SHEFFIELD FORMULA RACING

FEBRUARY NEWSLETTER

CO-WRITTEN BY GEORGE POULTER & ASHLEY DAVISON

OUR HISTORY

SFR01 (2009/10)

Final Position 62/76

Building a working car is a great achievement for any first-year team. We managed to pass scrutineering and compete in a dynamic event - marking the first of many great success stories. We gained a lot of valuable experience for the team seeing the competition first hand on track.

Skidpad	DNA	**Engineering Design**	58th
Acceleration	DNA	**Cost**	30th
Sprint	35th	**Business**	53rd
Efficiency	DNA		
Endurance	DNA		

SFR02 (2010/11)

Final Position 38/79

Building on our first-year car, we built a much improved car. It modelled one of the most outrageous liveries to ever appear in the Formula Student paddock. Component failure caused some problems but we did manage to compete in the endurance event. Unfortunately though, we did spin out due to changing track condition. Testing later showed that this car could have easily completed the event had we stayed on track.

Skidpad	DNA	**Engineering Design**	29th
Acceleration	DNA	**Cost**	4th
Sprint	DNA	**Business**	14th
Efficiency	DNF		
Endurance	DNF		

SFR03 (2011/12)

Final Position 37/102

The car was good, however packaging issues resulted in overheating the electronics. A faulty fuel tank breather compromised the car performance. We performed very well in static events.

Skidpad	33rd	**Engineering Design**	36th
Acceleration	37th	**Cost**	5th
Sprint	DNA	**Business**	18th
Efficiency	DNF		
Endurance	DNF		

SFR04 (2012/13)

Final Position 59/90

In many aspects, the design was improved. However, a differential mount stiffness issue caused the car to lose drive in dynamic events.

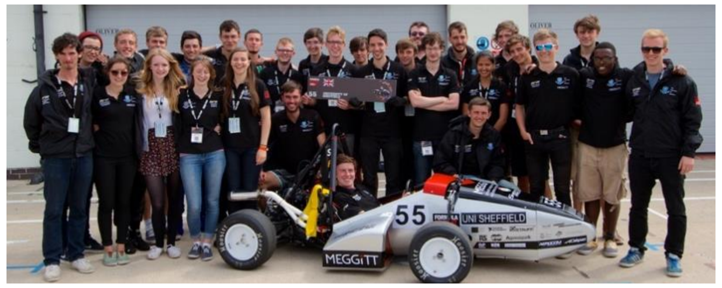
Skidpad	DNA	**Engineering Design**	50th
Acceleration	DNA	**Cost**	40th
Sprint	DNA	**Business**	75th
Efficiency	DNF		
Endurance	DNF		

SFR05 (2013/14)

Final Position 41/97

Fundamentally, a much improved car. The team switched to a single-cylinder KTM 500cc engine. Previously a four-cylinder Husqvarna engine had been used which was far larger and heavier. The team passed scrutineering in a record breaking time but a chain failure curtailed our run in the endurance event.

Skidpad	33rd	**Engineering Design**	40th
Acceleration	40th	**Cost**	12th
Sprint	39th	**Business**	30th
Efficiency	DNF		
Endurance	DNF		

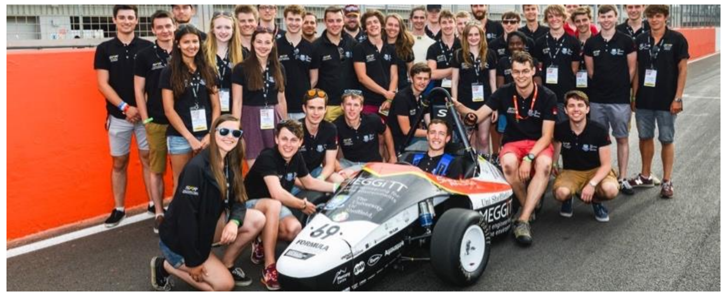


SFR06 (2014/15)

Final Position 46/96

The car was technologically superior to SFR05, featuring advanced manufacturing techniques which were unique to the grid. However, scrutineering was problematic and we were unable to attend all of the dynamic events. The car was a steep learning curve but gave us a strong platform for the 2015/16 season.

Skidpad	DNA	**Engineering Design**	44th
Acceleration	DNA	**Cost**	10th
Sprint	DNA	**Business**	51st
Efficiency	DNF		
Endurance	DNF		



SFR07 (2015/16)

Final Position 59/108

Undeniably the faster and most-advanced car to date. Had SFR07 had the reliability, it would have provided us with our highest position and surpassing most other UK teams in the process. Again, scrutineering held us back from attending all of the dynamic events.

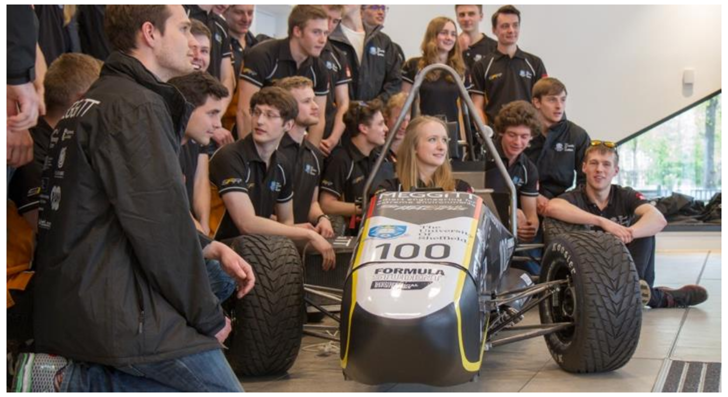
Skidpad	DNA	**Engineering Design**	50th
Acceleration	DNA	**Cost**	57th
Sprint	47th	**Business**	26th
Efficiency	DNF		
Endurance	DNF		

SFR08 (2016/17)

Final Position 20/63

The best result the team had achieved yet. The team also won GKN's lightest car award as well as best costing report. 2017 marked the first ever 1st place in a FSUK event.

Skidpad	22nd	**Engineering Design**	23rd
Acceleration	DNA	**Cost**	1st
Sprint	8th	**Business**	12th
Efficiency	DNF		
Endurance	DNF		



OUR HISTORY

SFR09 (2017/18)

Final Position 5/81

The best overall position for the team has ever placed up to the present date, including coming 2nd out of all UK teams. We continued with the light-weight philosophy coming in at a mere 158kg. This was the first year we completed every dynamic evet, whilst also achieving the most efficient internal combustion engine.

Skidpad	12th	**Engineering Design**	12th
Acceleration	17th	**Cost**	19th
Sprint	15th	**Business**	13th
Efficiency	4th		
Endurance	5th		

SFR10 (2018/19)

Final Position 14/81

A great, but unlucky year for SFR. This car was the most innovative we have ever had before, including a decoupled suspension and aerodynamic package. Throughout the weekend SFR10 was looking to finish in the top 5 again, but due to a suspension failure, we did not complete the endurance event. Once the parts were replaced, SFR10 went back out with courage to complete the remaining laps. However, we picked up two punctures on the out-lap, leading to a DNF. The result was unlucky, but the car was sensational.

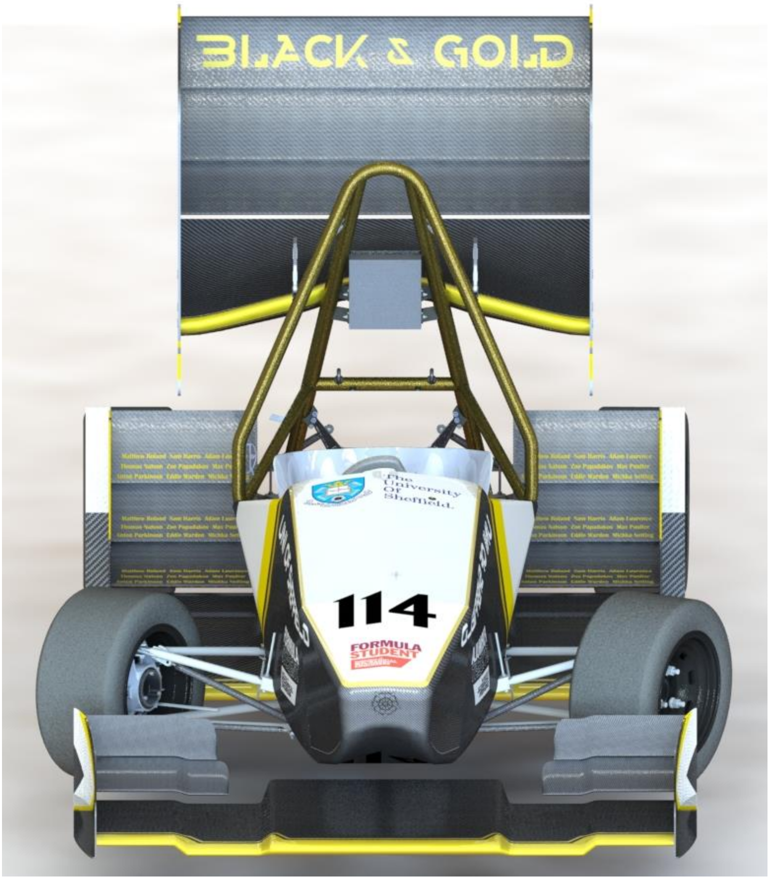
Skidpad	9th	**Engineering Design**	14th
Acceleration	15th	**Cost**	8th
Sprint	7th	**Business**	
Efficiency	DNF		
Endurance	DNF		

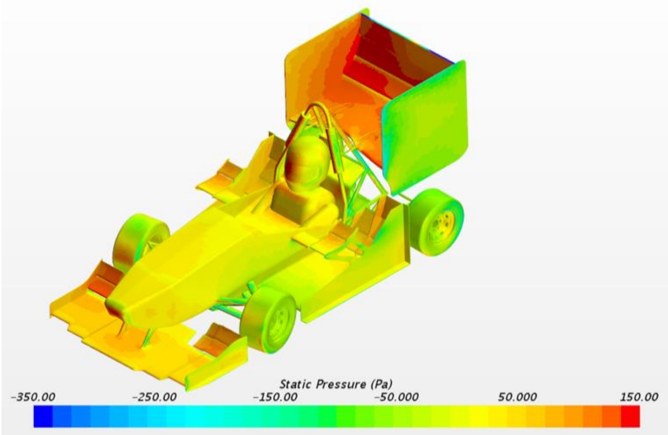
SFR11 (2019/20)

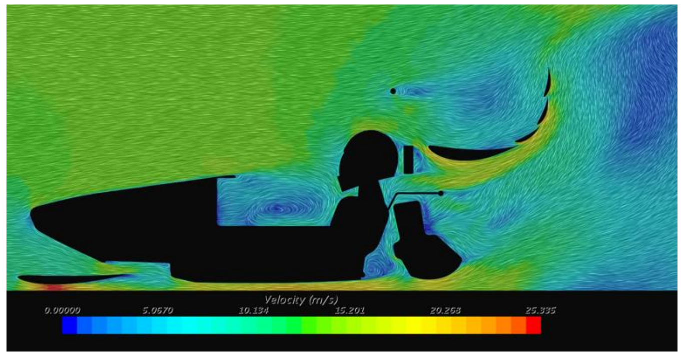
Final Position 14/34 (Dynamic) 9/66 (Static)

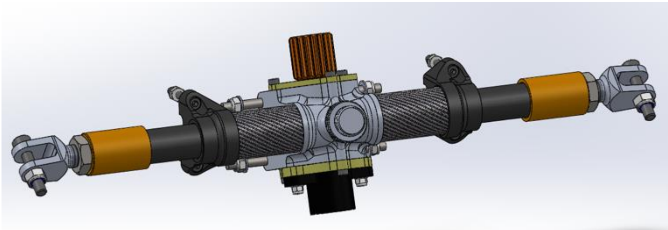
Sadly, in person competitions were cancelled due to the COVID-19 pandemic. SFR was lucky enough to compete virtually - showcasing some of the incredible development that had gone on behind the scenes and taking home a respectful 9th and 14th position finish. The car continued to improve in all areas.

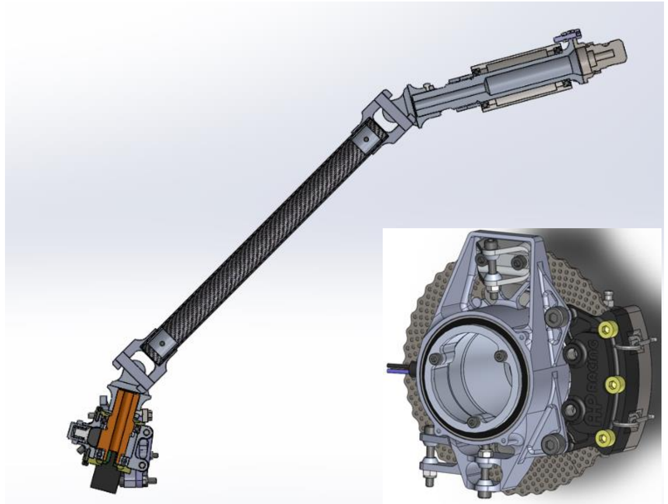
Skidpad	9th	**Engineering Design**	13th
Acceleration	DQ	**Cost**	15th
Sprint	11th	**Business**	14th
Efficiency	8th		
Endurance	20th		











TECHNICAL INSIGHT

LAP TIME SIMULATION

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LAP TIME SIMULATION

What is lap time simulation?

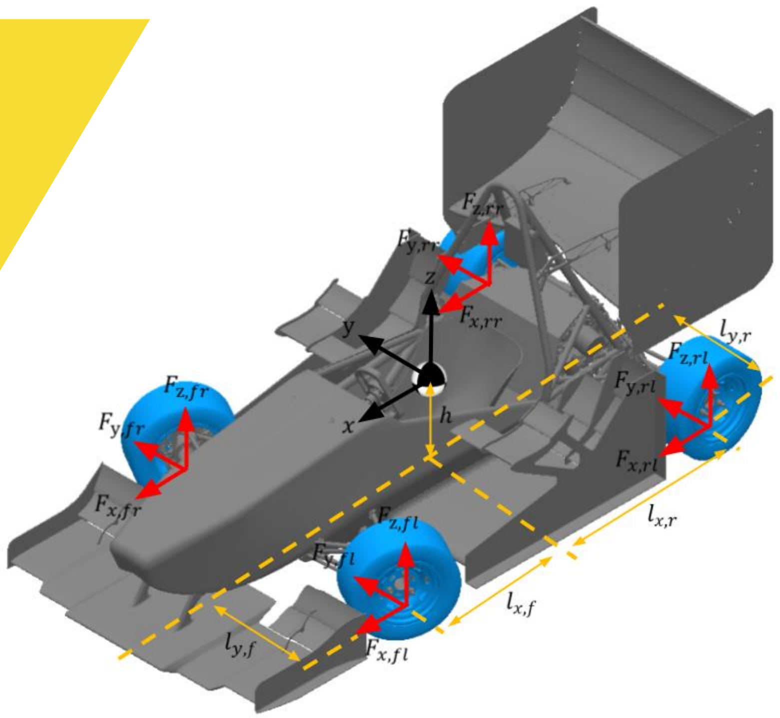
Lap time simulation (LTS) is a vital tool used throughout the automotive and motorsport industry. A number of virtual studies can be conducted that predict the vehicle's handling and performance characteristics. LTS needs to perform three main functions:

1. Accurately model the dynamic behaviour of the vehicle
2. Accurately predict lap times
3. Produce results rapidly to allow many different vehicle configurations to be examined.

So why should you use it?

There are many reasons that LTS should be a fully pledged aspect of race car design. Some of these include:

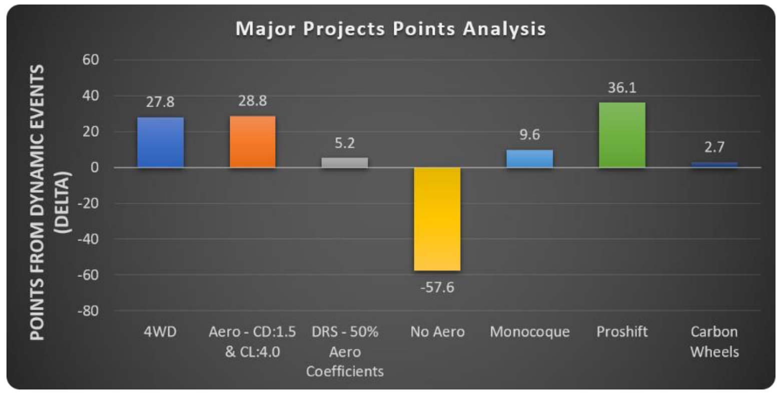
- Simulation provides detailed information about the vehicle performance. Much of this information can be difficult to determine from test rigs or track data e.g. tyre loads in all 6 degrees of freedom.
- Simulation improves the fundamental understanding of vehicle behaviour and its physical mechanisms. These can then be studied in detail and optimised in the simulation environment e.g. parameter sensitivity study of centre of gravity (COG).
- Simulation can identify undesirable design options early in the development process, significantly reducing design iterations and eliminating unnecessary physical testing e.g. concept level design choice of two vs four-wheel drive.
- Simulation allows the study of interactions between important vehicle parameters or subsystems. This is nearly impossible to do experimentally e.g. the best trade-off between downforce vs drag.
- Simulation is very cost effective. Evaluating vehicle components and design changes on a computer is much cheaper and quicker than hardware testing.

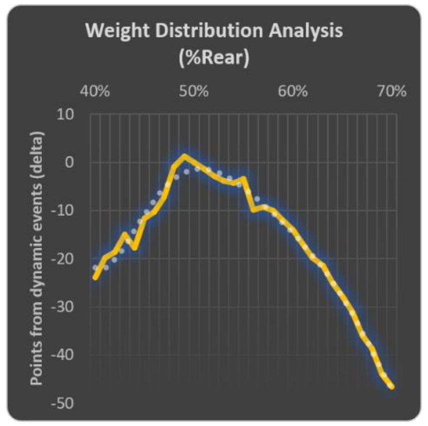


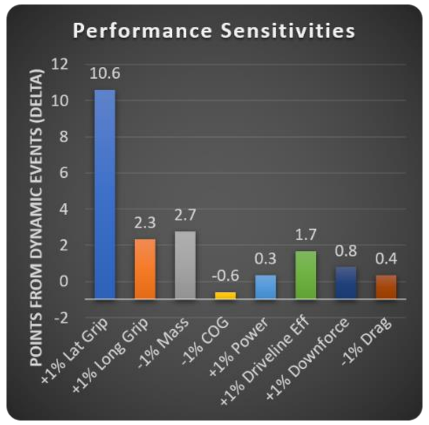
SFR's tools

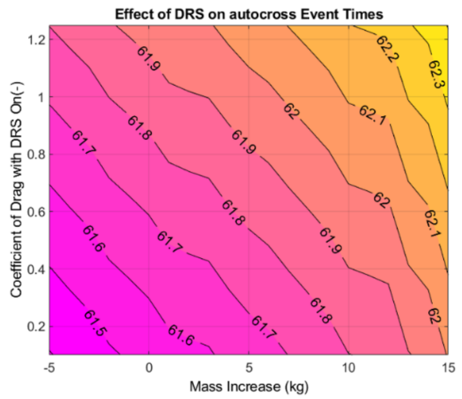
SFR has only relatively recently begun exploiting the benefits of LTS as part of the formal design process. Our first purpose-built tool was developed by our 2019 Technical Director, Matt Brown as part of his MEng final year project. Matt is now working with Williams Formula One as a design engineer. Matt introduced two different programmes: a quasi-steady state point mass; and a more sophisticated transient tool based on optimum control theory. Both of these LTS were written in MATLAB and used extensively in SFR10, 11, 11B and our future development programmes.

Our 2020 Vehicle Dynamics leader, Max Poulter has taken over leading LTS and is currently working on a Simulink transient model that will hopefully make the tool more accessible for all team members and allow easier development in future years to come. The programme will include a more detailed vehicle model allowing us to analyse a greater number of systems such as the brakes, steering and chassis.









Interpreting the results

LTS results need to be taken with a "pinch of salt". Many studies neglect the presence of a real driver which can lead to excessively quick and misleading lap times. e.g. LTS typically is on the limit of the tyres whereas a real driver either under or overestimates the potential grip and has to react constantly; remember tyres are very non-linear and influenced by a huge amount of parameters in reality.

How do we use LTS?

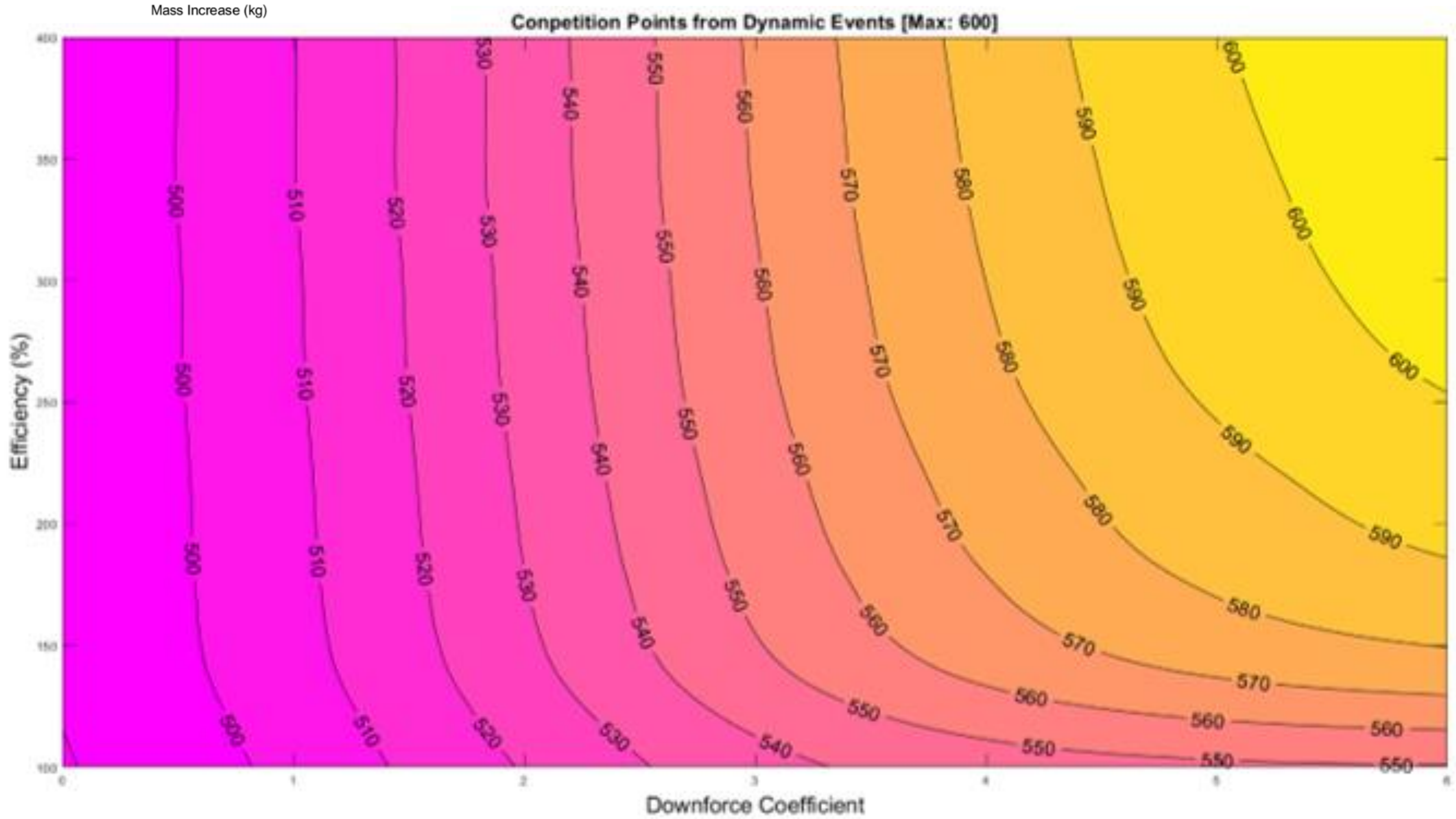
To start with, Formula Student comprises five dynamic events: skid pad, acceleration, sprint, endurance and efficiency. It is therefore crucial to analyse the vehicle parameter across each event; not just the raw speed in sprint. We study the vehicle across all the events and then convert the lap time into a point based system, by comparing against competitor times at previous competitions. This gives us a "net" dynamic events score.

We use this method in the early stages of our design to evaluate the best cost vs performance gains so that we can focus our limited team resources. The major projects points analysis plot helped us determine which projects to undergo for SFR11.

Aerodynamics

One of the key benefits of LTS is being able to analyse coupling of parameters. Two common ones we consider are downforce vs drag that our aerodynamic package produces. As the two are heavily connected, our engineers must consider that adding downforce does not necessarily mean the car will go quicker. It must be done efficiently!

One study that was performed last year was adding DRS. At first glance this appeared a great performance addition. However, the mass that adds must also be considered.

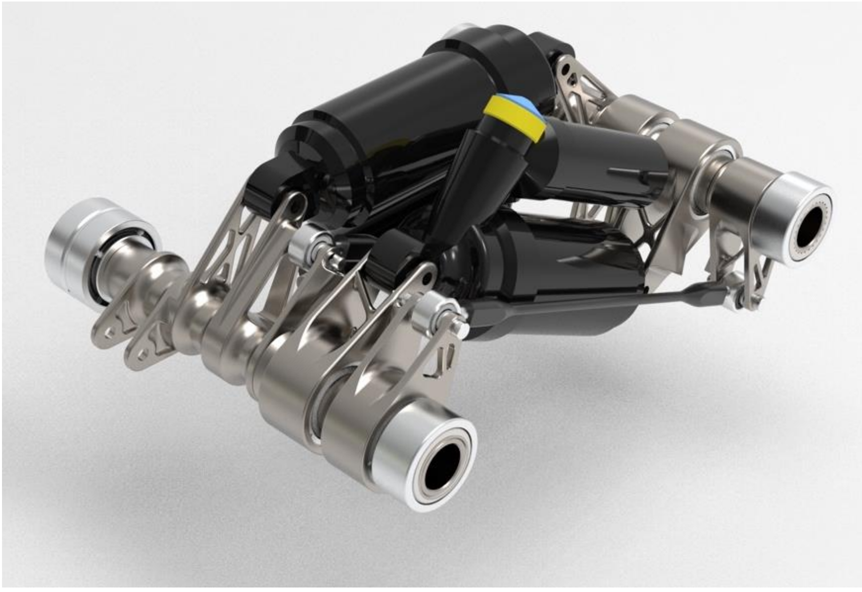


SPONSOR ARTICLE

AGEMASPARK

AGEMASPARK
INNOVATION IN ENGINEERING

Agemaspark are a Doncaster - based engineering company that offer multi – disciplined precision machining for metallic components. Agemaspark have been a proud sponsor of Sheffield Formula Racing since 2019 and have contributed towards metallic components that require high precision manufacturing, such as the driveshaft, rack and pinion, bellcranks, splines, CV housings and a variety of steering components. The image on the right shows the final CAD render of SFR10's inboard suspension, which Agemaspark had a large contribution to the manufacturing process.



Their up – to – date manufacturing plant includes a range of manufacturing machinery, including milling machines, EDM (Electrical Discharge Machining) and CMM (Coordinate Measuring Machinery). Agemaspark work within many engineering sectors, including the aerospace industry, power generation and mould making, working with the likes of Siemens and Rolls Royce. Our M3 threads and splines were manufactured using EDM.

Additive manufacturing technology has been a recent investment for Agemaspark, therefore Sheffield Formula Racing look forward to working towards designing more complex components that have the advantage of geometric freedom. The image on the right displays SFR10's bellcrank, which was additive manufactured from titanium. Agemaspark rapidly turned, milled and bored the parts before spark eroding the M3 threads and spline geometry to an exceptional tolerance.

ALUMNI ARTICLE

Aidan joined the University of Sheffield in 2015. He was already a keen motorsport and engineering enthusiast having racing karts as a child. Aidan told us "joining Formula Student was like the next level from that, and I really wanted to get involved".

Aidan has been one of our most enthusiastic students we've had on the team. He has held a variety of roles including being an engineer with Chassis and Vehicle Dynamics sub-team during his first, second and third years of study. He was also responsible for liaising with our sponsors in 2017. He then spent a year working with Williams Formula One as a design engineer, before returning with more expertise and taking on our Technical Director role for SFR11. Aidan has also been in our driver line up throughout his degree and has been fundamental in the success of the team in recent years.

When asked what skills Aidan developed whilst being on the team, he expressed "teamwork - definitely. Making a new car every year as group of undergraduate students (alongside full-time degrees) is only achievable through good teamwork". Aidan was always keen to learn from experienced members of the team, whilst also taking his own time to teach and help young members meet our tight deadlines. Above this, Aidan also believes Formula Student has proved he can project manage and communicate effectively.

Aidan graduated in 2020, where he started as a Mechanical Engineer at ATM Automation, who design and assembly various automated manufacturing and built-assist assembly lines. During the pandemic he has been working on a PPE mask production line.

AIDAN CHARITY

COURSE:
MEng Mechanical Engineering

DATE JOINED:
November 2015

ROLES HELD:
Chassis and Vehicle Dynamics Engineer (2015-2018), Sponsorship liaison (2017-2018), Technical Director (2019-2020)

CURRENT POSITION:
Graduate Mechanical Engineer – ATM Automation

"Apart from the mechanical engineering degree, SFR was the main reason why I got a year-in-industry at Williams F1, and then SFR and the year in industry where the main reasons I got my graduate job.

Formula Student gives you so much opportunity to build your engineering experiences outside of the scope of the University course, which really helps prepare you better for those interviews and job applications."

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