

## FSG MathWorks Modeling and Simulation Award 2024

<b>Event Name:</b>	FSG MathWorks Modeling and Simulation Award 2024
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### A. Award Overview

The FSG MathWorks Modeling and Simulation Award 2024 is designed to recognize and reward teams that excel in utilizing MathWorks tools for the design of their electric and autonomous vehicles in the Formula Student Germany 2024 competition. The goal is to have each participating team share how they use MathWorks tools and work to adopt industry-grade model-based design. The award determination process consists of two stages: evaluation of a detailed report and assessment of a formal presentation. The teams will be scored on the following criteria: vehicle dynamics; powertrain; control design and tuning; driverless/autonomous systems; verification and validation.

The top three teams that demonstrate the most effective use of MathWorks software will be honored with cash prizes: **3,000 USD** for the first place, **2,500 USD** for the second place, and **1,500 USD** for the third place.

### B. Procedure

- Participation in this competition is free.
- **Stage 1:**
  - The teams will need to submit a document in a PDF format to the organizers by **July 15, 2024, 23:59 CEST**. Only one entry may be submitted by each team. The detail of submission is provided in Section D.
  - All entries will be judged by MathWorks engineers on a 100-point scale. The scoring criteria is provided in Section C.
  - Up to **ten teams** will be selected to participate in Stage 2 of the Competition.
  - The result for Stage 1 will be announced on **August 2, 2024**.
- **Stage 2:** The teams that qualify the **Stage 1** will be invited for a formal presentation and they will need to present their work to the MathWorks judges at the Formula Student Germany event. The chosen teams will receive communication on **August 4, 2024**, to coordinate the scheduling of presentation slots.
- The 1<sup>st</sup>, 2<sup>nd</sup>, and 3<sup>rd</sup> winners will be announced at the Formula Student Germany 2024 award ceremony.
- **Judges' decisions are final.**

### C. Content

Points (out of **100**) will be assigned according to the submitted PDF document, evaluated against the following criteria:

1. Relating overall competition objectives, how has the team applied The MathWorks' tools to the task of:
  - a. **(25 pts) Vehicle Dynamics**
    - i. How were the vehicle dynamics models developed using MATLAB and Simulink?
    - ii. How were the models validated and what level of correlation to real world results was obtained?

- iii. Are the models architected in a way that provides for ease of use, understanding, extensibility and fast execution?

*Example: Suspension system, steering system, tire modeling, longitudinal and lateral vehicle dynamics models, lap time simulation, etc.*

**b. (25 pts) Powertrain**

- i. How were the powertrain models developed using MATLAB and Simulink?
- ii. How were the models validated and what level of correlation to real world results was obtained?
- iii. Are the models architected in a way that provides for ease of use, understanding, extensibility and fast execution?

*Example: Transmission, drivetrain, motor design, motor cooling system, battery modeling, etc.*

**c. (25 pts) Control Design and Tuning**

- i. How were the control models developed using MATLAB and Simulink?
- ii. How were the control models validated and what level of correlation to real world results was obtained?
- iii. Are the models architected in a way that provides for ease of use, understanding, extensibility, and fast execution?

*Example: Traction control, torque vectoring, longitudinal and lateral vehicle control, motor control, drag reduction system, battery management system, thermal management system, etc.*

**d. (10 pts) Driverless/Autonomous Systems**

- i. How was MATLAB and Simulink used to design driverless systems?
- ii. How were the models validated and what level of correlation to real world results was obtained?
- iii. Are the models architected in a way that provides for ease of use, understanding, extensibility and fast execution?

*Example: Perception, sensor fusion, planning, control, etc.*

**e. (5 pts) Verification and Validation**

- i. How does your team verify that your software meets your requirements?
- ii. How does your team validate that your software functions correctly?
- iii. Show how your team tracks and runs test cases for your software.

- 2. **(5 pts)** Plan for next year/ Lessons learnt– what would you do different next time and what is missing from the tools that would have helped you?

- 3. **(5 bonus pts)** Earn an additional 5 bonus points upon successfully completing any one of the projects listed in the MATLAB and Simulink Challenge Projects (<https://github.com/mathworks/MATLAB-Simulink-Challenge-Project-Hub>). Here are some Formula Student relevant projects: 1. *Cone Detection for Formula Student Driverless Competition*: <https://github.com/mathworks/MATLAB-Simulink-Challenge-Project-Hub/tree/main/projects/Cone%20Detection%20for%20Formula%20Student%20Driverless%20Competition>  
2. *Raceline Optimization*: <https://github.com/mathworks/MATLAB-Simulink-Challenge-Project-Hub/tree/main/projects/Path%20Planning%20for%20Autonomous%20Race%20Cars>

**D. Submission**

- Upload the document in PDF format to the FSG website (→ My Team → Competitions → Deadlines).

- Please name your file in the following manner: Car#\_TeamName\_FSG\_MW\_2024\_V#. For example: E01\_TeamFSRacers\_FSG\_MW\_2024\_V1

- To avoid download errors, please submit the document in PDF format.

- The deadline for submission is **July 15, 2024, 23:59 CEST**.

\* The number of pages in the document is not restricted. You also have the choice to include link to short videos in the PDF document to demonstrate the functioning of your model or code.

## E. Reference Materials

Recommended Tutorials:

- MATLAB Onramp: [matlabacademy.mathworks.com/details/matlab-onramp/gettingstarted](https://matlabacademy.mathworks.com/details/matlab-onramp/gettingstarted)
- Simulink Onramp: [matlabacademy.mathworks.com/details/simulink-onramp/simulink](https://matlabacademy.mathworks.com/details/simulink-onramp/simulink)
- Stateflow Onramp: [matlabacademy.mathworks.com/details/stateflow-onramp/stateflow](https://matlabacademy.mathworks.com/details/stateflow-onramp/stateflow)
- Simscape Essentials for Automotive Student Team: [mathworks.com/videos/series/simscape-essentials-for-automotive-student-teams.html](https://mathworks.com/videos/series/simscape-essentials-for-automotive-student-teams.html)
- MATLAB and Simulink Racing Lounge – Improving Your Racecar Development: [mathworks.com/videos/series/improving-your-racecar-development-101027.html](https://mathworks.com/videos/series/improving-your-racecar-development-101027.html)
- Get Started with the Extended Tire Features for Vehicle Dynamics Blockset: [mathworks.com/help/vdynblks/ug/get-started-with-the-extended-tire-features-for-vehicle-dynamics-blockset.html](https://mathworks.com/help/vdynblks/ug/get-started-with-the-extended-tire-features-for-vehicle-dynamics-blockset.html)

Published Videos/Blogs by Teams:

- Formula Student Vehicle Modeling Using Simscape Multibody: [youtu.be/YzCEyr2F3Rw?si=KJYe55RFN4uXUy3f](https://youtu.be/YzCEyr2F3Rw?si=KJYe55RFN4uXUy3f)
- Virtual suspension design processes with McGill Formula Electric: [blogs.mathworks.com/student-lounge/2021/08/27/virtual-suspension-design-processes-with-mcgill-formula-electric/?doing\\_wp\\_cron=1660639858.1010980606079101562500](https://blogs.mathworks.com/student-lounge/2021/08/27/virtual-suspension-design-processes-with-mcgill-formula-electric/?doing_wp_cron=1660639858.1010980606079101562500)
- Lap Time Simulation; Essential Part of Concept Development: [mathworks.com/videos/matlab-and-simulink-racing-lounge-lap-time-simulation-essential-part-of-concept-development-98733.html](https://mathworks.com/videos/matlab-and-simulink-racing-lounge-lap-time-simulation-essential-part-of-concept-development-98733.html)