Vehicle Dynamics

Week 1 - Introduction

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University of Strathclyde Motorsport

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Vehicle Dynamics is the study of how a vehicle moves.

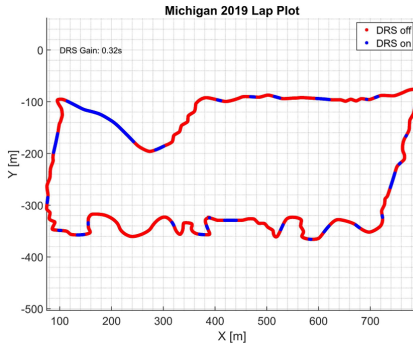In USM, we are responsible for anything related to performance:

- Laptime simulation
- Testing planning and execution
- Driver development
- Data analysis
- Engineering Challenge
- Laptime Simulation Event

Semester 1 Teaching Schedule

Week	Date	Topic
Week 2	30/09/2025	System introduction
Week 3	06/10/2025	Velocity-Acceleration plot
Week 4	13/10/2025	GG plot
Week 5	20/10/2025	Introduction to laptime simulation
Week 6	27/10/2025	Load transfer
Week 7	03/11/2025	GGV plot
Week 8	10/11/2025	Tyres
Week 9	17/11/2025	Advanced laptime simulation
Week 10	24/11/2025	Advanced tyres

Michigan 2019 Lap Plot

Laptime simulation can answer questions like: is it worth it to use DRS? What is the optimal final drive ratio? Should aero focus on increasing lift or decreasing drag? **Questions about the track**.

Lapsims

Existing Simulations:

- **OpenLAP:** Open-source point mass laptime simulation
- **Bailey's Lapsim:** Custom lapsim with better tyre model
- **Murray's Lapsim:** Four corner lapsim with better features

Problems:

- Doesn't model electric powertrain accurately
- Not accessible for wider team to use (complex to install)
- Code is difficult to maintain or add new features

The Vision

Oliver's Lapsim: New lapsim with transient powertrain simulation, written in Python, documented

OTHER PROJECTS

Driver-in-the-Loop Simulation: Setting up a real-time simulation using IPG software so that we can simulate driving the USM car. Our drivers could do virtual "test laps" with different setups.

Engineering Challenge / Sim Series: A series of scenarios where you act as race engineers and test drivers to tune the setup and performance of a car (begins November).

Testing Planning: Creating a schedule for pre-season testing. Deciding what data we would like, and how we can measure it. Tuning the car (springs/dampers, ride heights, tyre pressure, etc.)
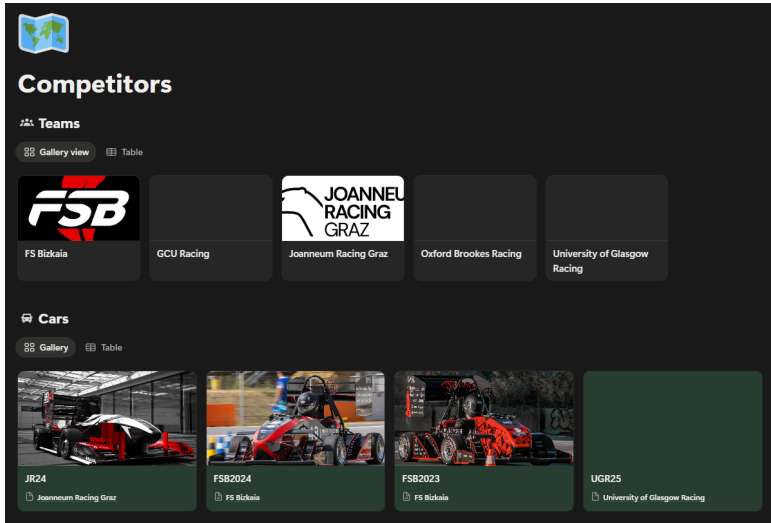
You are starting a brand new Formula Student team, and you want to know which parameters are most important for performance. You decide to carry out a study of your competitors.

1. Create a database of competitors, with stats about their cars
2. Look at how well each car performed at competition
3. Analyse which stats have the biggest impact on performance

You should look at fuel type, chassis construction, curb mass, maximum power, wheelbase, front and rear track width, aerodynamic package, suspension, and tyres.

1. Create a database of competitors, with stats about their cars

2. Compare to how well each car performed at competition
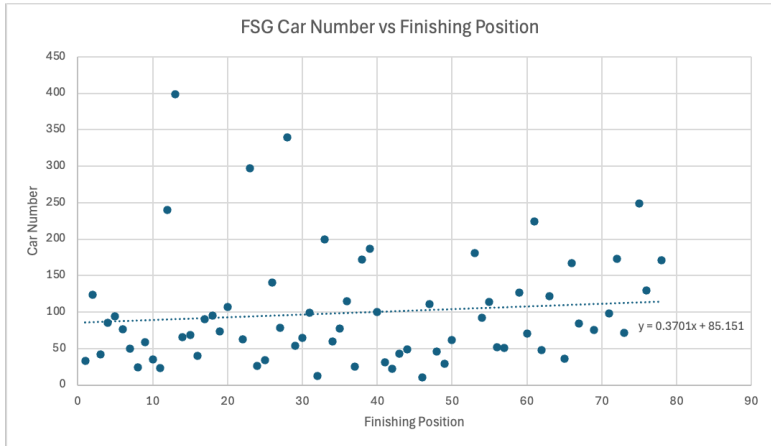
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rank	wrp	cn	university name	team	A
1	720,31	NZ	University of Auckland	--	A
2	718,93	JP	Nagoya University	--	A
3	715,85	AT	Fachhochschule Joanneum Graz	FSG	A
4	709,35	DE	Westsächsische Hochschule Zwickau	FSG	A
5	665,89	CA	École de Technologie Superieure	FSG	A
6	641,86	US	Carnegie Mellon University	FSG	A
7	638,46	US	Rochester Institute of Technology	--	A
8	624,61	DE	Universität Stuttgart	FSG	A
9	615,54	AU	University of Wollongong	--	A
10	602,65	EE	Tallinn TU UAS	FSG	A
11	584,26	AU	Monash University	--	A
12	546,48	CA	École Polytechnique de Montréal	--	A
13	535,35	HU	Budapest University of Technology and Economics	FSG	A
14	531,03	CZ	Czech Technical University in Prague	FSG	A
15	526,97	IN	Pimpri Chinchwad College Of Engineering	FSG	A
16	519,51	US	Georgia Institute of Technology	--	A
17	515,82	US	Virginia Polytechnic Institute and State University	--	A
18	514,24	AU	Swinburne University of Technology	FSG	A
19	504,99	US	University of Washington	--	A
20	504,77	US	University of Texas at Arlington	FSG	A
21	503,66	TW	National Tsing Hua University	--	A
22	497,69	AT	Technische Universität Wien	FSG	A
23	492,24	DE	Duale Hochschule Baden-Württemberg Stuttgart	FSG	A
24	485,07	CN	Tongji University	FSG	A
25	473,96	CA	University of Toronto	--	A
26	466,67	IN	Smt. Kashibai Navale College of Engineering	FSG	A
27	462,01	AU	The University of Newcastle	--	A
28	461,74	NL	Technische Universiteit Eindhoven	FSG	A
29	460,74	AU	University of Adelaide	--	A
30	452,88	GB	University of Strathclyde	FSG	A
31	452,23	DE	Rheinisch-Westfälische Technische Hochschule Aachen	FSG	A
32	446,66	GB	Oxford Brookes University	FSG	A

Overall Results
Formula Student United Kingdom 2023

City/Univ	place	cost	bp	ed	acc	sp	autox	endu	eff	pen	total
Modena UNIMORE	1.	6.	55.	2.	1.	2.	2.	1.	6.	13	835
Staffordshire U	2.	25.	4.	28.	3.	5.	7.	2.	7.	11	719
Oxford Brookes U	3.	15.	1.	1.	2.	1.	5.	12.	4.	18	700
Glasgow U Strath	4.	6.	10.	13.	4.	4.	6.	2.		14	638
Coventry U	5.	27.	27.	29.	7.	3.	1.	5.	8.	-10	597
Cardiff U	6.	19.	14.	57.	8.	13.	10.	3.	5.	12	568
Leicester U	7.	32.	31.	42.	10.	9.	9.	4.	9.	10	537
Bristol UWE	8.	4.	54.	20.	5.	3.	10.	10.	4.		453
Sheffield U	9.	11.	10.	19.	12.	8.	8.			-8	382
Vigo U	10.	40.	59.	6.	11.	6.	6.	17.		16	344
Porto U	11.	14.	2.	3.				14.		15	334
Modena UNIMORE	12.	23.	25.	7.	9.	7.		19.		13	332
Magdeburg OvGU	13.	42.	52.	10.				7.	1.	-10	319
Belfast U	14.	9.	13.	7.	14.	12.		8.		-6	315
Glasgow U	15.	7.	11.	3.						20	312
Bilbao EHU	16.	7.	7.	7.						17	304
Wolverhampton U	17.	43.	20.	35.	4.	11.	12.	11.		-10	292
Bath U	18.	1.	36.	27.				9.		9	284
Loughborough U	19.	19.	8.	10.						14	276
Cairo Shams	20.	11.	37.	17.				15.		15	271
Maribor U	21.	36.	38.	13.	6.		13.	16.		-10	256
Karachi NUST	22.	5.	9.	41.						14	254
Hatfield UH	23.	24.	24.	13.						11	252
Birmingham U	24.	27.	28.	13.						2	249
Uxbridge U Brunel	25.	3.	34.	31.						7	249
London QMUL	26.	2.	32.	38.						13	245
Southampton U	27.	19.	14.	32.						15	241
Kristiansand UIA	28.	56.	56.	48.		11.	13.	3.		-10	239
Coventry U Warwick	29.	35.	5.	38.						12	225
Sheffield HU	30.	10.	18.	37.						-1	224
Karlstad U	31.	13.	12.	50.						13	220

3. Analyse which stats have the biggest impact on performance

FSG Car Number vs Finishing Position

y = 0.3701x + 85.151

There is lots of information about different cars on team websites, Instagram, and LinkedIn. If you see something that looks cool or that you don't understand, post it on Discord in the #susposting channel.

Links

- Notion: Competitor database
- FS-World: World rankings of Formula Student teams
- FSUK Event Guide: Stats about cars appearing at FSUK 2025