](#)





Render Examples (*WFR20-E*)



# Professional Experience

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24-months of Professional Internship  
& Co-op Experience





# Intel Corporation 16-month Internship

## Platform Architect and PCB Designer

- Lead architecture and design for a high-speed silicon validation platform to be scaled across Intel validation teams
- Designed prototype PCBs to improve platform bring-up and validation efficiency in a laboratory setting
- Incorporated CPLD devices for system housekeeping tasks resulting in PCB layout area and cost reduction
- Implemented ECAD processes and tools to increase design workflow efficiency
- Managed Intel's relationship with third-party vendors for specific platform subsystems and exploratory projects
- Submitted two patent applications for system behaviour during power state transitions





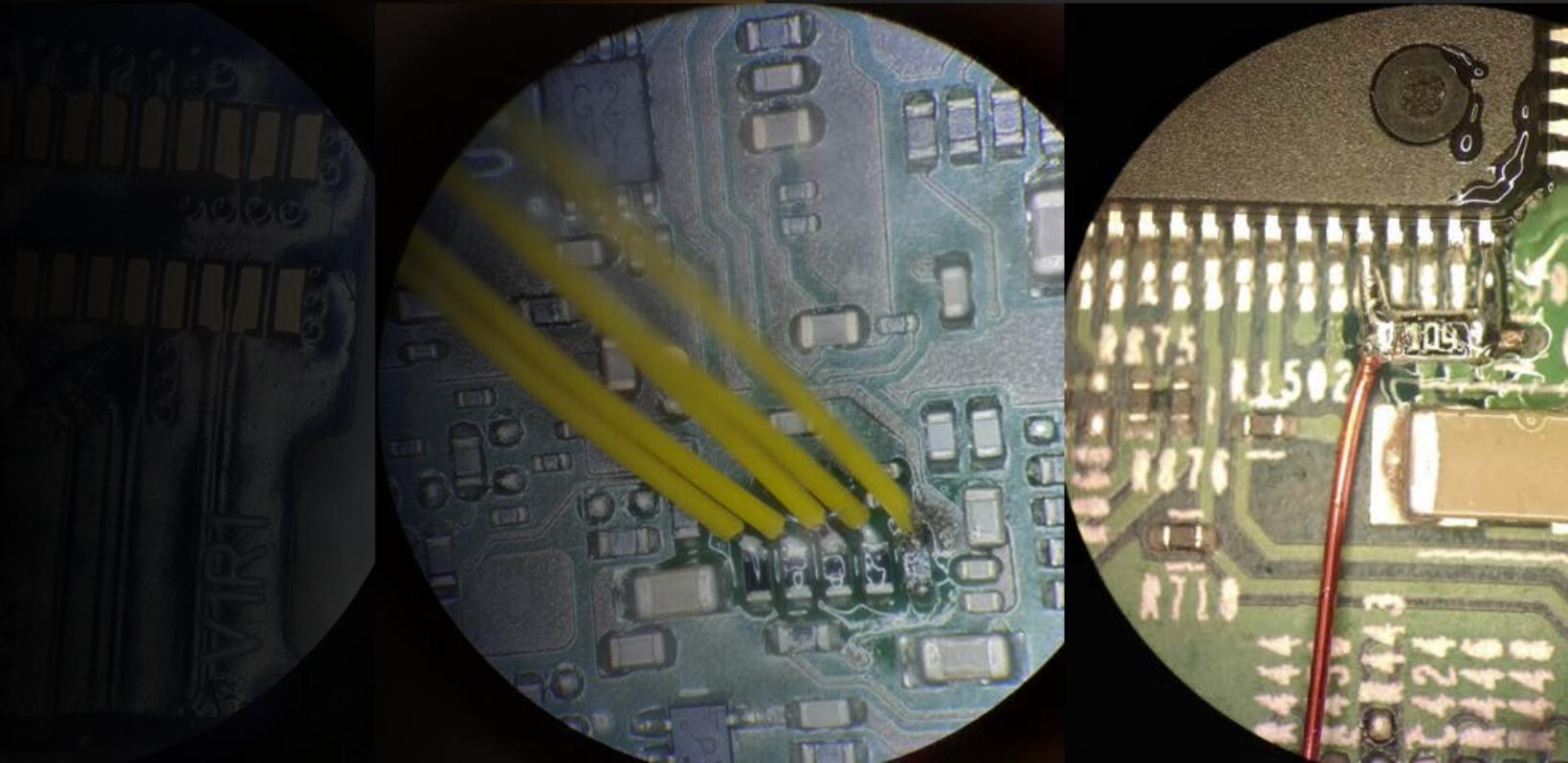
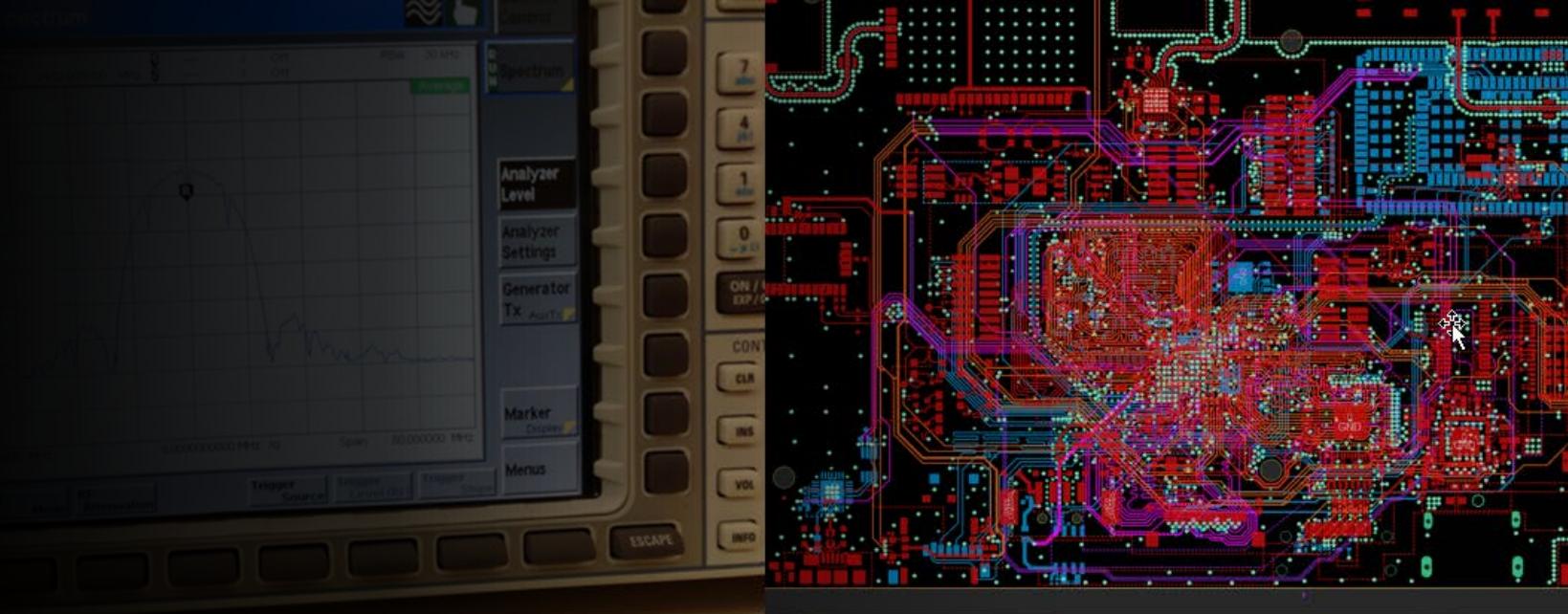
## Swift Labs 8-month Co-op

### Term 2: Hardware Designer

- PCB component selection, schematic capture, and board layout alteration for an IoT gateway
- Hardware debug, rework, and bring-up coordination for an IoT gateway in a laboratory setting

### Term 1: Firmware Developer

- Automated wireless testing and verification procedures via remote control of lab testing equipment over GPIB
- Specified and compiled Buildroot Linux firmware for a production IoT gateway





cādence

OrCAD™  
CADENCE PCB SOLUTIONS

 AUTODESK® EAGLE

 SOLIDWORKS

 KeyShot

 Ps Pr

 Excel

## Technical Skills

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### Design Tools

- OrCAD
- Allegro PCB Layout
- DE HDL Schematic Capture
- Eagle PCB
- MATLAB and Simulink
- Excel
- LTSpice
- PowerDC
- Solidworks (CSWA)
- Git & Github
- Python
- C++

### Prototyping

- Oscilloscope
- Logic Analyzer
- SMD Soldering
- Arduino
- I2C, SPI
- CANBUS
- High-voltage wiring
- 3D Printing

### Creative & Office

- Adobe Creative Suite
- Keyshot Rendering
- MS Office
- LaTeX



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Bachelor of Engineering Science  
Mechatronics Engineering 2021  
Dean's Honour List



# MSE4401 Path Planning

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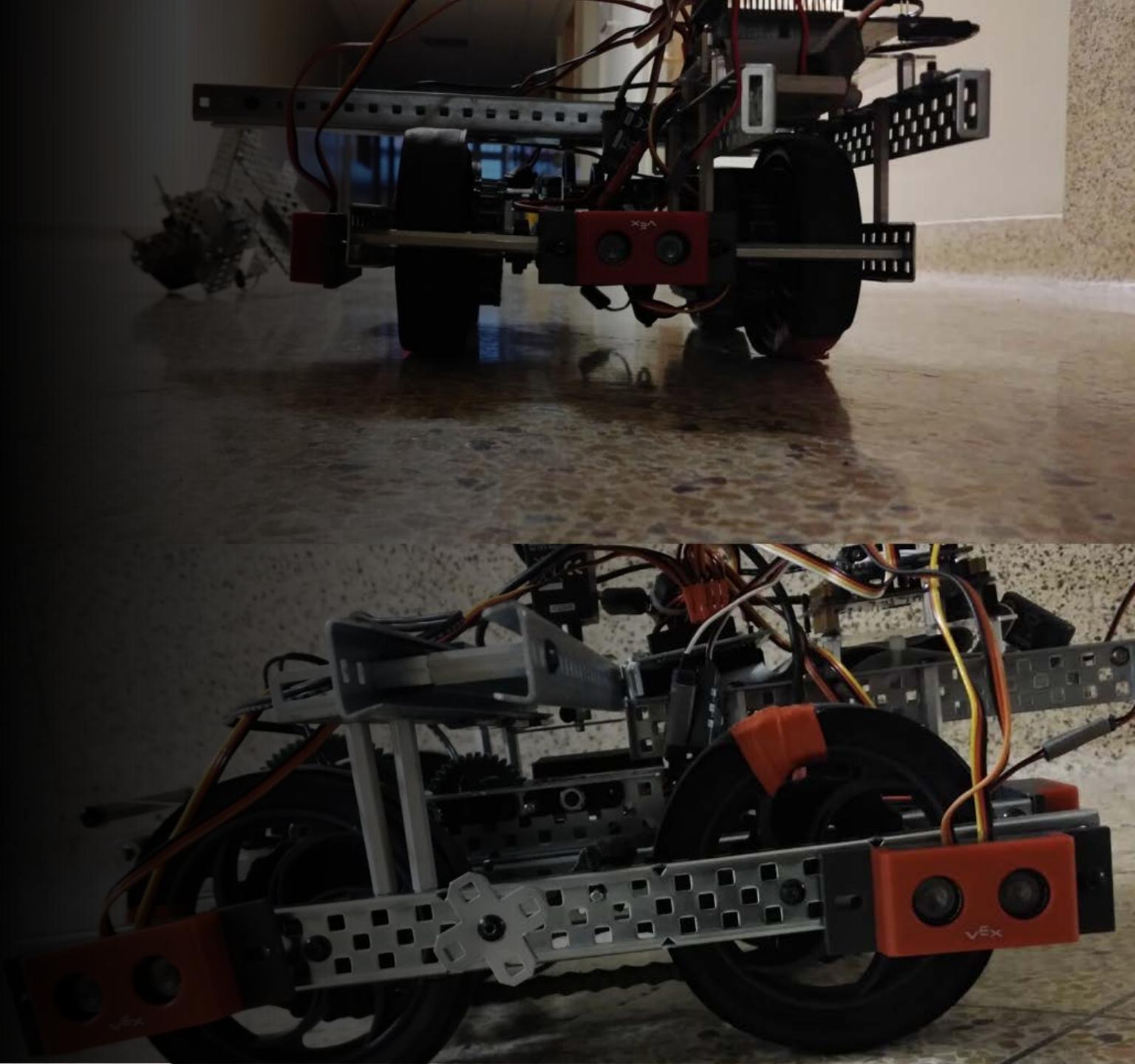
- Develop Code to control a robotic arm
- Move objects between positions
- Quintic Interpolations
- Gradient decent
- MATLAB based



# MSE2201 Autonomous Robot

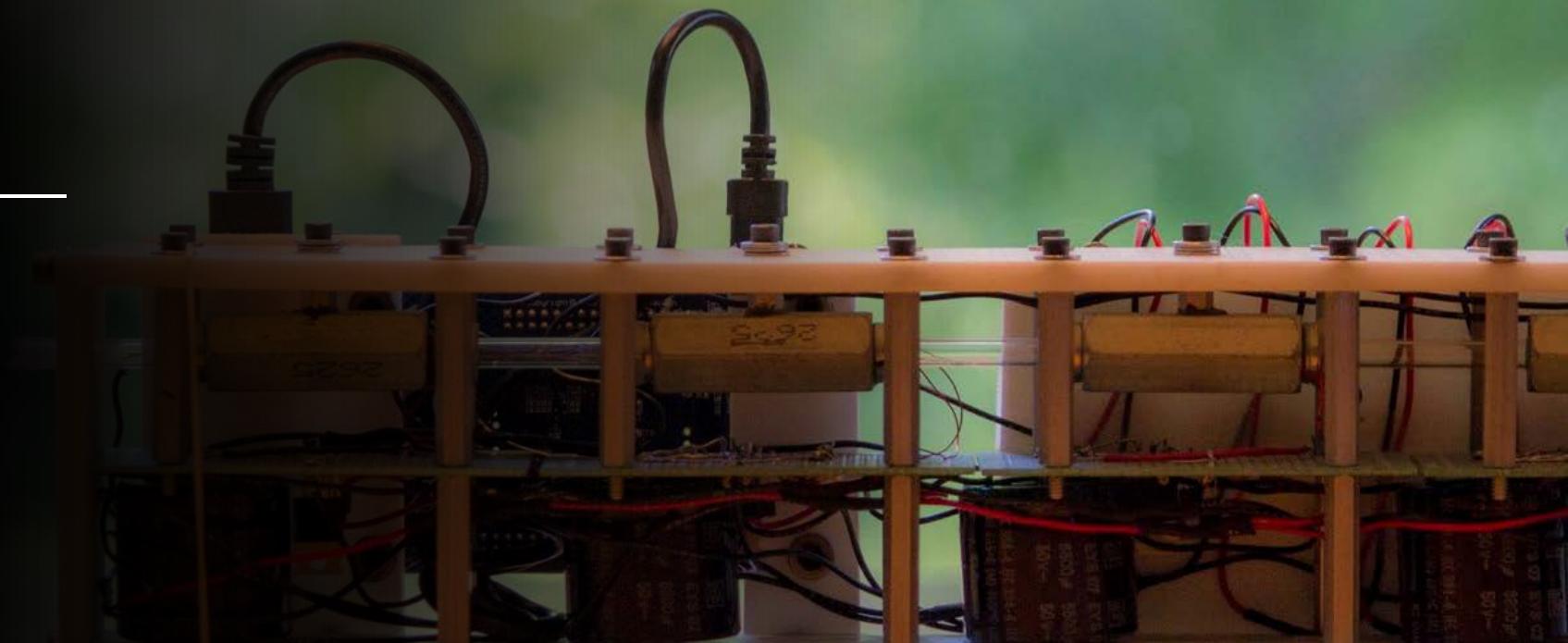
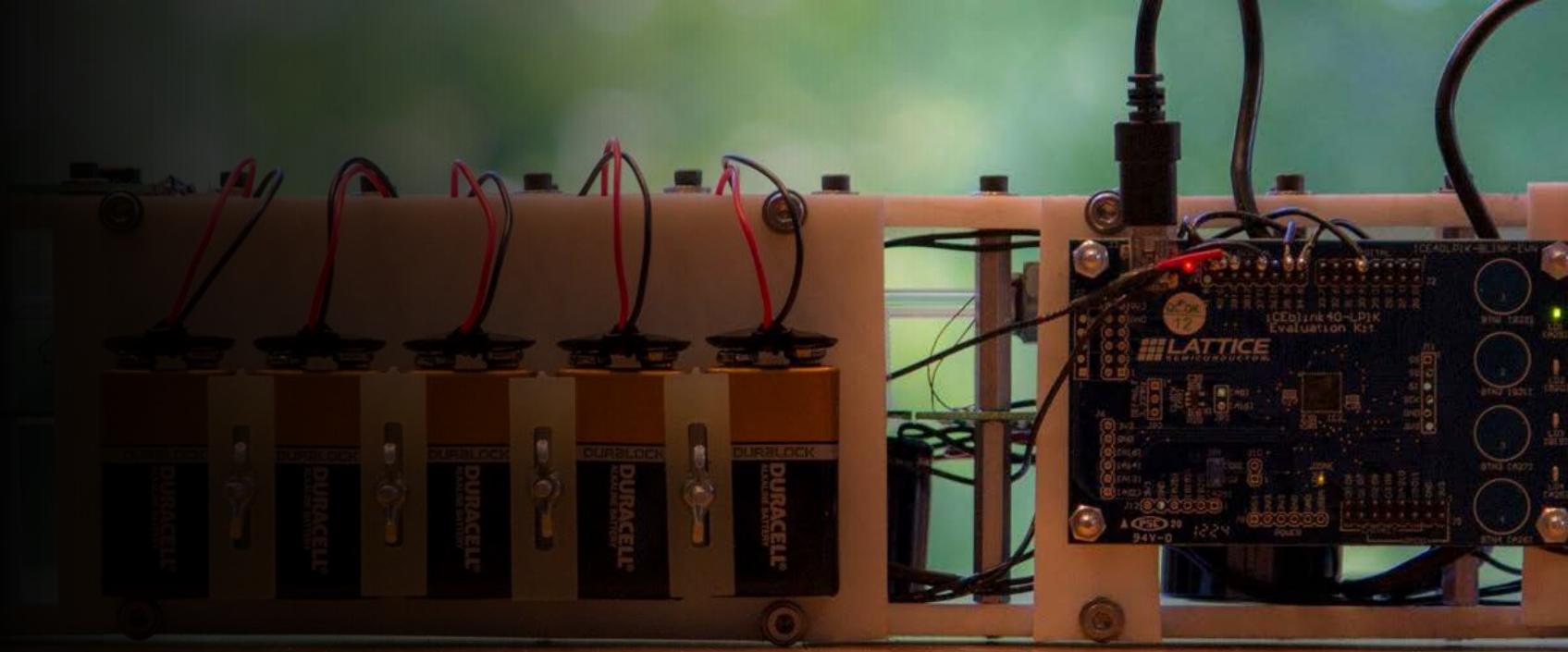
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- Develop an autonomous robot to navigate a course
- Detect and pick up objects
- Deposit objects in the proper location



# Personal Projects

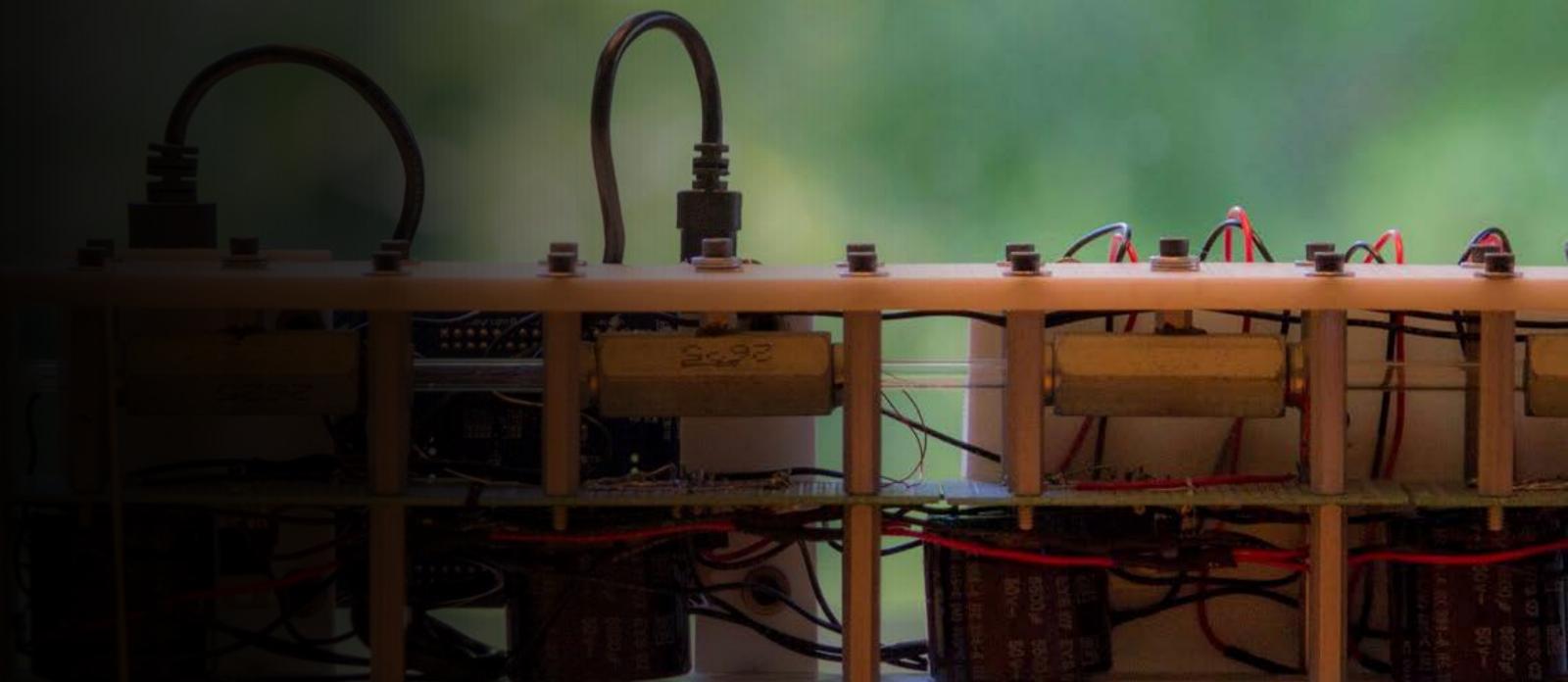
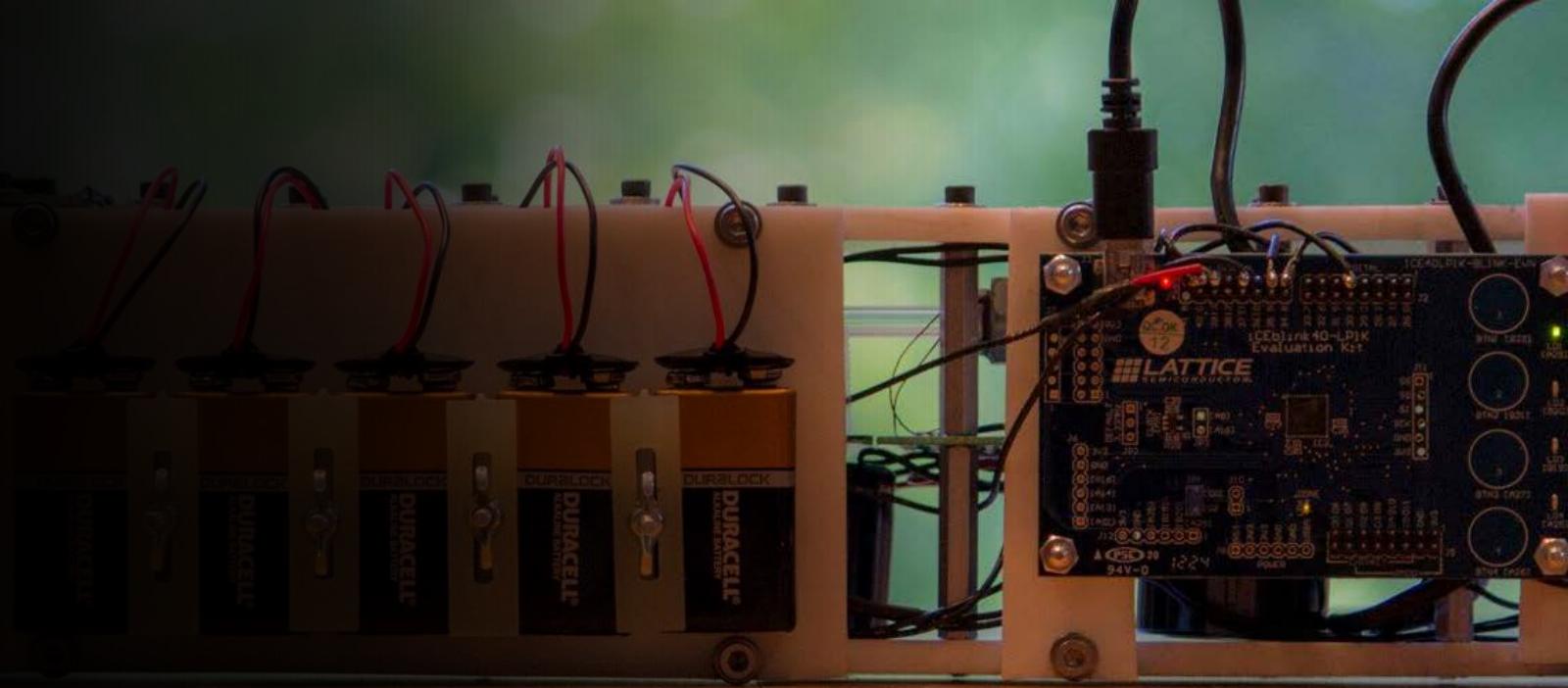
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# Home-built Linear Accelerator

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- Four-stages
- 6800uF Caps
- 48V
- MOSFET Switches
- FPGA Controlled
- [YouTube Video](#)

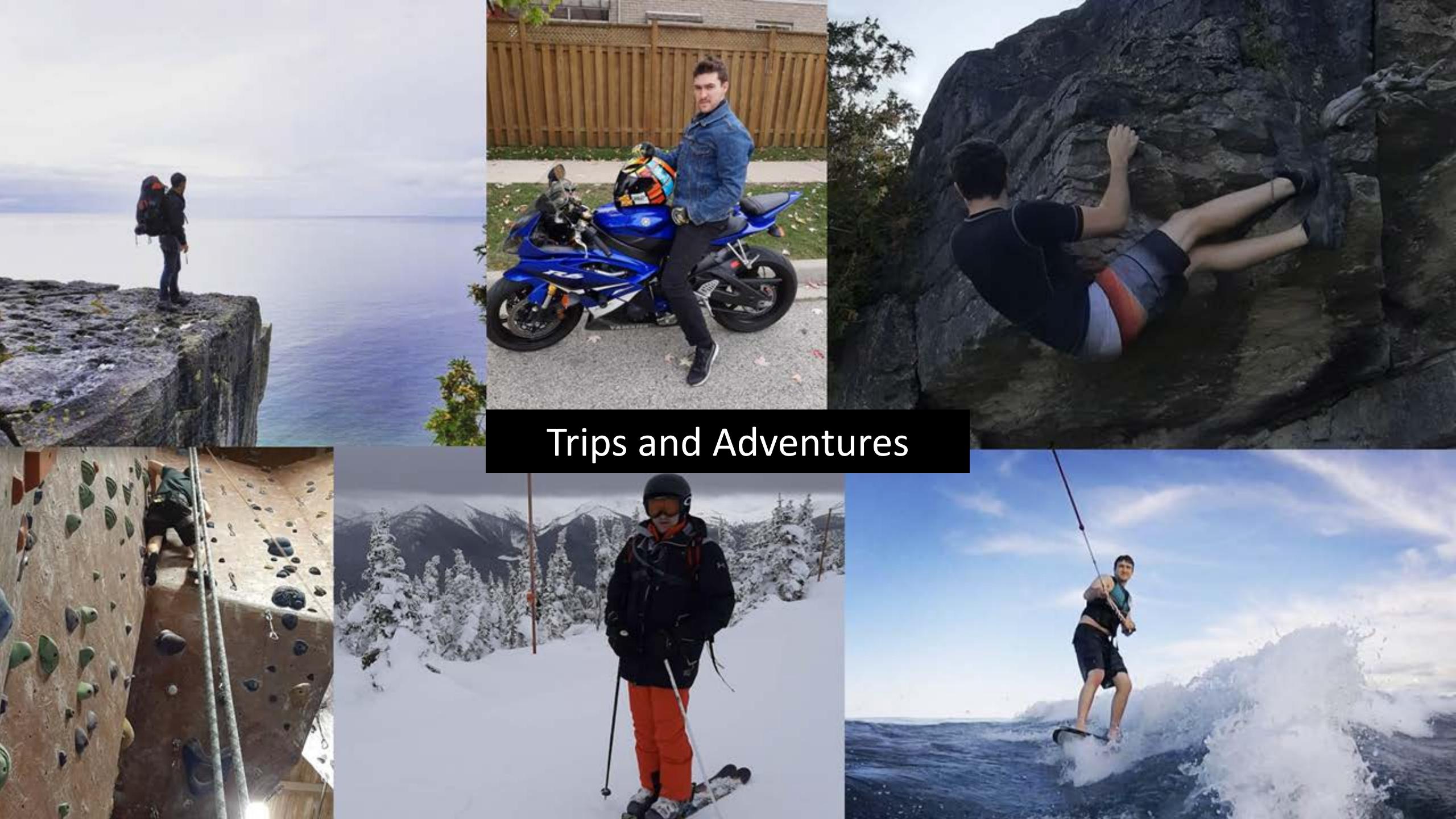


# Computers and Networking

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- Built several desktop PCs for personal and business use
- Manage a FreeNAS media server and NAS for personal use
- Set up several local area networks with multiple access points





## Trips and Adventures