Modeling Dragstrip Performance

Orientation:
Knowledge of vehicle road load along with engine performance data and drivetrain specifications allows you to study transit vehicle behavior. In the case of a dragstrip model, this can lead to recommendations for shift points as well as insight about how alternative engine sizings, gear reductions from the engine to the wheels, and wheel sizes will impact performance. In this activity, you will apply what you have just learned about road load requirements with previous understanding of differential equations in preparation for modeling the UI Hybrid FSAE vehicle on a 80m dragstrip.

Learning Objectives:
1. Relate traction force at the wheels to engine torque, gear ratio, and wheel size.
2. Formulate a set of differential equations for predicting position and velocity on a dragstrip as a function of time.
3. Predict engine operating points at every point along the track.

Targeted Skills:
Integrating – combining parts into a new whole
Selecting Tools – finding methods and software to facilitate solutions
Generalizing Solutions – modifying for broader applicability

Plan:

1. Write the equation for vehicle acceleration that includes traction force exerted by the engine to the wheels, drag, rolling friction, and gravity. Begin with what you know about steady-state road load. How does this function change with velocity?

2. How are traction force at the wheels and engine torque related? What drivetrain information do you need to know to express this relation mathematically?

3. Write differential equations for velocity (dx/dt) and acceleration (dv/dt) based on road load parameters from part 1.

4. Write finite difference formulas for determining position and velocity (step n+1) based on current vehicle conditions (step n) and a time step (Δt).

5. In addition to differential equations for dx/dt and dv/dt, what other information needs to be specified when working with a differential equation solver?

6. Assuming that you remain in a single gear, plot expected behavior of position and velocity versus time. Include changes in road load terms with vehicle speed.

7. How could you determine shift points from your acceleration model? What changes would you need to make to simulate performance after a gear shift?