



Interview with Jonny Jamison,
IPG Automotive UK Ltd.

Simulating Success with Queen's Formula Racing

Jonny is a recent graduate of Queen's Formula Racing (QFR) where he has been involved in various simulation projects for the past two seasons. For his final year project, he used one of the two free licenses offered to QFR to produce a high-fidelity, validated simulation of the previous season's entry which would provide the basis to represent estimations of the team's first fully electric vehicle. He experimented with CarMaker for Simulink and successfully managed to include aspects of machine learning into the simulation, creating a program which successfully produced self-optimised suspension setup. For his work, Jonny received Regional Winner of the Global Undergraduate Awards and 2nd prize in the NAFEMS/IMEchE Outstanding Project award.

What were the goals of your project? What were your greatest challenges?

QFR has had much success with a highly refined internal combustion engine developed over the past 20 years, winning many prizes and achieving high competition finishes. To keep with industry trends and the top-performing FS teams it was decided that the team would move in the direction of a single motor EV. However, with no prior experience and limited development time, this presented the complex issue of component specification. As many EV parts are notoriously expensive we had to ensure that we ordered the right bits on the first attempt, as in-field testing was not an option!

Traditionally, the team had relied upon custom-built simulations produced within MATLAB or Excel. Although these were successful in their application, they took an enormous amount of time to build and were limited in their outputs; they often could only be operated by the person who compiled them. Therefore, utilising a software package complete with user guides, dedicated support and all the simulation deliverables you could possibly require was a complete no-brainer. CarMaker allowed us to model our prototype effortlessly due to the many inbuilt EV architectures that come preloaded, and only limited knowledge was required to represent the battery as the software only required generic specifications – allowing a mechanical engineer such as myself to generate some really useful electrical data.

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How successful were you?

My project more than met its requirements and helped to refine our entry

in ways beyond our expectations! Over the years, QFR had accumulated lots of real-world data regarding their cars. However, this wasn't always fully exploited due to the complexity of integrating it into an in-house produced simulation. CarMaker therefore provided a focal point for other projects, both past and present. Our stockpile of data resulted in a model that was representative to within 5% of reality when validated against competition telemetry.

This base was deemed suitable to simulate our EV entrant by modifying parameters as to be representative of our initial estimations. Through doing so, component specification could be approved, and a competitive analysis could be performed to predict how the car might place at the competition. Using CarMaker and the resultant analyses really helped us to identify areas in which we may have been lacking, many of which would have been impossible to measure via physical testing. An optimised suspension set up was produced which helped alleviate the effects of the heavier electric powertrain, significantly improving the theoretical competition ranking.

What did you find most useful about using CarMaker?

The way in which CarMaker is an out-of-the-box, ready to go simulator was an invaluable quality to have when competing within the fast-paced environment of Formula Student. Not having to dedicate months to building our own solution granted us more time to ensure the quality of our inputs and better analyse our outputs. This really heightened scope for experimentation within the team as multiple component changes could be simulated within minutes, eradicating the need for physical prototypes and their costly design loops. This led to members from every sub-team coming to me to help quantify the performance gains of their

design changes, of which CarMaker was more than capable of doing due to the thousands of channels it measures.

I really enjoyed using the CarMaker for Simulink extension which enables the toolboxes and analysis features of MATLAB to be harnessed in conjunction with the simulation. This added an additional dimension for controller development which QFR used to test a bespoke torque-vectoring system. This functionality also permitted me to integrate a Genetic Algorithm into my project, which autonomously initiated TestRuns and updated parameters to produce the optimal suspension set up. This saved countless hours of manually updating each setting and determining the best out of thousands of potential combinations.

How does your team plan to use CarMaker for future projects?

CarMaker has cemented itself as the platform for all future simulation-based work within QFR and will continue to play a crucial role in development for many more seasons to come. At present, the program is being used to refine various aspects of design with a big focus being placed on battery management. This comes at a crucial period when practical testing has been adversely affected by COVID-19 as the team has limited access to university facilities, requiring development to proceed remotely.

Work is continuing within torque vectoring controllers as the team plans to eventually move towards a 4-motor design. This will make use of the HIL functionality offered by CarMaker and will tie-in with other on-going projects. The team also hopes to have an entry for the FSAI competition within the next few seasons, the sensors for which will be developed through the use of CarMaker's virtual environment.



What would you say to other teams who might be considering using CarMaker?

To any team thinking about using CarMaker within their team, I absolutely recommend adding this software to your toolbox as soon as possible. No matter what stage of development a team may be at, CarMaker serves as a really valuable asset thanks to the example cars provided and allows simulations to be ran without knowing every detail of a vehicle, helping design decisions to be made from the concept stages.

This really helps boost points scored in the static events! The software is really intuitive to use and the team at IPG Automotive were happy to help

whenever I ran into a problem. As the community of users continues to grow with the recent addition of a dedicated forum, it is great to hear what other teams are using the software for and provides much inspiration for future projects!

On a personal level, my project granted me with more experience and insight than I thought possible and has really inspired the direction of my career. As vehicle simulation is an industry that gathers increasing momentum with the development of autonomous

vehicles and sustainability concerns regarding physical testing, I believe that every automotive engineer will require expertise in dynamic simulation in the near future. Already having experience of using a professional software package such as CarMaker will hopefully set me apart from my peers and help me secure a role within automotive simulation.

To claim your free Formula Student CarMaker license, please visit:

<https://ipg-automotive.com/company/research-teaching/formula-carmaker-program/>

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