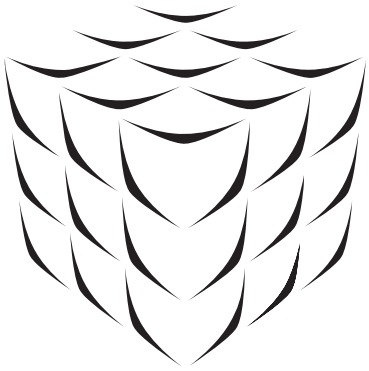

BME Formula Racing Team

Parameter identification of a Formula Student race car

System Documentation

Péter PÁCSONYI

2024.02.29.

Abbreviations

Abbreviation	Description
EBS	Emergency Brake System

Introduction

In the vehicle dynamics control of a Formula Student race car, rather complex methods are used to achieve maximum performance. In many cases, a sufficiently accurate system model is essential for the development of controllers in modern control theory.

Problem description

The quality and quantity parameters needed to be identified in this case are dependent on how sophisticated the given controller is. These parameters can be the aerodynamic properties, the height of the center of mass, values of the used tire model etc. There is also the question of validating different parts of the car. These parameters in some cases do not affect plant model used in the controller, or the performance of these controllers. Nevertheless they are important for proving that the given part or subsystem was designed according to the requirements defined during the concept phase. Examples of this type of parameters can be the friction coefficient between the brake pads and discs, the delay during the activation of the EBS, etc.

General solutions

Examples of existing units with similar functions. Look up products and technologies in different industries.

Competitor analysis

Same as the previous point, except this is for other Formula Student concepts. Take into consideration other team's designs. Contact alumni from our team who did similar projects, and ask for know-how.

Review by Group Leader

Requirements

In this section you have to collect all requirements that influence your part. Consider all levels. Rules, Vehicle level, System Level and then Unit level. Define everything very specifically, so it may not be misunderstood. Use correct definitions, and try to define everything in numerical values, or standards.

Rules

Collect all rule points that affect the part in question. Review the final list with in-team experts of the specific field. Requirements coming from rules are criteria.

ID	Description	Rule ID
RU1		
RU2		

Vehicle level requirements

Collect requirements from vehicle level, or vehicle level document. Review with Chief Engineer.

ID	Description	Prio
VL1		Criteria
VL2		Demand

System level requirements

Collect requirements from system level, or system level document. Review with Group Leader. This should be the main source of the high level requirements for your project.

ID	Description	Prio
SL1		Demand
SL2		Demand

Unit level requirements

Collect any other requirement affecting your part. These will be high level as well. Try thinking of critical parameters that you should define here, for example stresses, environmental parameters, manufacturability, inputs/outputs etc. Review with Group Leader.

ID	Description	Prio
UL1		Demand
UL2		Wish

Functions

Here you will derive functions from requirements. Reviewed by Group Leader.

Function table

Rqmt. ID	Defined function	Function ID
SL2		FN1
UL1		FN2

Concepts

Look up possible solutions for the defined Functions. Take into account only the requirements with demand priority. Define pros and cons for each. Consider which ones satisfies the requirements best, then mark with green color the selected solution. Reviewed by Group Leader.

Function ID	Principle 1		Principle 2		Principle 3	
FN1	Description					
	+pros	-cons				
FN2	Description					
	+pros	-cons				

Concepts

Where the pros and cons cannot define a trivial choice, do an analysis for each concept principle.

Decision matrices

During concept evaluation, define the critical parameters for the functions, and fill out the decision matrices accordingly. Rate in a scale of 0-10 with 10 being the best concept for the given parameter, and 0 being the worst. Weight factors are defined by Chief Engineer.

Criteria	Weight factor	Concept 1	Concept 2	Concept 3
Summary	Point:			
	Place:			

Detailed design

Design process

Fill out with project specific step-by-step points. Done by group leader.

BOM

Collect all necessary components needed for the assembly and final installation of the unit.

Part ID	Part name	Qty.
1100-100-01		
1100-100-02		
1100-100-03		

Manufacturing

Step-by-step write down the manufacturing process of the unit.

Required equipment

All necessary equipment needed for the completion of the unit. For example solder, cleaning materials, lubricants etc.

Assembly plan

How to assemble the components together for the finished unit, and how to assemble the finished unit into system. Also define assembly specific tooling if needed.

Testing

Test procedures

Here you will define all the test procedures required to validate that all requirements are met.

Test description	Rqmt ID
	FL2,SL3

Test plan

If testing and/or validation requires a specific order, set one up. Also consider destructive tests for specific requirements, and define the test order accordingly.

Required equipment

All necessary equipment needed for the tests. If destructive tests are need, also list the required parts with part phases.

Results

Go through the testing and validation of the unit. Always document any necessary information during testing, for example test setup, measured values, dates, issues and problems etc. Colour mark OK tests with green, and NOk tests with red. If a test failed, write conclusion and solution ideas.

Step	Expected values	Result (Value, OK/NOK)	Comment

Date: 2024.xx.xx

Testers: Gipsz Jakab and Móka Miki

Overall conclusion (if applicable): .

\ Changelog

Changes

If any modification was required during testing, or operation, document all changes of the unit.

Change Description	Affected function	Reason
Drilled bigger hole	FN3, FN6	Screw proved not strong enough

Appendices

Sources

Standards, articles, websites.

Tables

Datasheets, calculators etc.

Documents

Vehicle and system level document, other relevant documentations.

Other

Links to off the shelf products, etc.