Formula Student Driverless Concept Award 2016

Formula Student Germany e.V.

January 8, 2016

1 Preface

We believe the time has come to create another Formula Student competition dealing with the future trend in automotive industry: Autonomous Driving. Coping with the last big trend of electromobility, the Formula Student Germany has already very successfully established the Formula Student Electric in 2010. We want to keep on being an innovative and leading event qualifying future experienced engineers, who can solve that challenge. So we start a new contest: the **Formula Student Driverless** (FSD[1]).

But the possibilities for such an event seem to be endless. Therefore, we want to involve the teams in the design phase to get to know on what they want to challenge themselves and how to finally present it at the competition. For the best provided concept we will hand over a special award to the team at the Hockenheim 2016 event.

2 Task description

The 2016 Formula Student Driverless concept award gives teams the possibility to actively participate in designing the future Formula Student Driverless competition. It could also serve as valued preliminary considerations for the development of a real FSD racecar for new teams as well as for established teams wishing to participate in the future FSD contest. In the following we want to give an overview on what the concept award is about. For a future FSD competition, there are some boundaries which are already fixed, but there are many topics that are open for discussion. These specifications should be elaborated upon for the final submission.

2.1 Defined boundaries

1. The vehicle's concept mainly remains the same as for the FSC and FSE event, including the respective rules. That especially means that there must be a cockpit for the driver. Changes to those rules are at some points obviously necessary, but should be kept at a minimum and always need clarification.

[1] You might have noticed that FSD is perfectly fitting between Formula Student Combustion (FSC) and Formula Student Electric (FSE).

2. The teams will be scored on their engineering and presentation skills as well as on the performance of the car on the track (static and dynamic events). A choice that should be made in your concept is whether a safety driver should be included in the car during single dynamic events. Anyhow, the space for a driver must be available.
3. The competition will take place at Hockenheimring. So the known dynamic area and parts of the Grand Prix Course can be used for the dynamic events. By now, a Formula Student track is marked by cones. If you wish to use other track markings or penalty scoring systems, please provide detailed information about it as part of section 2.2.2.

2.2 Mandatory topics for the concept

The main topics for the concept award competition are the following:

- Safety & Security
- Environment and track appearance
- Competition

Each of them is a mandatory section of the final paper. Depending on your concept, the topics may be weighted differently. Either well described, interesting ideas or inadequately elaborated topics may be chosen as deep-dive topic for the presentation in Hockenheim (details see section 3).

2.2.1 Safety & Security

Needless to say that safety is the essential element for Formula Student events. This includes safety while working on the car as well as safety during testing and racing the car, both before and at the event. Describe possible subtopics that have to/could be dealt with related to safety/reliability and possible solutions to ensure safety of a test- or safety-driver, track marshals and visitors in your concept. Just as a hint for your work, we want to mention some key terms: wireless emergency switch (controlled by team and/or race control), redundant actuators, brake-by-wire, steer-by-wire, software development/testing, power supply/failsafe-states, functional safety and more. Finally, this section should also deal with the verifiability of the concepts including discussions about testing/verifying in general as well as for scrutineering.

A less obvious topic regarding automated driving is security. Nowadays a car-to-X communication is a common feature in Formula Student racecars. With a higher grade of automation, those links to the outside world need be secured. Although the Formula Student competitions take place in their own microcosm, it is necessary to use secure communications both to prevent misuse and manipulation of the teams' cars from anyone not authorized on the event site (or even from anywhere in the world) as well as being an integral part of the discipline of automation engineering. That also includes a transparent way of protecting the vehicle from being remote controlled by the own team during dynamic disciplines.

2.2.2 Environment and track appearance

A system with the same capabilities as a human driver in terms of environment recognition and situation understanding in all conceivable situations is still science fiction. Nevertheless, many research projects demonstrate that automated driving is possible under certain conditions. It is up to you to define these conditions. Ask yourself what the participating teams are likely to be capable of, and then design the preconditions so that the competition is challenging yet within the capabilities of a university team. The event rules can define the conditions of the event in nearly all aspects apart from weather. Therefore, think of potential ways of reducing the complexity of situations a car has to handle autonomously (i.e by limiting obstacles on the track or adding additional landmarks to the track). However, do not concentrate on a specific sensor setup as that would limit other teams in the concepts for their cars. Please provide a short description of possible technical solutions that can deal with your environment concept (sensors, computation hardware and software for reliable environment recognition).

2.2.3 Competition

As last mandatory topic the questions “What kind of disciplines (static and dynamic) are appropriate to compare the work of teams?” and “What is the best way to demonstrate the performance of your work?” should be answered.

These questions are where the concept teams should attempt to demonstrate how to compare the autonomous cars to each others (and potentially human-driven cars) in order to ensure fairness and transparency in the competition process. The teams should attempt to do so without unduly limiting creative and innovative solutions in creating the ideal autonomous car by for example restrictions on components or technology. Furthermore, it will be necessary to evaluate the different variants of the static events that are suitable for an autonomous car. These should accentuate the autonomous capabilities in the design event, and substitute the business plan with a comparable benchmark focusing on commercialisation.

For transparency reasons, always make clear why certain rules have to exist and how event scoring takes place.

3 Administrative issues

Finally as for every competition, there are some administrative issues to announce. These concern registration for the award, formalities and dates for the participation in the Formula Student Driverless concept award 2016.

3.1 Design competition rules

- For participation the precondition is that you are a team of students that meet the requirements of FSG 2016[2] rule 3.8. It is not necessary to be a Fisita organization member as claimed in rule 3.7. It is advisable but likewise not necessary to have a Faculty Advisor as stated in rule 3.9. Against FSG 2016 rule 3.5.7, it is allowed to be part of a participating team at either FSC or FSE.
- To apply to the FSD design competition you have to hand in a one side abstract of your concept, followed by max. three pages of graphics (see section 3.3 for submission details)
- We will nominate the best teams to take part at the 2016 competition. Thereby, you are registered to the event. There will be no participation fee!
- These teams have to submit their fully elaborated concept in the style of a scientific paper (maximum 15 pages, including graphics) touching at least one aspect of each of the three mandatory topics mentioned in section 2 at the given deadline.
- Based on your concept, we select an individual deep-dive topic for each team which in this context will be a very interesting aspect of the handed-in paper (hopefully in minor cases, it could also be a very poorly elaborated topic). From that topic, we want to hear some more details that were not published in the paper at the presentation in Hockenheim.
- All registered teams which have submitted their full concept are invited to take part at the event in Hockenheim (limited to 5 representatives). There, your concept including the deep-dive topic has to be presented to an expert jury by your team. This also includes a short question and answer section afterwards.
- The best concept according to the scoring scheme presented in section 3.4 will win the Formula Student Driverless Design Award.
- The event language is English only and the official time is defined as in FSG rules document, section 3.4.

[2] https://www.formulastudent.de/fsc/2016/rules/

- Finally, all submitted ideas and all concepts will influence the final Formula Student Driverless event and rules. So do not hesitate to take part, get familiar with the future topics of automobile industry and be well prepared for the next step of Formula Student!

3.2 Schedule

Januar 08th 2016	Design competition task description (this document) is published
March 07th 2016, 1200 CET	Register for participation by handing in an abstract
March 21st 2016	Participant list will be published
June 13th 2016, 1200 CEST	Hand in the full concept paper
July 18th 2016	Teams will be informed about their individual deep-dive topic
August 09th - 14th 2016	Presentation of paper and deep-dive topic at FSG in front of expert jury
August 14th 2016	FSD conceptional competition award ceremony

3.3 Submissions

Please submit your contributions as pdf documents via email to `FSD2016@formulastudent.de` on time as mentioned in section 3.2. For your documents use the following naming convention:

- For the abstract: `FSD2016_Abstract_COUNTRY-ISO2_CITY_UNIV-ABREVATION.pdf`[3][4]
- For the final paper: `FSD2016_Final_COUNTRY-ISO2_CITY_UNIV-ABREVATION.pdf`

The presentation does not need to be handed in. Please see FSG rules 7.2.3 for details on provided equipment.

3.4 Scoring

The scoring for the FSD concept award 2016 has three parts: submitted concept paper, presentation at the event and results on the deep-dive topic.

The following overview should give transparency on how the award judgement will look like:

- Submitted concept paper (50%):
  - Safety concept (10%)
  - Security concept (10%)
  - Environment and track appearance (20%)
  - Competition (5%)
  - Transparency of the decision process (5%)
- Presentation (30%)
  - design of the submitted paper (5%)
  - presentation skills (20%)
  - presentation media (5%)
- Deep-dive topic (20%):
  - technical expertise (15%)
  - contribution to the concept (5%)

[3] e.g. `FSD2016_Abstract_DE_Braunschweig_TU.pdf`
[4] see `https://en.wikipedia.org/wiki/ISO_3166-1_alpha-2` for details on country codes

3.5 Rules Questions

If you have any questions, feel free to ask. Please follow the procedure as described in FSG rules section 3.2, but use the FSD forum[5] instead of the rules tracker.

Also note that minor changes to this document may be possible! So please recheck from time to time and compare the changelog.

4 Revision History

Revision	Date	Author(s)	Description
1.0.0	January 8, 2016	JG, SH	Initial version

[5] https://www.formulastudent.de/fsg/forums/