EE382C: Verification and Validation
Project Proposal
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Project Title: Modeling of Dual-Clutch and Semi-Automatic Transmission Logic in Alloy

Project Description: Today's current transmission systems are much more complex than automatic transmissions of the past. With the removal of the torque converter in many currently produced automatic transmissions, the shift schedule, timing, and gear selection of a transmission are stricter, and have more influence to a car's drivability and resilience than ever before. A transmission in the wrong gear can cause the engine to be out of its torque band, or may over-rev the engine, causing an engine failure.

Transmission engineers today must model more complex state machines than in the past, and take in inputs such as vehicle speed, engine speed, and gear set selection. Many system restrictions must be abided to, such as a shift schedule provided by other teams within the manufacturer. Information such as component stress constrains is provided to ensure certain stresses are never exceeded. Examples of stress constraints would be min/max clutch pressures, maximum torque allowed, and engine specifications on max RPM and torque curves.

Alloy's ability to model an abstracted state machine such as a transmission (before it gets coded and compiled) would be a great demonstration to the automotive industry of new practices to ensure great drivability and platform resilience.

Comparison with related work: Previous examples exist, albeit written in Matlab of a standard torque converter automatic transmission.

http://www.mathworks.com/help/simulink/examples/modeling-an-automatic-transmission-controller.html

The objective that our proposed project is attempting to achieve, is an updated transmission model for current automotive technology, while checking the logic of the system with relation models and constraints. The example above uses formal physics equations as constraints, and we believe with Alloy that a more abstracted, general, and robust solution can be generated without having to multi-order relation from Matlab.

Project Plan: This team looks to develop a general model of the Dual-Clutch and Semi-Automatic transmission, such that number of gears, the stress constraints, and other specifics can be modeled as atomic relations - exposing the actual shifting logic in its most abstract form for analysis.

Once it is created to this point, we can then look for predicates that expose flaws or issues in the model, to better formalize the system for production and testing. A correct model would be able to also demonstrate conflicting constraints, which would benefit greatly to a manufacturer. New relations could also be defined for the system, presenting steps forward in standardizing the new transmission models for the automotive industry.