

FSAE BATTERY COOLING

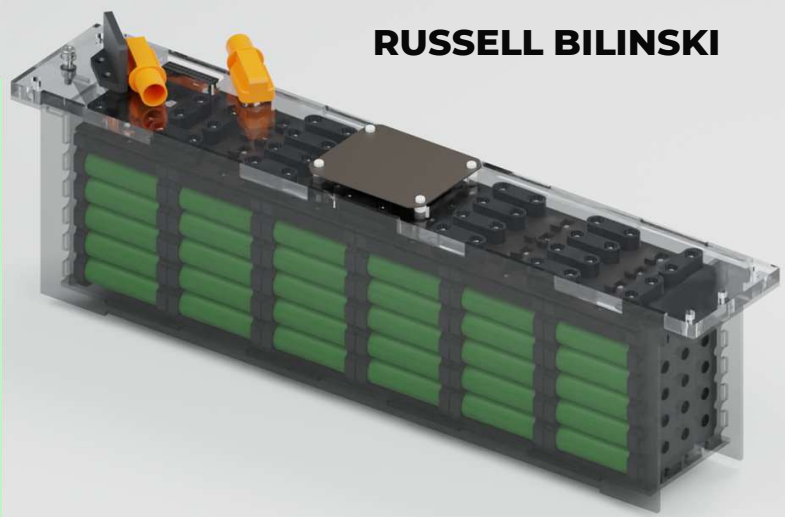
RUSSELL BILINSKI

My Role

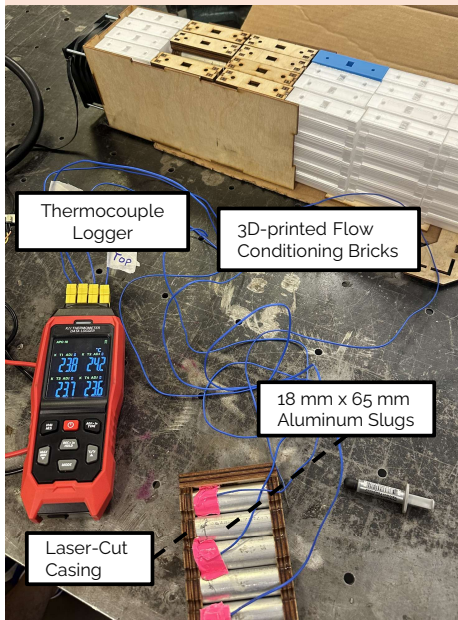
I developed thermal estimates, test setups, and instrumentation to select battery-cooling fans and define the cooling system's LV current requirements for our FSAE car.

Why was this important?

Overheating could prevent us from finishing endurance, and derating battery power would cost us lap time and competition points.



"Mock Brick" Testing

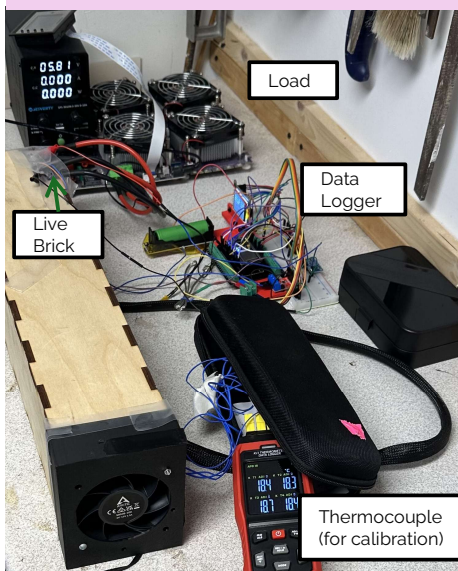


My initial test used a variety of fans to cool down heat-soaked, thermally similar aluminum slugs and casings.

The goal of these (scrappy) tests was to get rapid results before other systems started to finalize.

- *Mock 18650 Slug: ~41 J/K
- *18650 Li-ion Cell: ~43 J/K
- *Geometry is close to identical

Live Brick Testing



I then conducted a more representative test by discharging and measuring cooldown of live ENEPAQ cells under endurance loading while reading their in-built thermistors.

*Casing and internal flow conditioning mimic the airflow impedance of the real module. Custom DAQ also tracked ambient temperature and cell voltages.

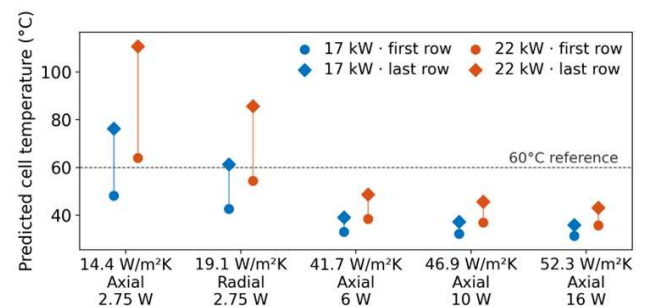
Why not CFD? CFD needed understanding and inputs I didn't have, risking convincing but incorrect results. Even with that, I expected physical testing to give more accurate cooling estimates while helping me learn heat-transfer fundamentals.

Estimated power from lap-time simulation and used a 1-Resistor Cell model to estimate heat generation.

$$\text{Isolated for } h \quad m c_p \frac{dT}{dt} = -hA(T - T_{\text{ambient}})$$

Applied additional safety factors and accounted for progressive airflow heating.

Predicted steady-state cell temperatures
RMS trim-cap range: 17 kW (lower)–22 kW (upper)



Conclusion

This test enabled high confidence that our fan sizing and current budget would survive a full FSAE endurance. This also allowed us to correlate cooling effectiveness to operating power.

Further Validation & Learnings

The airflow through our segments is a relatively high-impedance system. The radial (blower-style) fans showed higher cooling to power draw efficiency. The final selection upsized our blower fan to 60 x 23mm (~5W draw). Final validation rests on TMS & UV26 being fit to drive (est Oct. 2026).