Marcel Dabek

Projects & Photos

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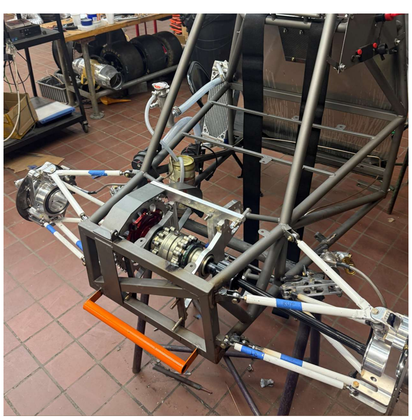
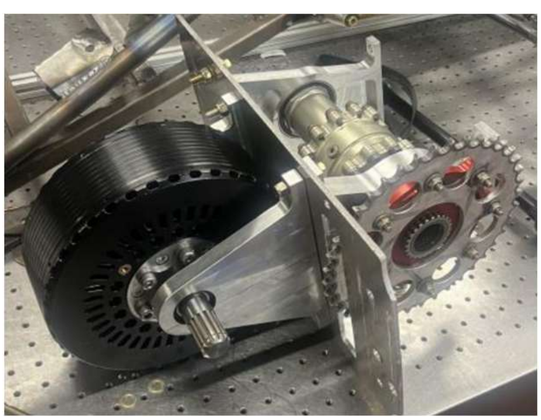
Introduction

I am Marcel Dabek, a third-year Mechanical Engineering student at the University of Connecticut and one of the team leads on UConn Formula SAE. My contributions this past year placed our first-ever Electric Vehicle 14th in the nation. In this portfolio I walk through the decisions behind the powertrain and the high-voltage accumulator—what I tried, what I changed, and why the final design worked. I also show related work from Infiltrator Water Technologies, where I applied the same design-iterate-test approach to a snap-fit assembly tool that ships with each tank and makes field assembly fast and repeatable, along with release-ready drawing cleanup for a large program.

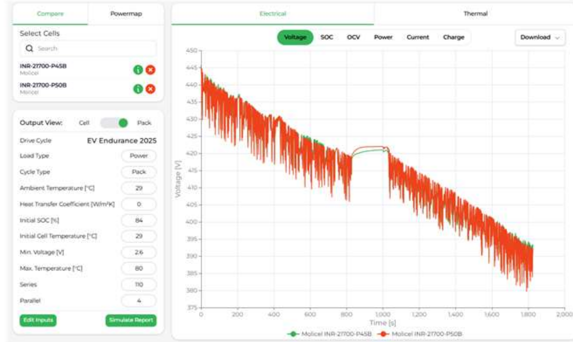
EV Powertrain – *UCONN FSAE*

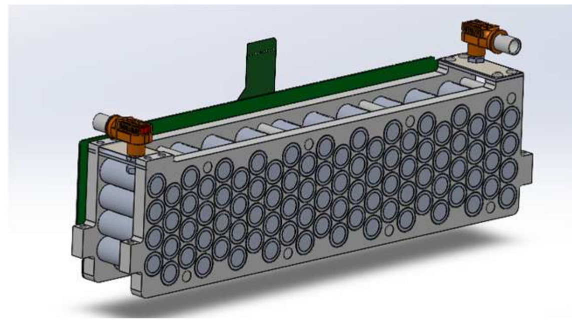
I approached the drivetrain with a simple goal: a reliable, rules-compliant system we could build quickly. I started with free-body diagrams for the major parts, then iterated designs in SolidWorks and checked them in ANSYS Static Structural. I used topology optimization to remove mass while maintaining stiffness, cutting weight by roughly a third on key brackets. After researching modal and harmonic response, I raised system natural frequencies above the motor operating range to avoid resonance. I designed an electric motor shaft to accept a Yamaha R6 sprocket, using MITCalc for spline geometry and a 3D scan to confirm dimensions. I verified bearing fits, snap-ring details, and materials/heat-treat choices. I produced drawings and a bill of materials and simplified designs when we moved fabrication in-house. The drivetrain was manufactured and assembled and then ran for six months without failures. I tuned motor-controller parameters using data in Race Studio 3 to improve drivability and reduce power cutbacks.





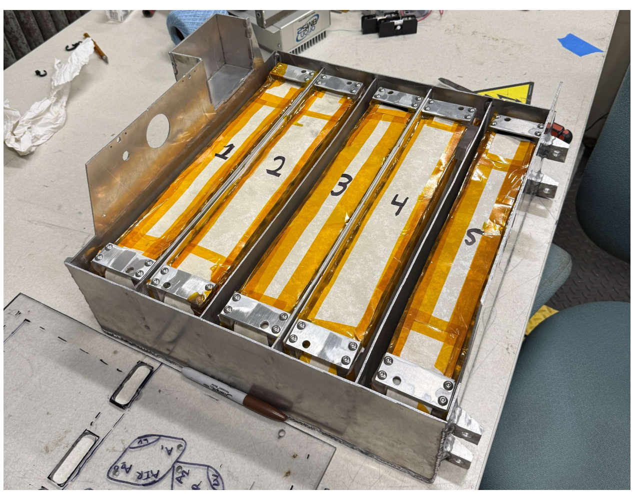
EV Accumulator – *UCONN FSAE*

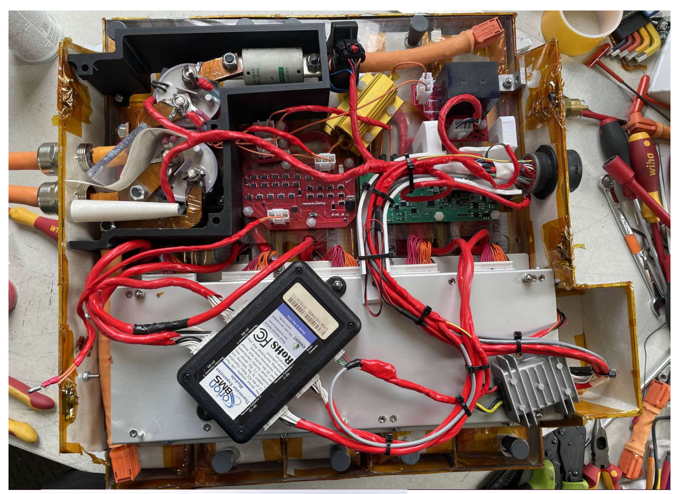




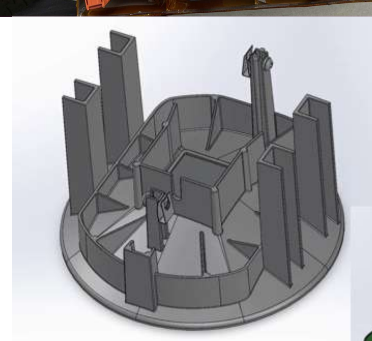
After the powertrain work, I led the design of the high-voltage battery. I worked within a fixed chassis envelope and the Formula SAE rules. I selected the cell format and configuration to maximize voltage for our components while reducing resistance, which kept thermal loads low enough to avoid active cooling. The pack uses 440 cells divided into five segments (about 462 V, 8.32 kWh). I designed the cell structure and the sheet-metal enclosure to meet 40 g load cases called out by the rulebook. Cells are secured between polycarbonate sheets with epoxy, insulated with Nomex 410 and Kapton, and individually fused with a five-layer clad fuse rated 95 A.

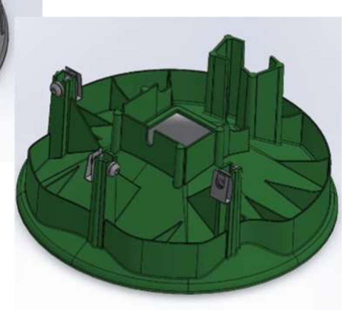
I integrated voltage/temperature logging through a custom PCB footprint and added thermal relief features in the busbar so soldering does not overheat cells. Segments are fully insulated and connected with off-the-shelf high-voltage connectors and pins. I also designed a service area that brings the high- and low-voltage interfaces together in a rules-compliant way. We manufactured and installed the pack in a two-week build window, and it ran reliably through the testing season.





Snap-Fit Assembly – *Infiltrator Water Technologies*

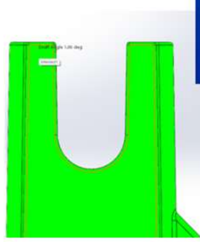


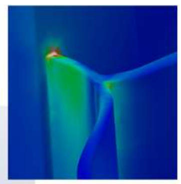


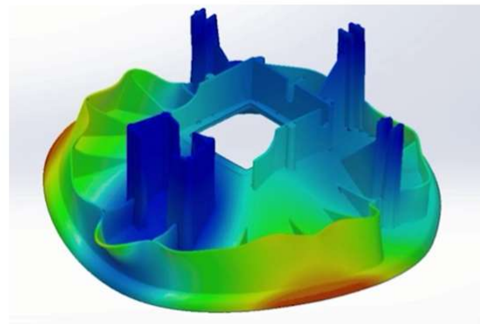
Distributors receive palletized tank halves and are the ones who join them at their warehouses. I designed a snap-fit assembly cone that ships with each EDGE-600 tank and makes that join fast, repeatable and safe. The cone indexes the parts, guides alignment, and keeps hands clear while the halves are brought together. The goal was simple—reduce struggle, prevent mis-alignment, and make assembly reliable for anyone at the distributor site.

Snap-Fit Assembly – *Infiltrator Water Technologies* *(Continued)*

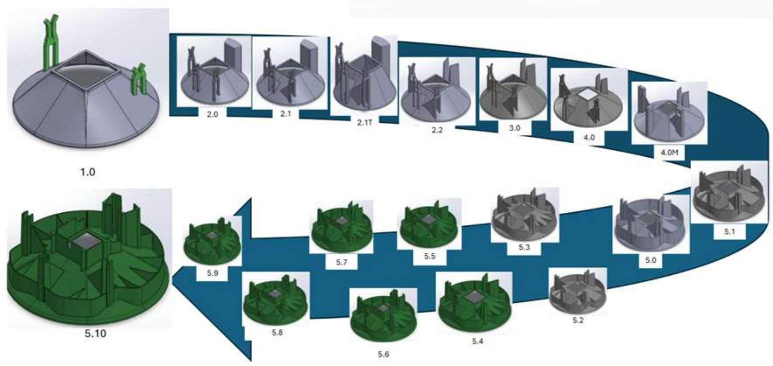
I ran a design–simulate–test loop in SolidWorks Simulation and iterated through roughly twenty-six geometry changes. Each iteration was 3D-printed first to check fit and handling. I measured installation and pull-off forces with a shop scale and set practical targets: 30 lb total to seat the part/remove it. Therefore about 10 lb per clip. Plastic clips failed to hold that consistently, so I moved to bolt-on metal U-nut clips while keeping the body polypropylene for manufacturability as 400 of these would be made annually. The final tool clips on positively, resists accidental removal, and installs with a firm, repeatable push. The body is a DFM'd injection-molded polypropylene part; retention is provided by bolts driven through the opposite side of standard U-nuts so they act as metal clip latches. The cone's role is packaging-friendly, field-ready, and it materially reduces the chance of crooked joins or rework.





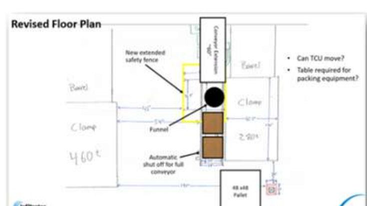


Cal installing cone into top tank half



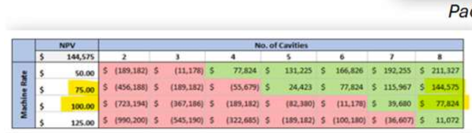
Injection Molded Manufacturing Layout – *Infiltrator Water Technologies*

I planned a simple, reconfigurable cap-assembly line so production could be brought in-house and the same stations could be reused for future parts. I laid out stations and fixtures around an eight-cavity shot plan, balanced tasks to match the shot rate, and sized throughput to about 400,000 caps per year. We referenced an internal cost-sensitivity table to set reasonable ranges; the case pointed to a low six-figure capital spend (about \$80k–\$150k) with roughly \$50k/year margin improvement if implemented. I also drafted an 8020 + vacuum-cup end-of-arm tool so parts could be handled without marking



Machine floor plan

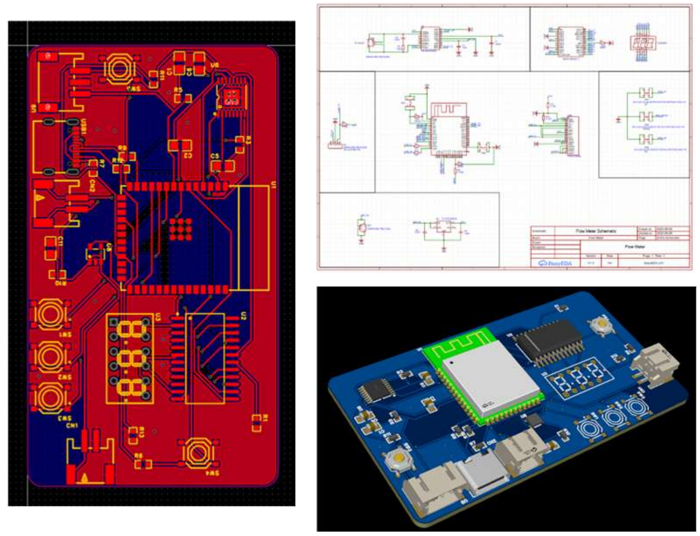
Packaging Options



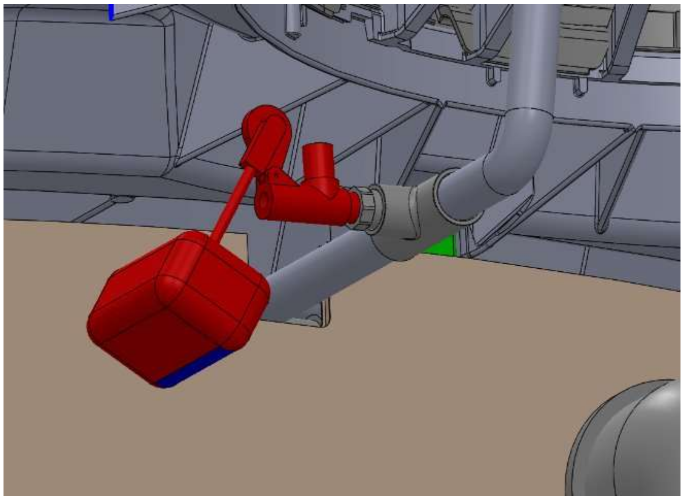
	NPV	No. of Cavities						
	$ 144,575	2	3	4	5	6	7	8
Machine Rate	$ 50.00	$ (189,182)	$ (11,178)	$ 77,824	$ 131,225	$ 166,826	$ 192,255	$ 211,327
	$ 75.00	$ (456,188)	$ (189,182)	$ (55,679)	$ 24,423	$ 77,824	$ 115,967	$ 144,575
	$ 100.00	$ (723,194)	$ (367,186)	$ (189,182)	$ (82,380)	$ (11,178)	$ 39,680	$ 77,824
	$ 125.00	$ (990,200)	$ (545,190)	$ (322,685)	$ (189,182)	$ (100,180)	$ (36,607)	$ 11,072

Cost sensitivity chart

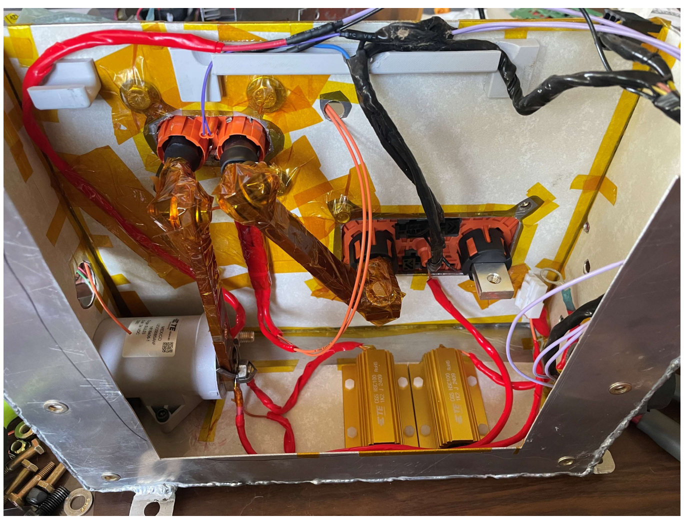
Other projects



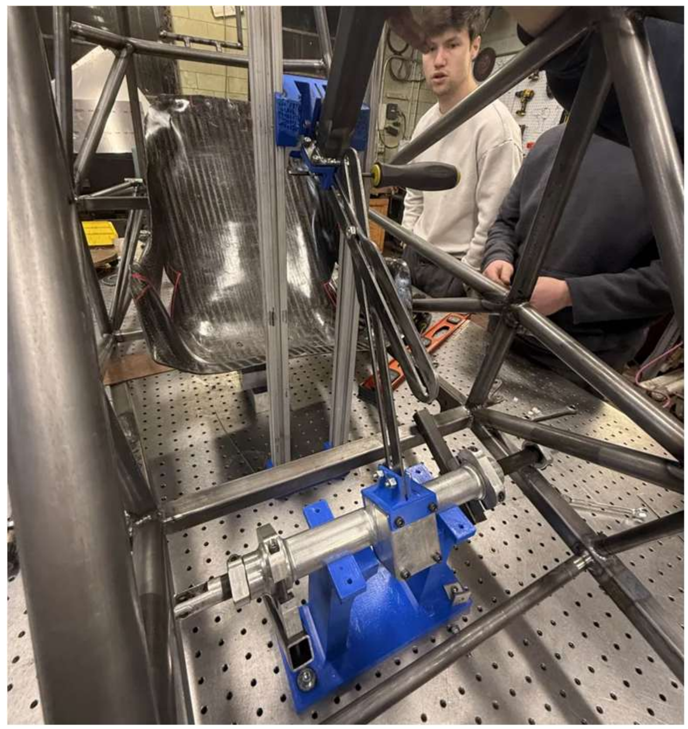
Custom Flow Meter PCB
Personal Project



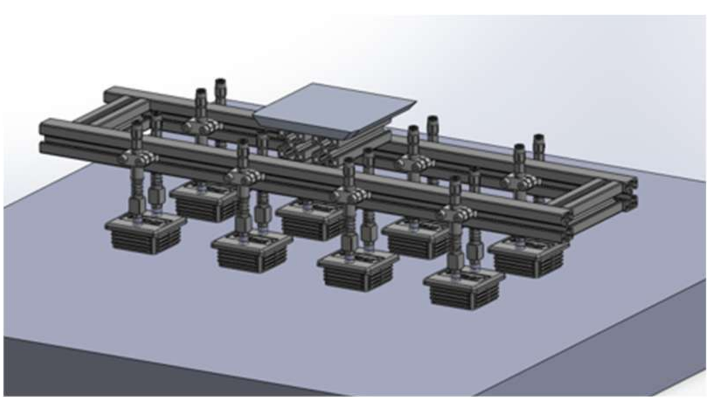
Cheap Float Valve Modification
Infiltrator Water Technologies



Electrical Structures
UCONN FSAE



Steering Column Jig
UCONN FSAE



Custom End of Arm Tooling Draft
Infiltrator Water Technologies

Generative Design Pedal Base Mount
UCONN FSAE