Formula Student Design Concept Specification

Guidance Notes for the Design Concept Specification submission

Introduction

The Design Concept Specification (DCS) submission serves three purposes:

- Registers your team's intent to compete in the forthcoming competition year
- Submits a biography to be used in event documentation / the FS website
- Establishes your high-level project targets

The first two items are simple administrative tasks, the third is by far the most important item for your team to consider carefully. These guidance notes focus solely on this element of the DCS submission, how they affect the rest of your Design and Development activity and relate to the Static events at Formula Student.

The Importance of Target Setting

The design, manufacture, testing and operation of a Formula Student vehicle is a complex timebound multi-disciplinary project. The key conceptual decisions you take in the early stages of the project have significant implications on all downstream aspects of your project and should be tailored to suit your chosen Target Market, as well as the experience and capabilities of your team.

The simplest eligible vehicle you can produce will have a steel spaceframe chassis, an internal combustion engine and no aerodynamic package. Any design features over and above this minimum requirement are adding complexity, which will require more resources (budget, design time, manufacture time, assembly time, etc.) and increase the difficulty level of getting to the event with a finished, tested and reliable car.

In the static events the judges will be expecting you to explain the rationale behind your conceptual design choices and high-level targets set out in your DCS submission; demonstrating how you have validated that the vehicle you present meets these targets and explain where and why you have deviated from the original intended specification, including that you understand the positive and/or negative effects of these deviations.

It is perfectly acceptable to explain that your team is operating under certain constraints, e.g. you have a limited budget and an existing pool of 600cc 4-cylinder engines, which incentivises you to choose that powertrain type. What's important is that you explain the knock-on implications of this enforced design choice and what you would have done differently in a non-resource limited scenario.

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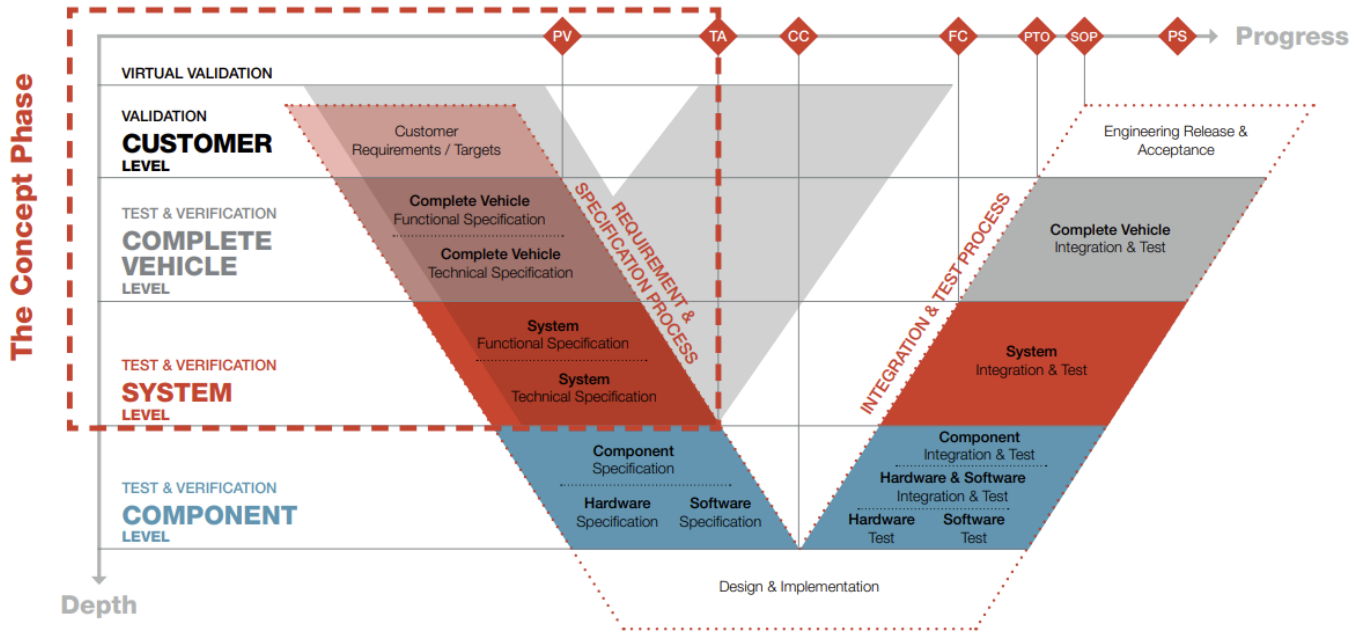
Target Market & Cascading Requirements

The premise of Formula Student is to produce a prototype demonstrator vehicle, for a new product that is aimed at the amateur weekend racer market. There are an infinite number of plausible business cases for this target market, for the DCS submission you must identify which of the three target markets your intended vehicle most closely aligns with.

From this Target Market you can then establish a set of Customer Requirements, which may be either objective or subjective, and cascade these to objective vehicle level, sub-system and component level targets via Functional and Technical Specifications.

There are many ways to complete this activity, the commonly used approach in industry is the “Systems Engineering” or “V-Model” methodology. If you are not familiar with this approach, there are a multitude of on and offline resources that cover this in general and automotive specific applications, the image below is taken from the “Complete Vehicle Insights” series on Magna Steyr’s website[1]:



An example cascade for the “High Performance / Low Volume” target market could be:

High Performance → < 3.5 seconds 0-75m acceleration → Power > 80kW, Weight < 200kg

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Key Performance Targets

Establishing your key performance targets can be achieved in isolation and by competitor benchmarking. Vehicle simulation tools such as Formula CarMaker[2], which is provided free of charge to all Formula Student teams by IPG Automotive, are extremely useful when investigating the impact of different conceptual design choices on your vehicle performance.

At the Concept stage this high-level evaluation can also be adequately completed by using simple spreadsheet calculations; for example understanding the impact of power and mass on the straight-line performance of your vehicle.

In the Formula Student environment, competitor benchmarking can be completed by reviewing the results of previous competitions[3].

There is no single “right answer” when establishing your Key Performance Targets. What’s important is that whatever you decide are realistic for your Target Market and can be justified with robust rationale when reviewed in the Static Events. It is perfectly acceptable for these targets to evolve as you progress through the project, but you should be able to explain what changed and why, with supporting evidence, to score well in the static events.

Key Design Features

It’s very easy for you to decide to produce a 4wd EV, with a monocoque chassis and full aerodynamic package that weighs less than 180kg, because “that’s what the best teams do”, but it is hopefully obvious that this is not a recommended approach to take.

By using the V-diagram methodology, with supporting evidence and rationale, you should be able to relate each of your Conceptual design choices back to your Target Market and Key Performance Targets. These must also be realistic; the 4wd EV example cited above is not going to be low cost or low maintenance compared to a steel spaceframe 2wd CV.

It is also strongly recommended that you be realistic about what your team can achieve, based on your previous experience and available resources. A simple car, finished on-time, that is well developed and reliable will likely score better in the dynamic events than a complex car finished at the event with zero testing.

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References

1. The Essentials of the New Car Development Process + Free V-Model, Peter. M, 06/04/2022. https://insights.apps-magna.com/essential-new-car-development-process
2. Formula Car Maker, IPG Automotive. https://ipg-automotive.com/en/support/licenses/formula-carmaker/
3. Formula Student Competition Results, IMechE. https://www.imeche.org/events/formula-student/previous-events