



2019: A Year in Review



Executive Summary

The 2019 season was a historic one for the Western Formula Racing Team. Having chosen to transition the car and team to the Electric FSAE class, the year required a variety of revolutionary changes to the team's organization, the vehicle's design, and its accompanying infrastructure. The team tackled all of these changes head on, creating the WFR19-E, a fully functioning, world-class electric race car.

The season's highlights include being only the 8th car in FSAE North American history to race in their first year as an EV, achieving best overall design at FSAE North, and placing 8th out of 30 teams at Pittsburgh Shootout.

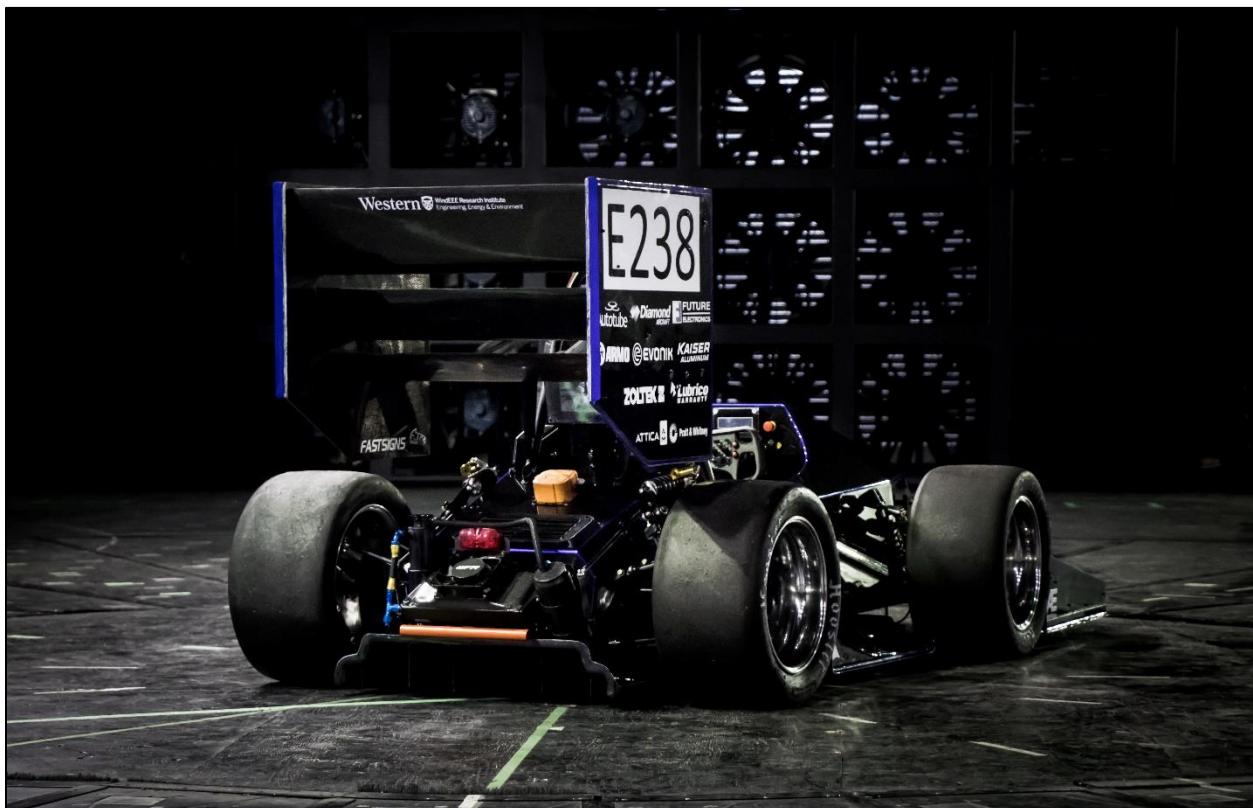


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Introduction

Western Formula Racing is a student team comprised primarily of Engineering and Business students who design, build, and race a formula-style race car every single year. The team uses our motto – Excellence, Endurance, Enthusiasm – to determine how we make decisions and what we pursue. Looking back on the 2019 season, we feel that we've stayed true to this motto by creating an excellent EV challenger, laying a strong foundation for the team's future in this class, and experiencing a summer filled with competitions, testing, and drive days.



Rear isometric view photograph captured at unveiling

Technical Innovations

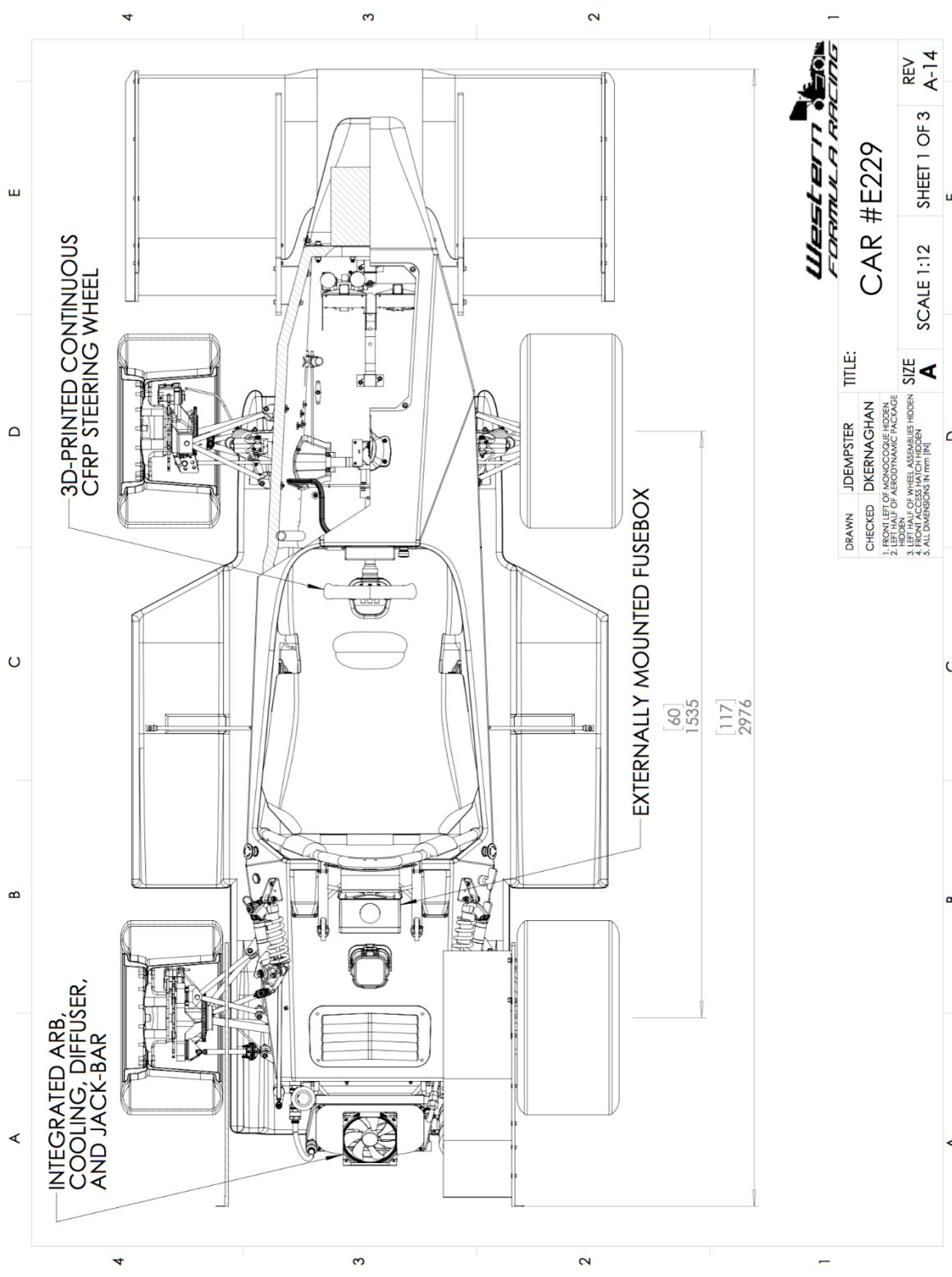
Due to the gracious support of our many generous sponsors we have been able to pursue innovative projects in a variety of areas. First was the development of the team's novel electric powertrain, which includes custom traction system software, a student-built battery and battery enclosure, a custom two-stage reduction gearbox, and a new electric motor and motor drive. To support the packaging changes introduced by this new powertrain, the team also developed its first ever full carbon fibre monocoque chassis and a brand-new take on the vehicle's rear suspension system. Finally, the team made a leap in its aerodynamic development, introducing its first ever undertray and diffusers, as well as implementing a variety of incremental improvements to manufacturing and design along the way.

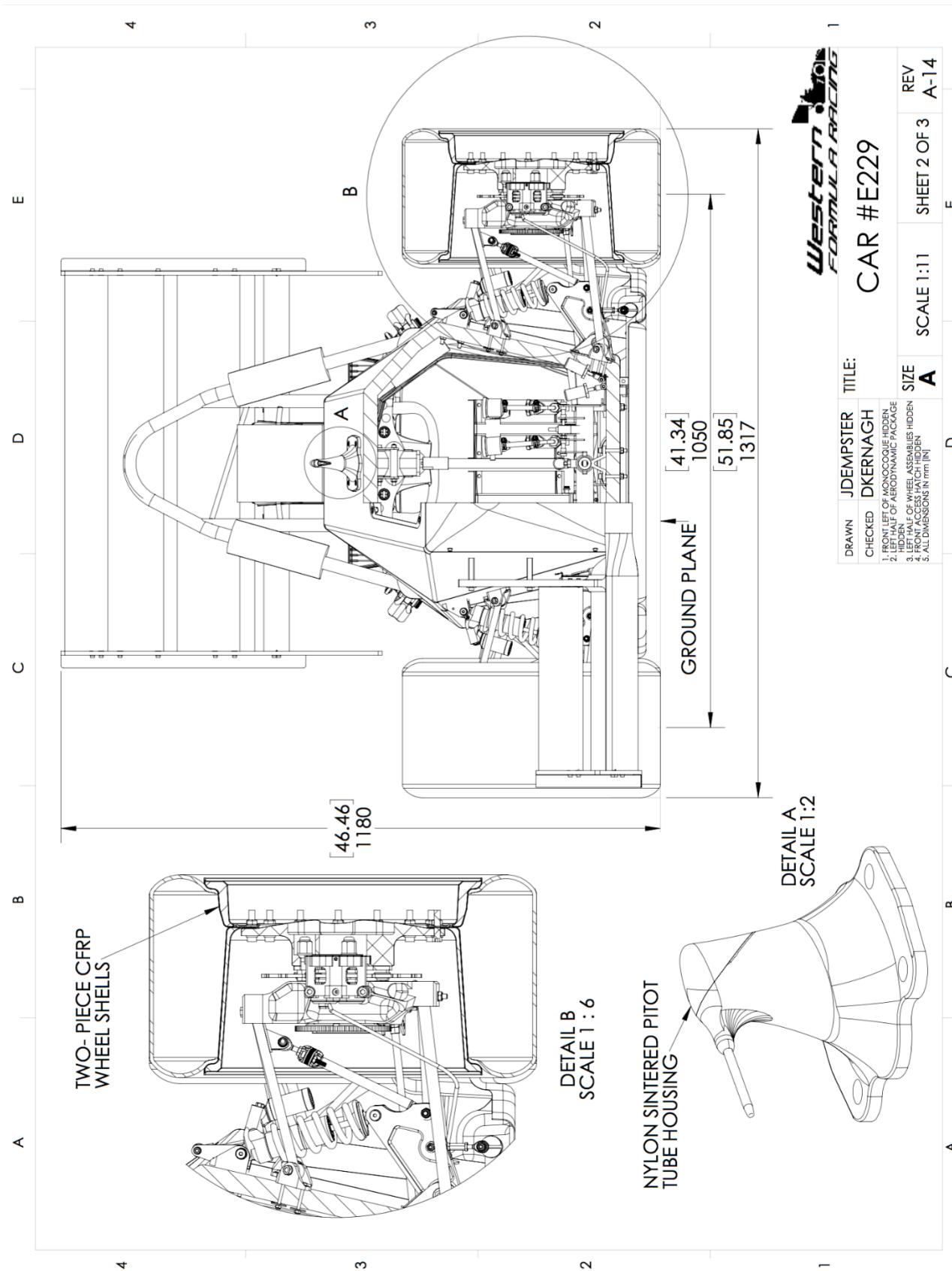


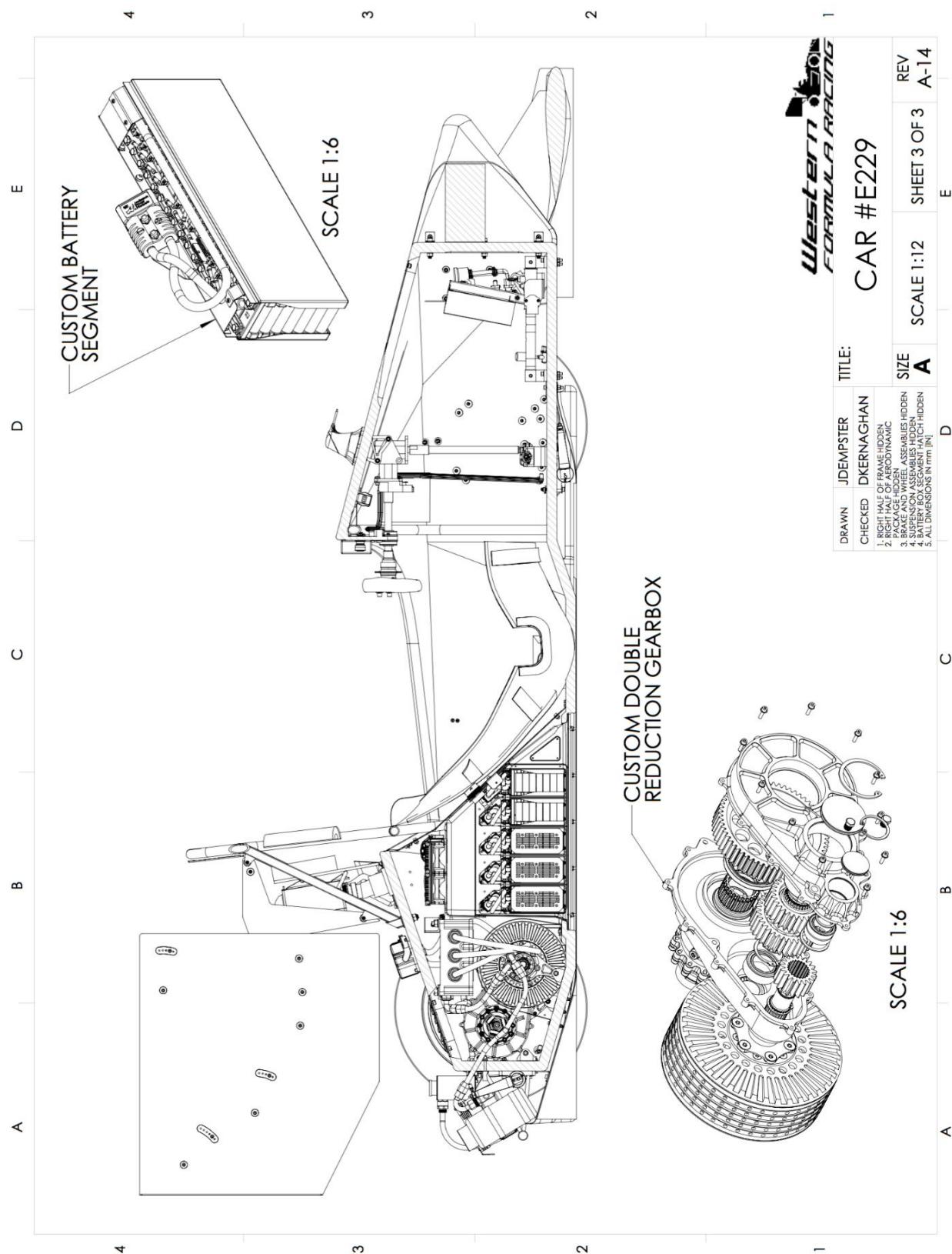
Final design render of WFR19-E (rear and front isometric views)

Three-View Drawing

The ultimate expression of the team's technical design, the three-view drawing shows off every detail of the new vehicle in three stunning views. This particular drawing was submitted as part of our design package to our FSAE competitions and won 2nd and 8th place at FSAE North and Electric respectively for best composed vehicle drawing.







Renders, Simulations, and Models

Before the team can start building, every component must be designed in CAD or modelled numerically. Below are a few of the team's favorite CAD renders and simulations, capturing the beauty and detail of some of our technical innovations.



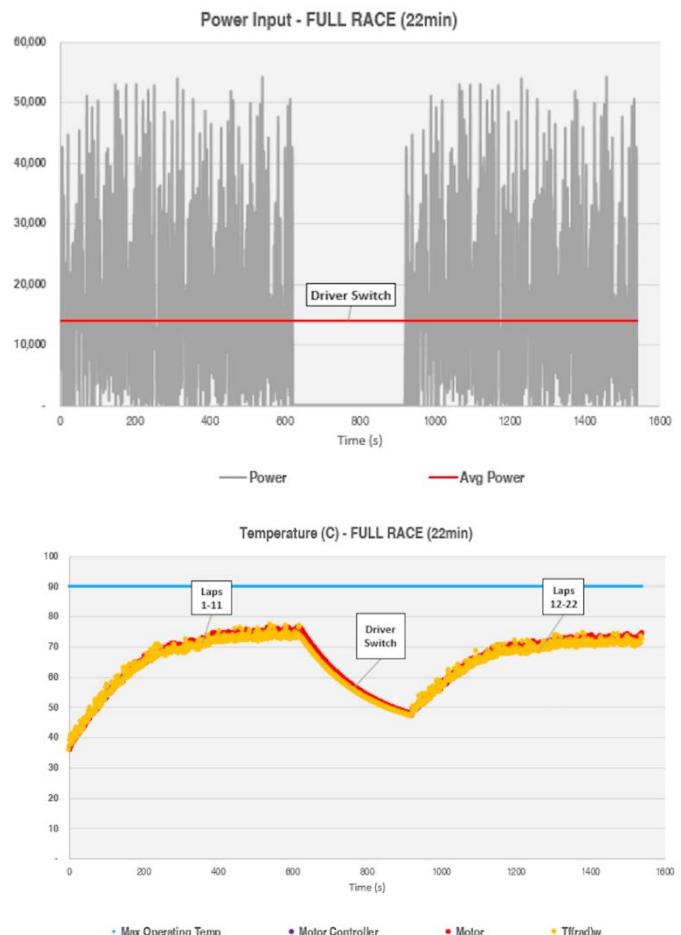
Accumulator (battery) with transparent casing and all components inside



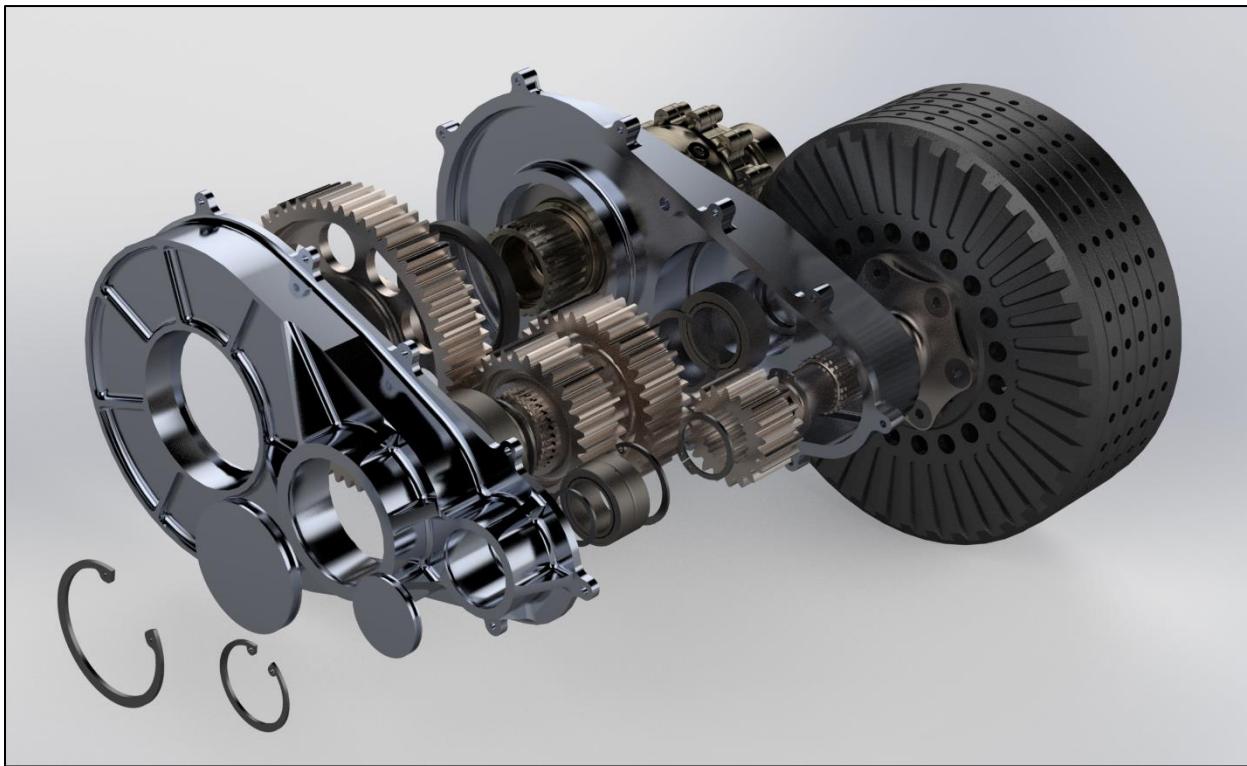
Undertray shown with mounting members



Front view of CFD simulation

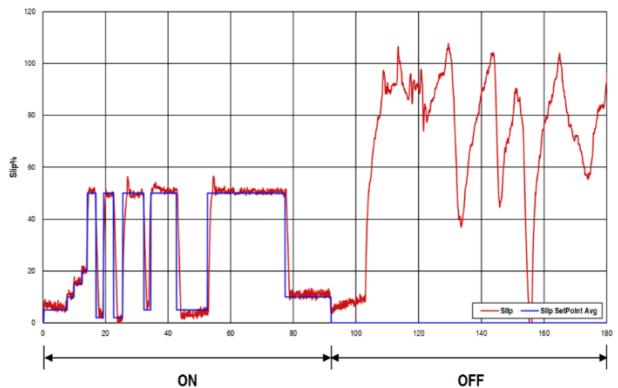


Input and output of heating/cooling model


Gearbox exploded view with casing and motor

		Pitch = 0 degrees										Pitch = 1 degrees									
		0	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	0	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00		
Ride Height = 10mm	Body Angle (yaw)	365	363	361	359	358	356	354	352	351	398	397	395	393	391	390	388	386	384		
		355	353	352	350	348	346	345	343	341	389	387	385	383	382	380	378	376	375		
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Ride Height = 30mm	Body Angle (yaw)	NOMINAL	0	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	0	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	
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		432	430	429	427	425	423	422	420	418	466	464	462	460	459	457	455	453	452		
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		287	285	284	282	280	278	277	275	273	321	319	317	315	314	312	310	308	307		

Aerodynamic map outputs (downforce (N) vs. vehicle conditions)


Steering wheel and dash

Traction system simulation

Lap time simulation used to select tires

Steering system

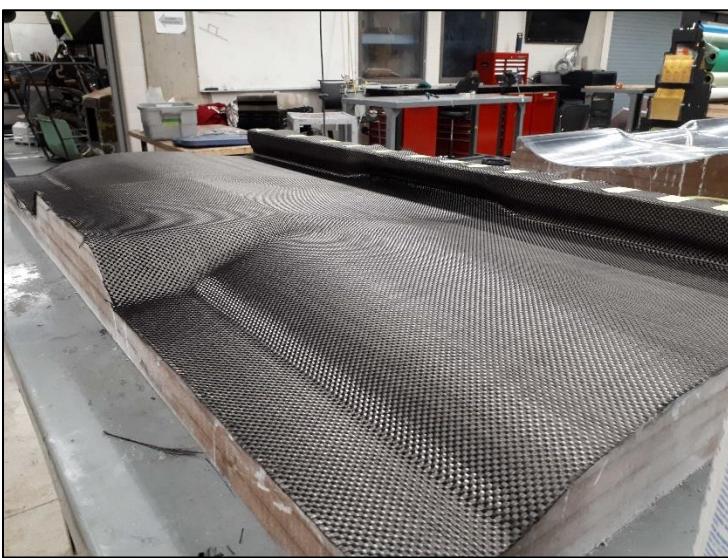
Monocoque with roll hoops, holes, and access hatches

Manufacturing and Finished Components

After design, everything must come together in time for unveiling and racing! Here are some of the best pictures from the all-important manufacturing and assembly portion of the team's season.



Finished accumulator (battery) being tested



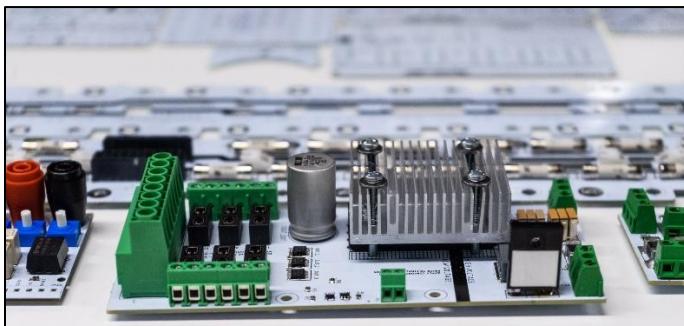
Layup of the front wing before infusion



Finished pedal assembly



Finished gearbox prior to final assembly, includes gears, casing, mounting



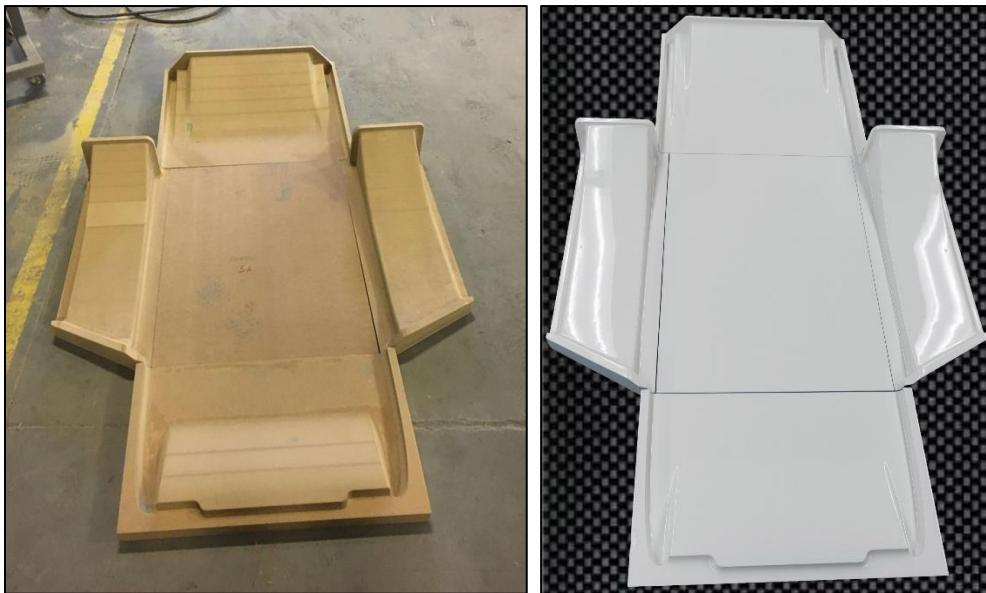
High voltage boards



Battery segments under construction



Monocoque in various stages of construction



Underbody molds before and after preparation



Monocoque with suspension awaits final assembly of other subsystems



And finally, some students making it happen!

Unveiling

The team takes great pride in the vehicle we make, and this shows when we compete. However, before we get to that point, we love to show the world our shiny new race car. As soon as we finish assembly, the team hosts an unveiling event, where the public is invited to view our vehicle for the first time.

This event featured alumni speakers, an exciting reveal of the 2019 car, and lots of eager spectators with questions about every part of the car's design. Unveiling was the team's biggest ever this year, with over 300 spectators in attendance, and it even made the local news.



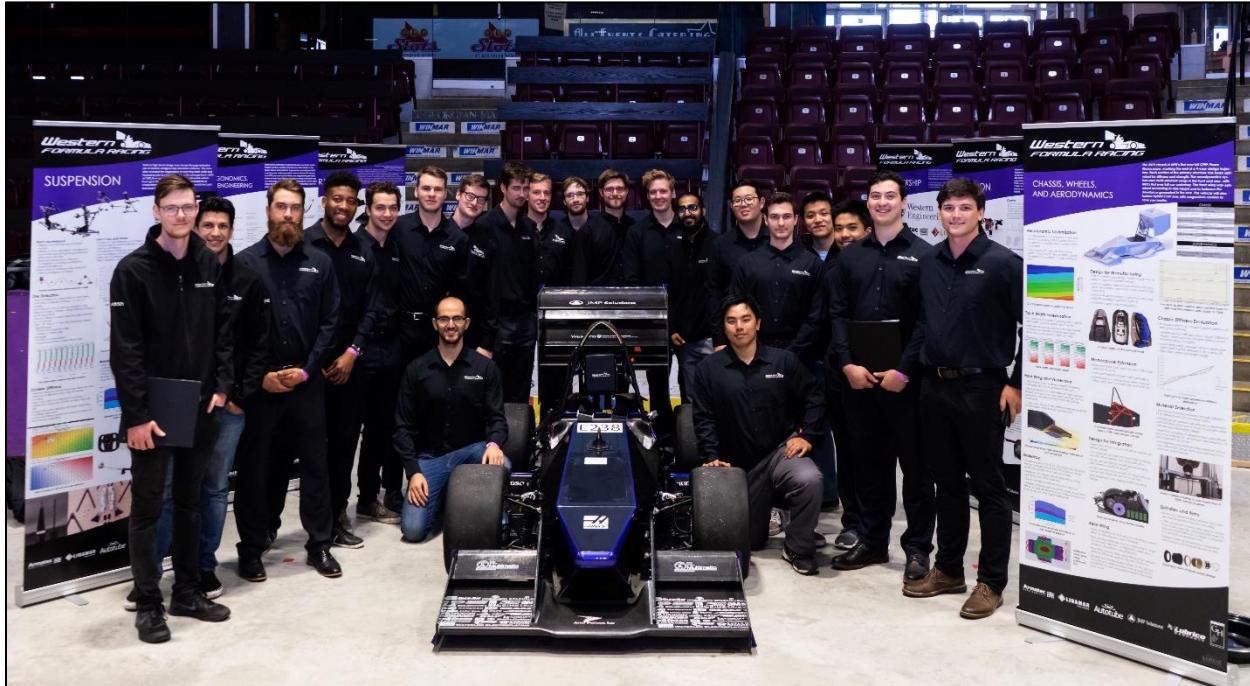
WFR19-E at unveiling

Competitions & Events

Competitions are the ultimate test of our designs, and what we spend all year preparing for. Each FSAE competition is a combination of the following events:

<i>Technical Inspection:</i>	Industry professionals scrutinize the vehicle to ensure safety
<i>Skidpad:</i>	A figure 8 to test maximum sustained lateral acceleration
<i>Acceleration:</i>	A drag strip to test maximum longitudinal acceleration
<i>Autocross:</i>	A 1km lap to test overall racing performance
<i>Endurance:</i>	A grueling 22km race meant to test reliability and performance
<i>Design:</i>	Industry professionals evaluate the team's design justifications
<i>Cost:</i>	The cost of the vehicle's manufacturing is evaluated
<i>Business Logic Case:</i>	The team pitches a business case in which they sell race cars

These competitions are also where the team can show off the car and interact with thousands of spectators, industry professionals, sponsoring companies, and other teams. These aspects of competition allow the team to rapidly grow their engineering knowledge, network with employers, meet like-minded students, and expose their technology and sponsors to the automotive industry. Most of all, competitions represent the highlight of any member's summer, each an intense week of problem-solving, learning, and lots of fun.



The team at FSAE North after presenting design

Formula SAE North

4th place overall

Formula SAE North is a growing competition, recognized for the first time this year by SAE International. As the first competition of the team's season, it represented a very daunting challenge as well as an opportunity to show the world our take on what an EV should look like.

The competition was both a success and an important learning experience for the season. The manufacturing of our battery system was not completed in time and thus unable to fully pass electrical scrutineering. This meant no dynamic events were run by the vehicle. This was not ideal, but it was a great opportunity to learn as much as possible from the tech judges about how to pass technical inspection at future competitions.

On the static side of the competition, the team was very strong, achieving Best Overall Design, beating out many EV teams with entrenched histories in the class. For the team to win this title for their first attempt at an EV is a monumental achievement. The team was also able to place 5th place overall in the business presentation.

These fantastic static event placements allowed the team to place 4th place overall without even being able to run, beating out 9 other renowned teams.



WFR19-E with 4th place overall trophy at FSAE North

Formula SAE Electric

13th place

Formula SAE Electric is North America's foremost competition for electric vehicles, taking place in Lincoln, Nebraska. This was the team's opportunity to come back from FSAE North and prove how much work had been put into the vehicle in the two weeks between competitions.



Part of the team at the Lincoln Airpark after the FSAE Electric Endurance Race

After being the first team through mechanical tech inspection and working very hard to get through battery and electrical tech inspection, the team was given the opportunity to attempt dynamic tech. This means the team's first ever attempt at driving the vehicle would be during the brakes test. After breaking a drive shaft and performing a major repair for a photo-finish in tech, the team was cleared to compete in the endurance race.

The WFR19-E put down 11 majestic laps, overtaking several vehicles and looking great doing it. Unfortunately, it was not able to finish the grueling race due to a battery fault code. The team is proud to be one of the 8 cars in North American history to attempt the endurance race in its first year of operation.

Again, the team performed very well in the design competition making design finals for the second competition in a row, tying for third place. This helped lead us to 13th place overall at FSAE Electric. This result is something the team is extremely proud of and can't wait to improve on in the future.

Pittsburgh Shootout

8th Overall

Shootout events are FSAE events made purely for the love of racing. There are no static events, and only one type of dynamic event; an autocross system where each team gets in line, puts down a hot lap, tunes their car to be faster, then repeats. At the end of the day, the fastest car takes home the trophy.

For our team, this was an opportunity to prove that reliability had been figured out, and the EV platform could do more than win design and put down a few laps. The WFR19-E delivered, putting down laps all day in the heat and the rain, and finishing 8th out of 30 teams, and 2nd among electric vehicles.



WFR19-E during its fastest lap of the day

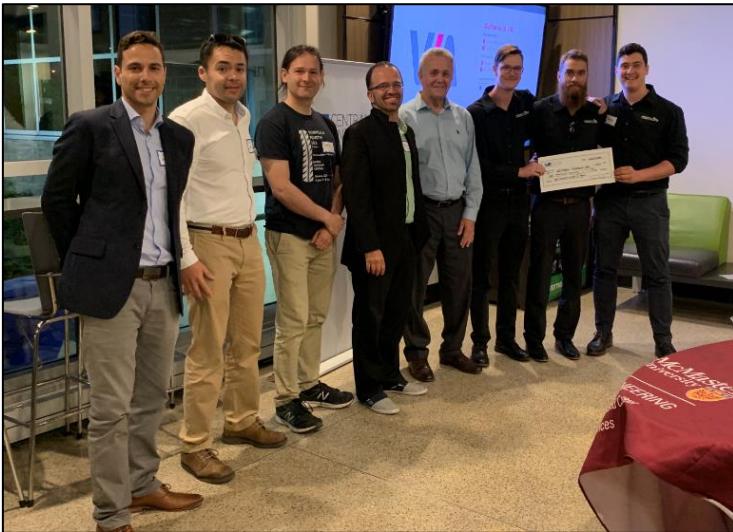
To add to the team's achievements, the legendary 2015 car was also restored by some alumni and outfitted with new carbon fiber wheels. The team was ecstatic being able to bring out not one, but two reliable, fast, and great-looking vehicles to Pittsburgh. The best of the combustion era, and the future of electric era of WFR were on display all day long. This competition was a true testament to the team's sustained excellence.



Pittsburgh Shootout team with both WFR19-E & WFR15 cars

SAE Student's Night

SAE Student's Night is a small competition where the team presents some of their biggest design challenges of the year and discuss with judges how they were able to overcome them. As a team that faces challenges head on and strives to document and learn from them, Western Formula Racing typically thrives at this event. This was the case this year when our presenters brought home first place in the event, along with a \$1000 cash prize to put towards next year's car.



Team with judge panel (left) and oversized cheque (above)

Outreach

When the team isn't working on the car, we love to connect with the greater London community and promote science, technology, engineering, and math a university major (STEM). We had the opportunity to do this through a variety of events in 2018 and 2019.

Go Eng Girl

This event lets our team meet with the next generation of female engineers. An event designed to promote STEM to girls in elementary school, Go ENG Girl is a favourite because of our proud history of developing female leaders on the team.



Shop tour, featuring the 2018 monocoque

Elementary and High School Outreach Events

The team's school outreach events include Fall Preview Day, speaking at high schools, and hosting tours. The team is always very busy filling the recruitment pipeline with eager grade 12 students considering Western Engineering. The team also had the added bonus of speaking to an elementary school this year, where over a hundred students in grades 3 and 4 learned about STEM, motorsports, and university.

Faculty Day

Happening during O-Week, Faculty Day is an extremely exciting event for our team because we get to introduce what we do and who we are to the incoming engineering class at Western. Since most of our current members joined during their own first year Faculty Day, this is an event that hits home and lets us show ambitious first years that putting your time into something you're passionate about is a great investment.

Homecoming

At homecoming the team can connect with Western Engineering and even Western Formula Racing alumni, discussing what's changed and what has stayed the same. Though the team has turned over its members, designed new cars, and even moved shops, the passion for learning and competing is something all alumni can remember and relate to.

Extended Team Drive Day

The final hurrah for our car, Extended Team Drive Day is an event where the team gives back to its supporters by letting them feel the thrill of racing in the car that they helped make possible.



Alumni and sponsors participating in a rainy drive day

Mock Design Day

As an addition to the extended team drive day above, this year the team added a mock design event to have our knowledgeable supporters test and challenge our designs. This allowed the team's designers to have industry experts and the team's competent alumni enhance their work, improving reliability and potential performance.



Our Members

Recruitment

One of our three core team values – Endurance – means that we are always looking ahead to future WFR teams and doing our best to ensure their success. Making sure that the next generation of WFR engineers and leaders are well prepared and ready to deal with the many challenges they will face in Formula SAE and their careers more broadly is the main goal of our recruitment program.

The 2019 season saw interest from over 100 first-year engineering students, which resulted in over 15 strong returning members taking on leadership roles on the team. This was one of our best recruitment efforts ever, made possible by a recruitment process newly focused on keeping recruits engaged with hands-on work, promoting intellectual curiosity by teaching workshops, hosting brainstorming sessions, and recruitment of 3rd, 4th, and 5th year students. We look forward to seeing what they can do!



Employment

Thanks to the wide variety of skills our members are exposed to every season, our alumni have been able to secure some of the most exciting and impactful jobs both in London and the world. As our members know, we can't underestimate the importance of our education, but the formula team teaches a set of real-world engineering and life skills that just can't be replicated in the classroom.



Western Formula Racing was happy to place its engineers and leaders at many companies, some of which are new to the team and some of which have long-standing relationships with us. Either way, what's most important is that our members and alumni are making an impact.


SCHAEFFLER
ONTARIO POWER
GENERATION

THE BORING COMPANY

JMP Solutions

Deloitte.
Western
UNIVERSITY • CANADA

Armatec
SURVIVABILITY


Strength
Through
Technology,
Multimatic
MOTORSPORTS

Looking Ahead

Western Formula Racing underwent a drastic change this year: designing and creating our first ever all-electric vehicle. This required revolutionary leaps in many areas of the vehicle, as well as drastic changes to the team's operations, infrastructure, and equipment.

The team chose to blaze this bold new path due to the skill profile we've developed in the last few years, the engagement and enthusiasm that members have for this new type of powertrain, and the team's long-term goal to stay at the forefront of technology in the automotive industry.

These reasons are all still true today, and the team is happy to continue along this bold path and pursue a better vehicle, team, and competition results in 2020.

As made evident in this review, the team has taken this year to both learn and grow from the challenges that came with the switch to EV. A variety of lessons were learned this year, and we are confident that we can implement them in the team's second-generation electrical vehicle. We are excited to meet our new challenges head-on and with gusto, and we hope to have your help and support along the way.



The team's first drive of the year at FSAE Electric

Thank You

As we wrap up our season, the team has lots to look back on and be proud of. We believe that Western is home to one of the top FSAE teams in the world, from design, to manufacturing quality, to racing results. Even more importantly, the team has grown and has seen many of its core members develop as leaders, designers, and engineers throughout the season.

The 2019 season wouldn't have been possible without the generous, and ongoing support of all our sponsors and supporters. Our sponsors are an extension of our team. They provide so much for us. It's not just monetary, it's advice, encouragement, and everything else that keeps us on the right track. But most of all, it's the experience of working with them. We couldn't ask for a better set of organizations to help us develop our skills and effectiveness as professionals and leaders. For all their support, Western Formula Racing would like to thank its generous sponsors and supporters for helping achieve another year of excellence!

