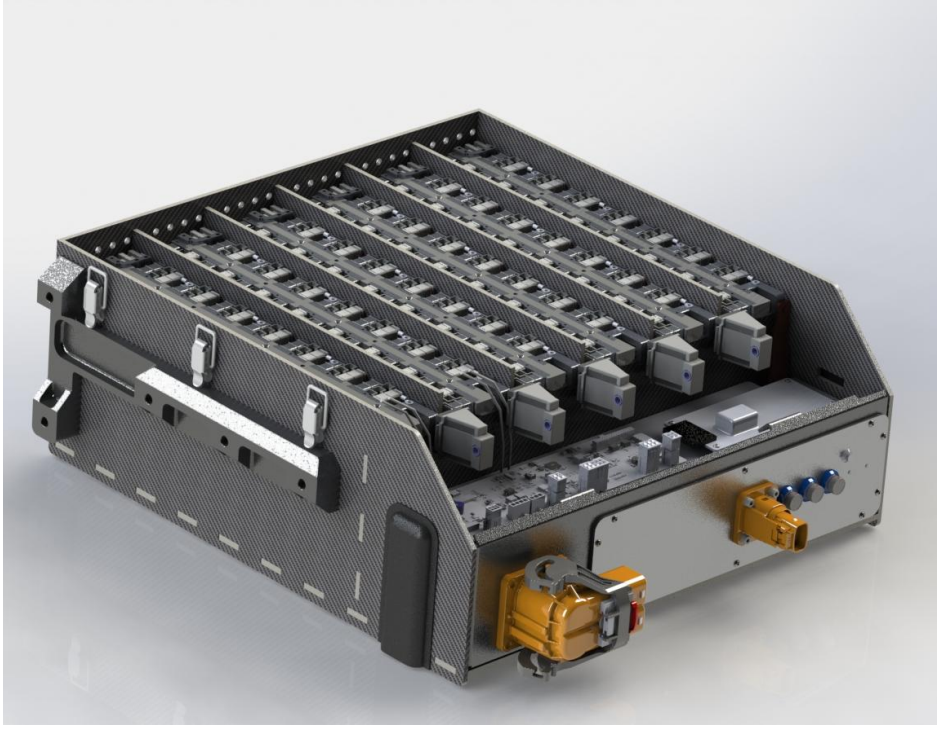
# Formula SAE Accumulator Gen 3



## Project Overview -

This was the battery pack for UBC Formula Electric's car for the 2023 FSAE competition. The project has 5 custom PCBs including 6 battery modules, BMS core, flexible voltage routing, charging board, and HVDC to LVDC converter. With over 6000 parts, careful considerations had to be made in maintaining and designing the assembly as well as to manufacturabity, thermal, power considerations.

## Technical Details -

The pack itself has 6 different segments connected in series for a nominal voltage of 355 volts. The enclosure consists of layered carbon fibre and fibreglass sheets around a hex core with an UL-94 epoxy adhesive to mount pieces together to create a strong but isolating material. The front enclosure was made of sheetmetal parts to allow for LV grounding and easy of manufacturability.

The segment centers around a delrin spine and end piece with an aluminum heatsink on the bottom. Cells are mounted on either side of the spine and bussed to BMS modules located on the top of the segment. Each cell is individually fused to the bus bars with a nickel fuse to prevent overloading of the cells.

## Results/Review -

This accumulator marks the safest, easiest to make, easiest to use, and highest preforming battery that was made in the team's history, making an extremely competitive design in our FSAE competition. This project was designed over 6 months from initial design stages to completion. I developed extensive track modeling to determine ranges, made thermal models for the cooling system, structural analysis to conform to strict FSAE requirements and electrical architecture for the battery monitoring system. Overall this pack placed 2nd in efficiency out of 75 teams internationally in our Micigan competition.

# Heads up Display for FSAE Racing

## Project Overview -

This project's goal was to provide a HUD for real time race data to drivers in a way that was safe, cheap, and easy to use. This would allow drivers to view real time data to improving lap times but see critical safety information such as pack capacity or faults.

## Technical Details -

The project was comprised of 2 major components, the display module and the control module. The display module housed the OLED display and optical system while the control module housed the electronics required to read the CAN bus data and display.

To allow for a further depth of focus, the display module featured a bifocal lens to reduce eye strain on the user which allowed for a focal range of 3 meters, which was determined to be the minimum focus range in which the driver routinely views.

## Results/Review -

Although the project was successful, a major flaw is the lensing system. Ideally the lens would allow an infinite focal point so that the information was always in focus without having to change focus. There are multiple methods to achieve this but using a specialized prism was seen to be the easiest. As well, removing the wires to drive the display for an internal battery and a paired bluetooth connection would allow a smaller and less intrusive package.

# Phased Array Ultrasonic 3D Printer

## Project Overview -

This project was my capstone research project where we I led my team to explore controlled ultrasonic consolidation to create a novel method of 3D printing polymers and metals. Because of the solid-state nature of the product, this method has the potential to be more precise and faster than any other method of printing polymers or metals.

## Technical Details -

The core mechanics work off a phased array of ultrasonic transducers. By filling the welding chamber with a powder and providing pressure, you can allow ultrasonic propagation through the powder and cause welding of the individual particles at peak ultrasonic amplitudes. This can be controlled by an external controller to fire individual transducers at specific times, controller where the peak amplitude lands. The project is base around similar 2D array medical imaginig systems, but at much high powers to allow further propagation and to create welding at the amplitude.

## Results/Review -

While still in progress, initial results look promising while achieved aluminum powder consolidation through fixed lens magnification. Next steps will be single triggered full array trials with copper, aluminum, and ABS plastic as well as virtual lensing with the fully controlled phased array.

# Compact External Graphics Card Enclosure

## Project Overview -

The goal of the project was to create an external graphic card enclosure that could be used with GPUs supported by Solidworks and still remained portable. This would allow me to use CAD programs in classes, libraries, and workshops on my laptop while keeping the project as cost effective as possible.

## Technical Details -

The initial concept was to replace shrouding on a given graphics card with a new enclosure to be used by a laptop through Thunderbolt 3. This would allow for a highly compact design while adding a larger heat sink to increase performance.

The enclosure itself is made out of machined 6061 aluminum alloy for high thermal conductivity and a clean aesthetic. To convert the graphics card's PCIe x16 to Thunderbolt 3 I used a PCIe riser to convert to M.2 and then used an external NVME SSD enclosure to convert to Thunderbolt 3. The graphics card I chose, a Quadro m2000, needed 75 watts which could be powered from a 100 watt external power supply over Thunderbolt 3 and still have 25 watts to charge the laptop.

## Results/Review -

Although less versatile than options on the market, this design is more compact by a factor of 1.5-2 times, less expensive to make, and can be used with Quadro and Radeon Pro cards which are required by Solidworks. I would like to expand on the project by making a custom PCB to convert from PCIe x16 to Thunderbolt 3 and have an integrated power supply for less powerful cards.