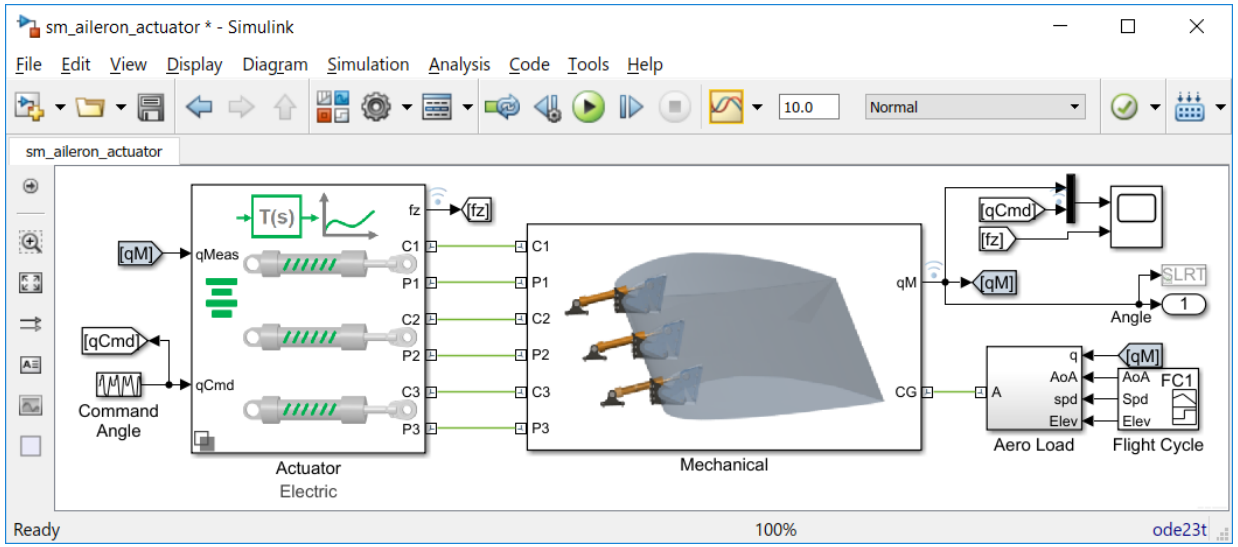
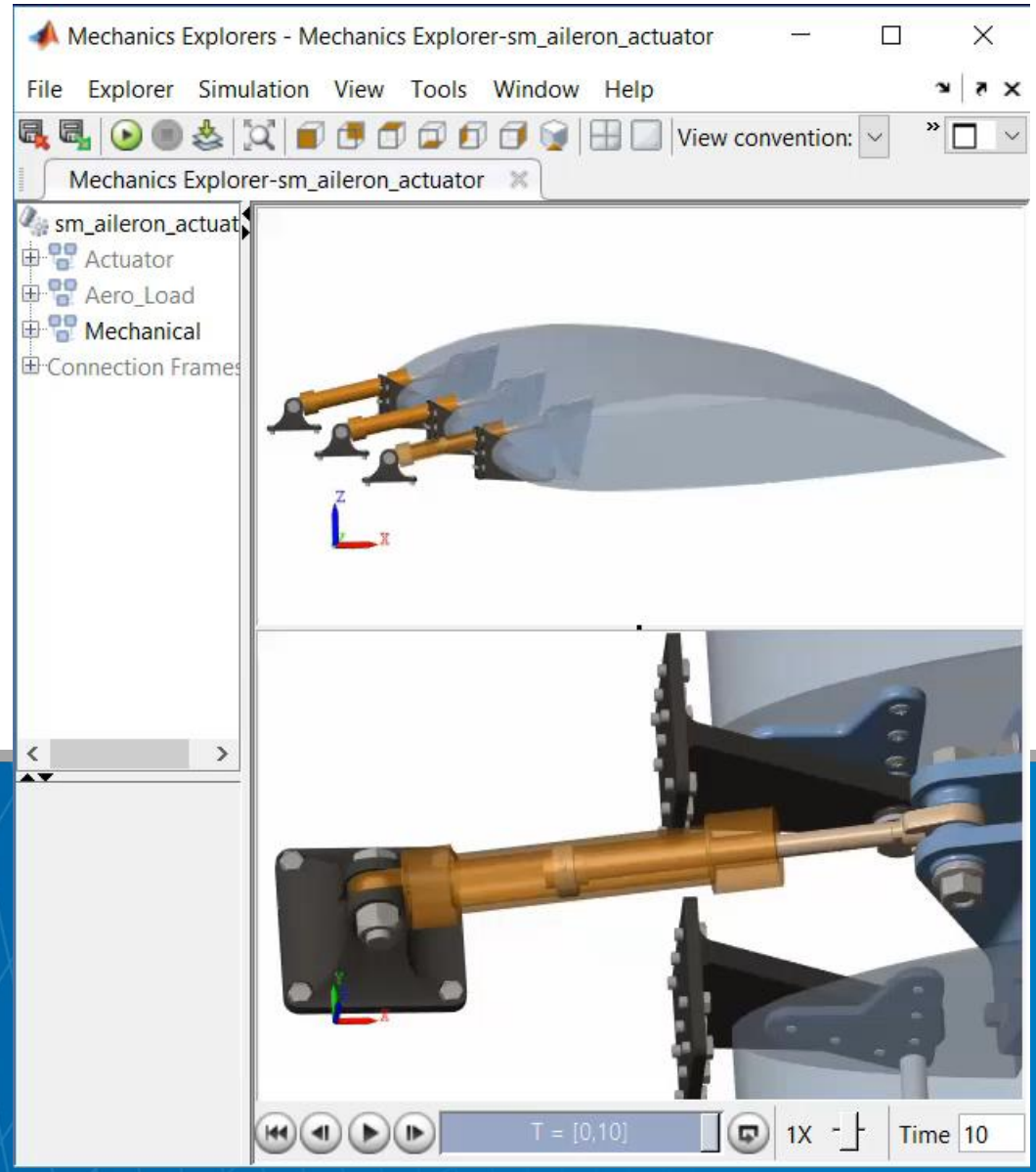
MATLAB EXPO 2018

Mechatronic Design for Aircraft Systems

Mirsad Bucak



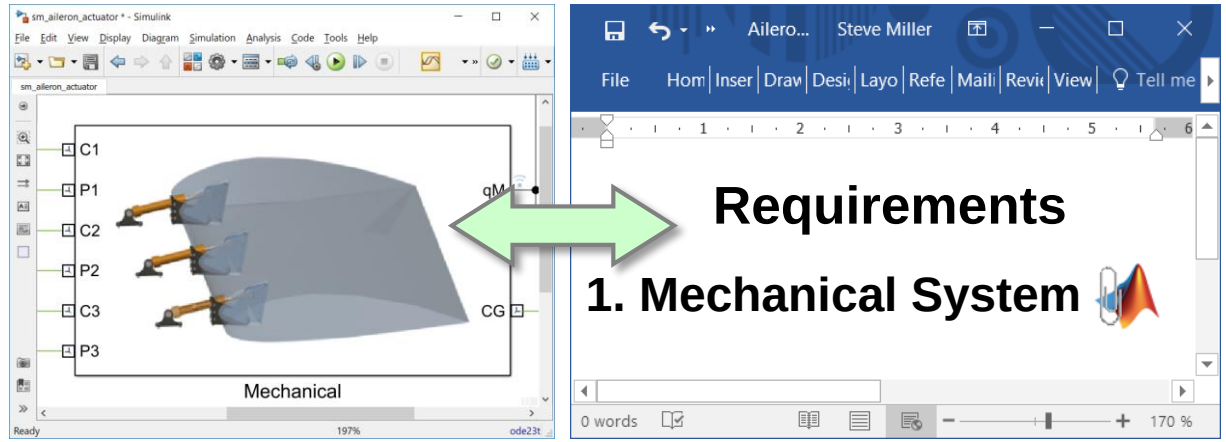


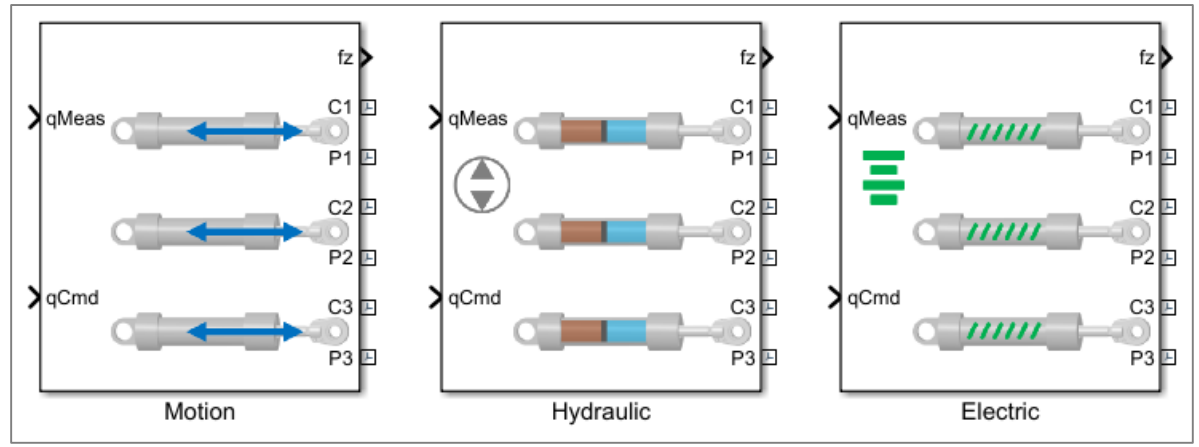
Aileron Actuator Development with Model-Based Design

http://www.mathworks.com/physical-modeling/

Key Points

- Tightly connecting the specification to the simulation model enables engineers to produce better designs
- Testing different actuator designs in one environment saves time and encourages innovation
- Plant model supports the entire development process





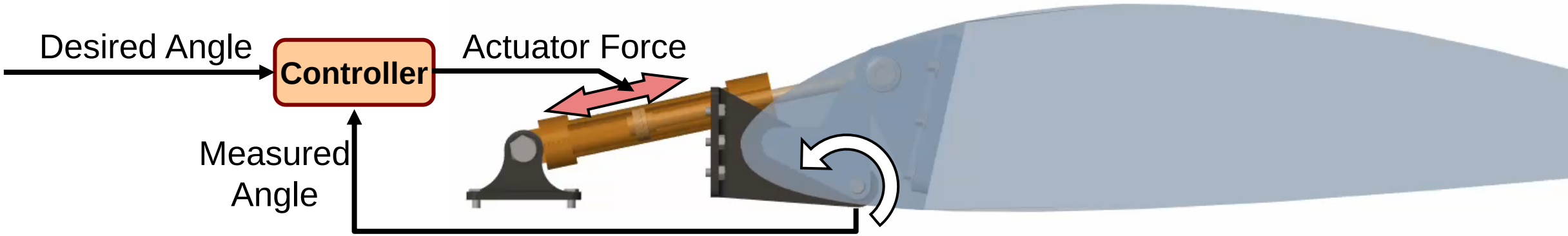
Configure Model → Real-Time Hardware → Generate C Code → Tune Parameter

Agenda

- Example: Flight actuation system
  - Benefits of Model-Based Design
- Actuator design
  - Modeling the mechanical system
  - Determining actuator requirements
  - Testing Electrical and Hydraulic Designs
  - Tradeoff studies
- Optimizing System-Level Design
- HIL testing

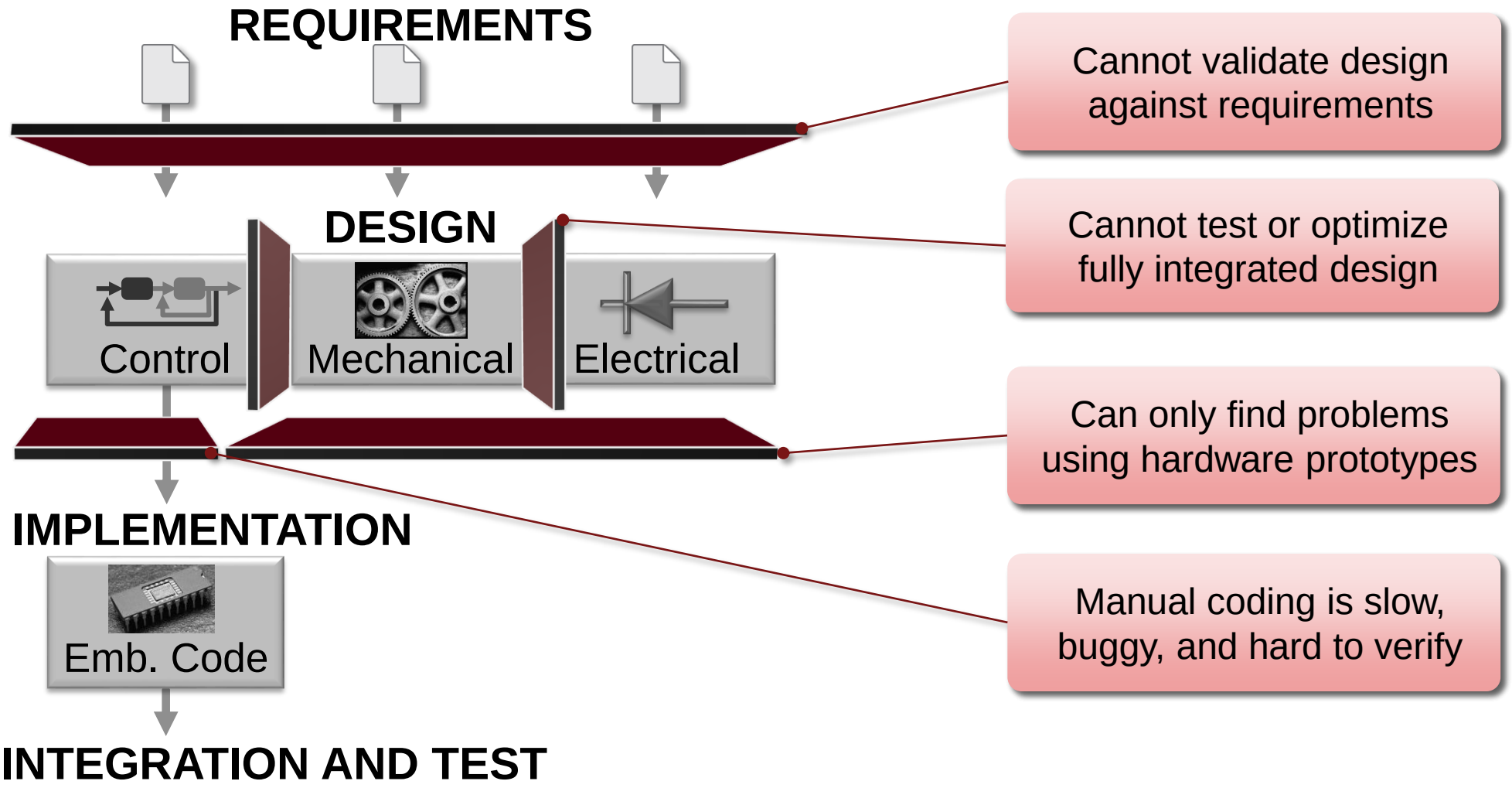
Example: Aileron Actuation System

- System

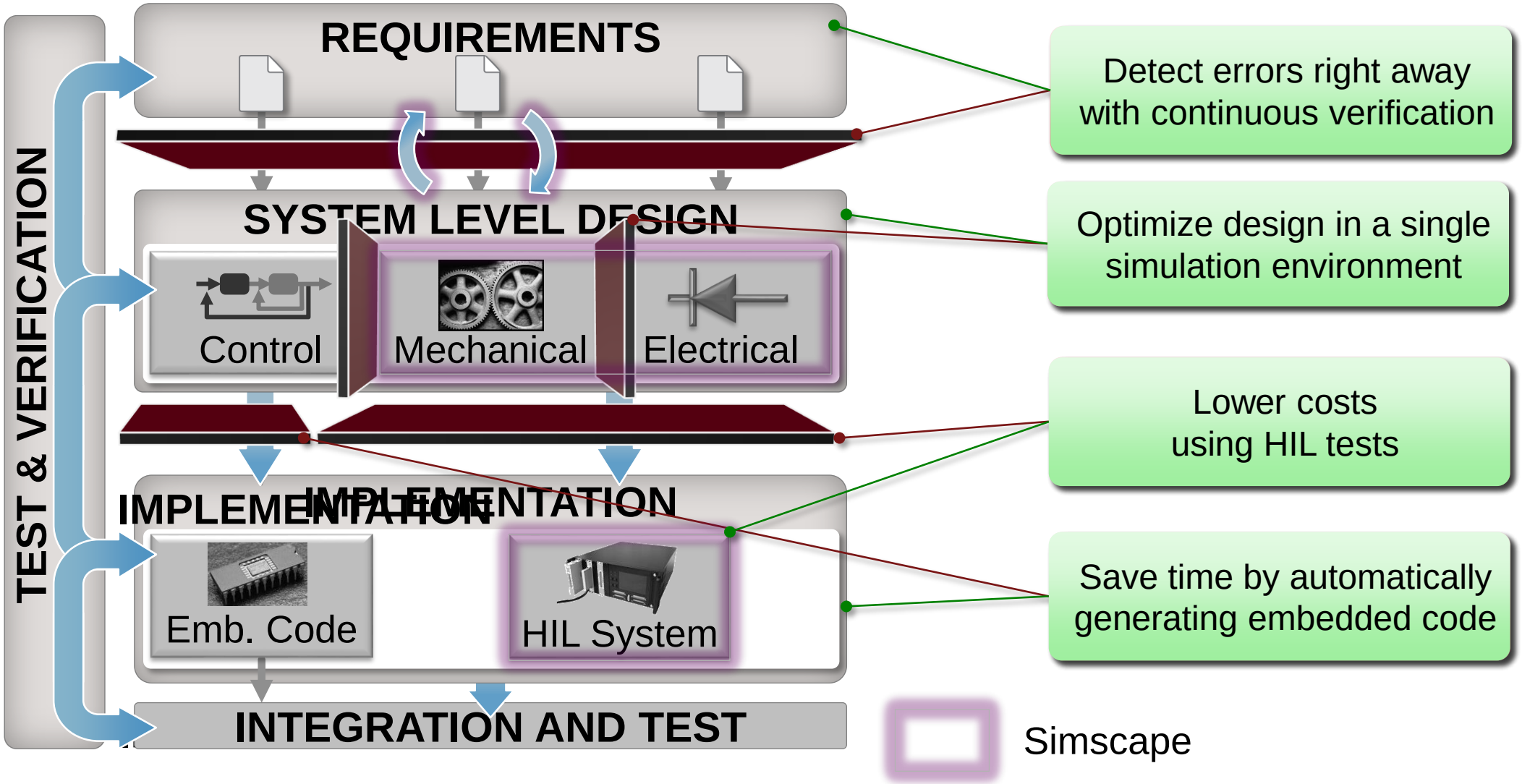


- Simulation goals
  1. Determine requirements for actuation system
  2. Test actuator designs
  3. Optimise system performance
  4. Run simulation on real-time hardware for HIL tests

Traditional Design Process



Model-Based Design



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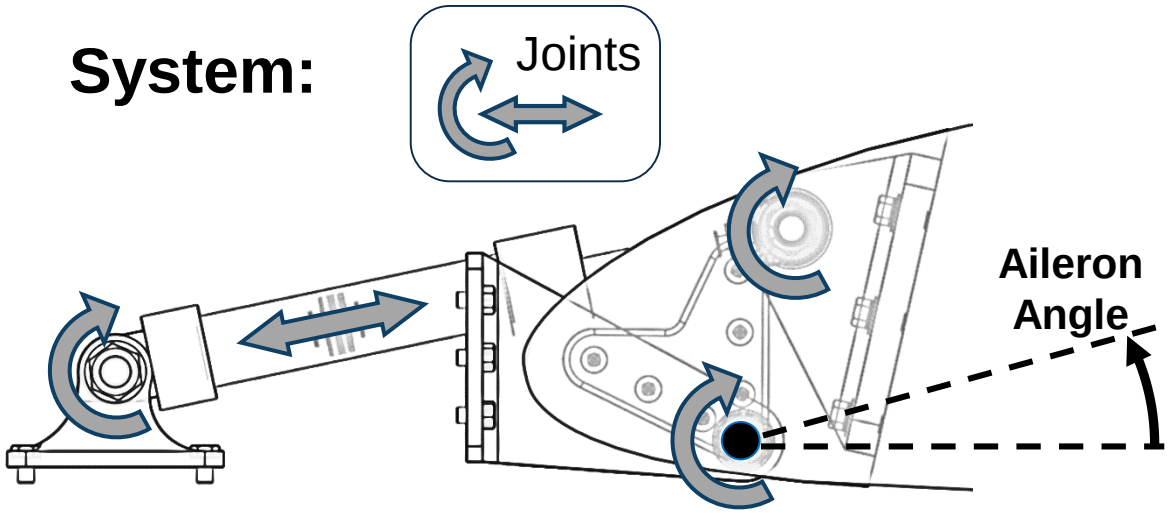
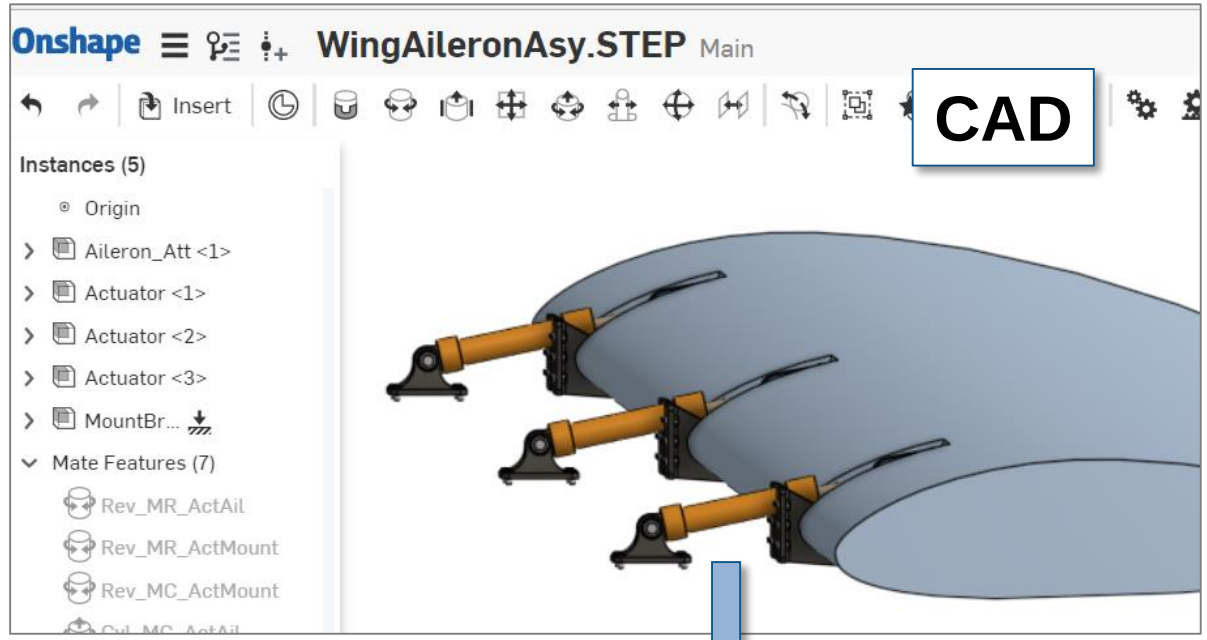
Modeling the Mechanical System

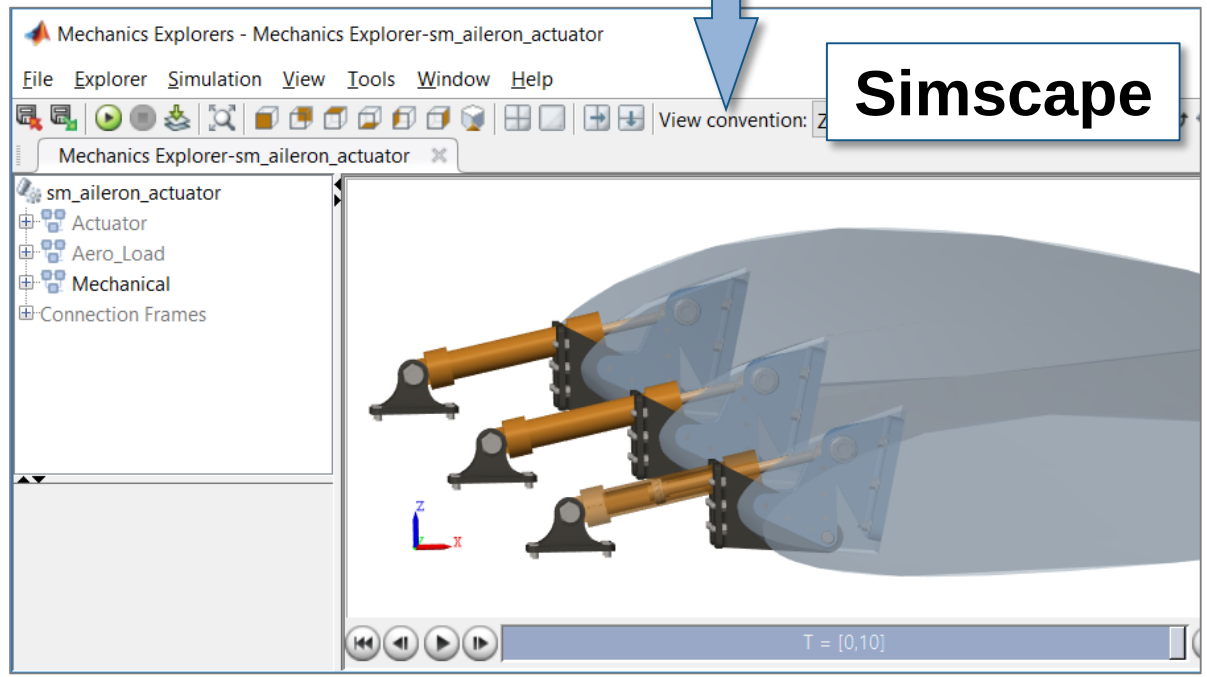
System:

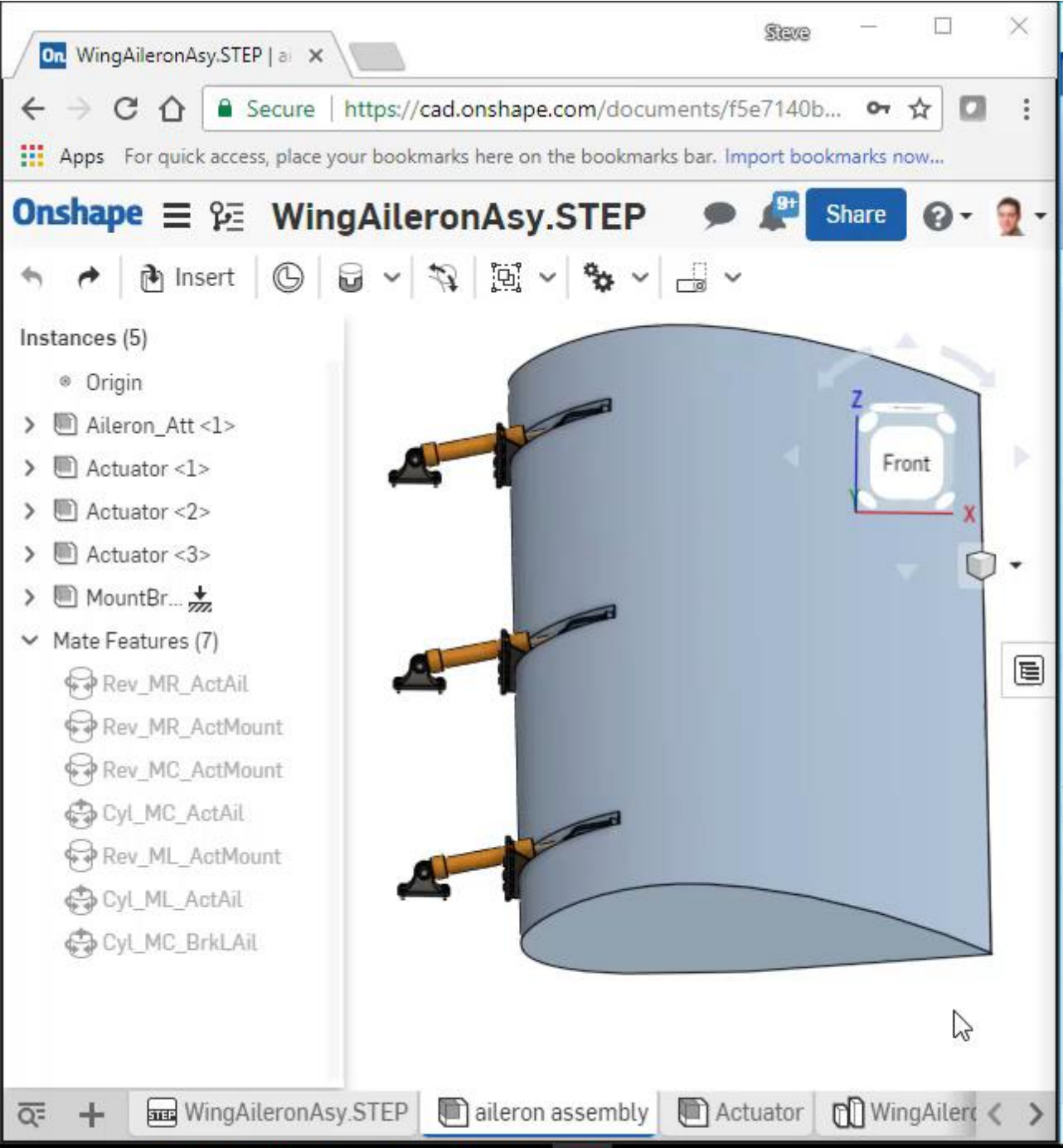


Problem: Model the mechanical system within Simulink

Solution: Import the mechanical model from CAD into Simscape Multibody



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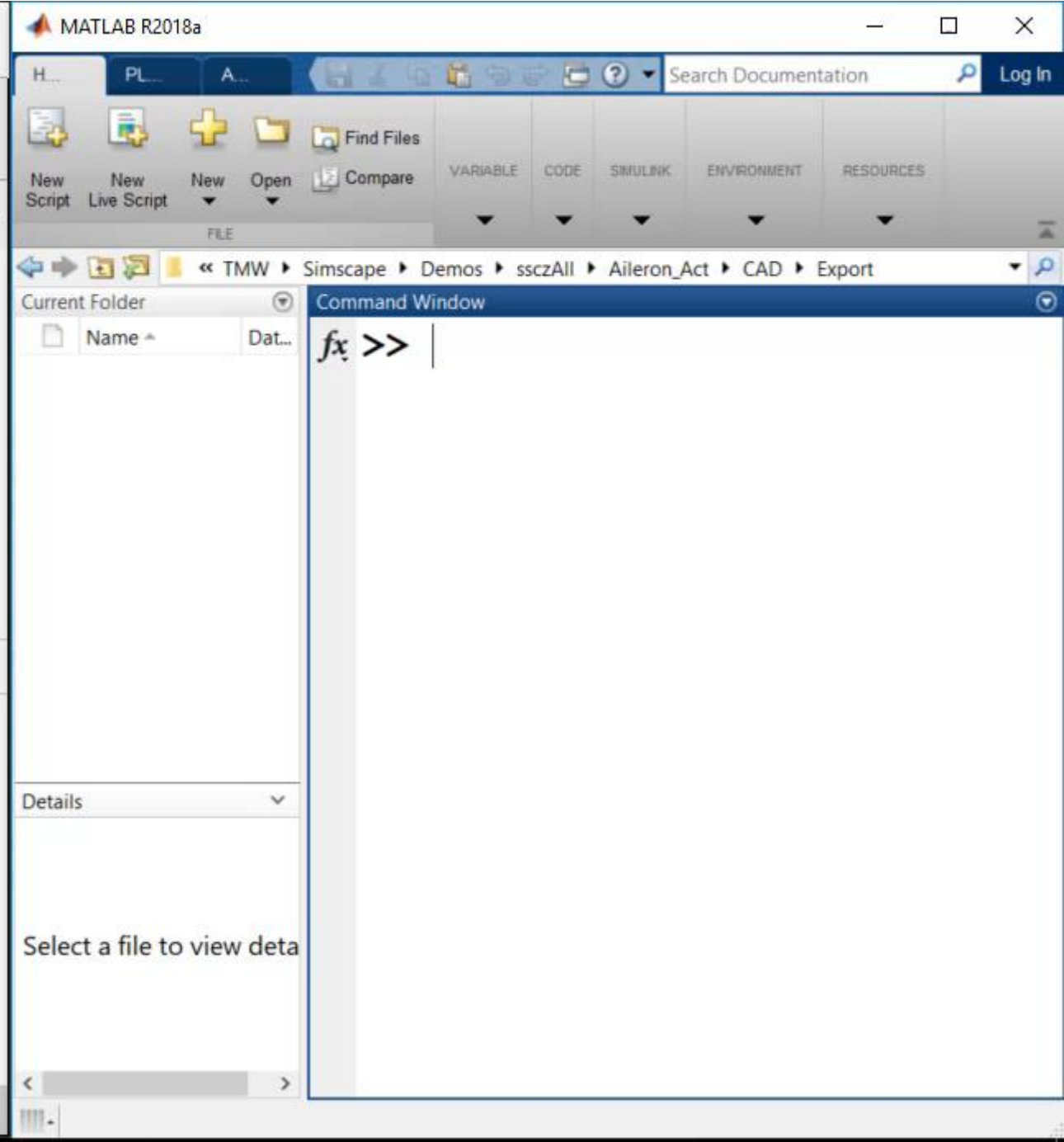
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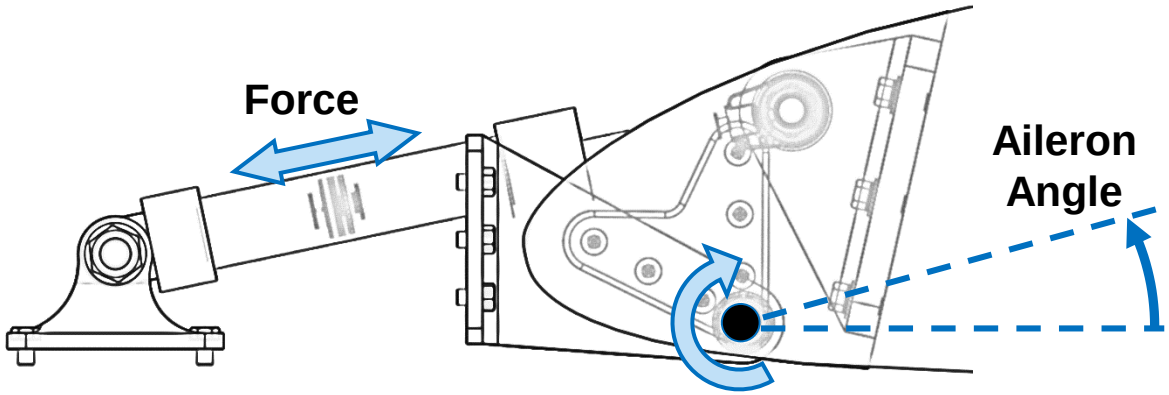
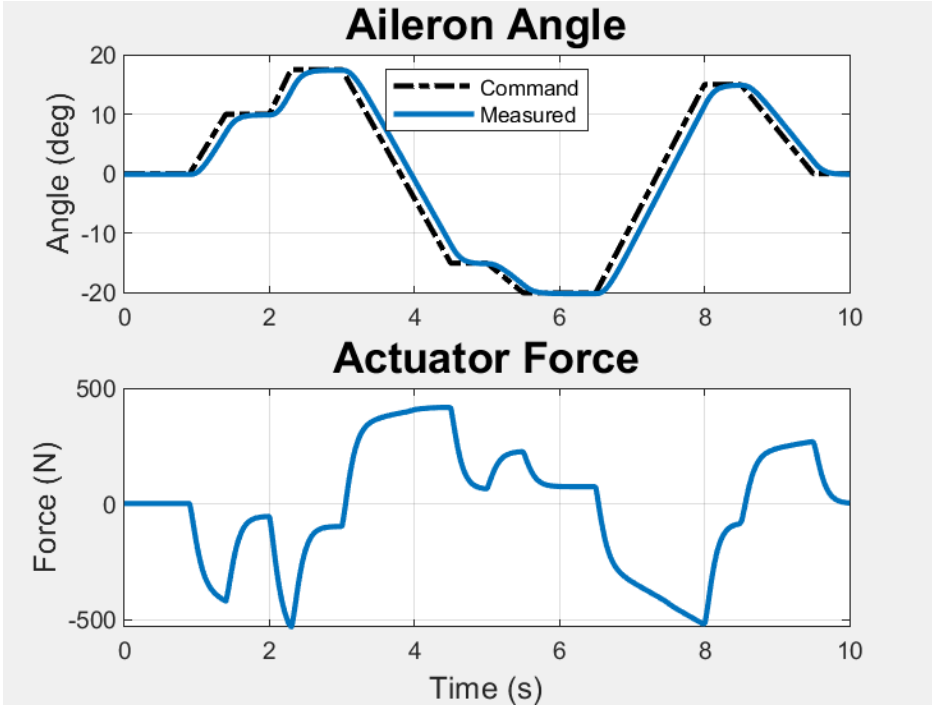
Determining Actuator Requirements

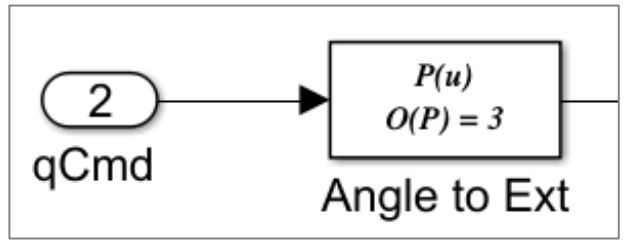
Model:

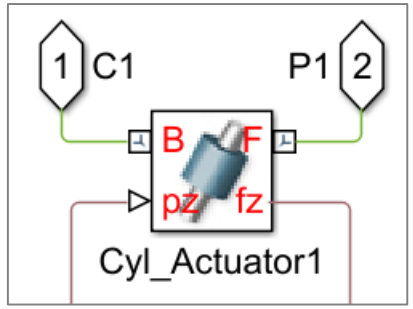




Problem: Determine the requirements for an aircraft aileron actuator

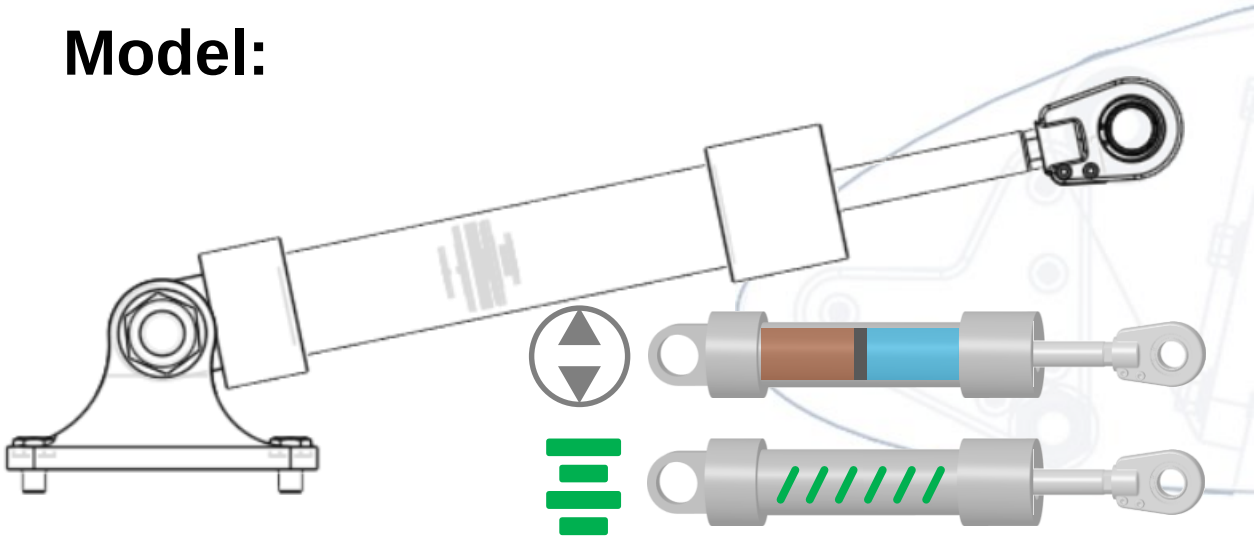
Solution: Use Simscape Multibody to model the aileron and use inverse dynamics to determine the required force

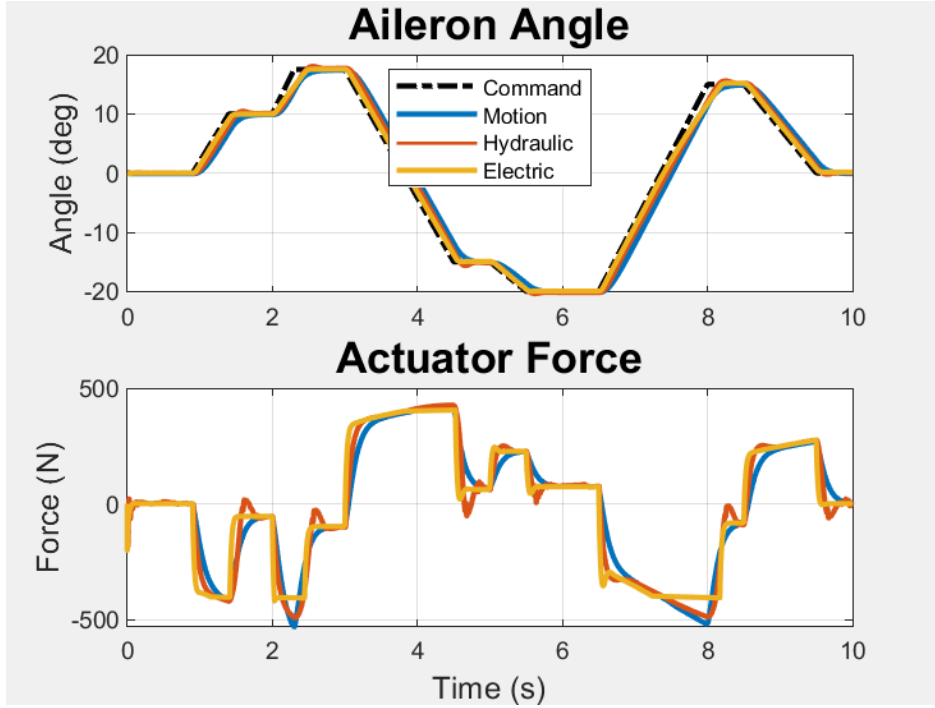




Testing Electrical and Hydraulic Designs

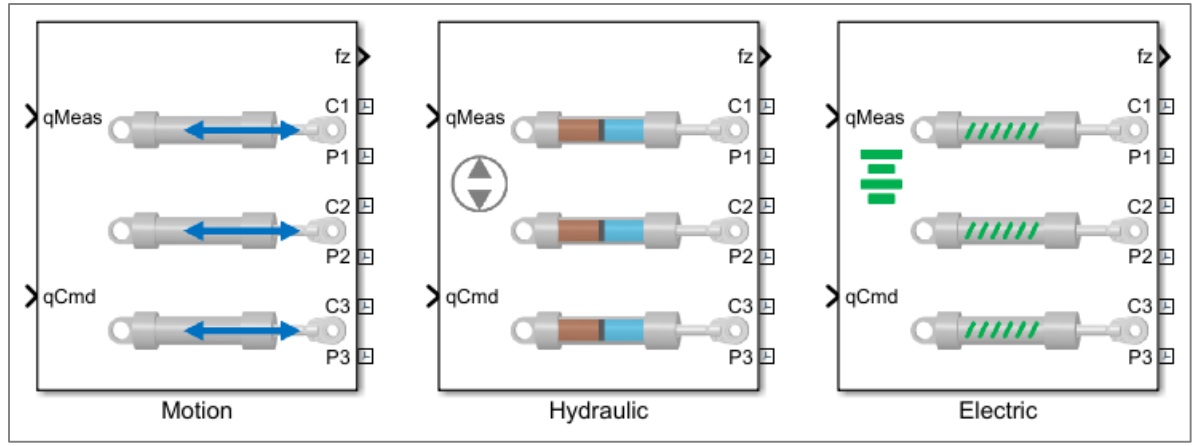
Model:





Problem: Select type of actuator based on system-level requirements

Solution: Use Simscape Fluids and Simscape Electronics to model the actuators, and variant subsystems to test them



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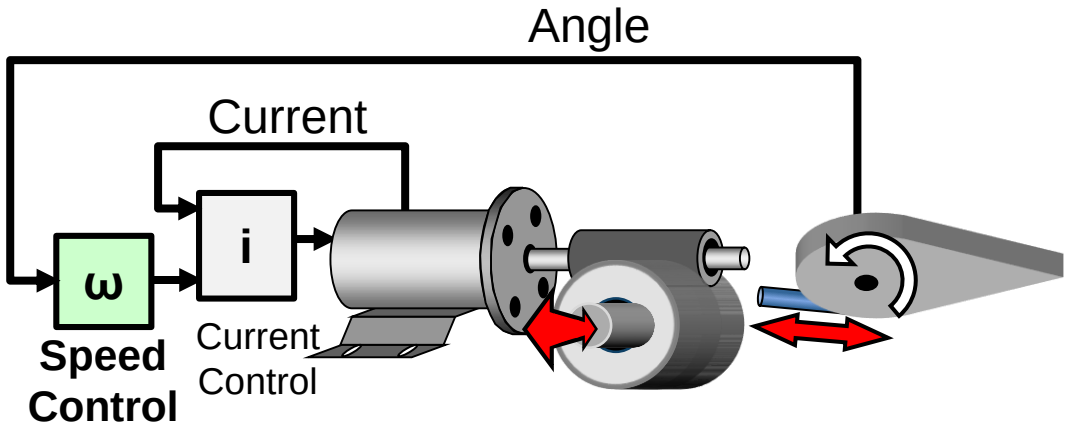
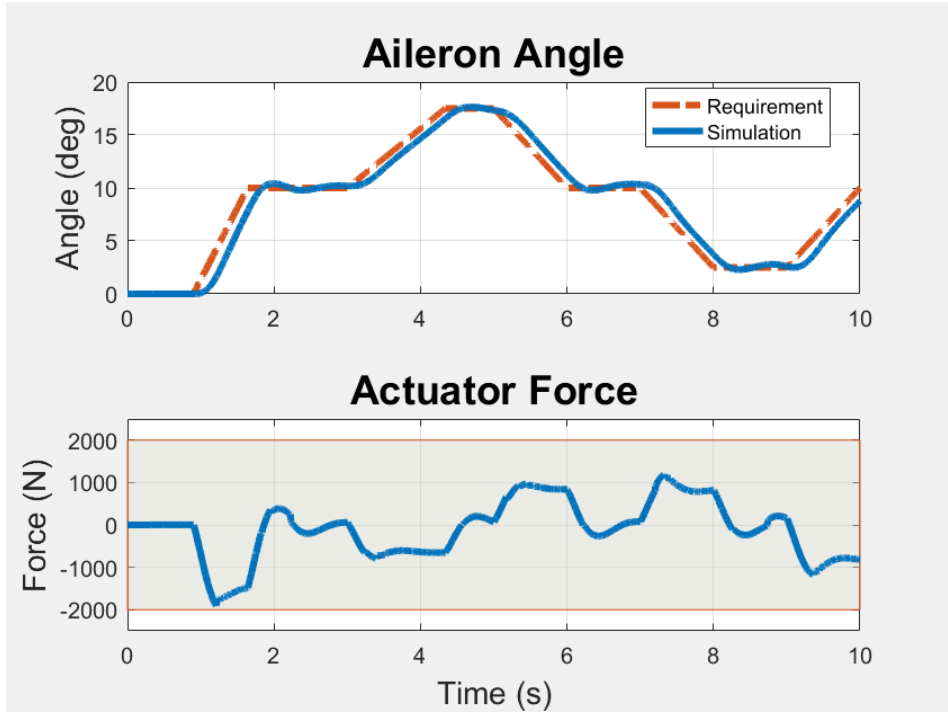
Optimizing System Performance

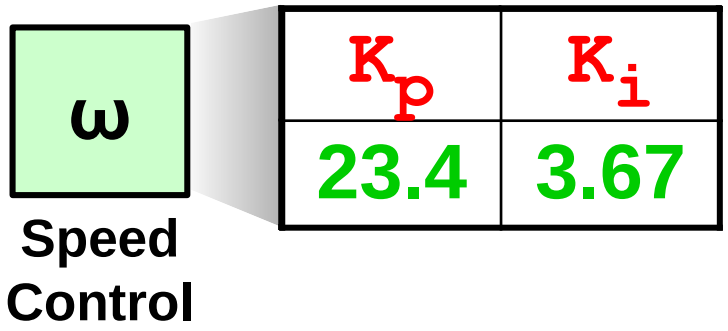
Model:

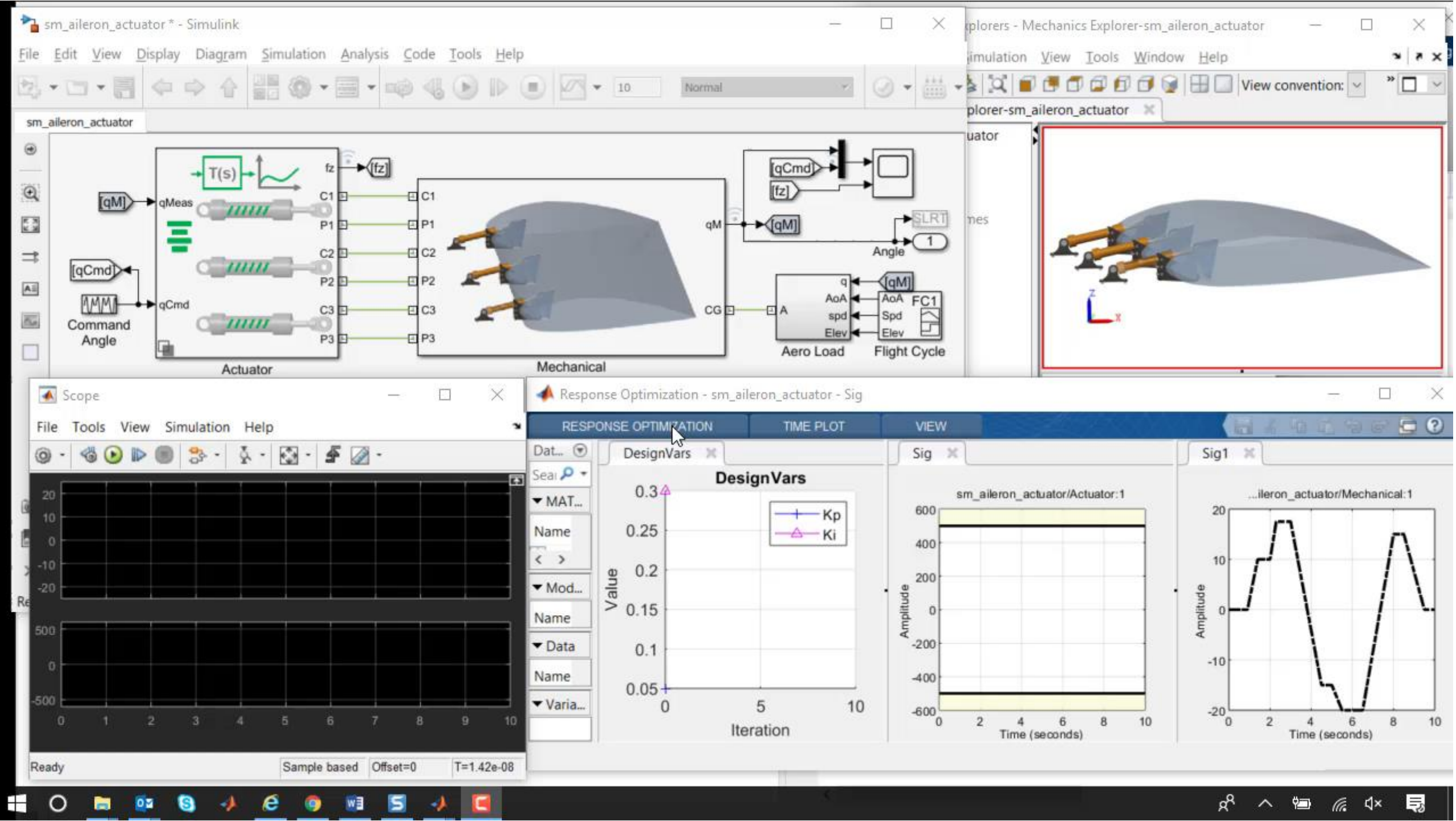




Problem: Optimize the speed controller to meet system requirements

Solution: Tune controller parameters with Simulink Design Optimization

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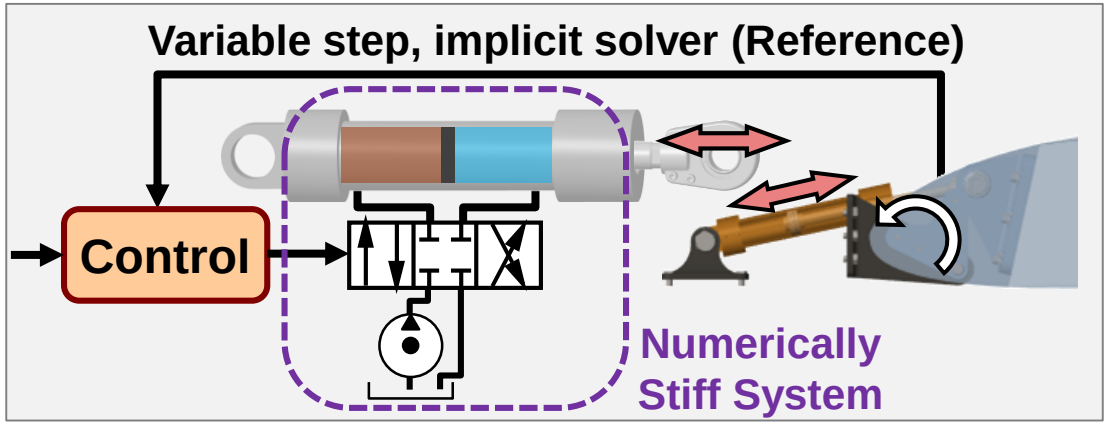
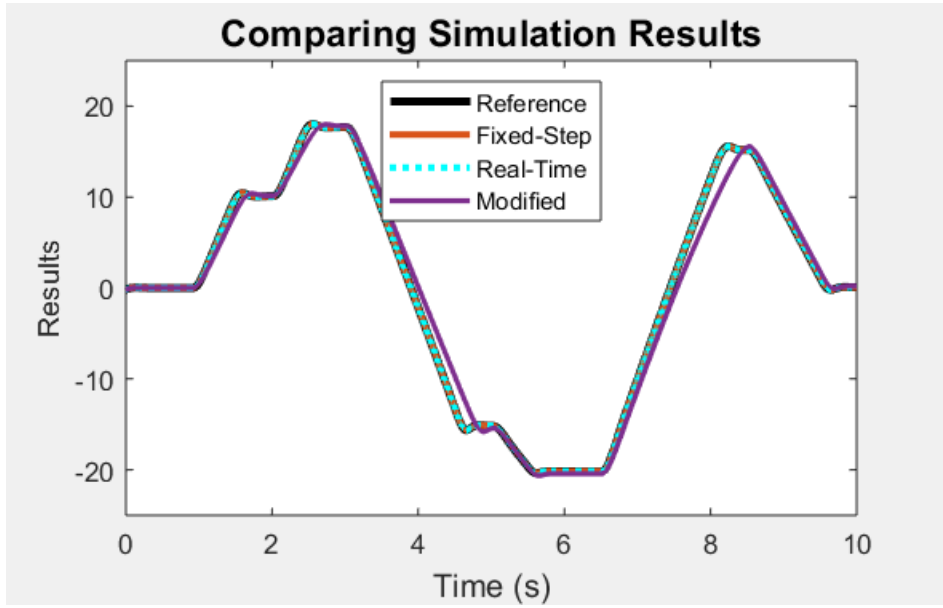
Configuring a Hydraulic Actuator for HIL Testing

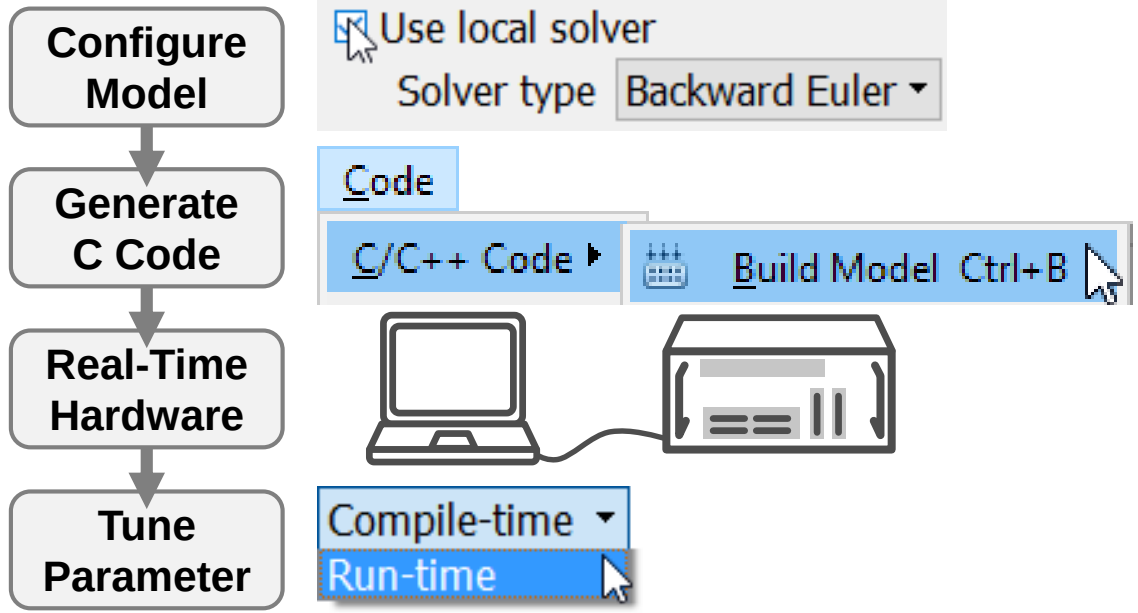
Model:

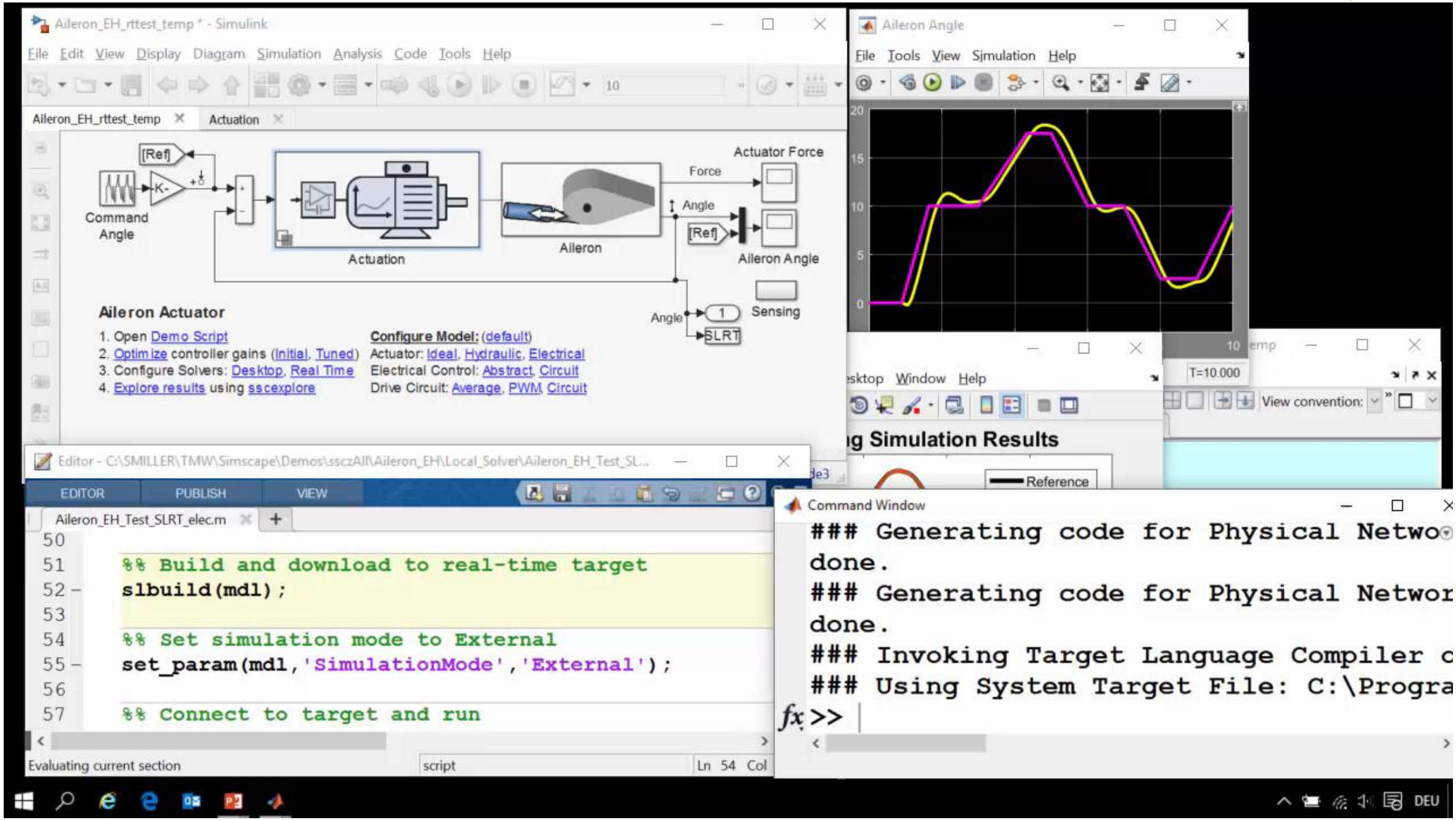




Problem: Configure solvers to minimize computations and convert to C code for real-time simulation

Solution: Use Simscape local solvers on stiff physical networks and Simulink Coder™ to generate C code

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Aileron Actuator
1. Open Demo Script
2. Optimize controller gains (Initial, Tuned)
3. Configure Solvers: Desktop, Real Time
4. Explore results using sscexplore
Configure Model: (default)
Actuator: Ideal, Hydraulic, Electrical
Electrical Control: Abstract, Circuit
Drive Circuit: Average, PWM, Circuit
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52 slbuild(mdl);
53
54 %% Set simulation mode to External
55 set_param(mdl,'SimulationMode','External');
56
57 %% Connect to target and run
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Key Points

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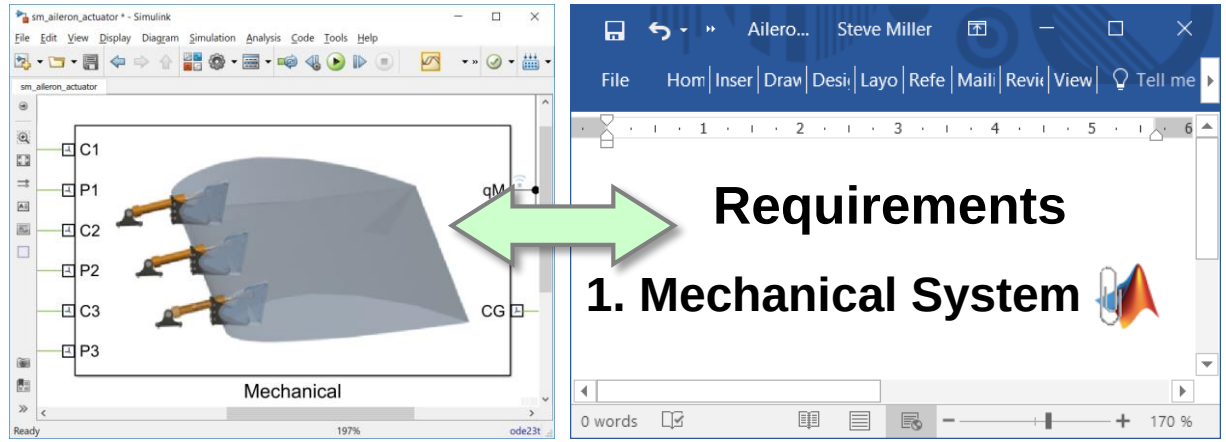

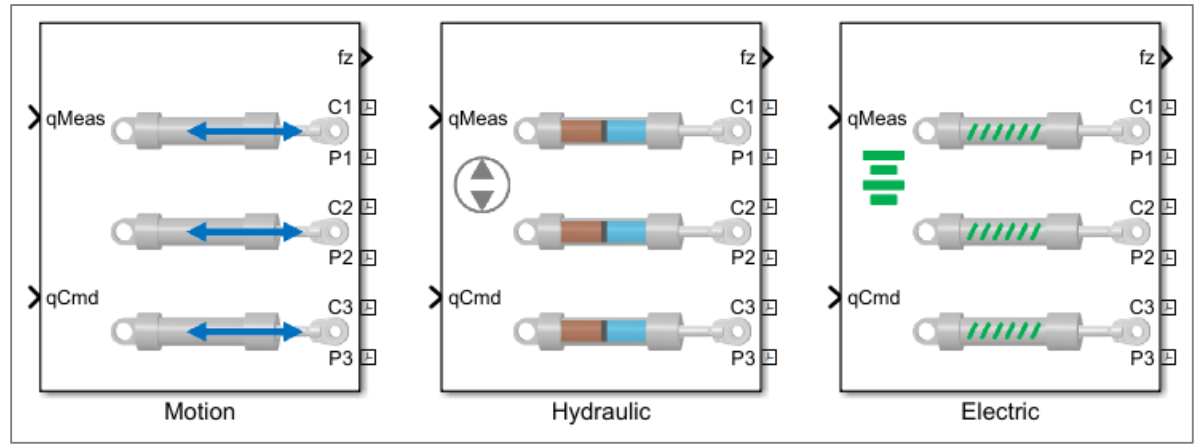

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