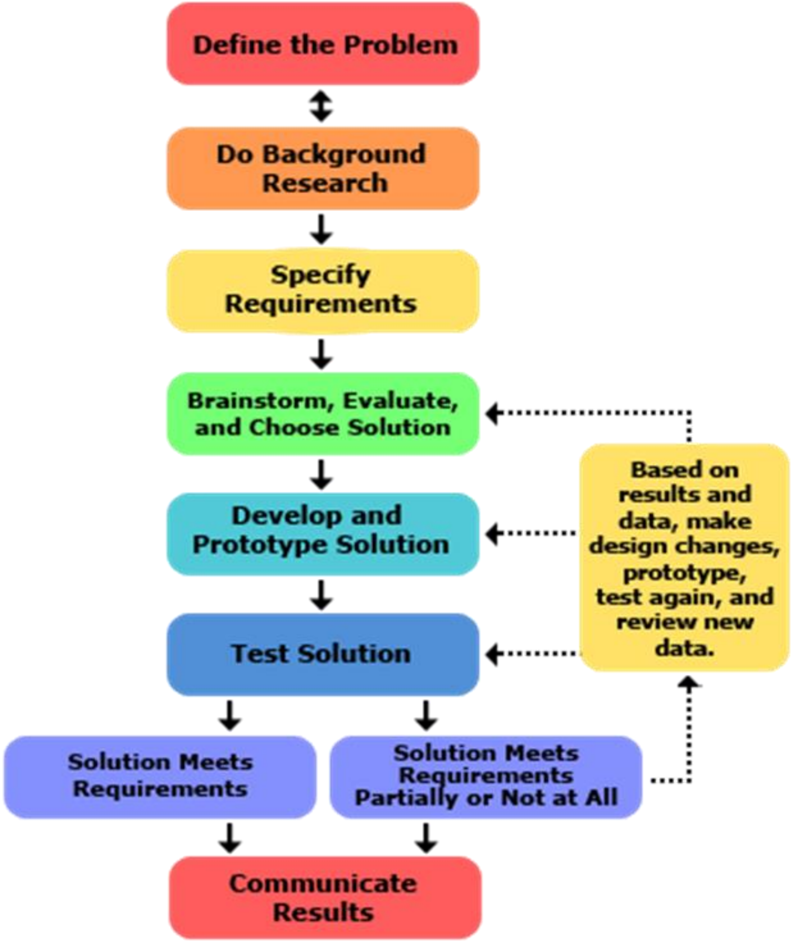
Control Systems

Jonathan Afzali – Torque Vectoring Lead
4th Year Mechanical Engineer

UNIVERSITY OF CALIFORNIA, RIVERSIDE

Agenda

1. Acknowledgements and Examples
2. The designing process
3. Testing and concerns
4. Simulations



Acknowledgements

- Control Systems are based on a system already in place, which has all the variables included with it. Do not be afraid to ask other teams about those variables. This helps you be more precise when interacting with another team's design.

- This presentation is focused on the mechanical side of the process. Likewise, this presentation uses torque vectoring as the main example.

- References can be found on the FSAE Database and the SVN

- Mechanical Engineering courses that refine this topic
  - ME 120, ME 121, ME 122, ME 133, ME 145
  - Taught by Prof. Franco, Wilson, and Pasqualetti

Control Systems

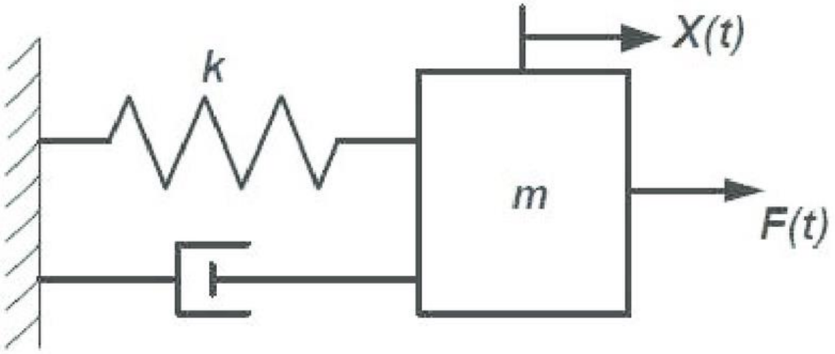
- A control system is a system of devices or set of devices, that manages, commands, directs or regulates the behavior of other device(s) or system(s) to achieve desire results.

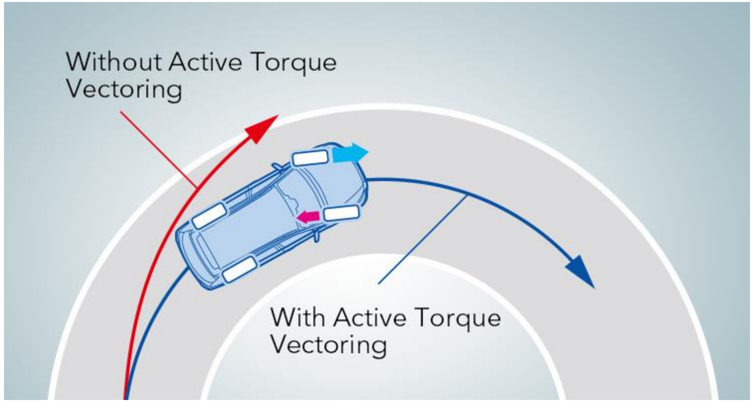
- Uses a combination of physics, block diagrams, logic circuits, bode plots and Nyquist plots, depending on what systems are being controlled or analyzed.

- Problem solving a control system completely depends on the system output and requirements

Examples

- Mechanical Corrections
- Spring Dampening System
- Torque Vectoring System





Defining the Problem

1. What system are you designing a control system for? What are its variables?

2. Does that system have a desired output? If so, how do the remaining variables vary the results of that output?

3. Do you know the original system well? If not, you MUST consult the team lead(s) in charge of whatever systems are involved.

Background Research

1. Depending on the system of concern, you need to know what variables you'll be using and what outputs are desired.

2. A plan of attack is needed. You'll need to decide what method of approach to take based on the initial background research.

3. Keep an eye out for high level block diagrams and their associated mathematical processes. You'll need intimate knowledge of both before beginning your own high level processes.

4. Useful Sources: SAE Database, SVN, Team Leads

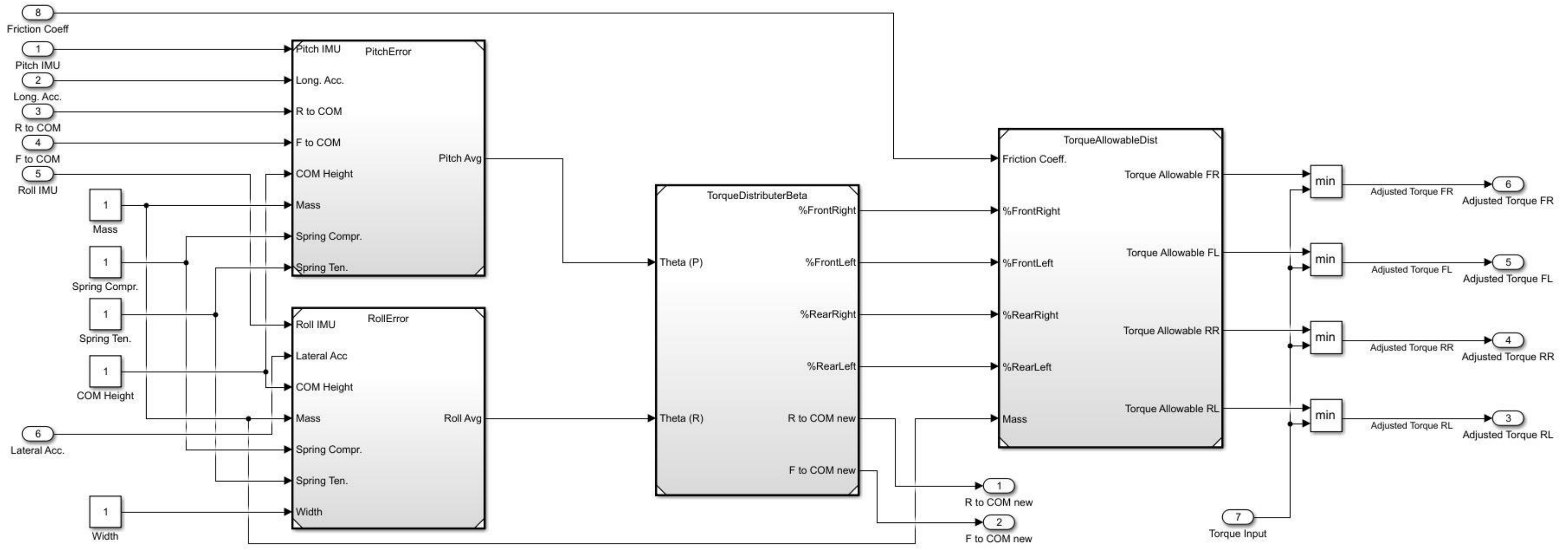
Specify Requirements

1. Each sub-team has a section of rules to follow. You’ll need to keep these in mind for every step of the process.

2. Along with the rules, once you have all of your governing equations, inputs, outputs and goal in mind, you can begin the high level processes.

Creating a High Level Diagram

- There are a few ways to approach the modeling process
    1. Using by hand methods
    2. Using a general diagraming software
    3. Using Simulink



Develop and Prototype

1. Double check all of the logic used in the high level diagrams. Were there any variables that required use of a complicated block calculation? If so, do you understand both why and how it works in the system?

2. Do you have an error calculation, or a way to correct a flawed input/output?

3. Have you tested your system within Simulink at length?

IF you’ve done the above, you can now move on to the conversion process!

This involves converting your high level block diagram to the interface used by the VCU (Vehicle Control Unit)

Simulations and Testing

- Once the conversion is done, the debugging process begins. Work closely with the VCU experts on the team, as they are the ones who will be applying these control systems to the vehicle.

- Once converted and debugged, run through varying scenarios with the updated VCU using normal and extreme cases for what your system is meant to correct.

  - If the system is successful, look for ways to optimize the system further, or begin on a new system.

  - If the system fails, look through your processes to see what fell short.

Recommendations

1. Find all the variables you need as soon as possible!

2. Learn each necessary part, variable or system used for your particular project. Knowing these factors will help in the later simulation stages.

3. Do not be afraid to ask for unknown information from other sub-teams. You are not expected to know everything!

Questions?

Lecture by Jonathan Afzali.
For full lecture: https://www.youtube.com/watch?v=ZIRm2C_pxtU