

WAR EAGLE MOTORSPORTS
FORMULA STUDENT COMBUSTION

Race Report

Formula Student Germany, 9-14 August 2016, Hockenheim, Baden, Germany

Auburn's Formula Student Combustion team returned to Germany, following on the 2015 effort, in order to grow our skills at competing in a less familiar, highly competitive environment. We made many good friends, learned a lot about logistics, racing, and engineering our car, finished all the events, and wound up in 22nd place overall (out of 75). We were handicapped by missing a registration deadline for our electronic throttle, and by the necessity of running at a ground clearance that upset our aerodynamic balance – the drivers said “it’s just not the same car”. But the lessons on what car to put into the box, and how to take it out of the box and compete with the world’s best, will improve our program in both foreign and domestic competitions.

The Genesis of the Effort

Formula Student Germany (FSG) has been improving in competitive sophistication as the Formula Student educational program has swept Europe in recent years. Today, it is probably fair to say that FSG has edged out Formula SAE Michigan as the world’s most competitive. In 2015 we made our first entry into FSG, failing to complete the Endurance Race, and placing 26th overall. We had been debating the idea that the experience gained on that trip should be solidified by putting the lessons right back to work in 2016. When registration day came up on January 26th, we took the plunge, rolled eight people into the Team office for the 5 am entry quiz (four workstation operators and four rules checkers), and pulled out a successful entry. Right after our return from Lincoln we built a crate and shipped it out.

Formula Student Germany

FSG is its own organization, a member of the World Formula SAE/Formula Student Consortium. The rules are the same as Formula SAE except for a short addendum. The competition began in 2006, gained the attention of the German educational/industrial partnership, and its star rose quickly. The competition is now sited at the Hockenheim motorsports complex in the German state of Baden, roughly between Mannheim and Karlsruhe. The 2016 FSG Formula Student Combustion (FSC) class competition was capped (in that feverish online quiz) at 75 entries. These represented 24 countries with cars from: Australia (1); Austria (2); China (1); Canada (3); Croatia (1); Czech Republic (1); Egypt (1); Finland (1); France (1); Germany (26); Greece (2); Hungary (1); India (6); Italy (5); Netherlands (1); Slovenia (1); Spain (4); Pakistan (1); Poland (2); Russia (1); Turkey (1); United Arab Emirates (1); United Kingdom (5); and the United States (5). The five entries from the US were: Auburn; California Polytechnic at Pomona; Oregon State University; University of Michigan; and University of Washington.

There is also a co-located Formula Student Electric (FSE) competition which follows the same running rules as FSC, though powertrain restrictions and technical inspection are necessarily a bit different. This field was capped at 40 cars and included

entries from 11 countries: Austria (1); Belgium (1); China (1); Germany (29); India (1); Italy (1); Netherlands (2); Norway (1); Spain (1); Sweden (1); and Switzerland (1). The FSE cars are allowed a 600 volt battery pack and 85 kW motor, and these tend to fit neatly into the volume that might have been taken up by an FSC tub's 600 cc combustion engine and ancillaries. The US Formula SAE Electric (co-located with Formula SAE Lincoln) places the limit at 300 volts. Safer, but the US battery packs tend to overflow the chassis, and FSAEE cars tend towards slow.

Auburn Does Germany

The European traveling squad consisted of: Nathan Baker; Nick Boehm (Business Lead); Robert Campbell (Technical Lead); Stuart Coats; Davis Edwards; Bryan Golden; Steven Hough; Kyle Kubik; Daniel Maddux; Harrison McCrorie; Michael Moritz; Evan Stegner; Mark Stepnowski; Hunter Wilkinson; and Payson Williams (Team Principal). Jeffrey Dejax, our intern from École d'Ingénieurs Sigma Clermont, joined the trip to keep our driveline functioning. Simon Descarpentries, Jeffrey's predecessor and now an engineer at Renault-Lille, drove over from France to join us at competition.

We tried something new and split into an early crew, to get the car unpacked and wrung out, and a late crew to work on all the extra duties brought up by a frantic competition. Then everyone returned home at once.

The unpacking and wringing-out functions were superlatively enabled by the supreme hospitality of our German host school, the Technische Hochschule Mittelhessen in Gießen (an hour north of Frankfurt). THM received our crate, lifted it off the truck and stored it, gave us a place to work and a place to live when we arrived, shared our campsite at competition, and shared their friendship for the time running up to competition, and at competition itself. We are tremendously grateful to our good friends.

The other half of the essential logistics that made this trip work was the sponsorship of Opel AG. Opel gave us time on the wet skid pad and the vehicle dynamics pad at their testing site in Dudenhofen (near Frankfurt), and organized a testing site in Rüsselsheim on that last weekend before competition, when Dudenhofen was closed. Opel's support was instrumental to making a smooth competitive effort, and is worth going back to FSG regularly to maintain.

It's good we had help, because we did have challenges to meet. In order to use the technology of Electronic Throttle Control (ETC), SAE requires teams to file a notice of intent to use ETC, followed by a detailed Failure Modes and Effects Analysis (FMEA). This is to reduce the possibility of unguided ground vehicles, randomly navigating the competition track at high speed. FSG has the same reporting requirements, but requires that the Notice and the FMEA be filed at the same time. Well, we made a filing error, and submitted our FMEA to FSG, but not our notice of intent to put that FMEA into operation. And so we were disqualified from using ETC – we had to build a mechanical throttle. This was a difficulty, because our car features an electronic throttle talking to an electronic engine control which sends signals to an electronic gear shifter. A nice mechanism, and one of the keys to our Acceleration performance. But

now we had to run FSG with only $\frac{2}{3}$ of this system, taking throttle commands essentially by smoke signal. We thought we had the mechanical throttle worked out before we shipped the car, but in Germany problems arose with shifting communication and actuation (throttle and shifter have to be carefully coordinated to slip the transmission into a new gear). A new shifter overnighed to Germany from England helped the situation, but shifting was still iffy until we got the car home and put our ETC back in. As a result, the early crew spent more time working hard and living with stress than practicing on Opel's great facilities.

Another whoops was in filing the quality and design assurance for our carbon fiber tub structure. With plenty of time to file (hours), the website went down. When it came back up, we were late with no way to avoid a 15 point late-filing penalty (moral – file early).

And on to Competition

Practice over, the early crew moved down to Hockenheim, and were joined by the late crew, fresh from its indoctrination to the Deutsche Bahn. At FSG, everybody camps. It definitely creates a refugee feel, but the camaraderie is there, the game-day style facilities provided by the organizers work fine, and it sure beats commuting at the beginning and end of every day. THM helped us out with a huge army surplus tent to serve as a kitchen, and we were good to go. At the race site, the Hockenheimring, we got a spot in the F1 garages for our paddock.

Technical inspection was tough. The “inspector’s judgement” category gets much freer rein in Germany. We learned to work with them, got our shopping list, worked it out with the help of many of our fellow competitors, and on the relaxed schedule of FSG, with two days for Tech, we were able to come back the next morning and get checked off. Then on to Tilt, Noise, and Brakes and we were good to race.

Static events were a bit of a twist to us. The official language of the competition is English, but it's German translated to English, and asked from a different cultural background. Fair enough, but something to come up to speed on (and a good learning experience). Cost was a little different than at FSAE, with 20 points for the cost number (we got 4.17), 40 for discussion (grilling - we got 29), and 40 for our response to a hypothetical change in production conditions (we got 34). 67.17 total Cost points out of 100 gave us 29th place. Mumbai Somaiya won with 83.93 points. Presentation was scored at 43.98 points out of 75, putting us 45th. We failed to connect with our audience (the judges). Oregon State won this event with 75 points. Design resulted in 24th place with 90 points out of 150. One of the things we're learning in international competition is that our design story needs to be logical, unassailable, and in preparation in parallel with the creation of the design. Technische Universität Stuttgart won Design with the full 150. After static events, we had 201.15 points out of 325, putting us 32nd. Technische Universität München led with 286.01.

We finished Acceleration with a time of 4.367 s for 75 m (slow for us) to get 55.35 points and 16th place. Politechnika Wroclawska ran 3.967 s to win with 75 points.

Skidpad has a unique twist in FSG – it's run wet. The cars wear rain tires, and the course is under constant watering by rainbirds. We knew, and practiced a bit, but it looks like we'll have to invest in some lawn gear and serious rain tires to tune up our performance. Our time of 6.160 s was good for 31.31 points and 24th place. Karlsruher Institut für Technologie won the event in 5.440 s for 75 points. Autocross featured a new technical difficulty for us. The Hockenheim autocross course features a crease in the pavement between the part on the Hockenheimring proper and the part on the infield. To traverse this crease without striking the ground (provoking a DQ), the ground clearance had to be dialed way up. We had not anticipated this course wrinkle in design, with the result that we could not change ride height without throwing out our aerodynamic balance. As a result, the car was weighted way too much towards the rear, and our drivers had a terrible time trying to turn in. We ran 80.364 s to place 47th with 23.95 points. Oregon State won in 69.146 s to gain 100 points. Our dynamic events total was 110.61 points out of a possible 275 – 33rd best. Fachhochschulen Graz had the best day with 227.31. Going into Endurance, we had 311.76 points out of 600, sitting in 27th. FH Graz held the lead with 469.99.



Heading into the Endurance Race, we still had shifting issues, and the car still would not handle, but at least we had sufficient engine cooling for a hot day in Central Germany, and were able to finish the race. The finishing rate was 40% at this competition. We ran a total time of 1496.87 s for 22 km, hitting 20 cones along the way (a result of having to wrestle the semi-responsive car around the course) to correct to 1536.87 s. This put us in 16th place with 172.10 points out of 325. TU München won Endurance in 1341.19 s.



Adding up the points, we had 484.31 total out of 1000, placing 22nd. The top three were TU München (852.42 points), TU Stuttgart (838.96) and FH Graz (782.30). The American teams had a tough time. Michigan was 20th, then Auburn, Oregon State in 24th, Pomona in 29th, and Washington in 34th. There is a new tire out, a radial ply Continental with a low profile on a 13 in. rim, and with a great matching rain tire, that many of the top European tires had, and none of the US teams. But that's just stuff to talk about. Really, FSG is top notch competition, and we just did not spend the year making it our design focus. It seems that in Formula Student, there is always more 'up' to go to. We plan on paying those dues, and expect to be back for FSG2017.