



# Andrew Randell

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

16-Months at Intel Corporation

48-Months of Formula-SAE experience





# Western Formula Racing: Formula-SAE

*Western*   
FORMULA RACING

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





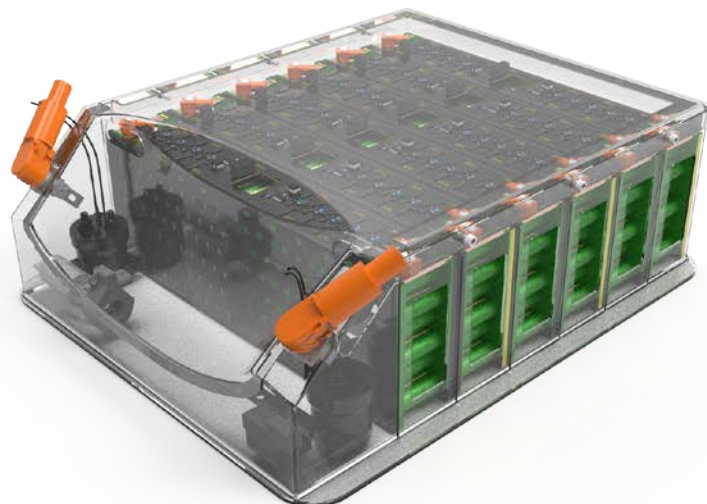
## 2021 WFR Electrical Director

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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



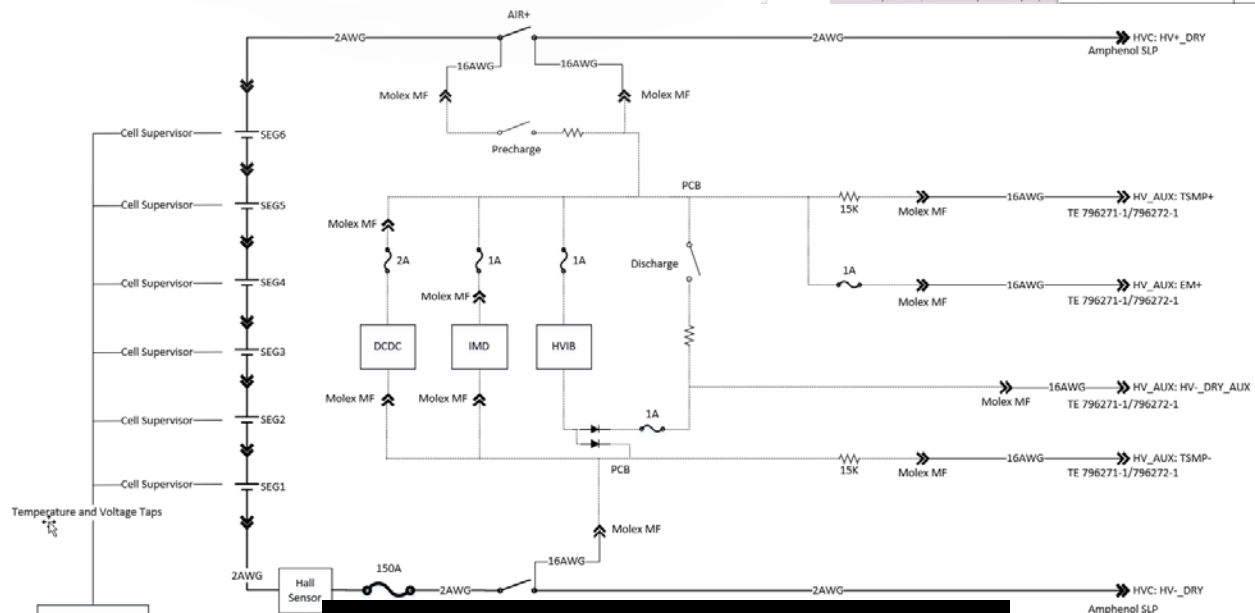
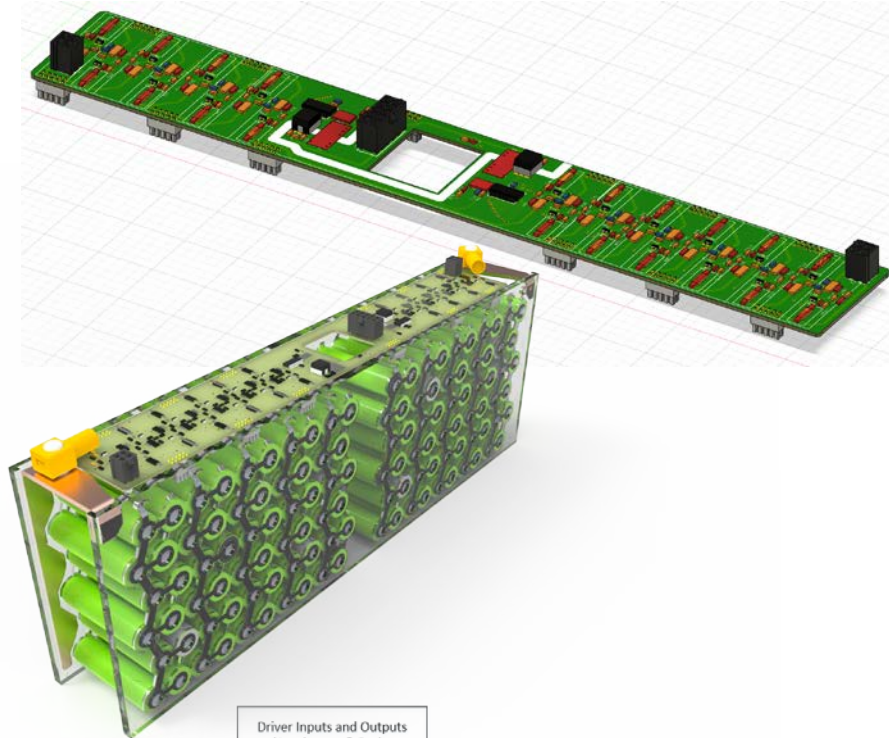
# 2021 Preliminary Accumulator



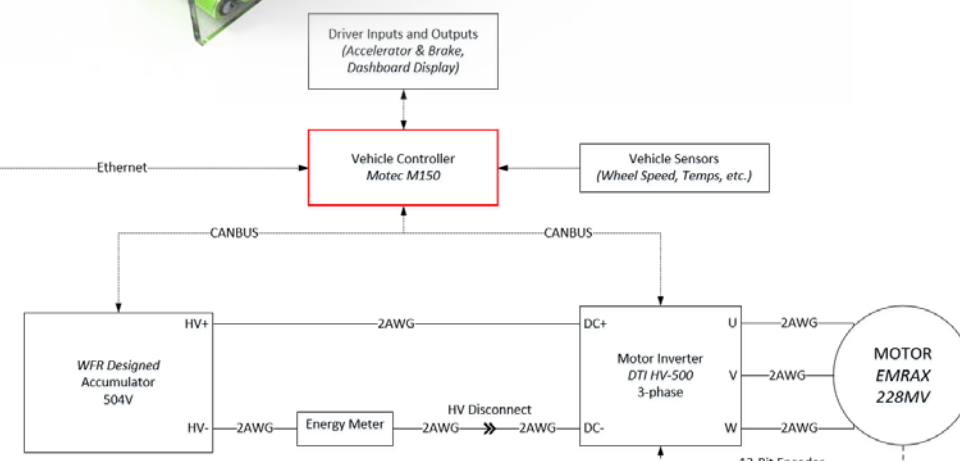
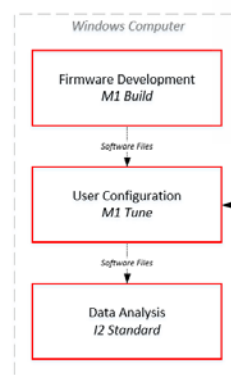
# Preliminary System Specifications

Not LTS Input	Not LTS	2019/2020	5 Module Wide 4P 500V DTI	7 Module Wide 7P 450V ScMo
ACCUMULATOR P Count	7	7	6	7
Module S Count	19	20	20	18
Module Count	5	5	5	6
S Count	95	120	120	180
Cell Count	605	720	720	756
Cell Selection	LG HG2 +	Sony VTC6 +	Sony VTC6 +	Sony VTC6 +
Cell Nominal Capacity (mAh)	3,000	3,120	3,120	3,120
Cell Rated Current A	20	30	30	30
Cell Peak Voltage	4.20	4.20	4.20	4.20
Cell ESR mOhm	30.00	21.00	21.00	21.00
Module Peak Voltage	79.0	84.0	84.0	75.0
Module Energy (J)	6,032.00	5,040.93	5,040.93	5,943.97
Peak Pack Voltage	395.0	506.0	506.0	453.0
Pack Peak Discharge Current A	140.00	180.00	180.00	210.00
Pack Energy (kWh)	5.43	7.40	7.40	7.50
Fractional Acc Case Mass Delta	1.00	1.20	1.20	1.00
INVERTER Inverter	RMS PM1000XK +	GTI HV-600 +	SoloS 10C1 (2K) +	ExoCore
Inverter Position Sensor Interface	Resolver Vdr	Resolver + Adapter	Resolver	Resolver
Inverter DC Voltage Vdc	400.00	500.00	500.00	600.00
Inverter Current Link Arms	450.00	350.00	350.00	35.00
Inverter Mass Kg	7.50	6.75	6.75	5.00
Inverter Cols	97,500.00	\$4,100.00	\$4,100.00	\$18,000.00
MOTOR Motor	Emrax 225 MV +	Emrax 225 MV +	2x SoloS SV31 +	
Motor Current Arms	340.00	340.00	100.00	100.00
Motor Voltage @ Max RPM	500.00	500.00	450.00	450.00
Motor Specific Load Speed RPM/Vdc	11.00	11.00	46.51	46.51
Motor Specific Idle Speed RPM/Vdc	14.00	14.00	46.51	46.51
Motor Mass Kg	12.00	12.00	11.00	11.00
Motor Peak Torque Nm	240.00	240.00	130.00	130.00
Motor Max Speed RPM	6,500.00	6,500.00	20,000.00	20,000.00
Motor Cols	4.00	4.00	20,000.00	20,000.00
Maximum Accumulator Voltage Permitted	400.00	500.00	450.00	450.00
Motor Max Speed Loaded RPM (100% SoC 4.2V/cell)	4,380.00	5,144.00	20,000.00	20,000.00
Motor Max Speed Idle RPM (100% SoC 4.2V/cell)	5,880.00	6,500.00	20,000.00	20,000.00
MOTOR SPEED Motor Max Speed	4.00	4.00	4.00	4.00
ESTIMATION Accumulator Load Current A (Steady State)	60.00	46.00	52.00	52.00
Loaded Accumulator Voltage (DCR Drop)	155.57	459.87	414.45	414.45
DC Bus Power kW	21.33	21.15	21.15	21.15
Motor Max Speed Loaded RPM (DCR Drop)	3,411.29	5,158.57	19,374.56	19,374.56
Motor Max Speed Idle RPM (DCR Drop)	4,578.00	6,438.19	19,276.56	19,276.56
DRIVETRAIN Gearbox Type	Double Reduction	Double Reduction OR Idler	Optimized	
Final Drive	4.30	4.30	13.00	13.00
Final Drive Ratio	3.84	4.30	13.00	13.00
Wheel Diameter in	18.40	18.40	18.40	18.40
Max Wheel Torque Nm	924.00	1,132.00	1,130.00	1,130.00
Max Vehicle Speed km/h (8% Loss from Specific Idle Speed)	104.74	121.36	120.18	120.18

# Bespoke BMS



Accumulator Diagram



Vehicle Diagram



## 2020 WFR Energy Accumulator Lead

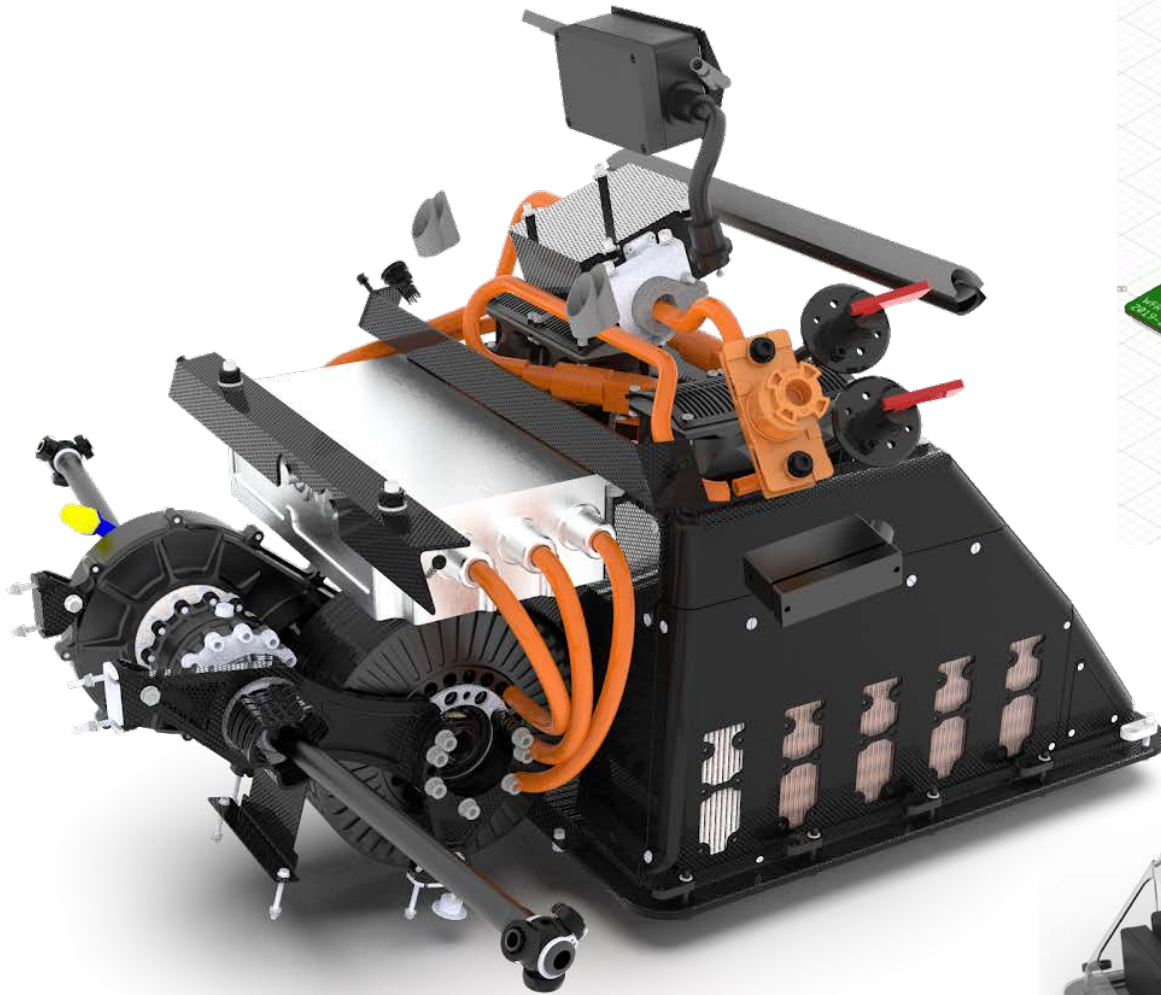
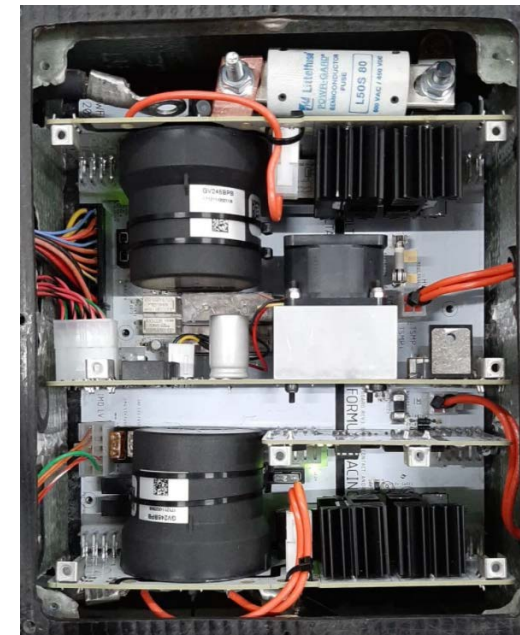
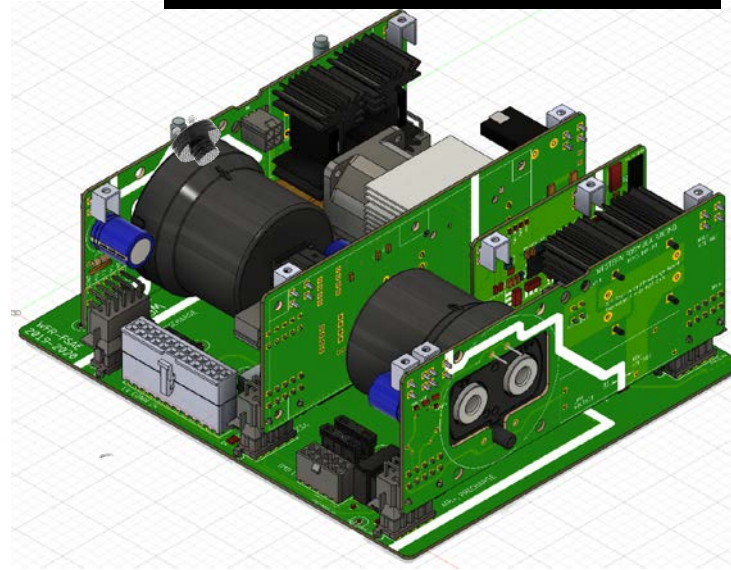
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- Lead electrical system design and assembly for a 400-volt energy Accumulator. Incorporated all discrete control components to a modular PCB assembly, resulting with stellar accumulator reliability and serviceability allowing the vehicle to complete 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

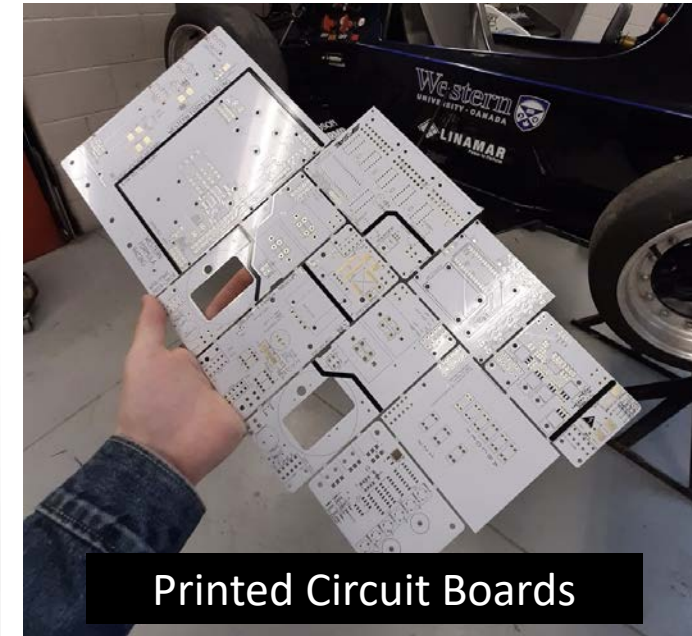




High Voltage Penthouse

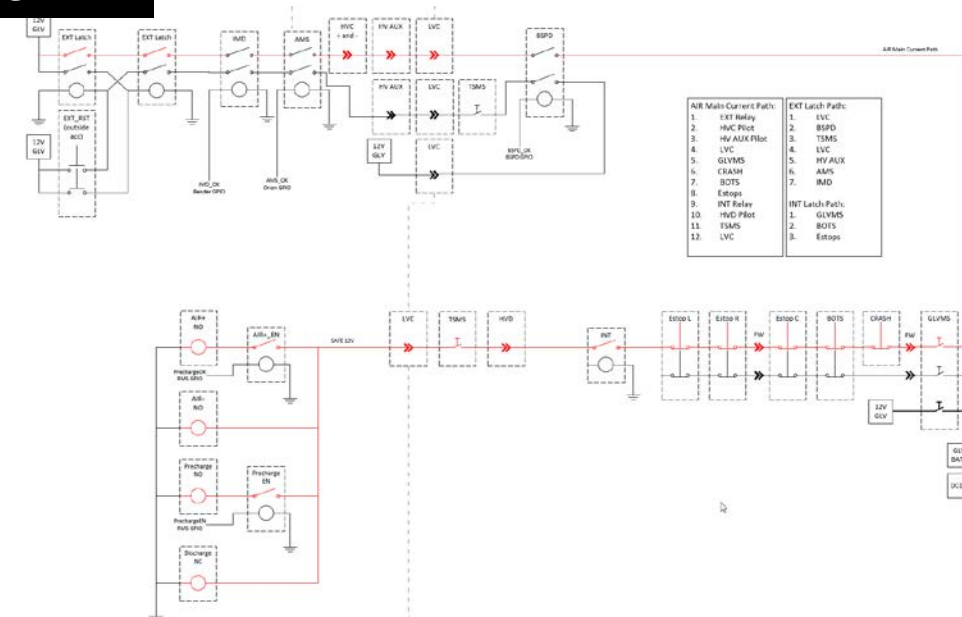
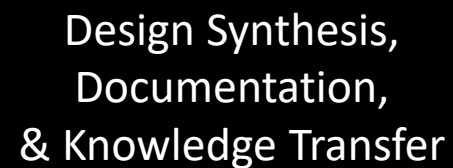


Propulsion System Rendering



Printed Circuit Boards

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

[illegible]





WFR20-E Glamour Shots





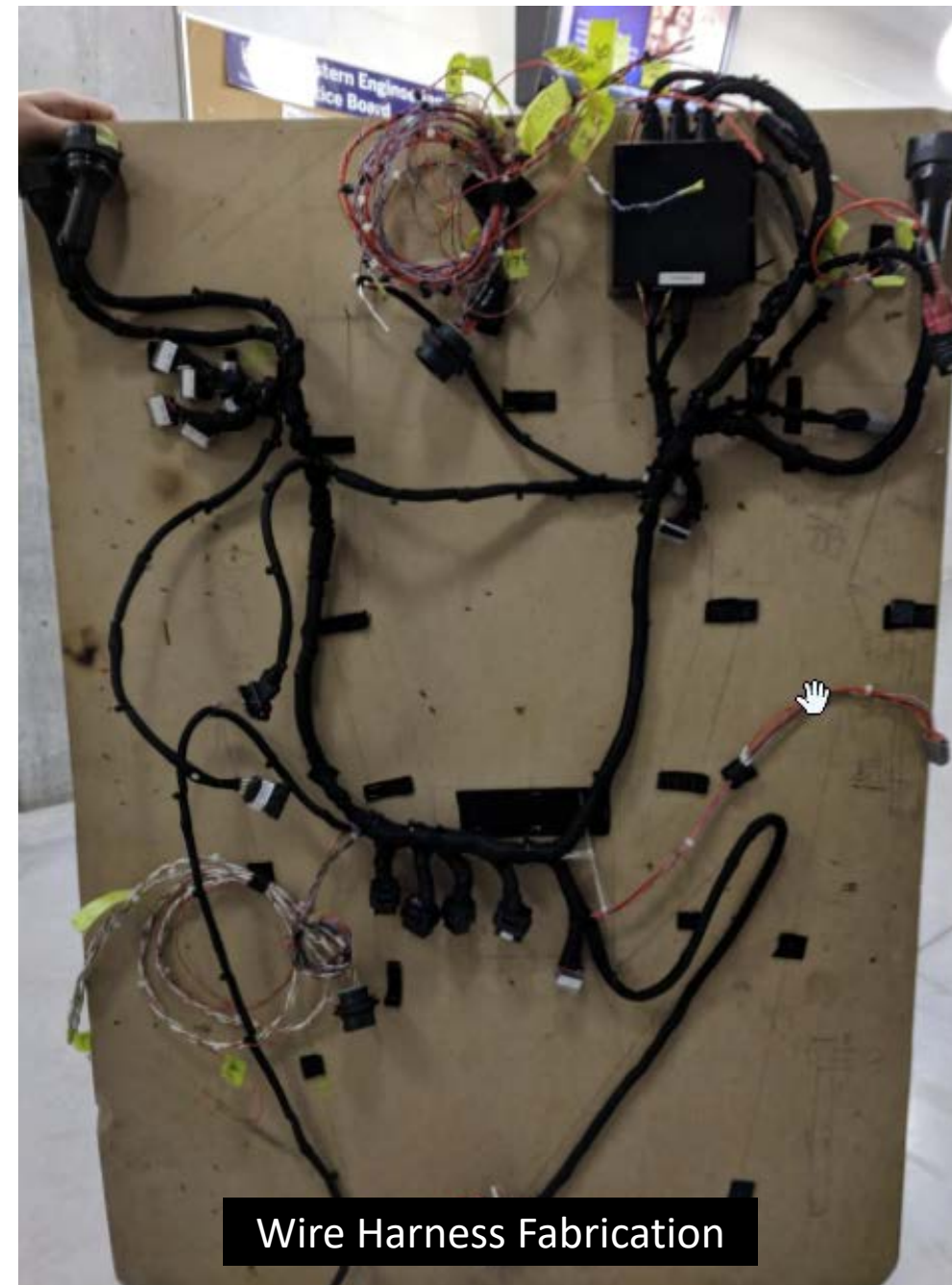
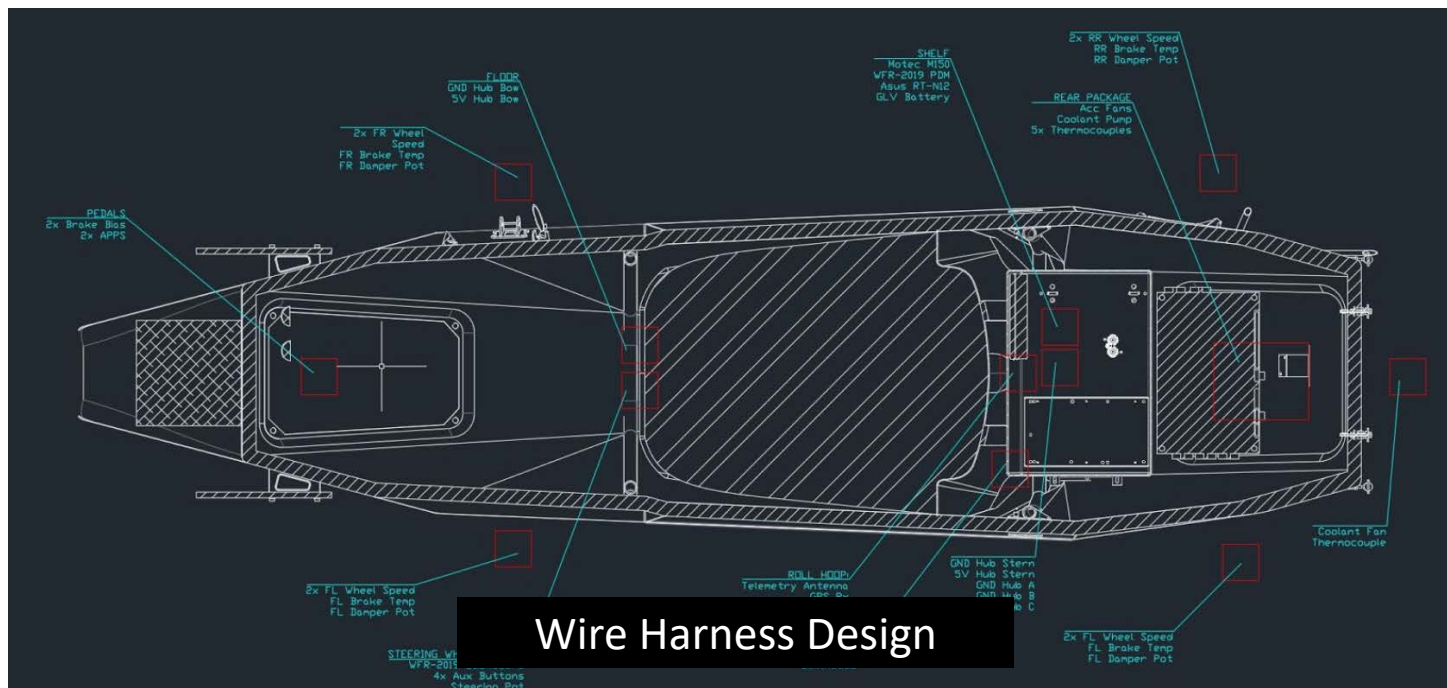
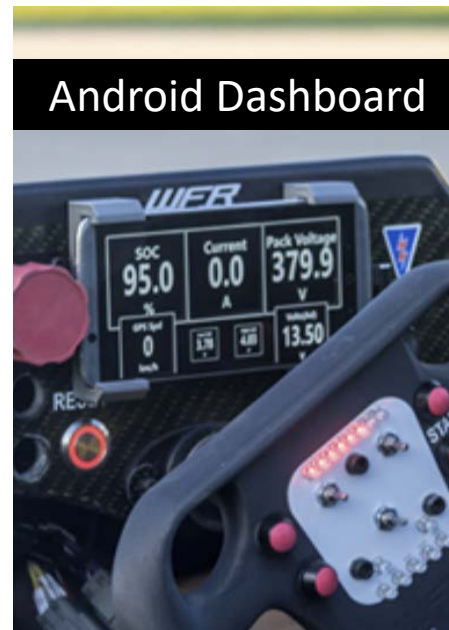
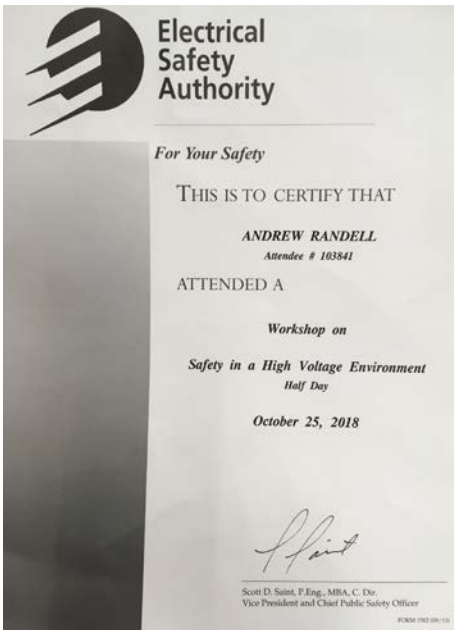
## 2019 WFR Low-Voltage & Data Acquisition Lead

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- 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











WFR19-E Glamour Shots





## 2018 WFR Electrical Member

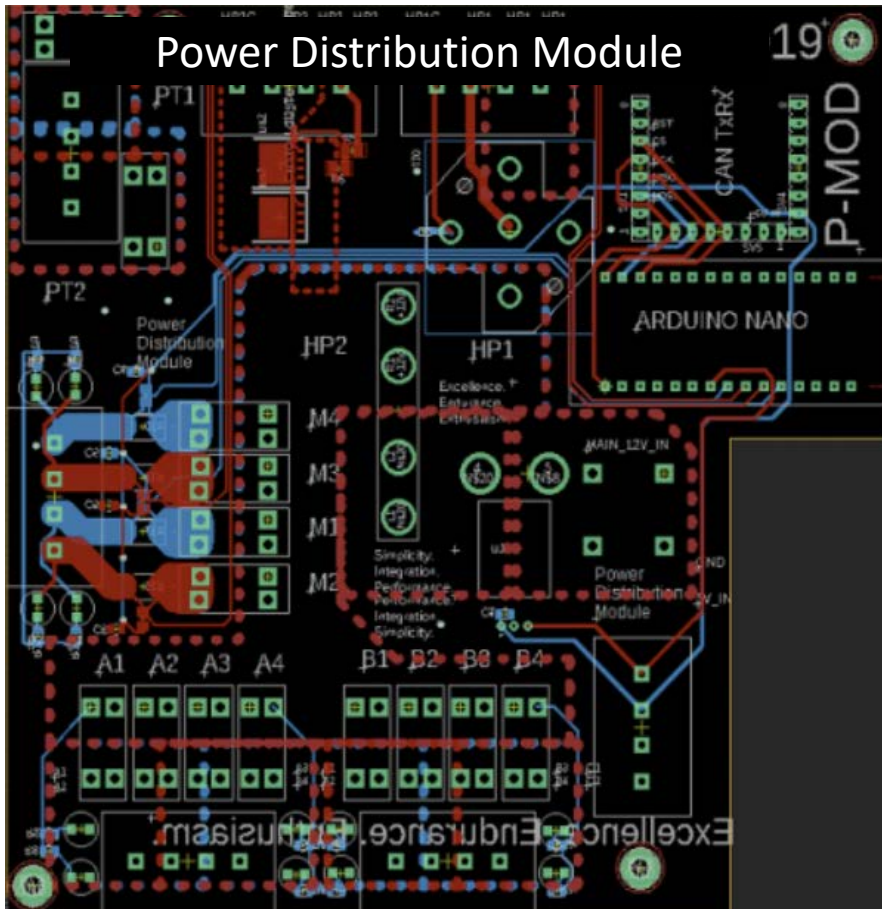
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- Incorporated wireless telemetry based on a generic 802.11n local area network with a router running OpenWRT
- Supported the electrical team with duties including: system design, wire harness assembly, and troubleshooting

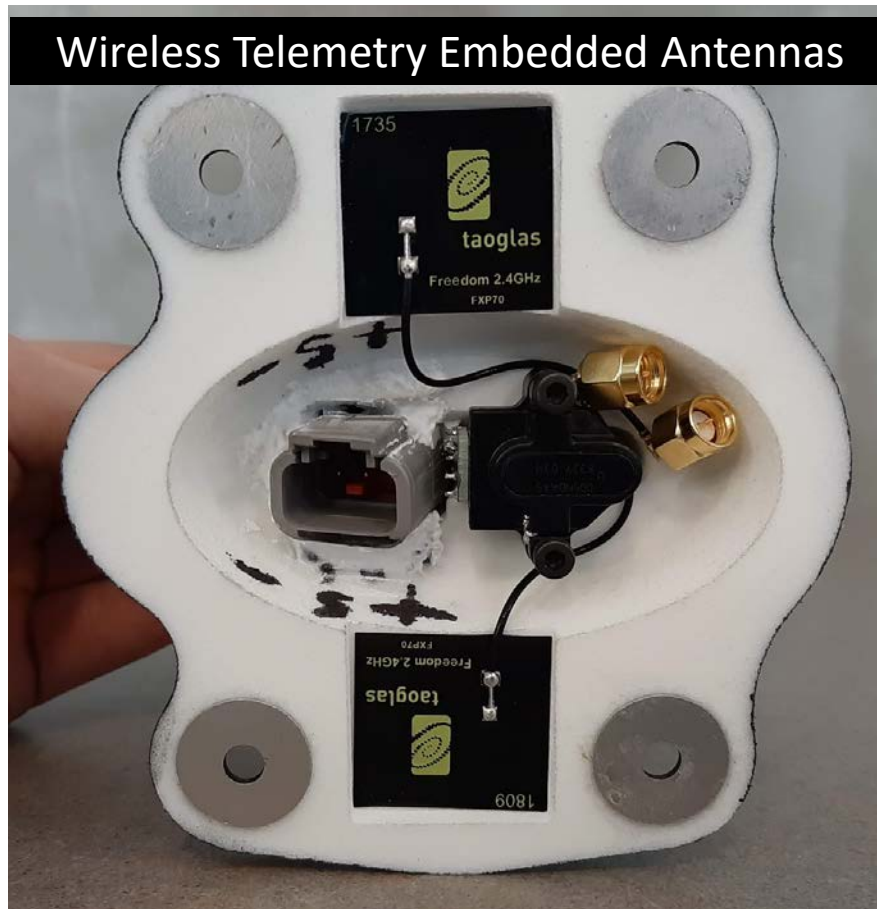




Power Distribution Module



Wireless Telemetry Embedded Antennas



Wire Harness Fabrication







## Product Marketing, Drone Photography, and Creative Content

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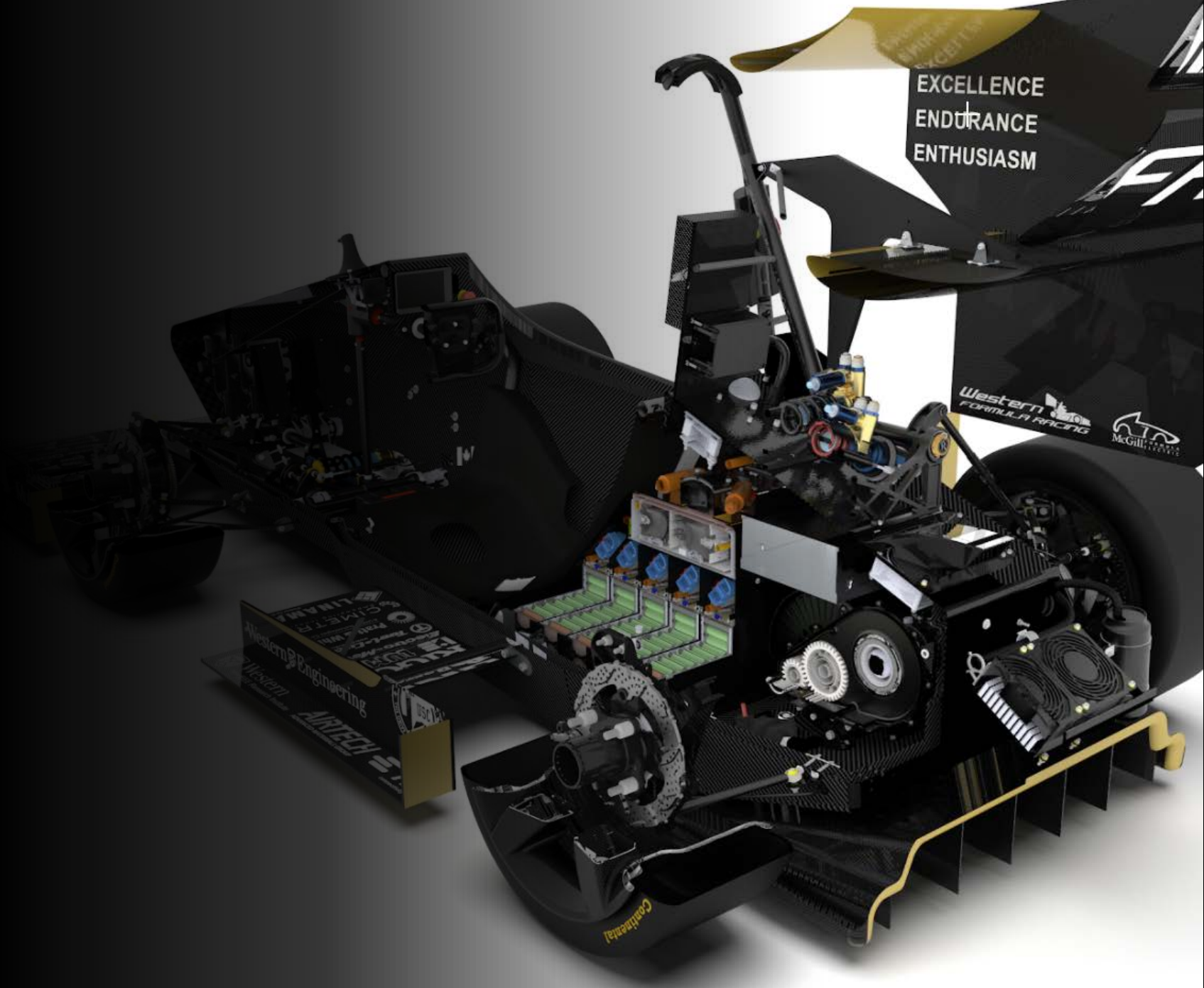
Photorealistic renderings of  
Solidworks models via Keyshot

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  
and Co-op Experience







# Intel Corporation 16-month Internship

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## 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

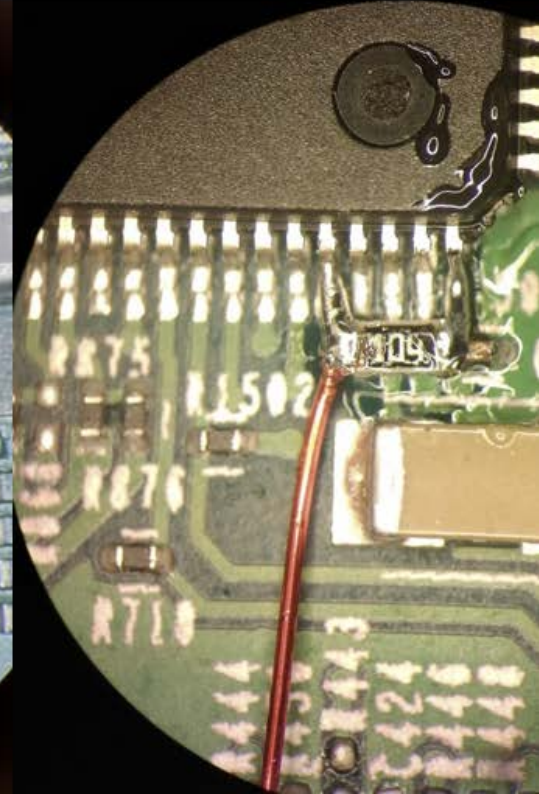
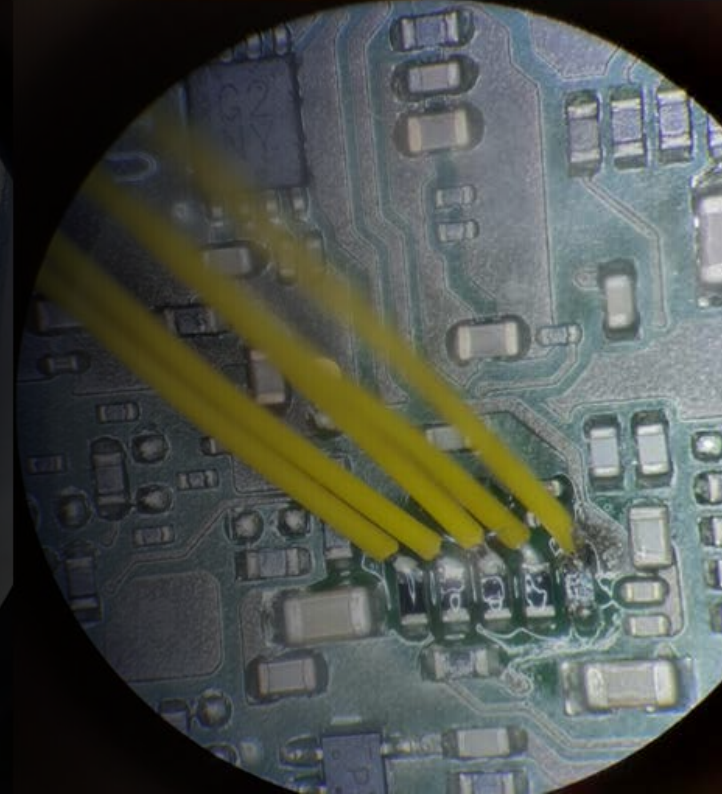
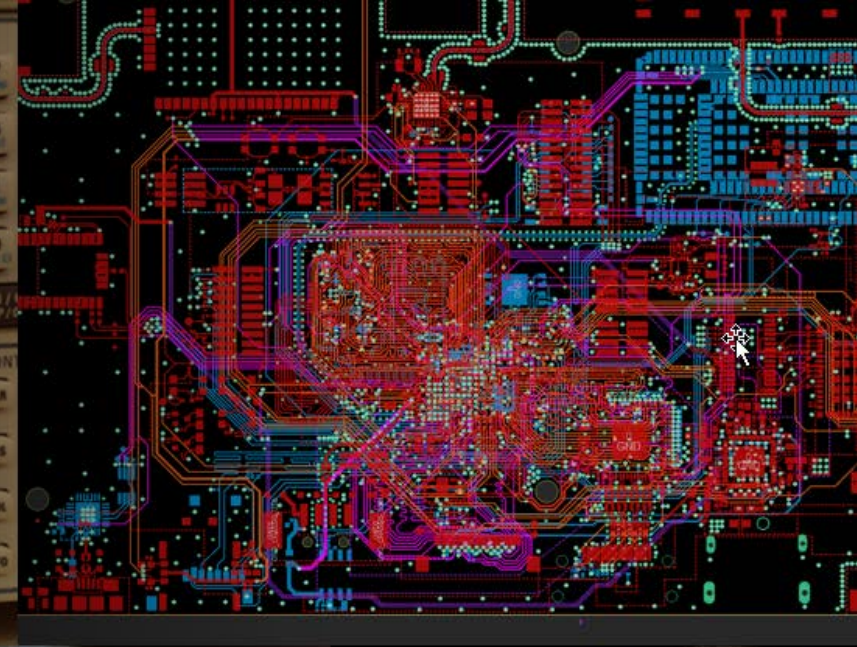
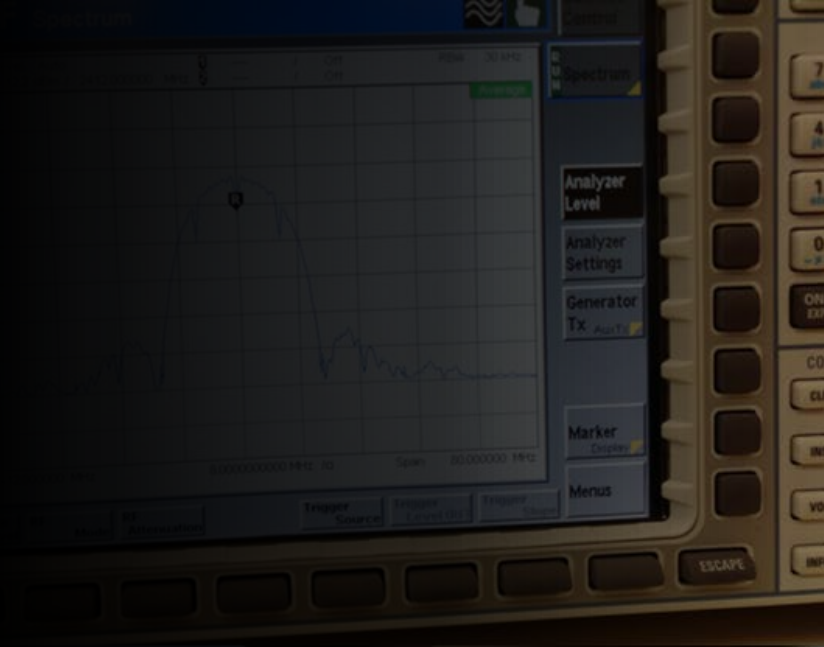
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## Term 2: Hardware Designer

- 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





# 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



cādence

OrCAD™  
CADENCE PCB SOLUTIONS







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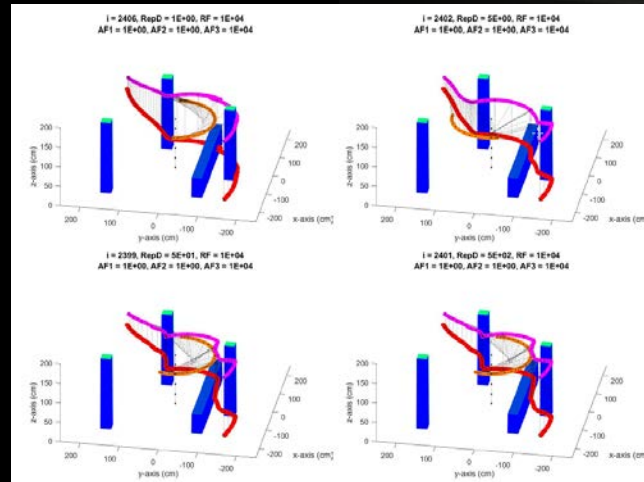
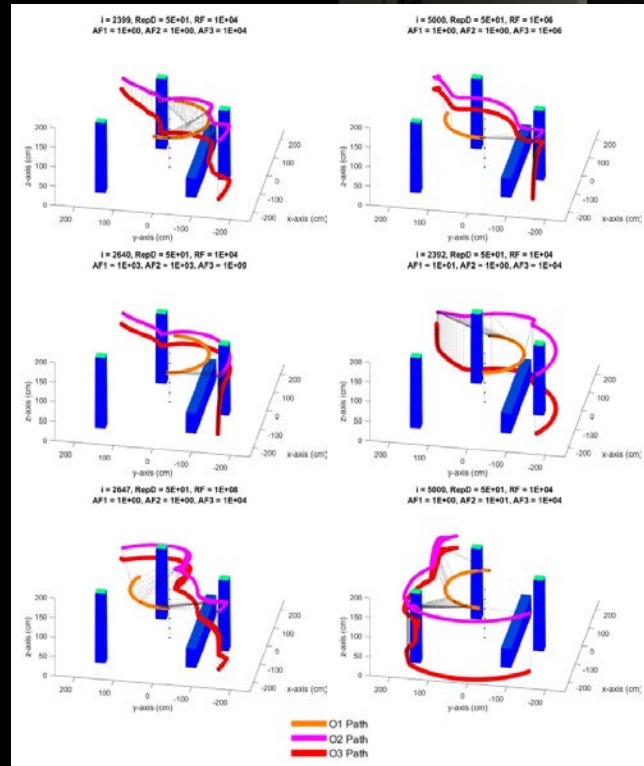
Bachelor of Engineering Science  
Mechatronics Engineering 2021  
Dean's Honour List



# MSE4401

## Path Planning

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



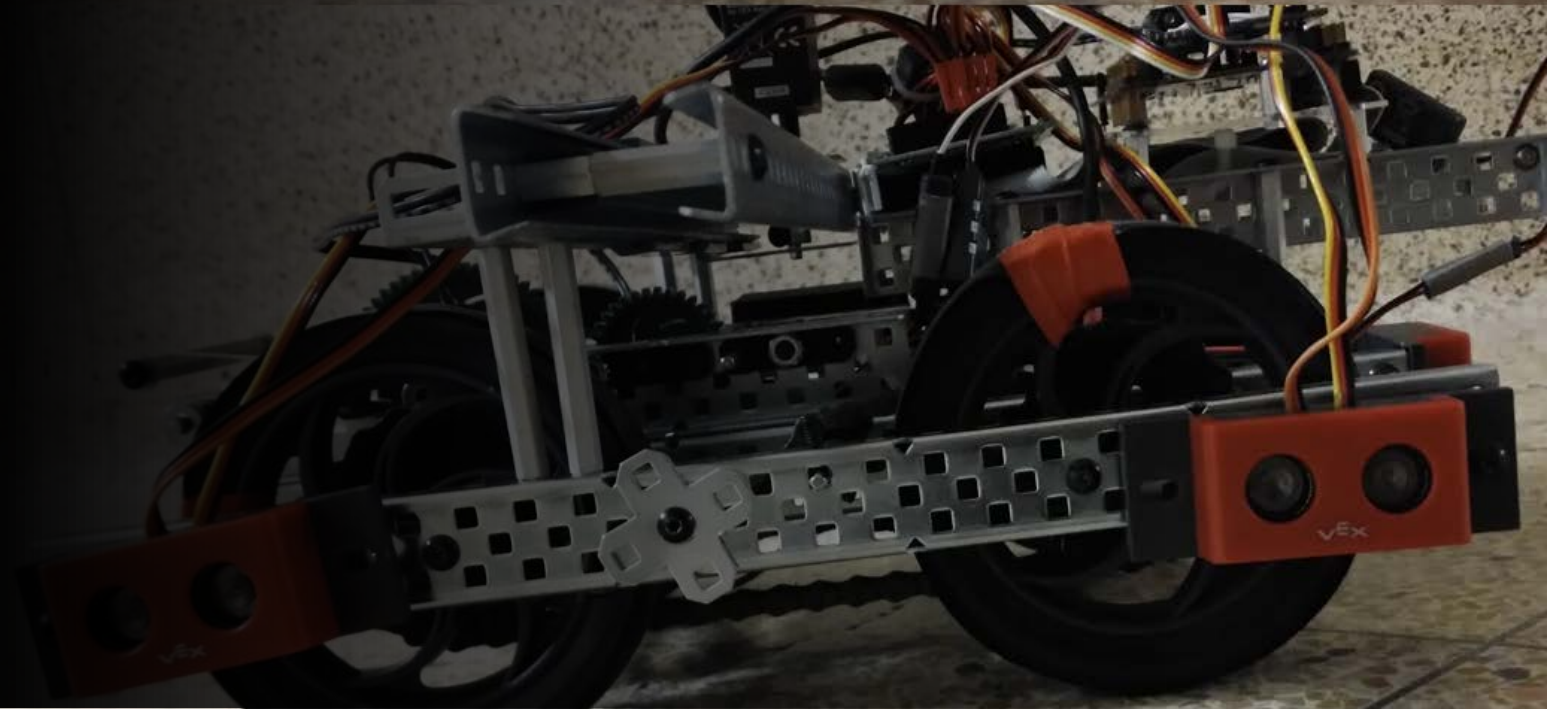
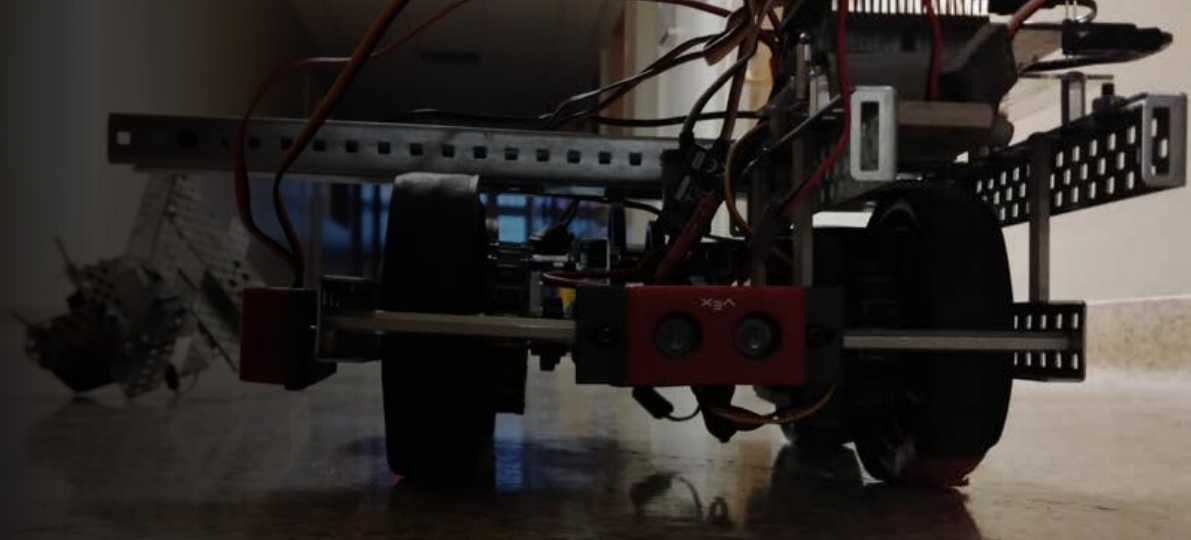


# MSE2201

## Autonomous Robot

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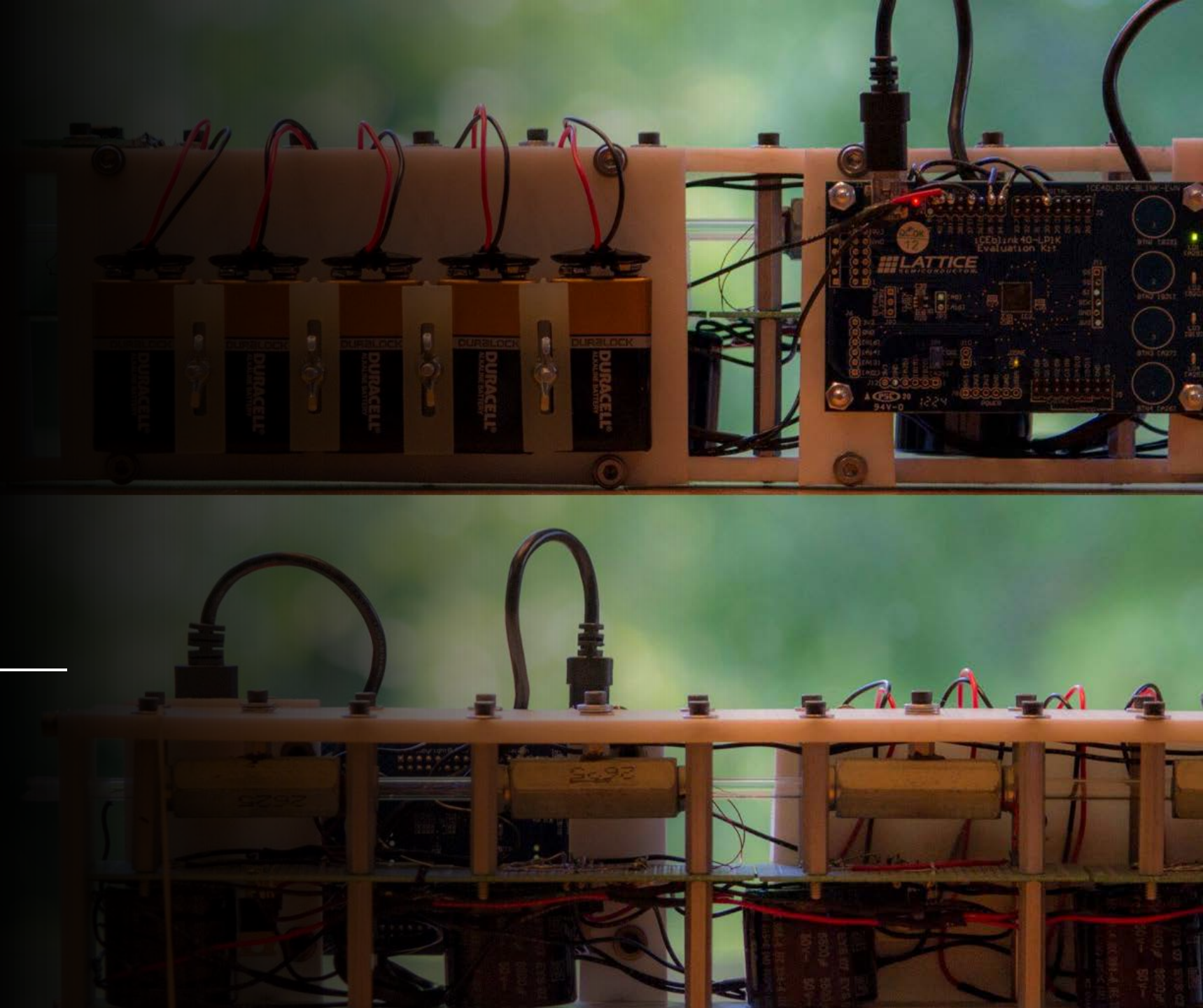
- Develop an autonomous robot to navigate a course
- Detect and pick up objects
- Deposit objects in the proper location





# Personal Projects

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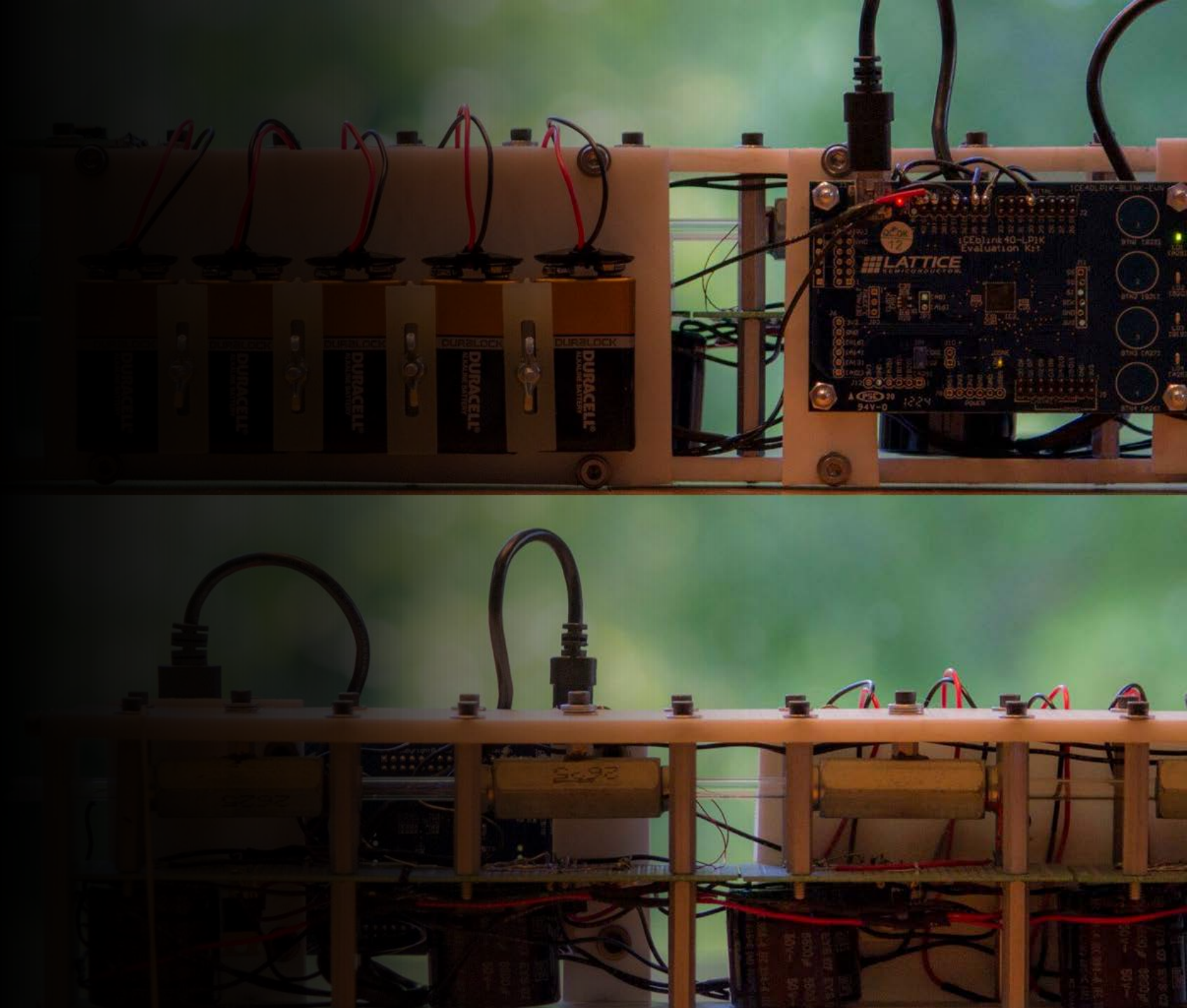




# Home-built Linear Accelerator

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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
- Portfolio site: [andrewrandell.ca](http://andrewrandell.ca)
  - Hosted on Github Pages
  - Modified HTML5 template







## Trips and Adventures

