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UPDATE MAGAZINE

IIIFSFEUP

FIRST EDITION

FORMULA STUDENT FEUP

PORTO, PORTUGAL

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CONTENT

THE TEAM

IT WAS IN JULY 2021 THAT THE FSFEUP STORY BEGAN.

Born from the will and commitment of a group of students from the Faculty of Engineering of the University of Porto, it quickly became a real and tangible project with one goal in mind: compete in Formula Student, electric class, with a car designed and manufactured by the students themselves.

After almost two years, the team now has about 40 students from various FEUP courses, divided by the departments that make up this project: Powertrain, Electronics & Software, Suspension, Chassis & Aerodynamics, Sponsors, Logistics and Marketing and led by Team Leader Afonso Costa and Chief Engineer Renato Ferreira.

At this moment, there are still about 35 recruits in the process of integration into the team, in order to ensure the continuity of the project for years to come, as well as an essential support in the manufacturing phase of the car scheduled for this year, 2023.

FORMULA STUDENT

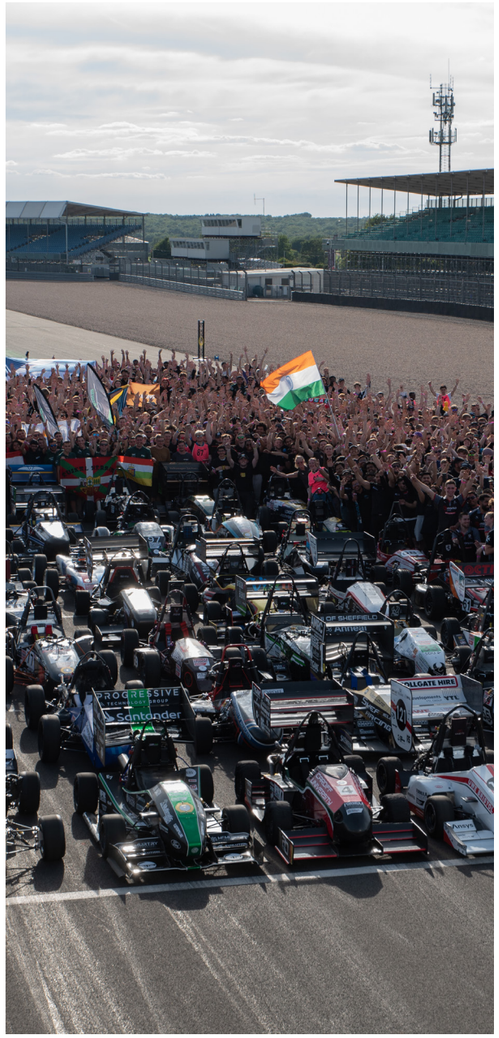
“THERE ARE TWO REALLY INNOVATIVE FORMS OF MOTOR-SPORT LEFT. ONE OF THEM IS FORMULA 1 AND THE OTHER ONE IS FORMULA STUDENT”

Ross Brawn OBE

Formula Student is an international engineering design competition first held by the Society of Automotive Engineers in 1979. The aim is to develop and provide a platform for students, future engineers to experiment, build and learn. The competition offers a unique way to test students’ theoretical knowledge in a practical context. Students gain and develop skills such as engineering, project management and teamwork.

There are various countries where the competition is held, and in Europe the main competitions are in Spain, Germany, Austria, Hungary, Italy, the Czech Republic and the UK, and usually hundreds of teams from all over Europe participate.

The team is evaluated not only in dynamic events where the vehicle competes on a circuit but is also evaluated in static events where a full range of aspects are analyzed, from prototype design to team management tools. The maximum score is 1000 points divided between the different categories of the competition.



STATIC EVENTS

In the Static Events, students must present their vehicle and the development process to renowned juries from the fields of economics, the automotive industry, and prestigious competitions such as Formula 1

-Engineering Design: evaluation of the technical aspects, construction and main features of the car.

-Cost & Manufacturing: financial planning of the entire car, including manufacturing.

-Business Plan Presentation: persuade a potential investor of a profitable business idea involving the race car developed by the team.

Dynamic Events demonstrate the performance of the prototypes. Each discipline puts different vehicle skills to the test

-Acceleration: acceleration race over 75m.

-Skid Pad: test race of the car's lateral acceleration.

-Autocross: fastest lap time around a track.

-Endurance & Efficiency: an endurance race over 22km distance.

DYNAMIC EVENTS

WHAT WE DO?

AS STUDENTS, WE HAVE THE CHALLENGING TASK OF BEING RESPONSIBLE FOR ALL PHASES OF THE DEVELOPMENT OF A PROTOTYPE FORMULA CAR.

The team's shared vision is that we should all contribute to building a more sustainable future. More specifically, as a Formula Student team, we aim to develop the interest of our students and everyone involved in electric vehicles, enabling us to push forward their development.

That said, the Formula Student of the Faculty of Engineering of Porto will be a continuity project in which the betting prototypes will be in the electric class (EV) and in the future in the class of autonomous vehicles (DV)

OUR RESPONSIBILITY WITH THE PROTOPYTPE	**CONCEPTUALIZATION DESIGN MANUFACTURING TESTING**

Besides the engineering responsabilities of the project, the has also the responsability of managing itself and gathering support and partners in order to produce the formula car and to compete internationaly

2021/2022 SEASON

1ST PLACE CONCEPT CLASS UK

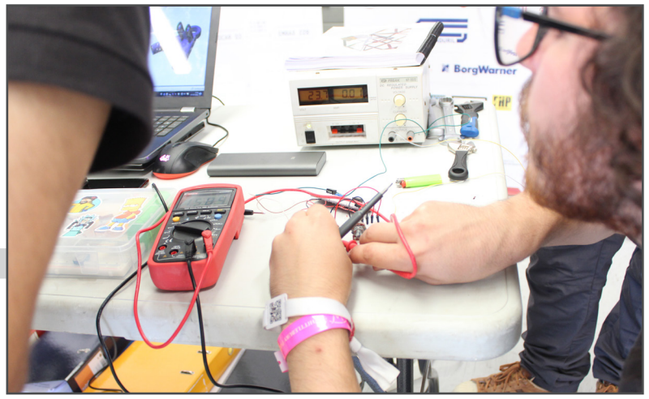
From a total of 400 points, we managed to achieve 343.86 points which guaranteed not only the 1st place in the Concept Class, but also the trophy in the Engineering Design event, competing against 33 other teams!

Our team debuted in the best way possible in the Formula Student UK 2022 competition, which took place at Silverstone circuit, winning 1st place in the Concept Class.

The juries of the car competition evaluated our Business Plan; the Cost & Manufacturing, which consists in describing the entire manufacturing process of the car taking into account variables such as cost / manufacturing time; the Design, where a technical description of the car is made, and the Lap Time Simulation Event.

After the victory at Silverstone circuit of the F1 international circuit, the team headed to the north of Italy to compete in the Formula SAE Italy championship.

Competing, also, in the Concept Class, where Business Plan, Cost & Manufacturing and Design were evaluated, the team achieved an honorable 2nd place, obtaining 303.028 points, only 16.532 points behind the winning team.



TESLA

Battery Sponsorship 2023
for Formula Student teams

Already at the end of the year this team was chosen as one of the recipients of the worldwide challenge Tesla issued to Formula Student teams, and is now a recipient of Tesla's "Formula Student Battery Sponsorship 2023".

RECRUITMENT

FSFEUP recruitment for the year 2022/2023 was a success, with a higher than expected student participation.

The number of desired new members was variable depending on the needs and expected workload of each department and on the number of final year members that left FSFEUP.

The interviews were conducted by the various department leaders and team leaders, over the course of a week, and then the candidates whose profiles best matched the selected departments were selected.

After being selected, the candidates became recruits and started a rotation period over 6 weeks.

THIS RECRUITMENT ALSO ALLOWED TO SELECT MEMBERS FOR FS-AI, THE NEW FSFEUP SUB-TEAM CREATED WITH THE OBJECTIVE TO DEVELOP AUTONOMOUS DRIVING TO PARTICIPATE IN THE FS UK DRIVERLESS COMPETITION.

FSFEUP DRIVERLESS

Initially about 250 students showed interest in participating in the recruitment process. This began with the registration and participation in one of the 2 mandatory information sessions, which aimed to clarify possible doubts, present the purposes and objectives of the team as well as what is expected from a member of FSFEUP.

The second step of the process involved filling in an application form in which candidates exposed their interest, motivation and experiences, the value they bring to the team, their CV and also short motivational videos.
From this stage, 62 candidates were selected to continue the recruitment process with individual interviews.

During this period, all FSFEUP's departments were presented, and small continuous tasks were performed about what was presented.This more in-depth training allowed that at the end of the 6 weeks, the members were now integrated as effective, in their respective departments, to start their work.

This recruitment model was very fruitful, not only for the recruits that could have an overview of the team and how each department fits in the ideal functioning, but also for the leaders that had the opportunity to evaluate in a more individual way the candidate's profile before becoming an integrant member of the team.

FST ALUMNI VISIT TO FS FEUP

Last October 29th, we had the pleasure of welcoming in our college a group of FST Alumni from Lisbon's Instituto Superior Técnico, a group that, it should be noted, already has many years of experience, making this opportunity absolutely unique.

First, we must highlight all the time spent by all the students, who dedicated an entire day of their lives to this exchange of knowledge. During the day, a design review was conducted that covered every point of our car with the utmost attention in order to cultivate critical thinking and to denote any problems that might have gone unnoticed until now.

This was followed by explanatory sessions by the knowledgeable ex-members of FST, in which we were given advice and insights of high interest for our progress on the project both from a technical and personal point of view.

Feedback from the more experienced students covered, for example, components and parts of the design that they felt might be problematic in competition and ideas for optimizing them were given, and ideas and opinions were shared about the process of participating actively in Formula Student events around the world, so that the team ended up with a clearer vision of what they can do in 2023 and are already on track for future international competitions.

VISIT TO BORGWARNER

Last December 13, FS FEUP went to visit BorgWarner's facilities in Viana do Castelo. The day started with a presentation in which were presented the various sectors in which BorgWarner operates, particularly in the area of electrification and energy solutions, topics of high relevance to our project.

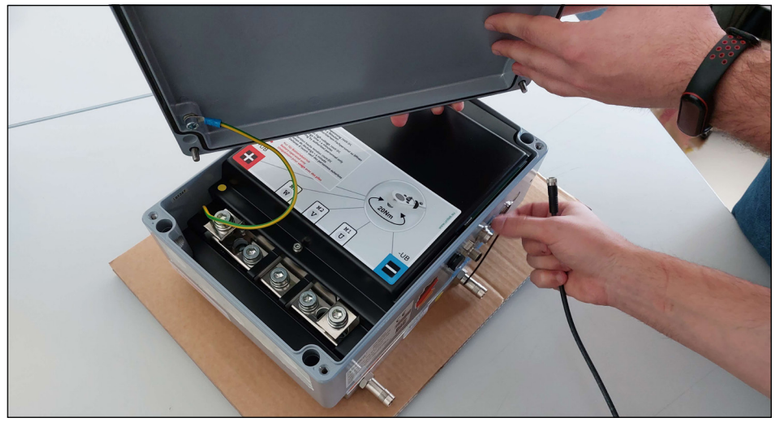
Following this presentation, we were given a tour of the facility where we got to see the various technologies used during the controller production processes, as well as the testing and validation processes. In addition, the team gained knowledge directly from professionals in the field and had the opportunity to talk with them, this chance was invaluable for our progress as a team.

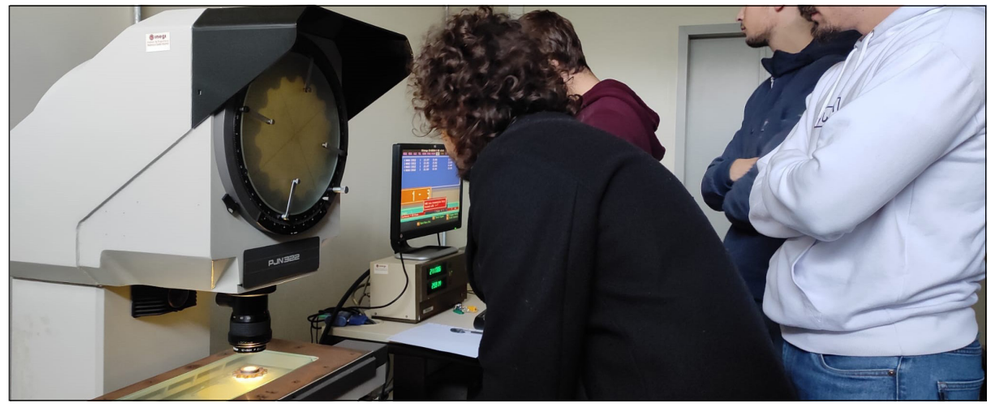
Through this visit, the entire group has increased their knowledge in the area of electric vehicles and can broaden their understanding of the amount of investment and research that goes into this sector.

KEY DESIGN FEATURES OF OUR 2022/23 CAR

Being a first-year team, simplicity, low cost, medium performance and reliability were the main design goals. These core objectives were expressed in all conceptual and design choices for the vehicle. Our performance goals are to pass intense scrutiny and finish all dynamic events, focusing on the most demanding event, endurance.

The design was based on a tubular steel frame and the team also decided from the beginning that the first design would include a fiberglass composite body without any form of advanced aero package (wings, undertray, etc.) as it would only divert attention from understanding how the suspension works. As for the latter, we opted for a converging arm and uneven, double wishbone suspension system with a front and rear stem and air damper configuration. The prototype will have a DTR motor with chain drive and tension eccentric, as this is the simplest and cheapest option. To transmit the power to the wheels, an adjustable Drexler limited-slip differential and two fabricated steel half-shafts are used on an adaptability basis, resulting in an expected transmission efficiency of 85%.

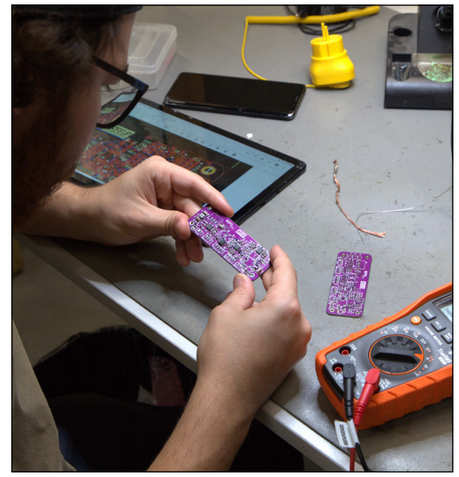




Having chosen a single RWD motor system, a crucial design priority was the powertrain and drivetrain packaging and engagement. The engine chosen was the Emrax 228, liquid-cooled, medium voltage. This motor has a high-power density, being as close as possible to the maximum allowable 80 [kW] and 600 [VDC] indicated by the rules, and is available at our university facility, allowing us to perform validation on the cooling system.

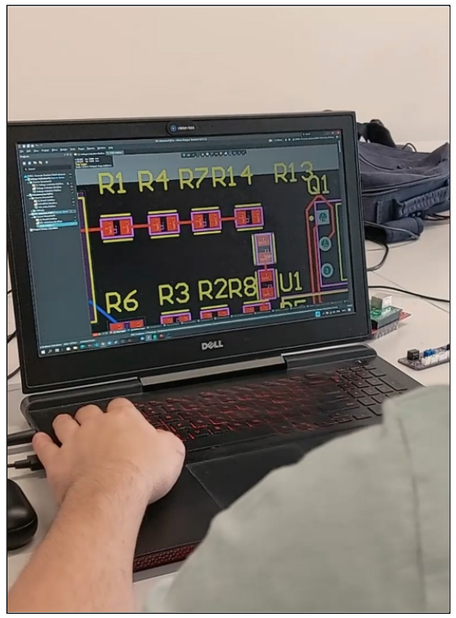
For the cooling system, the motor and controller rely on water-based cooling, with two side mounted radiators and two small pumps in series. To control and reverse the DC to AC power, we followed the manufacturer's recommendation due to compatibility with the motor as well as the extensive documentation on the Unitek Bamocar D3 700-400 sensor.

After defining the conceptual choices and choosing the various subsystems, we proceeded with the development of a mass of lap time simulation points, a quasi-steady model to achieve the final gear ratio and a compromise between lap time and power required per lap. As a result of the teams' initial objectives, the results of the endurance event were prioritized. Our final gear ratio is 4:1 and the values for current were an average of 76.3 [A], with a maximum of 172 [A] for 3 seconds and an average power of 33 [kW].



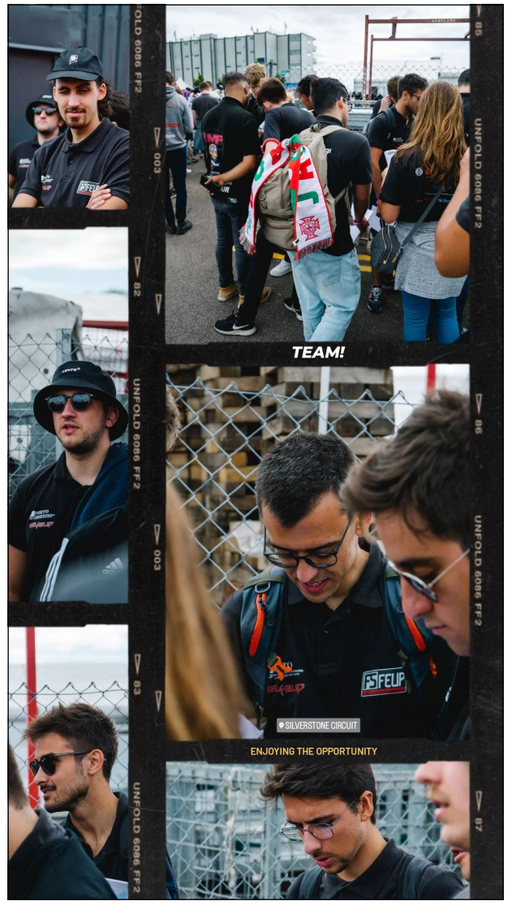
This allowed us to select the most suitable high voltage wiring to support the maximum peak current extracted from the instantaneous current graphs without reaching the critical operating temperature point. The second step was to find the cell that would best meet our needs. To do this, a scoring system was used. To implement this system, we created a database of over a thousand cell models that take into consideration aspects such as cell shell, internal resistance, volume, weight, power density, and ease of assembly.

The next phase was to normalize the data and collect our figure of merit that led us to Enepaq's Li1x6pVTC6 modules. This cylindrical cell has robust thermal management, high mechanical stability and easy assembly with a building block system.



Finally, our accumulator configuration was chosen to be 120s6p, with 120 modules from Enepaq equally divided into 6 segments that, when combined, give us a nominal voltage of 432 [V] and an expected efficiency of 94%. With the accumulator configuration, the AMS chosen was the Orion BMS2 with a centralized topology that performs monitoring, evaluation, CAN bus communication, balancing, protection, and has excellent documentation available. In the end, our accumulator capacity is 7.8 [kWh] counting on the air-cooling system, ensuring that the cells do not exceed 60 [ºC].

WHAT´S NEXT?



Right now, the team's focus is divided into several areas that are important for the 2023 competitions.

Firstly, training for the competition selection quizzes, which guarantee the entry or not of the team in the desired competitions. The goal for this year is the participation in 2 international competitions and also the debut of Formula Student Portugal with foreign teams.

In terms of manufacturing there are already advances in welding the chassis and in the main subsystems that require machining, with some of these processes being provided by our sponsors. The expected planning guarantees a finalization of the car assembly next April, with 2 months of testing before the beginning of this summer's competitions.

END.

FSFEUP

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