Problem Statement and Goals
ProgName

Team #, Team Name
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Table 1: Revision History

Date	Developer(s)	Change
Sept 19	Travis	Wrote down problem, stakeholders and potential extras/challenge level
Sept 22	Travis, Kai	Intial draft of problem statement and goals
Sept 23	Kai	Added more information regarding the goals and stretch goals
Sept 23	Travis, Kai	Updating reflection
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1 Problem Statement

1.1 Problem

The McMaster Baja engineering team is seeking to improve the tuning process for their Continuous Variable Transmission (CVT). The tuning of a CVT typically involves extensive real-world testing of physical components, which is time-consuming and prone to inconsistencies due to factors such as wear and weather. These conditions complicate the ability to fine-tune the CVT's torque transfer, which directly impacts vehicle acceleration and hill-climbing performance, both which are two of the team's main objectives in competition.

1.2 Inputs and Outputs

1.2.1 Inputs

- CVT parameters

  - Primary weight
  - Primary Ramp Geometry
  - Primary Spring Rate
  - Primary Spring Pretension
  - Secondary Helix Geometry
  - Secondary Spring Rate
  - Secondary Spring Pretension
- Vehicle and Driver Weight
- Traction
- Angle of Incline

1.2.2 Outputs

- Graphs
  - Acceleration
  - Speed
  - Distance
  - Clamping Force
  - CVT Ratio
  - RPM
  - Torque
  - Belt Slippage
- 3D Model Visualization

1.3 Stakeholders

- McMaster Baja Racing Team
- Dr. Spencer Smith

1.4 Environment

1.4.1 Hardware

- Device can be configured through the use of a personal computer or laptop.

1.4.2 Software

- The application will be supported on Mac, Windows and Linux operating systems.

2 Goals

Develop a 3D model and simulation of the CVT system, which will include the driven pulley, driving pulley, belt, and engine, and will be implemented within a graphical user interface.

2.1 Mathematical Model

The mathematical model is the main component of the simulation and will be used to calculate the output of the CVT system based on the input parameters. This includes the calculation of the driving pulley's weights, ramps, and spring, as well as the driven pulley's helix and spring. From these, simulating the belt's interaction with both pulleys will allow us to output the CVT ratio, RPM, torque, and belt slippage. Finally, combining this with the engine's input will allow us to calculate the vehicle's acceleration, speed, and distance.

More simplified

The simulation will focus on key components of the continuously variable transmission (CVT) system. This includes modeling the driving pulley and driven pulley, specifically their weights, ramps, springs, and helixes. By simulating the interaction between the belt and both pulleys, we can determine the CVT ratio, RPM, torque, and belt slippage. Integrating these results with the engine's input will enable us to calculate the vehicle's acceleration, speed, and distance.

True simplified

The mathematical model will need to accurately simulate the interactions between the various components of the CVT system as defined above.

2.2 Graphical User Interface

The graphical user interface will allow users to input various parameters such as CVT specifications, vehicle and driver weight, traction, and angle of incline, while also displaying graphs of the simulation output and enabling the export of simulation data. Users will then be able to see the output of there simulation in the form of graphs and export the data for further analysis.

2.3 Data Output and Visualization

After the simulation is complete, the application will display graphs of the simulation output and allow users to export simulation data.

2.4 Data Validation

Validation of the simulation data against real-world data is crucial to ensure the accuracy of the simulation. Will need to gather data from the McMaster Baja Racing Team to validate the simulation data. This will include RPM, speed and basic torque measurements.

3 Stretch Goals

3.1 Simulating Heat

Heat can play an important role in the behaviour of the CVT system, especially in extreme configurations. Including basic heat simulation would allow users to understand which setups would lead to catastrophic results. Further, minimizing heat can also lead to an optimized performance.

This goal can be considered complete by including heat readings of various points on the 3D model, powered by the simulation of the heat generated by the CVT system.

3.2 Simulating Inertia of Non Rigid Components

Include complex simulation of the intertia of non-rigid components such as the belt and springs rather than treating them as rigid bodies.

3.3 3D model something something

3.4 Optimization Algorithm

Implement an optimization algorithm to find the optimal CVT parameters for a given set of conditions.

3.5 Advanced Data Validation

Depending on the available data, more advanced data validation techniques can be used to ensure the accuracy of the simulation. This includes validating belt slippage, advanced torque readings and acceleration data.

4 Challenge Level and Extras

4.1 Challenge Level

The challenge level for this capstone project is general.

4.2 Extras

The extras for this capstone project are:

- Code walkthroughs
- Validation Report

Appendix — Reflection

The purpose of reflection questions is to give you a chance to assess your own learning and that of your group as a whole, and to find ways to improve in the future. Reflection is an important part of the learning process. Reflection is also an essential component of a successful software development process.

Reflections are most interesting and useful when they're honest, even if the stories they tell are imperfect. You will be marked based on your depth of thought and analysis, and not based on the content of the reflections themselves. Thus, for full marks we encourage you to answer openly and honestly and to avoid simply writing "what you think the evaluator wants to hear."

Please answer the following questions. Some questions can be answered on the team level, but where appropriate, each team member should write their own response:

1. What went well while writing this deliverable?

   While writing this deliverable some of the things that went well included defining the problem, inputs, stakeholders, goals and environment. They were very easily definable and well understood.

2. What pain points did you experience during this deliverable, and how did you resolve them?

   While writing this deliverable some of the pain points included determining the outputs, stretch goals and extras. We had to really think out what exactly the outputs of our application were going to be which ended up being a larger task then oringally thought. As well determing what our stretch goals were involved required us to think ahead and determine which aspects of the math simulation were going to be more difficult to implement then originally intended. Also as a group we have went back and forth on which extras to include as part of our project, since we were unfamiliar with the options present to us it was hard to determine which extra we wanted to take on.

3. How did you and your team adjust the scope of your goals to ensure they are suitable for a Capstone project (not overly ambitious but also of appropriate complexity for a senior design project)?

   The scope of our project had to be adjusted a bit to ensure it was suitable for a capstone project. Originally it was a bit over ambitious and we had plans to implement an optimization algorithm to be used to find the optimal parameters for the CVT. Howeer upon flushing out the goals for this project we realized the optimzation goal would be better suited as a strech goal rather then a required goal for the completion of the project since its quite a large goal to achieve.