FORMULA STUDENT:
SURVIVE TO DRIVE

Filip Söderberg

Contents

1 What is the purpose of the book?

This book is a tribute—plain and simple. A tribute to the people I've had the privilege of working with, to the late nights we spent in our garage, and to the kind of relentless problem-solving that builds not just race cars, but future engineers.

For those of you who don't know, Formula Student is an international competition where university students design, build, and race autonomous electric cars. It's equal parts innovation, teamwork, and sheer determination. One of the goals of this book is to spread awareness of these competitions and their technical level.

It's also about learning how to keep going when things don't go to plan. Because, as much as we aim for perfection, something always goes wrong. A sensor stops working just when we need it most, a part behaves exactly as our calculations insists it shouldn't, or someone makes a "minor adjustment" that turns into a major problem. That's the reality of a project like this: you learn how to adapt, how to fix, and how to stay calm when you'd rather throw something across the room. It's not about avoiding failure, it's about getting better at dealing with it.

That's what I want to share: what this experience really feels like. It's long nights and early mornings. It's arguing over millimeters and celebrating millimeters. It's the quiet focus of a garage where time seems to blur, and the rush of figuring out a problem just before you're ready to give up. And it's the camaraderie of knowing you're not in it alone, because no matter how tough the day gets, you're surrounded by people who believe in the work just as much as you do.

The reality is that this project asks a lot of us, and we give it willingly. Not because it's easy, but because it's worth it. You learn more than you thought you could, push harder than you thought you would, and discover what's possible when people from completely different backgrounds come together, argue fiercely, compromise thoughtfully, and move forward toward a shared goal.

This isn't about me or any single person. It's about the team. Everyone you'll read about in these pages has agreed to be here. This isn't a formal book. It's a story about a project and the people behind it. A story about what we built, what we learned, and who we became along the way. Of course, any missteps in these pages, whether in tone or content, are entirely my responsibility. But if something resonates, inspires, or impresses you, that's the team's accomplishment through and through—a reflection of their incredible dedication and talent.

Let's get started.

2 What is Formula Student?

Formula Student is the world's largest engineering competition at the university level. Think of it as a mini Formula 1, but instead of world-class teams like Red Bull and Ferrari, it is students who take the wheel, both literally and figuratively speaking.

The competition revolves around designing and building autonomous electric race cars, with students taking on everything from technical challenges to project management and sponsorships. There are multiple international competitions every summer, and the participants from Formula Student Germany (FSG) 2024 are shown in Figure 1.

Figure 1: All teams at FSG 2024 - ©FSG Maru

At the heart of these international competitions are what I would call three key pillars. First, ensuring the car meets all safety and technical standards through rigorous **scrutineering**, or scruti for short. This involves the following tests: battery, mechanical, and electrical inspections, as well as the tilt, rain, and brake tests. Next, there are the **dynamic events**, where the car's performance is put to the test in four events: acceleration, skidpad, autocross, and endurance. Lastly, there are the **static events**, where teams present their car's budget, pitch a business case, and explain their design choices to industry professionals.

Like Formula 1, Formula Student has a detailed rulebook that governs the competition. The rules cover everything from safety standards to how points are awarded, and naturally, a big part of the challenge is finding ways to push the boundaries of those rules without breaking them. The rulebook is updated every season, just like in F1, and for the 2025 competition in Germany, you can preview it here: FSG 2025 rules.

At around 130 pages, it is not a light reading, but it is absolutely essential for any team aiming to succeed. One particularly important rule is that the car's chassis must be "newly manufactured", in other words: remade every year. For those unfamiliar, a monocoque is a structure where the entire chassis is built as one cohesive piece. This means that every team must design and manufacture an entirely new monocoque for each season, ensuring fresh innovation and new challenges with every competition.

2.1 KTH Formula Student: Meet My Team

Sweden is home to six Formula Student teams (more about them shortly!), with more than 500 teams competing globally. Throughout the 2023–2024 season (the focus of this book) I had the privilege of serving as one of the team captains for KTH Formula Student, alongside Axel Hällefors. The team represents KTH Royal Institute of Technology in Stockholm, Sweden, and we are around 80 members, coming from 18 different countries. We pride ourselves on this diversity, which brings a ton of different perspectives and ideas to our work, making the team stronger and more dynamic.

Our team is divided into six subgroups: Vehicle Dynamics (VD), Business & Marketing (BM), Mechanical Design (MD), Driverless (DV), Aerodynamics & Composites (AC) and Powertrain & Electronics (PE), each responsible for specific parts of the car. These subgroups form the backbone of the team's structure, as shown in Figure 2. While each subgroup has its own responsibilities, no system works in isolation. A change to the suspension might affect aerodynamics, which in turn could influence the battery. Ensuring everything comes together requires seamless collaboration and clear communication.

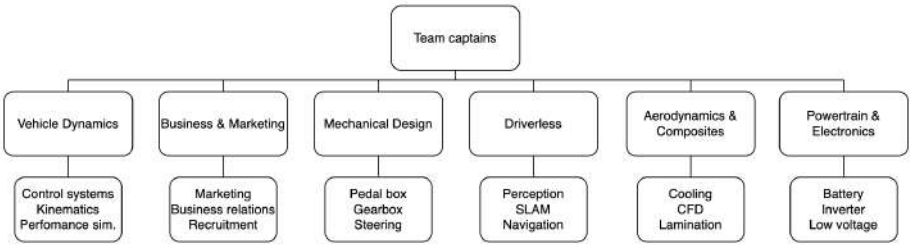

Figure 2: Subgroup responsibilities

We have a leadership team consisting of the subgroup heads (one or two per subgroup) and the team captain(s). Every member provides weekly updates to their respective subgroup head, which helps identify potential issues early and keeps everyone aligned. Communication across such a large team is always a challenge, and while we've made significant improvements, there's always more to learn. Balancing technical dependencies and maintaining clear communication might be tough, but it's also what makes this project so uniquely rewarding.

The team has a long history, dating back to its founding in 2003 as a combustion racing team. Ten years later, we transitioned to electric cars, embracing a more sustainable future. The 2023–2024 season was particularly special because, for the first time in years, we managed to build a car within just one year, a huge milestone for us. Our car, Dev18 (short for Driverless Electric Vehicle, and yes, it's our 18th car), is pictured in Figure 3. Seeing the car come together after countless late nights and challenges is a very rewarding moment, and it's

hard not to feel a sense of pride when looking at it.

Figure 3: Dev18, our 2023–2024 car.

Building a car like this requires a serious commitment. Every member is expected to contribute at least 15 hours a week, but in reality, many of us dedicate far more to keep everything running smoothly. Those hours are outside of our full time studies, mind you. This minimum is necessary to maintain steady progress, but the project often demands above and beyond that. To help with collaboration and accountability, we hold mandatory work sessions twice a week. These sessions provide an opportunity to troubleshoot issues, coordinate with other subgroups, and discuss progress with subgroup heads.

Thursdays are a highlight, with a homemade team dinner after our weekly meeting. During the meeting, we review what is happening next week and share important technical updates. A snapshot from one of those meeting is shown in Figure 4, in which a former head of MD, Karl, was giving an update in the lecture hall we commonly use.

Figure 4: Weekly Thursday team meeting

One thing that sets KTH Formula Student apart is how long members stay with the team. Many of us, Axel and myself included, joined during our first years at university and stayed for several seasons. This continuity makes a big difference, as it allows members to grow into their roles, passing on knowledge to newer recruits. We encourage students to join early in their academic careers, giving them time to develop from curious newcomers into skilled engineers and leaders.

2.2 Frequently Asked Questions

The more technical details will come later, but let's get a few of the most common questions out of the way. These are the ones we are asked repeatedly at fairs, presentations, or pretty much any time the car is on display. So now you don't have to wait to know!

How fast does it go?

The tracks in Formula Student are designed to be quite narrow with a lot of turns, so scoring more points is not about having the highest top speed. That being said, the car can reach around 110–120 km/h, which is plenty for these tracks. Acceleration, however, is a key part of the competition. Our car does 0 to 100 in just under 3 seconds, about the same as a Porsche 911. Not bad!

How much does it weigh?

Our car weighs a little over 200 kilograms. For context, the best teams have managed to bring their cars down to around 160 kilograms. To put that into perspective, that is lighter than most motorcycles, yet packed with enough electronics to make a spaceship jealous.

It is an electric car, so how far can it drive?

The endurance event at competitions is 22 kilometers, which is exactly how far the car is designed to go. We include a small safety margin, of course, but any extra range would just mean carrying unnecessary weight. The battery has a capacity of about 6.5 kWh, which is tiny compared to the 40–100 kWh batteries you find in most road-going electric cars. But then again, we are not trying to take this thing on a road trip.

Can it drive on its own?

Yes, it can. The car is equipped with a lidar, which is similar to a radar but more advanced: it uses laser beams instead of radio waves. The lidar scans the surroundings, and our onboard computer runs algorithms that decide where to steer, accelerate, or brake. It is like teaching a teenager to drive, except the teenager is really good at math and doesn't get distracted by their phone.

Can the driver sit in the car while it drives autonomously?

Absolutely not. The rulebook specifically forbids this for safety reasons, and it applies even outside of competitions. If we were ever caught using the car in an unsafe manner, we could be banned from future events.

Does the car use AI?

Yes, the car genuinely uses AI. While it may be the buzzword of the decade, in this case, it's more than just a label. Our systems incorporate advanced machine learning and deep learning algorithms to process data, make decisions, and ensure the car performs at its best. From perception to navigation, AI is at the core of what makes the car autonomous.

Who gets to drive the car?

This is one of the most common questions we get. Driving the car isn't just about being quick, it's about earning the trust of the team. The process begins with go-kart tryouts, where we test for speed and control. I came ninth, and trust me, I am proud of that. While the drivers can't be professionals, they're still incredibly skilled. Take David (previous AC head), for example, he's a sim racer who once held a world record at the SPA track in Belgium. But here's the real secret: spending months working on the car gives you a unique feel for it. A great driver isn't just fast; they can sense when something is even slightly off

during testing. So to answer the question, the drivers are a mix of the quickest and hardest working members in the team.

How often do you test drive the car?

Testing the car is incredibly important. In school, you can flip to the back of the book to check your answers, but in Formula Student, testing is the closest we get to that luxury. It's how we figure out if the car behaves the way it's supposed to, or if our calculations were perhaps a bit too optimistic. On average, we test every other weekend, gathering data, fixing issues, and occasionally creating entirely new problems. Here's a snapshot of what a typical testing session looks like, with the car driving autonomously in Figure 5.

Figure 5: Dev18 driving autonomously during a testing session

What is the timeline for a season?

The Formula Student season follows the academic year. In the fall, we recruit new members and test the old car to gather as much data as possible for designing the next one. This flows into design and validation work, where ideas are put to the test. By winter, we're qualifying for competitions and starting the build, racing against time to finish by spring so we can test before the summer. Summer is competition season, where all our effort is put on the line. Then it's time to begin the cycle again, hopefully a little wiser.

2.3 Other Teams in Sweden

Sweden currently has six Formula Student teams: KTH, Luleå, Linköping, Karlstad, Lund, and Chalmers. Each team brings its own approach and strengths to the competition, and having such a diverse set of teams within the country is something we're incredibly proud of.

Luleå is the newest addition to the Swedish Formula Student family, since they restarted their team in year 2022. To learn and get the team going, they have started to convert an older combustion formula student car into an electric one. It's no small feat, but we admire their determination and wish them the best of luck. We're looking forward to seeing what they bring to the table in the upcoming seasons.

We had the pleasure of being neighbors with Linköping and Karlstad during FSUK 2023, and what a joy that was. Both teams are incredibly kind and willing to help, and we leaned on each other a lot during the competition. Karlstad, in particular, was impressively prepared, far more than we were, if we're being honest. While we showed up without even bringing chairs, they graciously helped us out.

Lund, on the other hand, deserves a shoutout for their initiative with the Nordic Test Event (NTE). This event, held early in the summer, is a chance for Nordic teams to test their cars, go through scrutineering, and share ideas before the competition season begins. It's a brilliant idea, and we've benefited greatly from the opportunity to learn and prepare in such a collaborative environment, as can be seen in Figure 6.

Figure 6: Nordic Test Event (NTE) 2019

Then there's Chalmers. If most Swedish teams have strengths and weaknesses, Chalmers seems to have skipped the weaknesses entirely. They've even won the autonomous driving event at FSG, which is no small accomplishment. Their performance speaks for itself, they are consistently among the best.

That brings us to an interesting point about the different setups across Swedish teams. Many universities provide academic credits for Formula Student work, and it's no surprise that the teams benefiting from these credits often perform exceptionally well. Coincidence? Hard to say. While we at KTH don't receive any credits, we like to think it builds character. And maybe just

a touch of envy when we see teams like Chalmers consistently nailing it on the competition circuit. But hey, if being relentlessly impressive is their thing, we're happy to cheer them on.

Ultimately, we hope for the continued success of all Swedish teams and even more universities starting their own teams in the future. Formula Student turns good engineers into great ones, and great engineers into amazing ones. From what I have seen, the next generation of engineering in Sweden looks both promising and ready to make it's mark.

If you wish to support these incredible teams, please visit their respective websites. Every team benefits greatly from additional resources, and if you're looking to recruit top talent, this is the perfect place to start.

As for my team, I would humbly ask for a small donation of at least 50 SEK, which equals 1 SEK per page of this book. It feels like a fair deal, don't you think? If you would like to donate through PayPal, please click this link. If you can use Swish, our number is 123 234 29 54, and our QR code is in Figure 7. Thank you for helping us continue our work!

Figure 7: Swish payment option to the team

3 Competitions

I've had the privilege of attending four international competitions with the team: Silverstone in the UK in 2023 (FSUK), Red Bull Ring in Austria in 2024 (FSA), and Hockenheim in Germany (FSG) in both 2023 and 2024.

To even get to these competitions, teams must first qualify through an intense quiz that tests their knowledge of the rulebook and engineering expertise, all under a tight time limit. It's a true trial by fire, and the playing field is completely leveled. Everyone faces the same questions, the same pressure, on the same day. For example, at FSG, several hundred teams compete for a coveted spot in the competition. Our team has consistently performed well in these quizzes, showcasing not only our deep theoretical understanding but also our ability to perform under pressure. It's a critical step that proves we belong on the international stage.

Before diving into the specifics of each competition, it's worth mentioning the shared effort behind them. These trips are entirely self-organized, meaning every detail is our responsibility. We plan the logistics, book tickets, make sure passports and insurance are sorted, pack the tents, and even handle cooking and buying food ourselves. The car is loaded into a trailer and driven across borders, with no room for mistakes. If we miss something, like not buying enough camping slots, there's no backup plan or safety net. It's a lot of work, but that's part of what makes the experience so rewarding.

At the start of the season, Axel and I were asked about our favorite memories during an interview for social media. Without hesitation, we both said "the competitions." But as we explained our stories, they sounded more like accounts of survival than fun: driving for hours, pitching tents in the dark, fixing parts on no sleep. On paper, it probably doesn't sound all that enjoyable. But when you go through it as a team, the tough moments become shared memories you laugh about later. It's not glamorous, but it's unforgettable.

Competitions push you to the limit, but that's also what makes them exciting. You go from solving one problem to the next, whether it's setting up your camp or passing technical inspections. And sure, there's always the looming possibility that something might not comply with the rules, but that's just part of the challenge.

It's also where you realize that no team has it easy. Everyone is scrambling to fix things, adapt, and make it work. Another key aspect of competitions is that they reveal everything you've done, or not done. If a system isn't properly documented, you will lose a lot of points, and if a part doesn't comply with the rules, you don't get to drive the car. It's as simple as that. And it's strangely comforting to see that you're not the only ones with duct tape holding things together. Let's dive into our most recent competition experiences!

3.1 Formula Student UK – Chaos, Bonding, and Mud

The UK competition was the team's first in several years, and let's just say the logistics were ... rough. We ate dinner during midnight when the pit closed, crawling into bed right after and wondering if sleeping on a full stomach was a new low or just a questionable form of efficiency. Tools were missing, and as you'll see in the photo of the pit in Figure 8, organization was clearly not our strong suit. Yes, that's a team member soldering on the floor in the back.

Figure 8: Pit from FSUK 2023

3.1.1 We Were Not Prepared

One particularly memorable moment came just after we entered the UK, before we even arrived at the competition. We found ourselves troubleshooting the car in the parking lot of a Tesco. Naturally, we asked the staff if it was okay, and to our relief, they were genuinely curious and supportive. So there we were, a group of motivated engineers working to get the car ready, huddled around it with soldering irons in hand. It wasn't the most glamorous setup, but the excitement of making progress kept us going. Figure 9 is a photo from that moment.

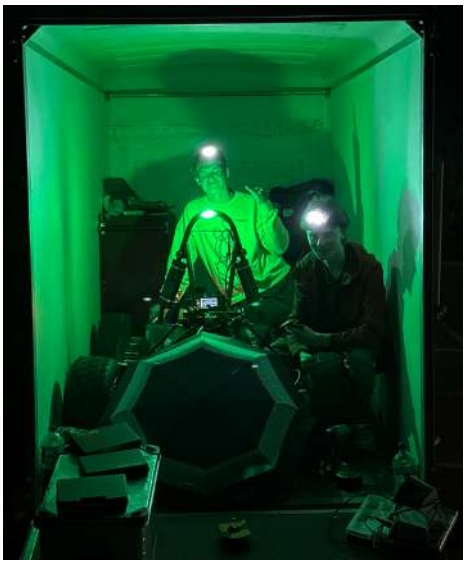

Figure 9: Working in a parking lot at Tesco

As if Tesco wasn't chaotic enough, we still hadn't completed the car's charger by the time we arrived at the competition site. Unsurprisingly, a charger is a bit of a non-negotiable for an electric car, it's hard to drive anywhere when your battery is as useful as a brick. Inside scrutineering, as seen in Figure 10, we somehow got it to work, for the first time ever.

Figure 10: Building the charger at FSUK

When it came time to demonstrate this to the judges, we had to maintain

the most serious, poker-faced composure, even though inside, we were absolutely euphoric. In Formula Student, first tries are almost guaranteed to fail. This time? It worked flawlessly! None of us dared celebrate too early, just a few knowing glances and an unspoken agreement to keep it together. Moments like this leave a lasting impression, both nerve-wracking and thrilling in their own way.

3.1.2 Rule Britannia

If you guessed the weather in the UK was terrible, congratulations, you're absolutely correct. From the moment we arrived, the weather refused to let up. Storm warnings were issued, and tents were not faring well. Borrowing my kind aunt's tent, I thought it wise to avoid risking damage by taking it down. My brilliant alternative? Sleeping in the team's Mini Cooper—after all, what's more British than sleeping in a Mini? (Huge thanks to a key partner of ours, Essiq, for providing the team with a car!)

As it turns out, sleeping in a car during a rainstorm is far from brilliant. Roll down the windows to prevent fog, and rain pours in. Keep them up, and you're stuck in a sauna of your own making. In hindsight, turning the car on and using the AC would've been clever, but unfortunately, we were not operating at peak intellectual capacity. After a night of no sleep and increasing regret, it was back to work in the pit lane.

By the final night of the competition, the weather was still rough, and I was out of better options. So, I ended up back in the Mini. Let's just say it wasn't a highlight of the trip. Parked on a muddy field, the car's interior took on a distinct swampy aroma by morning, thanks to our dirt-caked shoes. Meanwhile, others weren't faring much better. One tent blew away (Figure 11) and another team member ended up curled inside an IKEA bag to escape the flooding in his.

Figure 11: A team member's tent blowing away

On another note, the facilities at Silverstone were excellent, plenty of space and well-organized pits that made working on the car far more manageable. Britain also has a very rich motorsport culture, so there were a ton of interesting companies at the competition recruiting for talent. However, when it comes to organization, the UK likes to do things their own way, in more ways than just geopolitics... Instead of following the same rulebook as the rest of Europe, FSUK has additional requirements that complicate attending both their competition and others in the same season. While we'd love to return, these unique rules make it highly impractical for our team to compete there again, at least for now.

3.2 Austria – Red Bull Ring Adventures

It turns out the Red Bull Ring in Austria is much much farther from Hockenheim, Germany, than we had fully anticipated, especially when towing a trailer at a maximum speed of 80 km/h. We knew the drive would be long, but the extra hours added by the trailer made it feel never-ending. After driving through one night, the entire next day, and yet another night, we finally arrived the following morning, exhausted and running mostly on caffeine and questionable McDonald's meals. Trust me, your fourth Big Mac in a row really loses its charm.

Austria itself, though? Amazing. The competition had a fantastic atmosphere, and the judges were excellent, not just knowledgeable but genuinely supportive. One thing Austria did particularly well was conducting the mechanical scrutineering directly in the pits. This meant the car didn't have to be transported back and forth constantly, saving an incredible amount of time and effort. Huge props to Austria for that! That said, there were still moments that made you question humanity. One team decided to sleep in their pit to stop others from "spying" on their work. Yikes.

One thing we were absolutely not prepared for was the pit staying open 24/7. At most competitions, the pit typically closes around 11 or 12 at night, but here, you could work around the clock, and that's exactly what we did. Unfortunately, staying up all night didn't do us any favors. Lack of sleep caught up with us quickly, and it is definitely a mistake we will not repeat. Figure 12 is a photo of two well rested gentlemen.

Figure 12: Beauty sleep in Austria

It was a harsh lesson in the importance of rest and pacing, but we had made some significant improvements since the previous summer. Cooking went much better this time, and we also learned from past mistakes and brought a lot more tools with us, which made a huge difference when things needed fixing. The pit, as you can see in Figure 13, typically looked like this: around twelve team members working on the car simultaneously, navigating the chaos with surprising efficiency. It wasn't perfect, but it worked better than expected, and the shelves we added for organization were a game-changer

Figure 13: Pit from Austria 2024

The Red Bull Ring also featured MotoGP-style practice sessions happening around the track during the event. Not the actual MotoGP, mind you, but one of those paid experiences where people get to ride MotoGP bikes and live out their racing dreams. Hearing the bikes roar around the circuit for the first time was incredible, a proper motorsport moment. By day four, though, the novelty had worn off. "Around and around" had turned into "enough already," though perhaps it wasn't all that bad. We were just too tired and preoccupied with everything else to fully appreciate it.

Then came the cost event, where we had... limited preparation. And by "limited," I mean winging it. The cost event is all about understanding the cost of the car, you have to account for every part, machining time, and assembly processes. It's not about how expensive the car is, but rather how well you understand its production costs. I opened up the document 30 minutes before the judges came. Somehow, though, we pulled it off and placed in the top half of the competition in that event. Considering the circumstances, it was nothing short of miraculous.

The car itself reflected our "limited preparation" approach, as the competition came early in the season and the car wasn't fully ready. Some members didn't sleep at all for two nights straight before the competition, working tirelessly to get everything as ready as possible. Despite their efforts, a collision issue was discovered at the last minute, forcing us to load the car into the trailer without its wheels and leave the fix for when we arrived, please see Figure 14. It was literally stacked on MDF instead of its wheels. Still, we managed to solve it at competition.

Figure 14: Dev18 in a trailer to Austria

3.3 Formula Student Germany (FSG)

FSG is the world's largest Formula Student competition, attracting not only the best teams but also a host of fascinating companies scouting for talent. It's an event that's as challenging as it is exciting, packed with unforgettable moments. Most teams are incredibly friendly, and we have to give a special shoutout to two of the top ones: AMZ Racing from ETH Zurich and Ecurie Aix from RWTH Aachen.

After every competition, there's a big after party, and AMZ, staying true to their Swiss roots, has a tradition of handing out raclette cheese to other teams. If there's anything better than top-tier engineering, it's free melted cheese after a long day. Despite winning FSG last year in both the manual and autonomous driving categories, they remain impressively open and helpful with their technical solutions. Hats off to AMZ!

Then there's Aachen, whose pit has been close to ours for the last two years. They didn't just offer occasional help, they were genuinely instrumental to us. From sharing tools to helping us troubleshoot brake issues, Aachen has always gone above and beyond. Their support embodies the spirit of the competition, and I am personally very grateful for their assistance.

Of course, no FSG experience would be complete without mentioning Schokolade, a certain SpongeBob SquarePants remix that has become infamous among

competitors. Imagine this: it's barely 6:00 in the morning, you've had maybe three hours of sleep, and from painfully close by, a team is blasting a German techno remix of SpongeBob character (Figure 15) screaming about chocolate. It's absurd, it's relentless, and it's a great way to question every life choice that brought you here.

Figure 15: Schokolade! - Spongebob Schwammkopf Remix

3.3.1 FSG 2023: A Chaotic Start

FSG 2023 was our first experience at the world's biggest Formula Student competition, and it started with pure chaos before even coming to the competition. The car wasn't competition-ready, so we reasoned it would be more efficient to fix the issues in the garage rather than at the event. This led to an exhausting day, starting at 08:00 in the morning and working nonstop until just after 01:00 in the morning the next day. By then, we were already running on fumes.

At 01:00, we finally left the garage, with Malte (previous VD head) and me taking turns driving the 24 hours down to Hockenheim. Meanwhile, the backseat became an impromptu engineering station as Emil T (previous PE head) and Emil N (current PE head) worked on some last-minute logic, as seen in Figure 16.

Figure 16: Debugging on the way to Germany

It is on the way to the competition and they already look dead-tired! Exhaustion quickly set in, I even started hallucinating that I was part of the Cars movie, driving alongside Lightning McQueen, which probably had something to do with overplaying the soundtrack.

Once the event kicked off, the exhaustion didn't let up. The pit was a slight improvement over how it was in the UK, thanks to shelves and a bit more organization, but still far from ideal, with tools and parts scattered everywhere. The campsite, however, was another story. By the end of the event, the fridge smelled so bad that leaving food out in the 30-degree sun seemed like the safer option. As for sleeping, the ground delivered everything you'd want from a bed, as long as your expectations were 'horizontal' and 'solid' (Figure 17).

Figure 17: Beauty sleep in Germany

We did have a pool, though, and it was surprisingly nice. Many other teams had pools as well, but by the next year, a pool size limit was introduced. It turns out pools can hold an incredible amount of water, and let's just say not everyone disposed of that water in the most responsible way. Figure 18 is a picture of Emil T, Emil N, and me relaxing in the team's pool after passing the battery scrutineering, definitely one of the highlights! The weather at FSG is surprisingly unpredictable. It's either scorching, well over 30 degrees, or raining so heavily that you start questioning the integrity of your tent.

Figure 18: Enjoying the campsite pool

3.4 FSG 2024 - Our best result in 7 years

Driving to FSG (2024) was a lot of fun, and I was quite cocky. I drove to the German border from Stockholm in one go, and was considering driving the entire way. I take literally two steps out of the van, and the tiredness hits me like a truck. I had the best beer of my life in a German beer hall, and then I passed out in the van (from tiredness of course), as seen in Figure 19.

Figure 19: Crashing in the van

The pit was the best it has ever been, although I could only find a photo (Figure 20) from when we started packing up. Notice even more shelves!

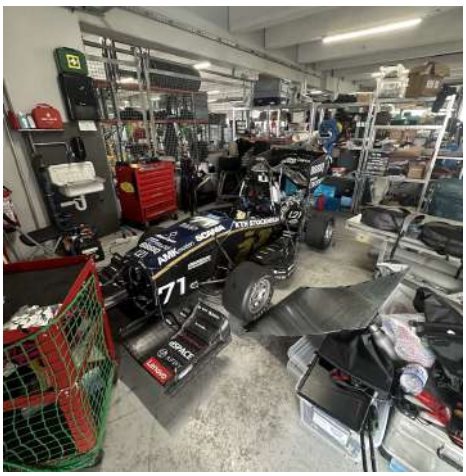

Figure 20: Pit 2024 FSG (when packing up)

In 2024, we had been to the competition once before, so there was a lot more understanding of what to expect. Also, we did our best meals to date, especially with our Italian team mate Davide's crazy spaghetti bolognese, one of the best I have had in my life.

The competition marked our best performance in seven years, with the car successfully passing all but one of the technical scrutineering tests: the brake test. While the issue with the brakes meant we couldn't compete on track, it was incredibly encouraging to see every other system meet the rigorous requirements. It showed just how far we've come as a team, and though we fell short this time, the progress we made sets a strong foundation for the future. In Figure 21, you'll see the car in the tilt test, where it is tilted to an angle of 60°, making sure that there are no leaks and that the mechanical integrity of the car is sound.

Figure 21: Dev18 in the tilt test

During the mechanical scrutineering, we ran into an issue with our driver's headrest. Ours wasn't rule compliant because it was made of multiple segments

glued together instead of a solid block. With no extra foam on hand, we turned to other teams for help. One very generous team offered us their spare headrest, made in exactly the same way as ours. Grateful but cautious, we informed them it might not be legal either, but their incredibly kind team member insisted it was and even followed us into scrutineering to speak to the judges. Unfortunately, the judges confirmed what we had feared: his team's headrest was also illegal. For one horrifying moment, we weren't just worried about our car passing; we thought we might have made history as the first team to achieve *-1 cars passing mechanical scrutineering*. Thankfully, everything worked out in the end. Shoutout to Lorenz Ballenweg from Delta Racing, who generously gave us some spare foam (Figure 22). This meant that both cars passed scrutineering, and we all got a good laugh (eventually).

Figure 22: Headrest foam given to us by Delta Racing

Our team is truly global, drawing members from all over the world. That international network sure has its advantages, like the evening when Sebastian, a German former member who now works at Mercedes-Benz, showed up to our muddy campsite in a specced out prototype S-class. The contrast was massive, going from a crusty tent to a car with scented air vents and a speed limit of 260 km/h, which he demonstrated by the way. The autobahn is pretty sweet when you are in a car like that, compared to towing a trailer at 80 km/h... Thank you Sebastian!

From the autobahn to the pit lane, the road to engineering excellence is paved with curiosity and hard work. Now that we've explored the broader world of Formula Student, it's time to zoom in on the technical details of Dev18!

4 Technical stuff

Building a car is no small feat, so skipping over how it's done would feel a bit out of place, wouldn't it? I've done my best to keep things understandable, even if the technical details might not be your favorite topic. But if you do find it a bit dry, please take a moment to enjoy the pictures, they're there to give you a glimpse of the car's complexity and to show just how much planning and precision go into bringing it to life.

At the competition, nothing on the car is taken for granted. Every aspect is scrutinized by the judges, and we're expected to justify every single design choice. Why is the battery this size? Why does the car weigh this much? Why did we choose this gear ratio? To answer these questions, we rely on detailed simulations and calculations to show that every decision was made with one goal in mind: maximizing our points while pushing the car to its full potential.

There's a big difference between assembling and building a car. When we say we build the car ourselves, we mean it in the truest sense. This isn't about unpacking a kit and following instructions; it's about designing, manufacturing, and integrating nearly every component from scratch. From concept to reality, every piece is a product of our team's work, sweat, and sometimes questionable late-night snacks. As I've said, I'll spare you the most technical details here, but if you're ever curious, you're more than welcome to visit the garage, it's where the magic (and occasional chaos) happens.

Now, let's get started on building the car. While it took us countless hours and a year of hard work to bring it to life, you'll get the condensed version in just a few pages. Every great car begins with its foundation, and ours is no exception. We start with the chassis, the backbone that supports everything else.

4.1 Monocoque

The monocoque, or MQ, is the most labor-intensive part of the car, and building it takes an enormous amount of time. It starts with months of designing and simulating every detail, followed by carefully building it from scratch, layer by layer. This was the second MQ our team has made, and we managed to reduce its weight to just 22.3 kilograms. It is made out of carbon fiber because its stiffness is four times higher than that of steel. It is this careful balance of strength, weight, and effort that makes the MQ such a critical part of the car, and one of the most rewarding challenges to complete.

Our manufacturing process consists of three key stages. Creating the **positive mold (plug)** involves gluing sheets of medium-density fiberboard (MDF) together and milling them into four precise pieces. Forming the **negative mold** comes next, where each MDF piece is laminated with a thick layer of fiberglass

(totaling around 100 kilograms) to ensure stability and prevent warping during curing. Once cured, the four pieces are assembled into a sturdy negative mold. Finally, **laying the carbon fiber** begins with applying the outer layer of carbon fiber of the monocoque inside the mold, followed by curing it in an oven. The core materials and inserts for hardpoints are then added, and another curing cycle is performed. The process concludes with applying and curing the inner carbon fiber layer. We owe a special thanks to XShore for providing us with industrial oven facilities essential for this process, their support was invaluable in bringing the MQ to life. The 3D model of the MQ is shown in Figure 23.

Figure 23: 3D model of the monocoque

The MQ has so called hard points, reinforced areas where critical components like the suspension are mounted. When the wheels are attached, suspension becomes absolutely necessary. Without it, driving would feel like sitting on a wooden chair rolling down a cobblestone street at full speed. Not exactly a pleasant ride.

Suspension is what allows the car to handle bumps, corners, and changes in terrain while keeping the wheels firmly planted on the ground. It is not just about comfort; it is about control, stability, and, ultimately, performance.

4.2 Suspension

The suspension is a decoupled system, designed to separate two critical types of motion: heave, which is the up-and-down movement of the car as it travels over bumps, and roll, which is the tilting motion when the car corners. Each axle features two dampers: one for heave motion, equipped with a coilover spring to provide heave stiffness, and one for roll motion. The roll damper uses two

small coil springs, installed both internally and externally, along with two blade springs that can be easily swapped to adjust the roll rate. This setup allows us to fine-tune the car's handling and ensures it remains stable and predictable under varying track conditions, and it is shown in Figure 24:

Figure 24: Suspension of Dev18

Driver Environment

When driving a car, having a steering wheel and a few pedals to control it is essential, not to mention a seat to sit in. Our steering system, including an in-house-designed steering wheel, provides precise control for the driver. It's shown in Figure 25:

Figure 25: Steering solution of Dev18.

The driver's seat is custom-made by us, molded using a two-component fire-retardant foam to provide a bespoke fit tailored to the driver. This ensures both safety and maximum comfort, if you could call it that. At the front of the car, we've integrated a custom pedal box, complete with brake- and accelerator

pedals. This compact design also houses the emergency brake system (EBS) for when the car is driving autonomously and must be shut down, saving valuable space without compromising functionality, as shown in Figure 26.

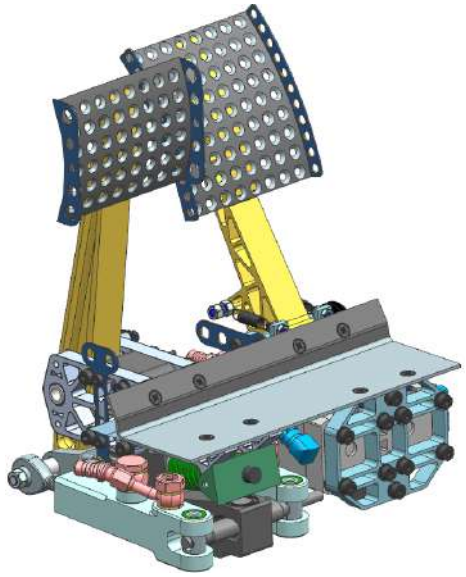

Figure 26: Pedal box of Dev18.

To optimize braking, we collaborated closely with ISR Brakes to refine the design of our brake master cylinders. This enabled a decoupled hydraulic and regenerative braking system. Speaking of regeneration, let's dive into the heart of the car: its powertrain.

4.3 Powertrain

Pressing the pedal of a car with no powertrain is, as you might imagine, not very exciting. To fix that, we need three essential components: a high-voltage (HV) battery, an inverter, and electric motors.

The HV battery is where everything begins. While the individual cells are not manufactured by us, we take it from there. Once we have the cells, we assemble them into six segments, connected in series to form the complete pack. Beyond the cells, every other part of the battery is designed and built by us, including a compartment that houses both HV and LV control logic. The entire battery is remarkably slim compared to other teams', a feature that significantly benefits aerodynamics and vehicle dynamics. Of course, achieving this compact design causes no small amount of frustration for the electronics team. The battery is shown (without a lid) in Figure 27.

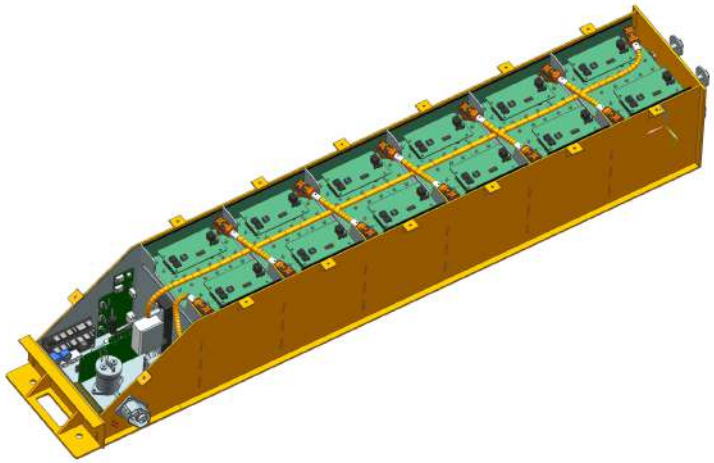

Figure 27: High voltage (HV) battery of the car

Batteries provide direct current (DC), but our electric motors require alternating current (AC). This is where the inverter comes in. It converts DC to AC, enabling the motors to function. This process also works in reverse: when the car slows down, the motors act as generators, producing AC that the inverter converts back into DC to recharge the battery. This regenerative braking system complements the physical brakes, recovering energy that would otherwise be lost.

Building an inverter is an incredibly complex task, and it is one of the few components, like the electric motors, that we do not make ourselves. However, the commercial package it comes in is bulky and heavy, far from ideal for a high-performance race car. To address this, we meticulously disassembled and reassembled it, optimizing the layout to make it more compact and lightweight. The result is an inverter that fits seamlessly into our design, without compromising functionality. The inverter is shown in Figure 28.

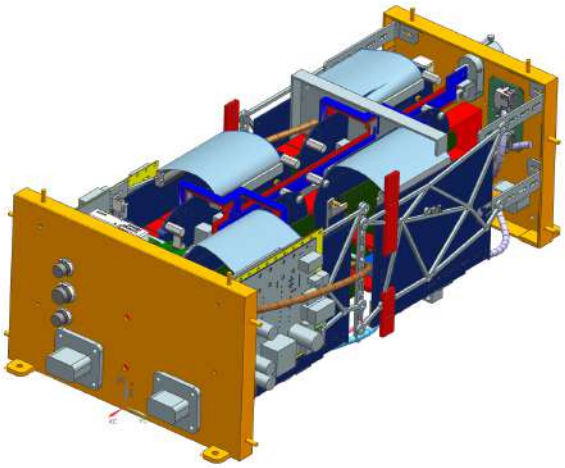

Figure 28: The car's inverter (without its casing)

Having powered the car and converted DC to AC with the inverter, the next step is to ensure that torque from the motor reaches the wheels. This is where the wheel assembly comes in, and at its heart lies the gearbox. Despite the name, it operates with just a single gear (1:14 in our car) and its purpose is to translate the high-speed, low-torque output from the motor into a form usable by the wheels. A term like "transmission box" might feel more accurate, but regardless of its name, the gearbox is the most mechanically complex part of the car, as can be seen in the exploded view in Fig. 29.

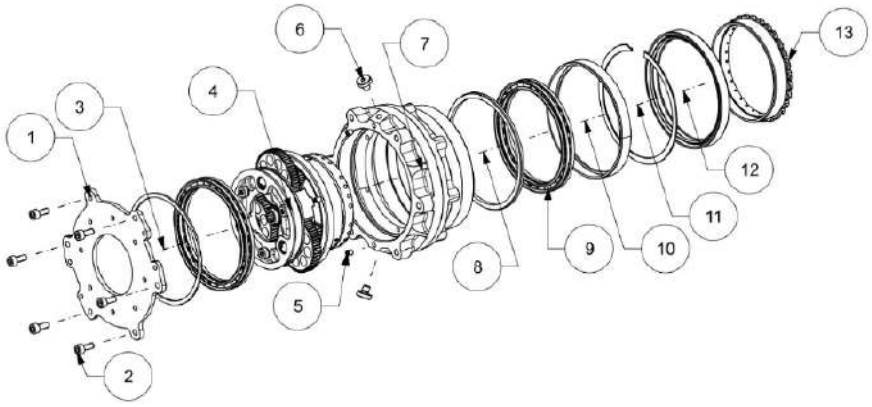

Figure 29: Exploded view of the entire gearbox

The gearbox required components sourced from multiple companies to come together seamlessly. A huge thanks goes to Sandvik Coromant, a key sponsor and major contributor to its precision manufacturing. As a further example of its intricate details, the part labeled 4 in Figure 29 is itself exploded in Figure 30.

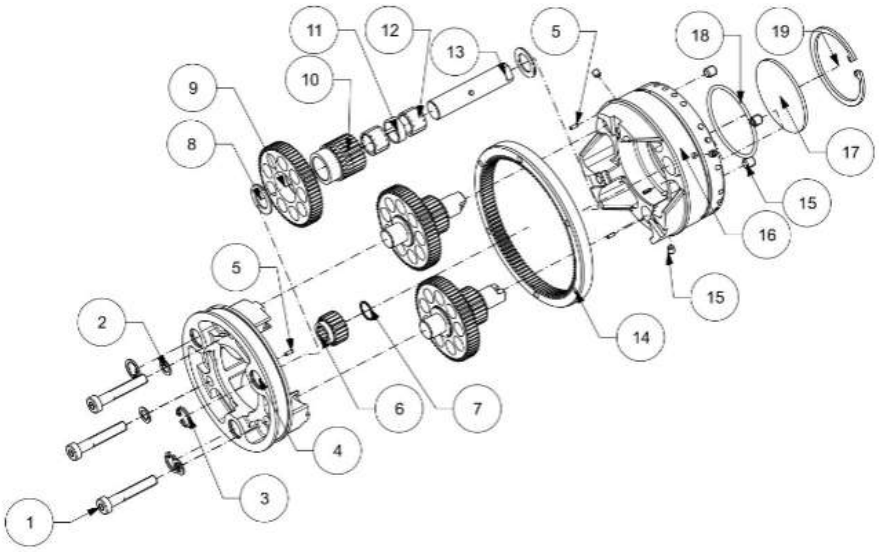

Figure 30: Exploded view of component 4 in the previous schematic, Figure 29

In the wheel assembly, the hub connects the gearbox to the rim of the wheel (colored blue in Figure 31). If you have ever changed a tire, this is the part where the bolts go. Finally, the uprights complete the assembly. This component houses the gearbox in place and mount the entire system to the suspension, ensuring it remains stable under the immense forces generated during racing. Together, these parts form a seamlessly integrated system that takes the motor's torque and delivers it to the wheels with precision and reliability.

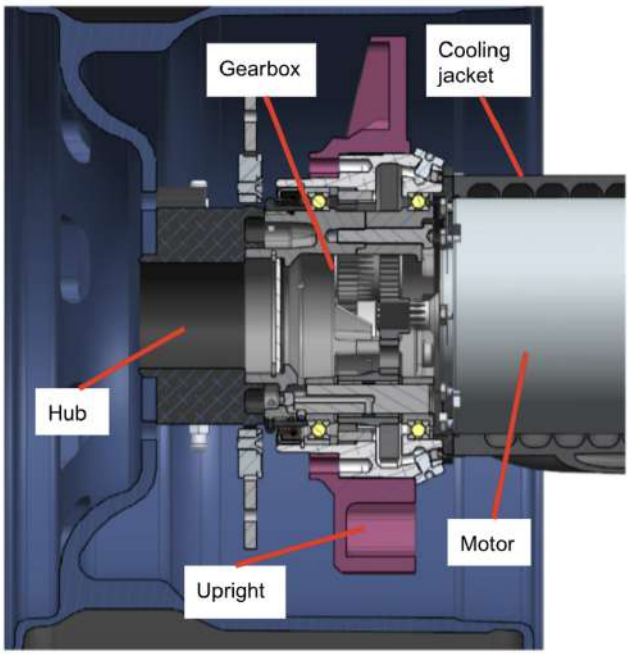

Figure 31: Wheel assembly - Converting electrical energy to movement

4.4 Driving performance

With the powertrain and wheel assembly in place, we are almost ready to drive. The final step is ensuring that the car handles as fast and predictably as possible while providing the driver with the confidence to push it to its limits. Achieving this requires careful planning, advanced control systems, and extensive testing.

It all begins with simulations to decide on the drivetrain layout. After evaluating several scenarios, layout C3 (hub motor AWD), shown in Figure 32, was chosen since it would maximize our point scoring at the competitions.

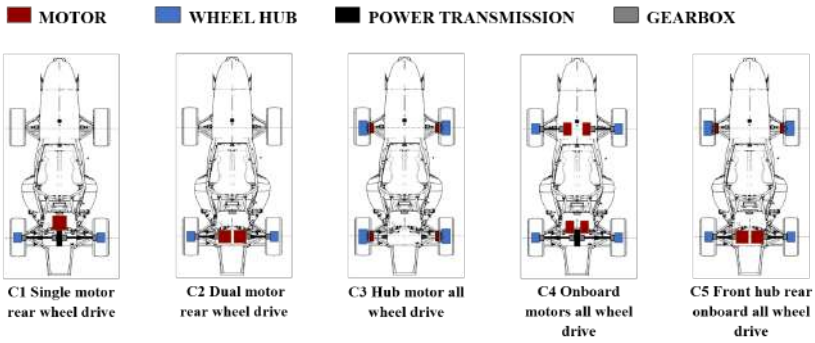

Figure 32: Investigated drivetrain scenarios

For maximizing grip and lower our laptimes, intricate driver assist systems are required. Both torque vectoring and traction control systems are designed and implemented entirely by us, running on the car's onboard computer. Together, these systems ensure that the car delivers its full potential on the track, combining speed, control, and precision.

Without going too deep into the math, torque vectoring allows each wheel to receive a different amount of speed during the race. For example, in a corner, the outer wheels must travel farther than the inner ones. Torque vectoring compensates for this by sending more speed to the outer wheels, improving stability and speed. If we wanted to, the inner wheels could even go in reverse, allowing for turning on a dime! The result is a car that handles corners with greater precision and at higher speeds. A snapshot of the system in action is shown below, where the car with torque vectoring (solid car) stays on the track at 60 km/h, compared to the car without torque vectoring (gray car) losing grip.

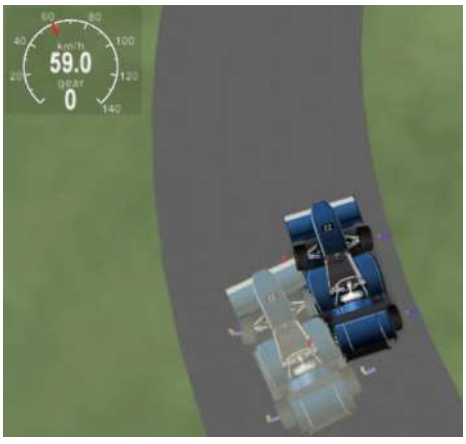

Figure 33: A simulation of torque vectoring in action

In addition to torque vectoring, traction control is critical for optimizing performance. Without it, pressing the accelerator flat out would overwhelm the grip of the tires, causing all four wheels to spin without the car accelerating as effectively as it could. Traction control prevents this by using algorithms to calculate the optimal amount of torque to apply, ensuring maximum acceleration without slipping.

In addition to clever algorithms, the car benefits significantly from an aero package that generates downforce. Downforce is essential when taking corners, helping the car stick to the track and maintain control at higher speeds. While it might seem like a secondary goal, making the car look awesome doesn't hurt either. What started as something my fiancée Linnea jokingly referred to as "a banana boat" has evolved into a car that not only performs like a race car but looks like one too.

The aero kit is split into three sections: the front wing, the side structure and the rear wing. Figure 34 below shows the downforce generated by the new aero kit (marked in purple) compared to the older kit (dashed lines). Our focus for this iteration was the front of the car, due to some inbalances from the previous season, and the difference there is noticeable to say the least.

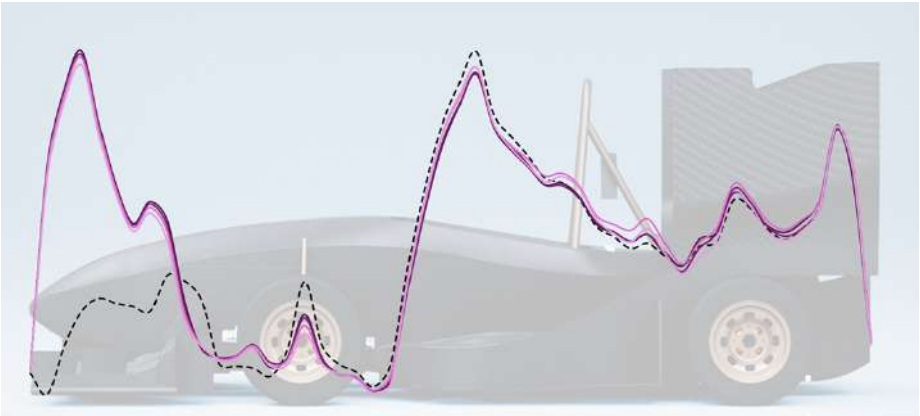

Figure 34: Downforce from the aero kit, old kit in dashed and new kit in purple

We rely heavily on Computational Fluid Dynamics (CFD) to guide our designs. Every aerodynamic device on the car is the result of extensive calculations and simulations. By analyzing airflow and optimizing the car's performance virtually, we ensure that every decision is backed by data before moving to the physical stage.

Of course, theory can only take you so far. Judges value real-world validation, and so do we. To ensure our simulations reflect reality, we built a 1:3 scale model of the car and tested it in KTH's wind tunnel. We are pleased to say

that the data confirmed that our designs perform as intended. The scale model in action is shown in Figure 35, and it is a smaller version of the car doing big things.

Figure 35: 1/3 scale model of Dev18 in a wind tunnel at KTH

4.5 Autonomous driving

Once the car is performing as it should, we replace the driver, not with another human, but with a lidar sensor and some exceptionally clever algorithms. One of the stars of the system is YOLOv8 object detection. And no, this is not YOLO as in "you only live once", thankfully, we aim for a bit more precision in autonomous driving. Instead, YOLO stands for "you only look once," a method so efficient it makes detecting cones and obstacles look almost effortless. Paired with a self-developed lidar algorithm boasting a 35-meter detection range, this system ensures the car doesn't just see the world, it understands it.

The autonomous driving system is divided into three main sections. The **perception** module observes the environment, identifying cones and other obstacles with remarkable accuracy. The **SLAM** module (short for simultaneous localization and mapping) ensures the car knows exactly where it is within that environment. Finally, the **navigation** module decides where the car should go, making real-time decisions to follow the optimal path. Together, these modules form the backbone of the car's autonomous capabilities.

Unlike pre-programmed systems that rely on knowing the track layout in advance, our car uses machine learning and AI, trained entirely by us, to make decisions in real time. It doesn't memorize the track, it interprets and reacts to

it as it drives, cone by cone. A visual example of how the car perceives cones through lidar is shown in Figure 36, though the complexity of the system is difficult to fully capture in a single image.

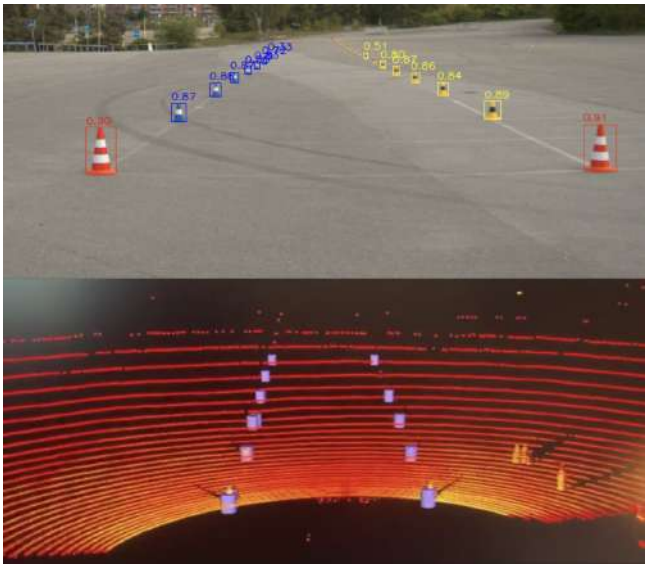

Figure 36: Visualizing how the car perceives cones through lidar

Beyond all this technical brilliance, our autonomous team also doubles as one of Sweden's most overqualified tech support crews, ensuring licenses and software stay up-to-date. Special thanks to Aron (current DV head) for keeping everything running smoothly while delivering cutting-edge AI.

4.6 Built In-House

Everything you've read about: the monocoque, suspension, powertrain, and countless other systems—is built by us, and it all happens in our small, unassuming garage. It's not a state-of-the-art facility, but that's what makes it special. Working in a space like this forces us to be creative and resourceful. From carefully managing the limited room available to overclocking a drying cabinet into an oven, every corner of the garage has a purpose.

And while I've described some of the major systems, there's so much more happening under the surface. Low-voltage electronics, intricate mechanical components, endless simulations, and calculations, all are critical to bringing the car to life. The photos below (Figure 37 and Figure 38) and below offers a glimpse of the place where this all comes together. It might not look like much, but it's where ideas are turned into reality, one piece at a time.

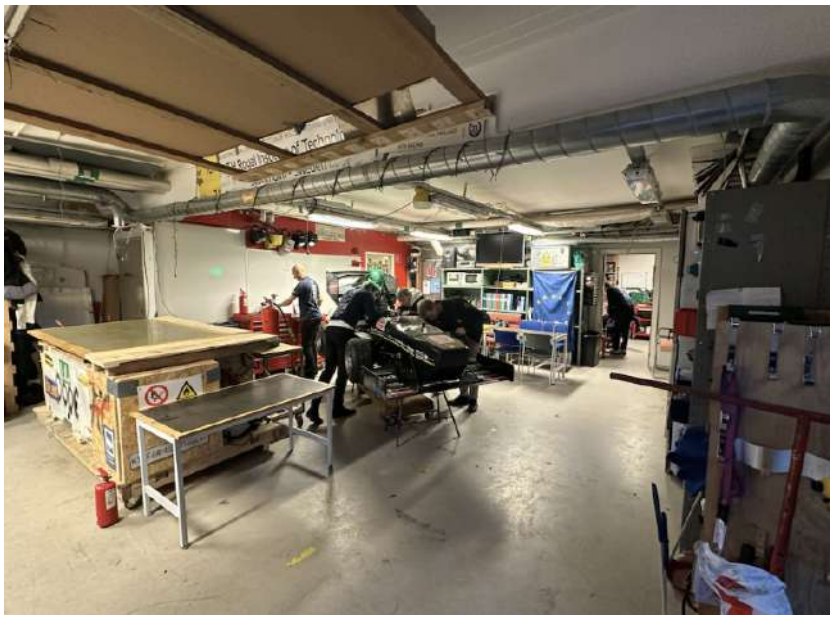

Figure 37: Our garage some part of the time

Figure 38: Our garage some other part of the time

5 Our stories

We've had some incredible experiences in this organization. With countless stories and shared memories, I've chosen a few that I think truly capture what Formula means to us. To give you a complete picture, I thought it best to start with what it's like to join Formula, followed by a selection of stories that highlight the challenges, triumphs, and humor that define our journey. After those three stories, we will go into first official fun stories, and then a few stories that are not as official.

5.1 What It's Like Joining Formula

The first time you step into the garage during a busy day, it feels a bit like encountering the older kids when you just started high school. Everyone looks intimidatingly professional, the technical level seems impossibly high, and you half expect someone to ask if you're even supposed to be there. At least, that is how I felt.

What we value most when joining the team, though, is commitment and engagement. If not for that clause, I'm sure I would never have been accepted. I joined the Powertrain & Electronics subgroup because, frankly, I struggled with electromagnetism at school. My first project? Troubleshooting the inverters with Tore (previous PE head), one of the most skilled engineers I've had the pleasure of working with. I doubt he'd say the same about me in the beginning, though. I still vividly remember asking him which way to turn a screw, and the look he gave me could have stopped a DC current dead in its tracks.

I'm not the only one to use a tool improperly when new to the team. Drills have gone in reverse, with loud complaints that they "don't work," and someone once tried to cut through wood with a saw upside down, which was about as effective as using a butter knife.

On another note, when running in the new gearboxes, you usually take it slow, letting the oil splash around and giving tiny metal shavings time to smooth out. It's a careful process, or at least it's supposed to be. During one test, someone accidentally set a minus sign in the wrong spot. The second we hit start, the gearboxes spun wildly in reverse, leaving us staring in shock, and maybe a little admiration at the sheer speed. Thankfully, a quick hit on the shutdown button brought everything to a safe stop. No harm was done, except maybe to our pride.

Mistakes happen, but what is important is that we learn from them and improve. And this is where Formula truly shines: a unique opportunity to fail quickly and often in a controlled environment, turning every misstep into a valuable learning experience. This process of trial and error is what sets the foundation for the incredible growth every team member experiences.

The progression in Formula is straightforward but transformative. You start by helping out: getting the tape when needed, observe and look at how tools are operated, holding things in place. Then, you take on small practical tasks yourself, like mounting parts or soldering a few components on something non-critical. Before you know it, you're leading a project, and suddenly, you've become one of those scary independent people who seem to know exactly what they're doing.

That growth is one of the most rewarding things about Formula Student. Watching members come in with no experience and leave as highly skilled engineers is nothing short of inspiring. Of course, this transformation doesn't happen on its own. Like any organization, knowledge transfer is vital, and we work hard to prioritize it as best we can.

5.2 Koenigsegg Factory Visit

Let's begin with a story from when we were in the South of Sweden. All the team captains from the Swedish Formula Student teams were invited for a private tour of the Koenigsegg factory, and Axel and I gladly accepted the opportunity. Visiting the factory was an incredible experience, walking through a place where engineering meets art was nothing short of inspiring.

A team member of ours, Emil T (previous PE head), was doing his master's thesis at the company. Given Emil's expertise with the inverter package and the time constraints we were facing back in the garage, we saw an opportunity to tackle two things at once. Instead of struggling with the complex inverter assembly on our own, we brought it to Emil along with every tool we thought we might need. It was the perfect solution to save time and make use of Emil's expertise. With everything packed and ready, Axel and I headed south to Ängelholm.

After an unforgettable factory tour (yes, it's every bit as impressive as you'd imagine) we got to work on the inverter. A few hours in, we hit a major setback: we realized that when the inverter casing had been prepared, one of the metal parts had been bent and welded in the wrong direction. After carefully considering our options, we decided to take a dinner break to clear our heads. We grabbed some pizzas at a local shop, but before we could finish eating, the shop was closing. Like true students, we relocated to the car to eat, as can be seen in Figure 39.

Figure 39: Eating pizza in the Mini

While sitting in the car, Axel had an idea: Google "TIG-welding Ängelholm" and call the first result. It sounded desperate, but we had no other choice. This was after 9 pm on a Friday, mind you. To our amazement, someone answered. We explained our situation, the urgency, and who we were: Formula Student competitors trying to fix an inverter. His response was unforgettable: "Yeah, I know who you are. I saw you earlier today."

It turned out that we had stumbled upon one of Koenigsegg's own welding engineers, a world-class expert in his field. This was quite literally the only solution to our problem, and we couldn't believe our ears. Barely able to process our luck, I raced back to Emil's place to grab the parts while Axel and Emil worked on preparations in the backseat.

We arrived at the engineer's workshop, tucked away in his backyard, and he immediately got to work. For 40 minutes, he angle grinded, bent and welded with incredible precision, achieving a result we had thought impossible. We could hardly believe our eyes. To top it off, he gave us a student discount, meaning that everything he did was just 200 SEK, or about 20 Euros. Huge thanks to Ajden Mekaniska & Motorsport for saving the day!

With the part repaired, we were able to finish assembling the inverter over the weekend. It was exhausting, but we had a blast, and it all worked out in the end. To me, this story perfectly captures the spirit of Formula Student: always facing strange challenges, pushing for creative solutions, and somehow, always finding a way. Figure 40 is a photo from when I was working on the inverter on Emil's bed.

Figure 40: Building an inverter in Emil's bed

5.3 Romance & Relationships

Even in an organization like ours, where time feels like a rare luxury, there's still space for relationships, though they often require a bit of creativity. The partners of our members deserve immense credit. It is quite strange living or dating someone with an obsession: never knowing where they are, what they're doing, or when (or if) they'll pick up the phone. Late nights, missed plans, and weekends spent at the garage become the norm. It's enough to make anyone think we should start a support group just for our partners.

This constant juggling between commitments has led to some challenging, even absurd, moments. Emil T, on vacation in France, received so many calls from us that we sent flowers to his girlfriend as an apology. Axel, trying to enjoy a weekend trip with his girlfriend, ended up fielding 50 calls from the team while writing a cost event report from a beach. As for me, I've had to work on the inverter cost analysis from a bedroom in Spain and pull all-nighters to meet documentation deadlines. Once I had to call my boss the next morning to explain I wouldn't make it to work because of some unexpected events in the garage. These situations may sound amusing in hindsight, but they highlight just how demanding this project can be, and the strain it places on everyone involved.

Linnea has been incredible through all of this, even if she's had to endure some rather unconventional dates. Take one evening, for example, when I had promised we'd spend some quality time together. Everything was planned, until

we realized someone had to pick up an urgent package a few hours away from the garage, and no one else could do it. I called Linnea, explained the situation, and asked if she'd like to join me for what I optimistically described as a "car date."

So, instead of a cozy evening at home, we found ourselves going through the countryside with the package secured in the back. It wasn't the most romantic evening in history, but we made the best of it. Conversation flowed, the road stretched ahead, and it turned out to be... nice, in its own way.

5.4 Sleeping

Sleep is a cornerstone of good performance, something we're constantly reminded of, even if it's not always easy to prioritize. When deadlines are tight and the car demands all our attention, sleep often takes a backseat. But don't worry, we've learned to adapt. Sleeping in the garage is a practical, if unconventional, solution. Why waste time going home when you can just crash where you work? Look at this great example of Aron sleeping on three chairs.

Figure 41: Aron sleeping on three chairs in the garage

Olof (previous AC head), who was in charge of manufacturing the MQ, has taken this to heart, so much so that he's fallen asleep standing up more than once. The sound of him hitting the floor has become an unexpected alarm clock. Then there's the time our kind cleaning lady, who takes care of the building above the garage, asked us if we were having trouble with homeless people. She'd spotted someone upstairs early one morning, looking, as she put it, a little rough. It turned out to be another MQ team member who had spent the night and was caught just as they were waking up.

Luckily, we've upgraded since then. We now have a mattress, which I've had the pleasure of sharing with two other guys during one occasion. Not stacked on top of each other (just to be clear) but with the mattress under all of us.

5.5 Fun Stories: The Ones We Can Admit To

5.5.1 From Schnitzel Dreams to Wedding Crashers

When heading to FSG for the first time, eating a schnitzel was, naturally, at the top of our to-do list. Emil T, in charge of schnitzel reconnaissance, found what he swore was the perfect spot online. With me driving and everyone else half-asleep, we trusted him completely. Things got weird when the GPS led us to what looked like an abandoned hospital. Still, schnitzel knows no boundaries, so we followed a narrow road lined with gardens, parked the car, and walked down a winding path surrounded by about 15 gnome-filled plots.

At the end of this surreal hike, we reached what Emil T had dubbed "schnitzel paradise." Except, it wasn't. Instead, we walked straight into a wedding. Not a quiet, quaint backyard affair, but a full-blown celebration complete with blasting music, suited guests, and absolutely no schnitzels. For a few awkward seconds, both sides just stared at each other: us wondering where the schnitzels were, them wondering who invited the weirdly underdressed strangers.

Realizing we weren't about to be handed plates of golden, breaded perfection (or wedding cake, for that matter), we made a hasty retreat. To this day, we're still not sure how Emil T's research went so catastrophically wrong, but one thing is certain: he lost all schnitzel-choosing privileges for life.

5.5.2 Charging a Laptop in a Thai Kitchen

Sometimes Formula Student isn't about racing, it's about survival. Once, while trying to record and submit the required car footage for competition, we realized the laptop holding the video was about to die. With no outlet in sight and a looming deadline, we sprinted to the nearest mobile Thai kitchen and somehow convinced the staff to let us plug in. A few minutes later, we were crouched in the middle of their kitchen, charging the laptop and frantically uploading the footage. The car might be autonomous, but sometimes our solutions are far from high-tech.

5.5.3 Heavy Vans and Loud Customs

Driving to competitions is always an adventure, mostly because it involves learning lessons the hard way. Like the time we packed a van 500 kg too heavy and got flagged by a roadside scale. In the middle of the night, we had to unload and stash the excess weight at a team member's parents' house, leaving them with a pile of car parts until we could send reinforcements to pick it up.

And then there's customs. Crossing borders with a Formula Student car isn't exactly a smooth process, it's a regular trailer, but unpacking it for inspection is a major headache. Once, at the UK border, the car made it through without a hitch. To celebrate, the then team captain let out a victorious scream of

"YES!"—completely forgetting the windows were down. It probably didn't look great, but luck was on their side, and they weren't stopped.

5.5.4 Goodbye Shoes

No amount of washing powder could salvage the shoes we wore during the competitions. By the time we got home, some pairs were beyond saving, so naturally, we did the only reasonable thing: we set them on fire. A fitting farewell for footwear that had survived mud, grease, and a thousand hours of garage life.

5.6 Fun Stories: The "Unofficial" Chronicles

The following is a collection of stories that may or may not be true, think of them as harmless tales from the Formula Student world, completely fictional and impossible to trace to any specific team. After all, with so many teams spread across Europe, who's to say where these imaginative accounts might have originated? Take them for what they are: lighthearted anecdotes that capture the spirit of the competition without pointing any fingers.

Take, for example, the creative problem-solving required when access to a building was critical, and the solution just so happened to involve sleeping inside it overnight. Surely, that's not bending any rules, just a very committed approach to time management! Or the time a Formula car had an unfortunate collision with a private car, sparking a monumental insurance headache. Unsurprisingly, Formula cars aren't exactly covered by standard policies, making the situation as complicated as it was embarrassing.

Then there's the logistical ingenuity of transporting team members in trailers alongside the Formula car, sometimes with someone sitting inside the car itself due to limited space. Or the heart-stopping moment when a car slipped during lifting, resulting in broken wings and hours of frantic repairs, not a proud moment, but a humbling one.

And finally, during the recording of a video, there was a slight oversight: the emergency braking system wasn't engaged. This led to a dramatic moment where a team member had to quite literally throw themselves in front of the car to stop it. Not exactly the preferred braking method, but certainly a memorable one.

These stories, while humorous, also underscore the challenges and unpredictability of working on cutting-edge projects. They're a reminder that even the best teams sometimes stumble, but they always pick themselves up and keep moving forward.

6 On a more serious note

Being a team captain has been a crash course in people, problems, and persistence, often all at once. Some lessons feel obvious in hindsight, others hit me like a ton of bricks. I don't have all the answers, but here are a few scattered thoughts that stuck with me.

Motivation is a funny thing. When someone truly believes in what they're doing, they'll climb mountains, or learn how to build a suspension system from scratch at 2 a.m. But when that belief isn't there, even simple tasks feel impossible. It's a stark reminder that understanding the *why* behind something is just as important as the *how*.

Of course, keeping that fire alive takes effort. Small gestures, like giving kudos in a meeting, can make a big difference. A simple "great job" can go further than you'd think, especially when it's public. On the flip side, criticism needs a lighter touch, best delivered privately and with a bit of tact. Getting that balance right is tricky, but when you do, it's magic.

And then there's failure. Honestly, we've gotten quite good at it. Not in a bad way, though, it's the "fail fast and figure it out" kind of way. Mistakes happen; what matters is how quickly you pick yourself up and adjust. The trick is to keep failing forward, not downward.

And then there's the cycle. As a new member, it's easy to be ambitious, to brush off the warnings of older members and think that sheer hard work will solve everything. Then reality hits, and you realize there was some truth to their advice. All those late nights and overcomplicated designs catch up, and you find yourself struggling to get the car ready in time. Before you know it, you're the older member warning the next group to keep things simple. It's a frustrating, almost comical loop, but one that drives progress, even if it's slower than anyone wants to admit.

In the end, it's the people that make it worthwhile. The diversity of ideas, experiences, and perspectives creates something far bigger than any one of us could manage alone. It's messy, inspiring, and totally worth it.

7 What was my role?

As I've said, together with Axel Hällefors, I had the privilege of being team captain for the 2023-2024 season. What did that actually mean? Well, it was less about glamorous speeches or grand gestures and more about being the glue that kept everything, and everyone, together. Axel and I spent countless evenings and weekends discussing plans, solving problems, and making sure things stayed on track.

Most of the time, our work was the kind that nobody really notices but everyone benefits from. Drafting contracts, meeting sponsor commitments, planning timelines, and yes, occasionally playing referee in the heat of a technical debate. If things were running smoothly, it usually meant we were doing our jobs right, though there were plenty of moments when we were reminded that smooth sailing doesn't come naturally in motorsport.

One thing Axel and I both missed was the hands-on part of building the car. While our focus was elsewhere, we couldn't help but feel a bit envious watching the team in the garage, getting their hands dirty with epoxy and carbon fiber. But leading the team wasn't about us; it was about empowering others to bring the car to life. And honestly, seeing everyone come together, working tirelessly to create something extraordinary, was worth every moment.

8 Acknowledgments

This book is a tribute to the extraordinary people who made it all possible. Joining this team has been the best academic decision of my life. It wasn't only about the car, though the car was our driving force and greatest achievement. It was about the people, the challenges we overcame, and the unforgettable memories we created together. As a new journey begins with the building of Dev19, I feel an immense sense of pride watching how the team continues to grow, innovate, and push boundaries. I hope these pages capture just how much I value this team and the incredible journey we shared.

Axel Hällefors wasn't just the team captain alongside me; he was a partner in every challenge, an extraordinary engineer, and an even better friend. You know that expression about friends you can call in the middle of the night? With Axel, both of us have been on the receiving end of that call more times than I can count. Whether it was solving a last-minute crisis or talking through a moment of doubt, Axel was always there, and I hope he'd say the same about me. Together with the team, we accomplished something incredible: building a car in one year, a feat that had taken four years previously.

Of course, as we say in Swedish, even the sun has its spots. Axel has one tiny imperfection: his Swedish. For reasons none of us can explain, he insists on pronouncing "shorts" as "skjhourts." And if you haven't heard it live, trust me, it's every bit as strange as it looks written down. But jokes aside, Axel's dedication, sharp mind, and ability to lift up everyone around him made him a privilege to work alongside. I couldn't imagine having done this without him.

To the entire team: none of this would have been possible without you. Your dedication, hard work, and enthusiasm turned what seemed impossible into reality. You weren't just colleagues; you were friends, problem-solvers, and a constant source of inspiration. The late nights, the shared laughs, and even the occasional frustrations brought us closer together, and I am endlessly grateful for the memories we've created. Working with such a talented and kind-hearted group has been one of the greatest privileges of my life.

This journey wouldn't have been possible without the incredible support of our sponsors, who not only believe in our vision but actively enable us to achieve it. Around 50 companies are actively helping us, contributing in countless ways to make this project a reality. A special thanks goes to our four main partners: Atlas Copco, Sandvik Coromant, Essiq, and Level21. Their contributions, whether through funding, resources, or expertise, have been invaluable in turning our ideas into reality. We're immensely grateful for their partnership and the trust they place in our team. Your support makes all the difference—thank you for being a part of this journey with us. Thanks also to Göran Strömberg from MMX Reklambyrå for contributing to the book's title page!

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Finally, to Linnea: your support has meant the world to me. Thank you for making it possible for me to dedicate so much time to this project and for your endless patience as I talked about the car, at all hours and in every possible setting. I couldn't have done this without you.

This book is, at its core, a celebration of all of you. It's a way to say thank you for making this experience what it was: challenging, inspiring, and unforgettable.

Cheers!

9 Supporting my team

Thank you for reading the book and taking a part of our journey. If you wish to support my team further, you can donate via PayPal using this link. In addition, if you are in Sweden, Swish is also greatly appreciated, using our number of 123 234 29 54, or the QR code shown in both Figure 7 and Figure 42. Another way of greatly supporting the team is to donate supplies and material, and if you are interested, please reach out to us! Our email is info@kthformulastudent.se.

Figure 42: Swish payment option to the team