MATLAB EXPO 2018

System modeling using Simulink and Simscape

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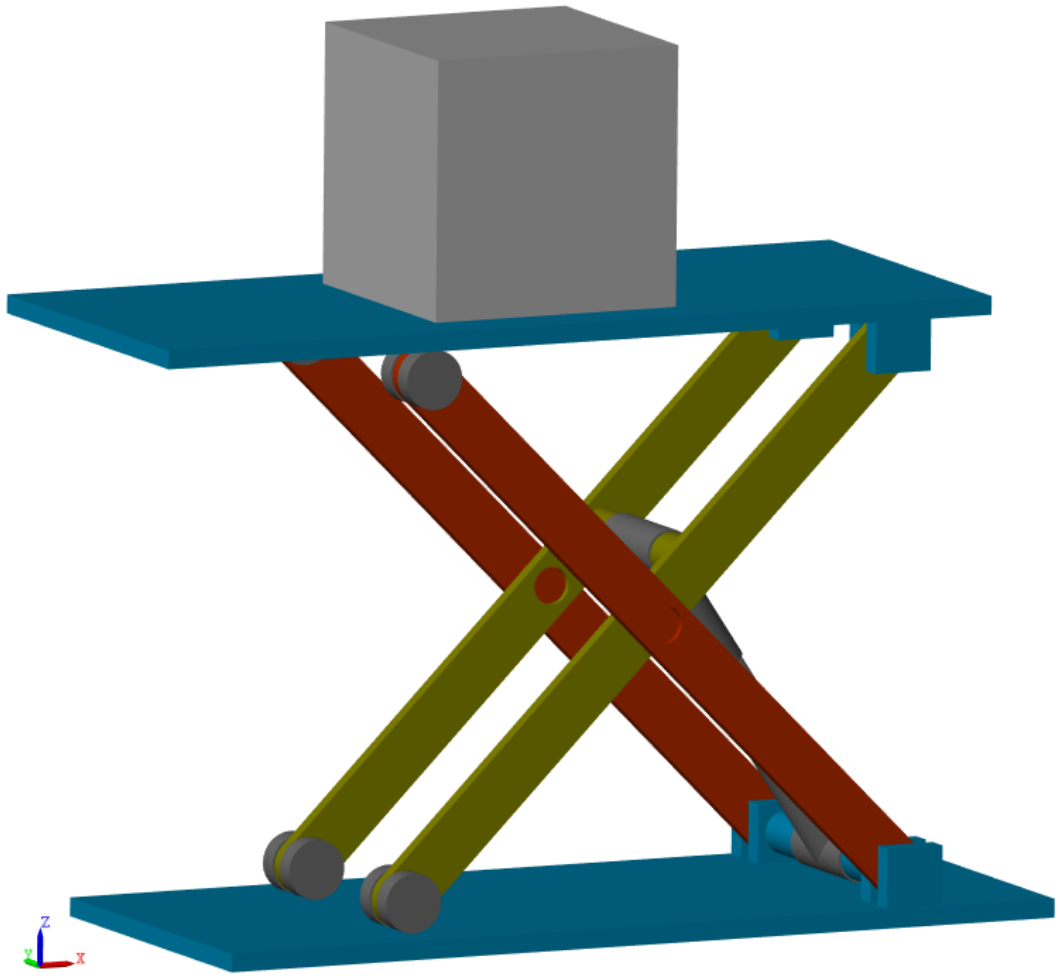
Multi-domain Systems

Common challenges

1. Multi-domain simulation
2. Capturing the system dynamics at desired complexity
3. Developing controls algorithm

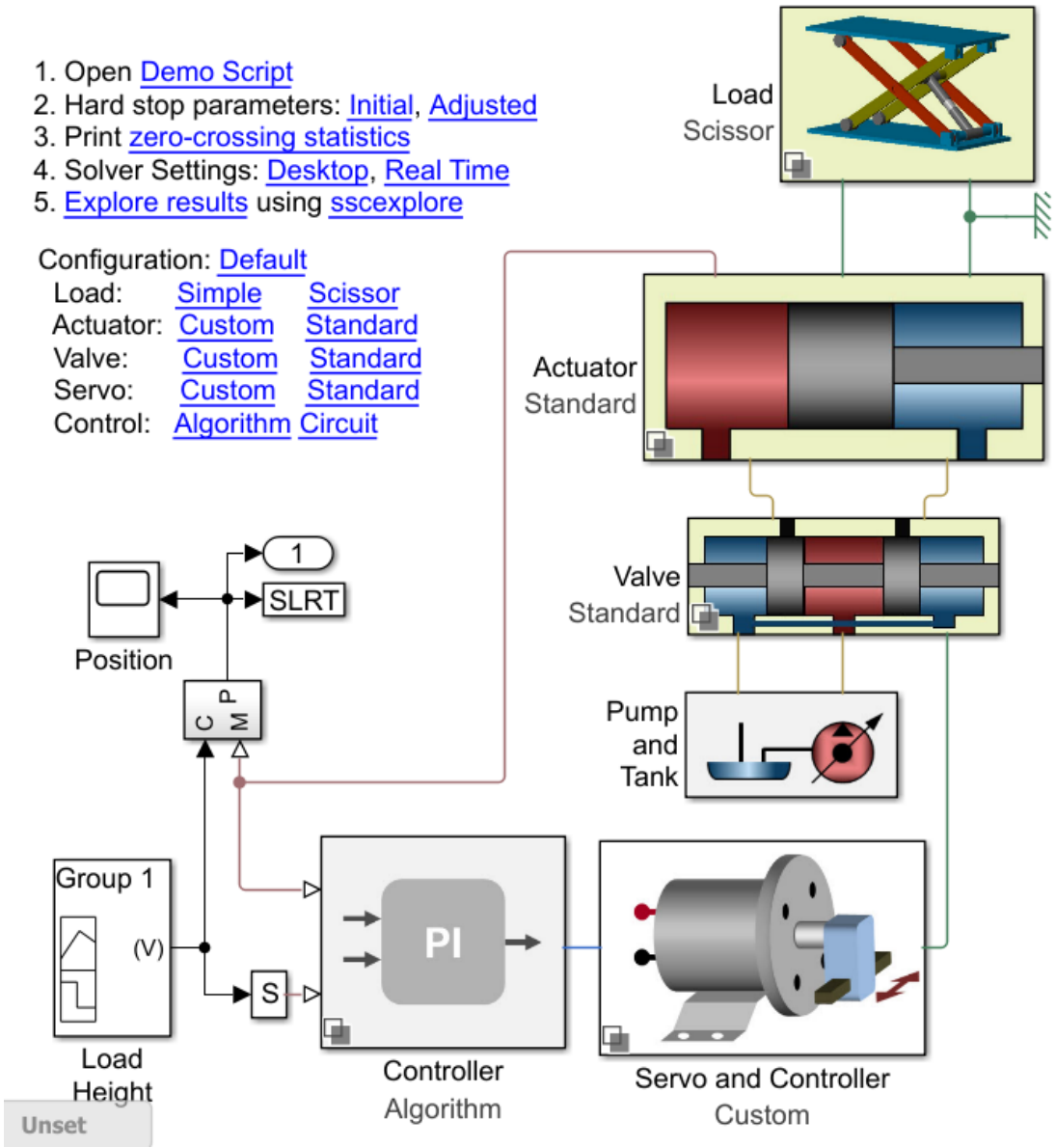
Scissor Lift

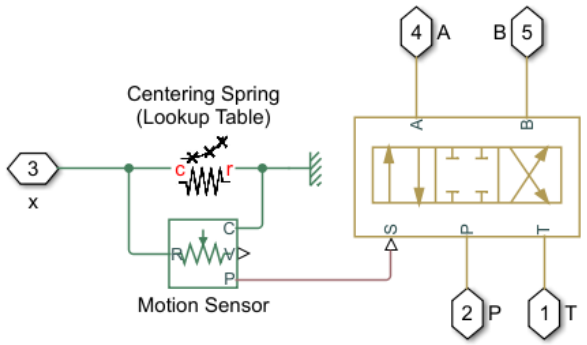


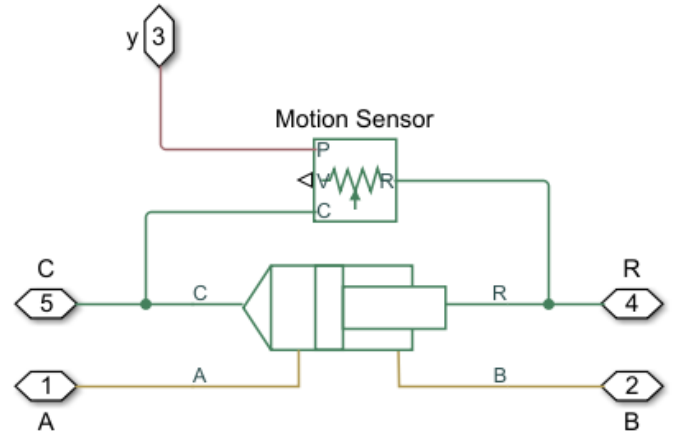
Scissor Lift

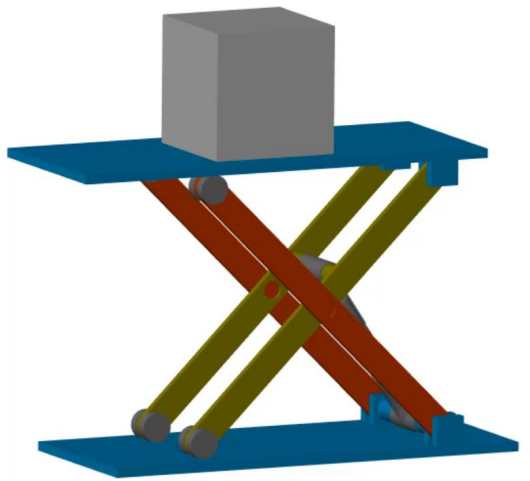
1. Open Demo Script
2. Hard stop parameters: Initial, Adjusted
3. Print zero-crossing statistics
4. Solver Settings: Desktop, Real Time
5. Explore results using sscexplore

Configuration: Default
Load: Simple Scissor
Actuator: Custom Standard
Valve: Custom Standard
Servo: Custom Standard
Control: Algorithm Circuit







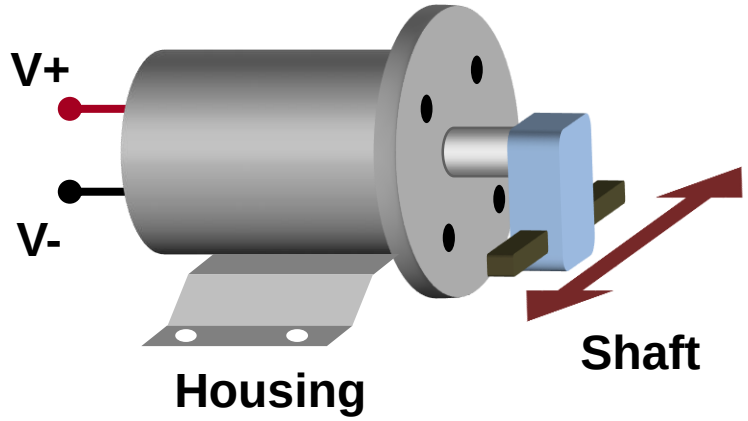


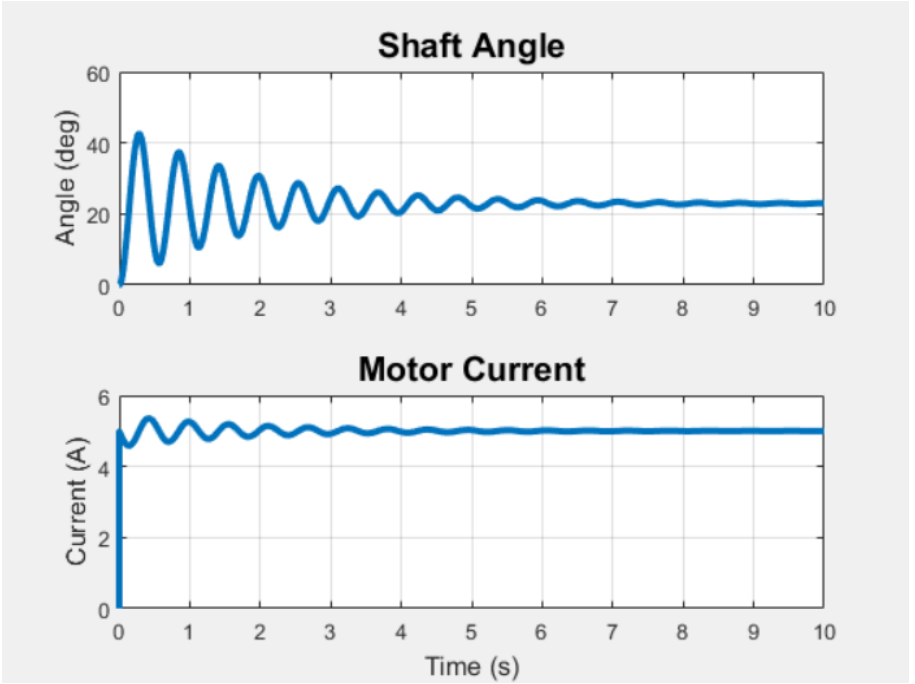
Agenda

- Understanding and capturing the behavior of a system
  - Various approaches of modeling
  - Example: DC motor
- Model the Scissor Lift
  - Hydraulic actuation system
  - Mechanical System
- Developing control strategy

Modeling a DC Motor

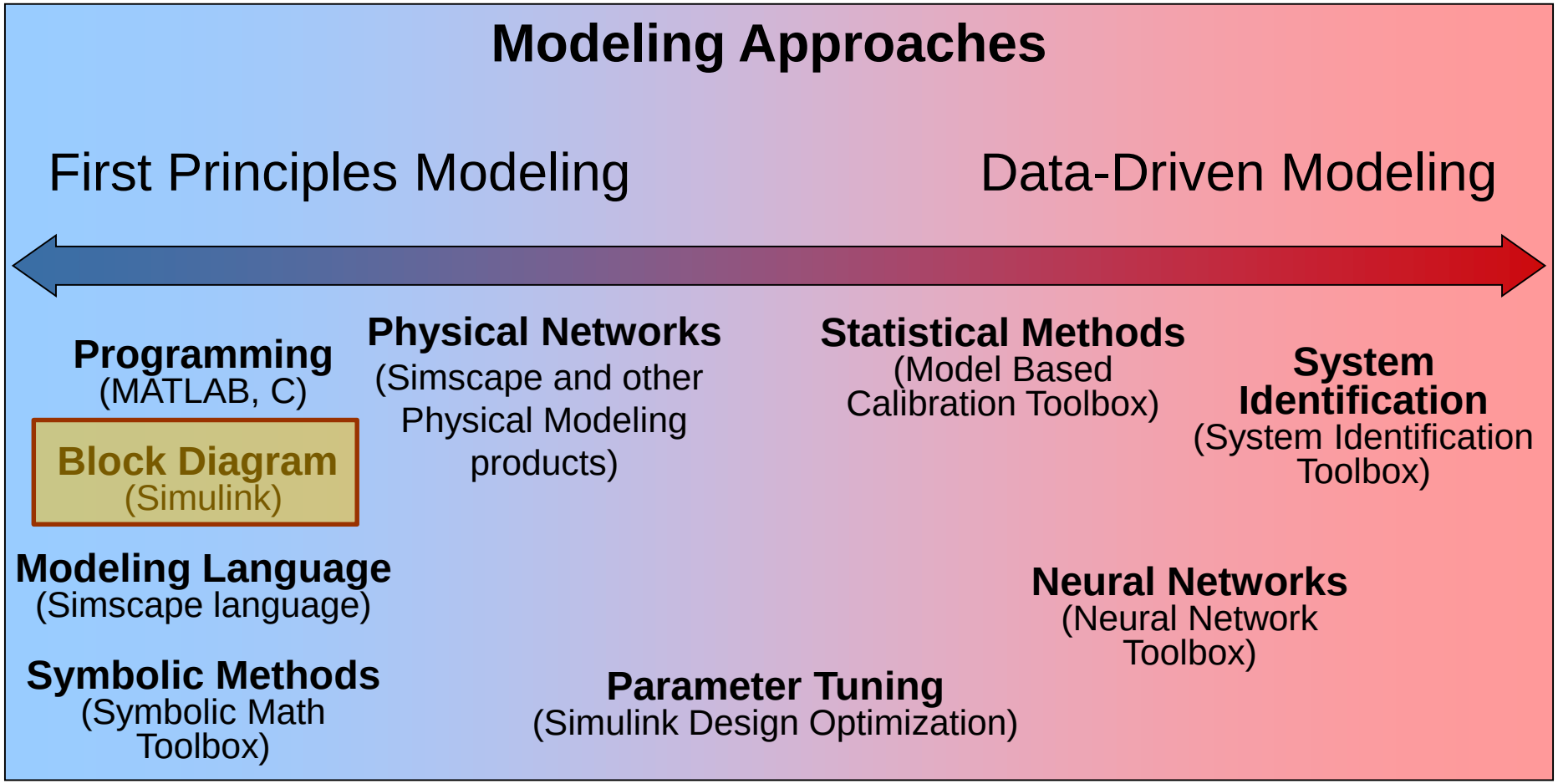
Model:





Problem: Model a DC motor with electrical and mechanical effects

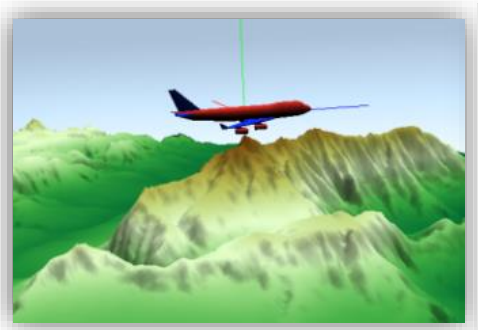
Different Approaches for Modeling Dynamic Systems

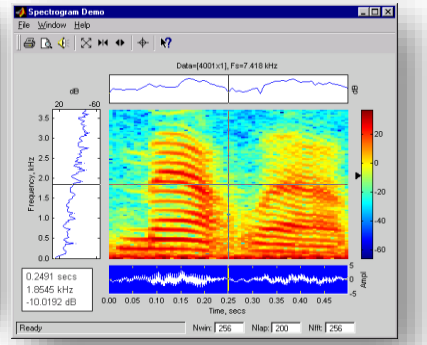


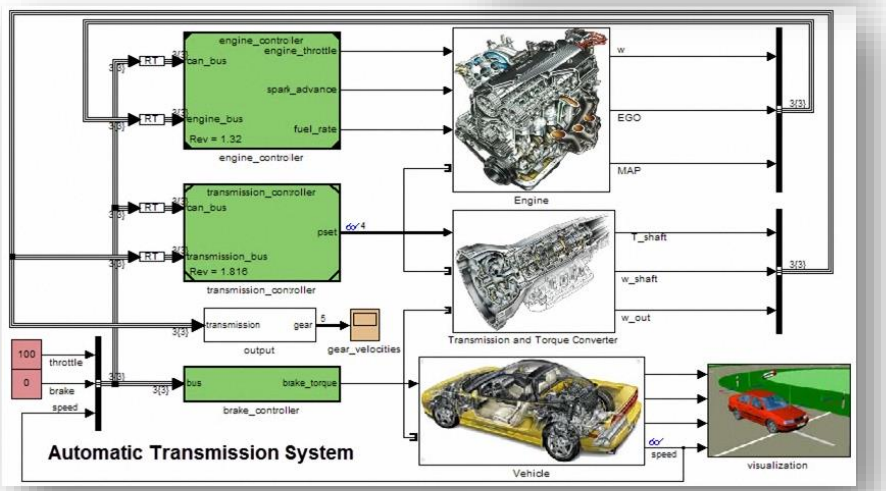
What is Simulink?

The leading environment for modeling, simulating and implementing dynamic and embedded systems

- Block-diagram environment
- Model, simulate, and analyze multi-domain systems
- Accurately design, implement, and test complex systems for:
  - Communications
  - Control
  - Signal processing
  - Video and image processing
- Platform for Model-Based Design

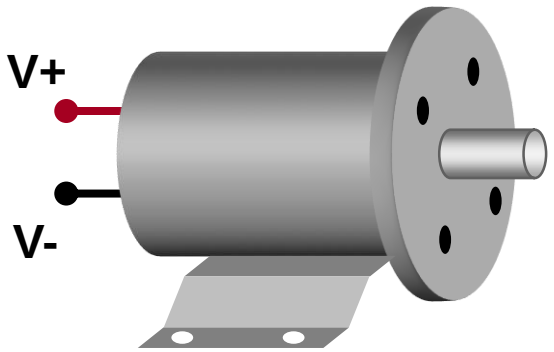


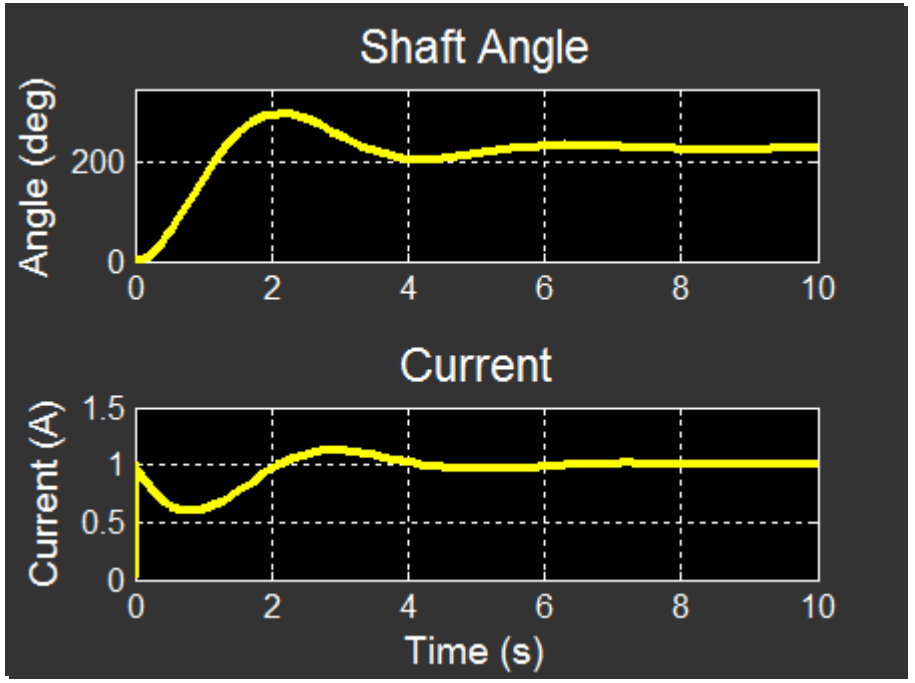




Modeling a DC Motor in Simulink

Model:





How to model a DC Motor in Simulink?

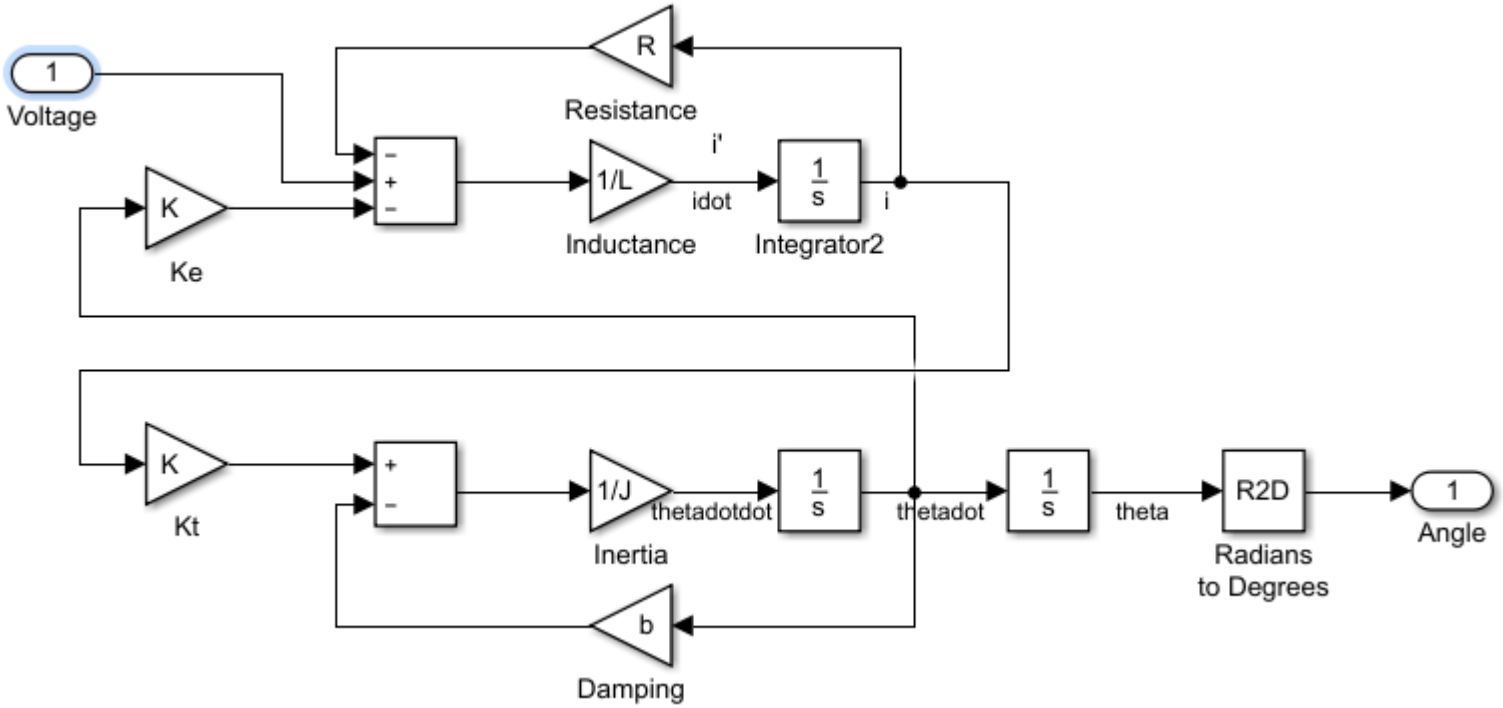
Based on its equation:

$$V = K * w + i * R + L*(di / dt)$$
$$T = Kt * i - b * w - J * (dw / dt)$$

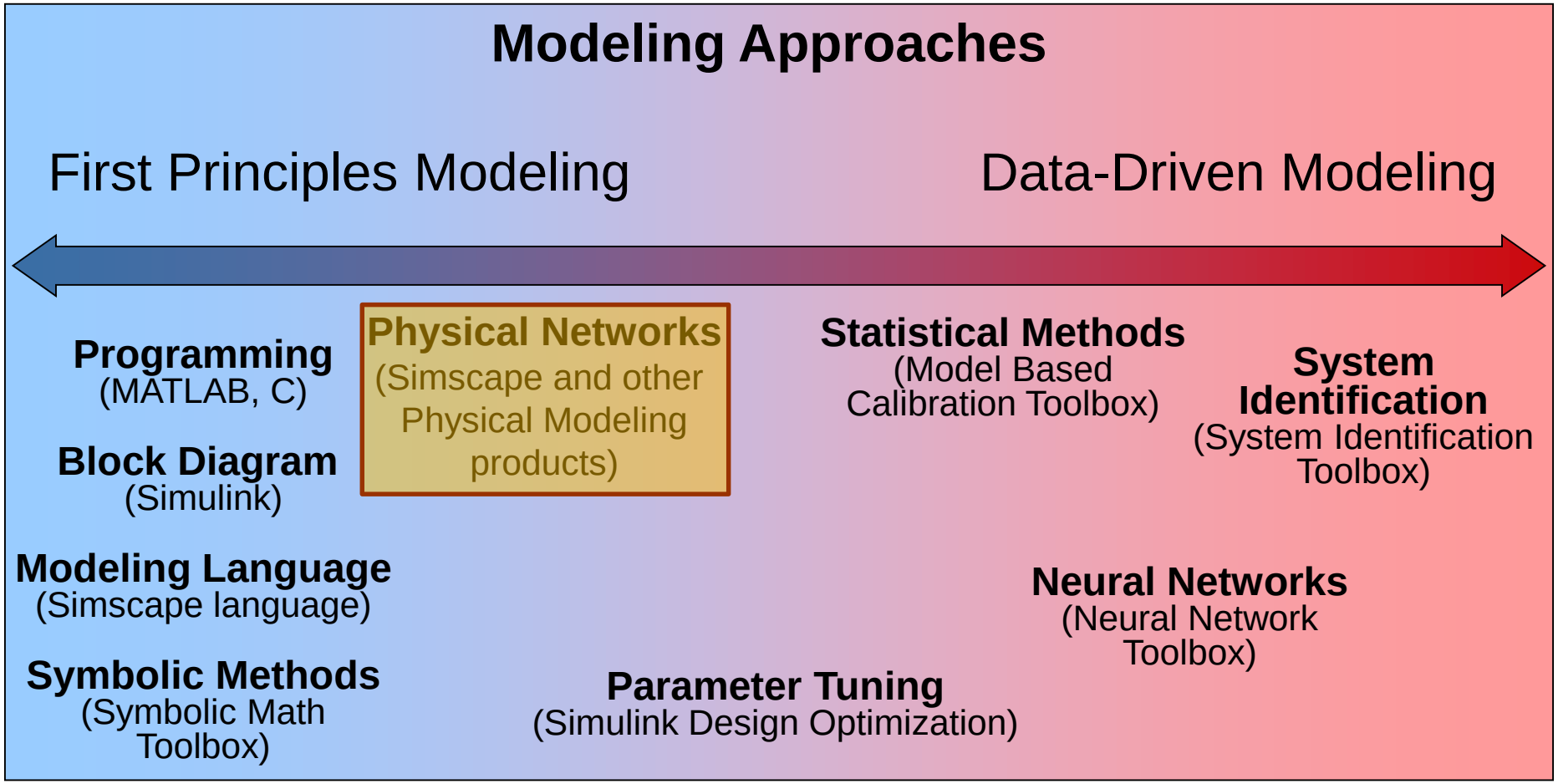
$$di / dt = 1 / L * (- R * i + V - K * w)$$
$$dw / dt = 1 / J * (Kt * i - T - b * w)$$

$$i = integral\{ 1/L * (- R * i + V - K * w)\}$$

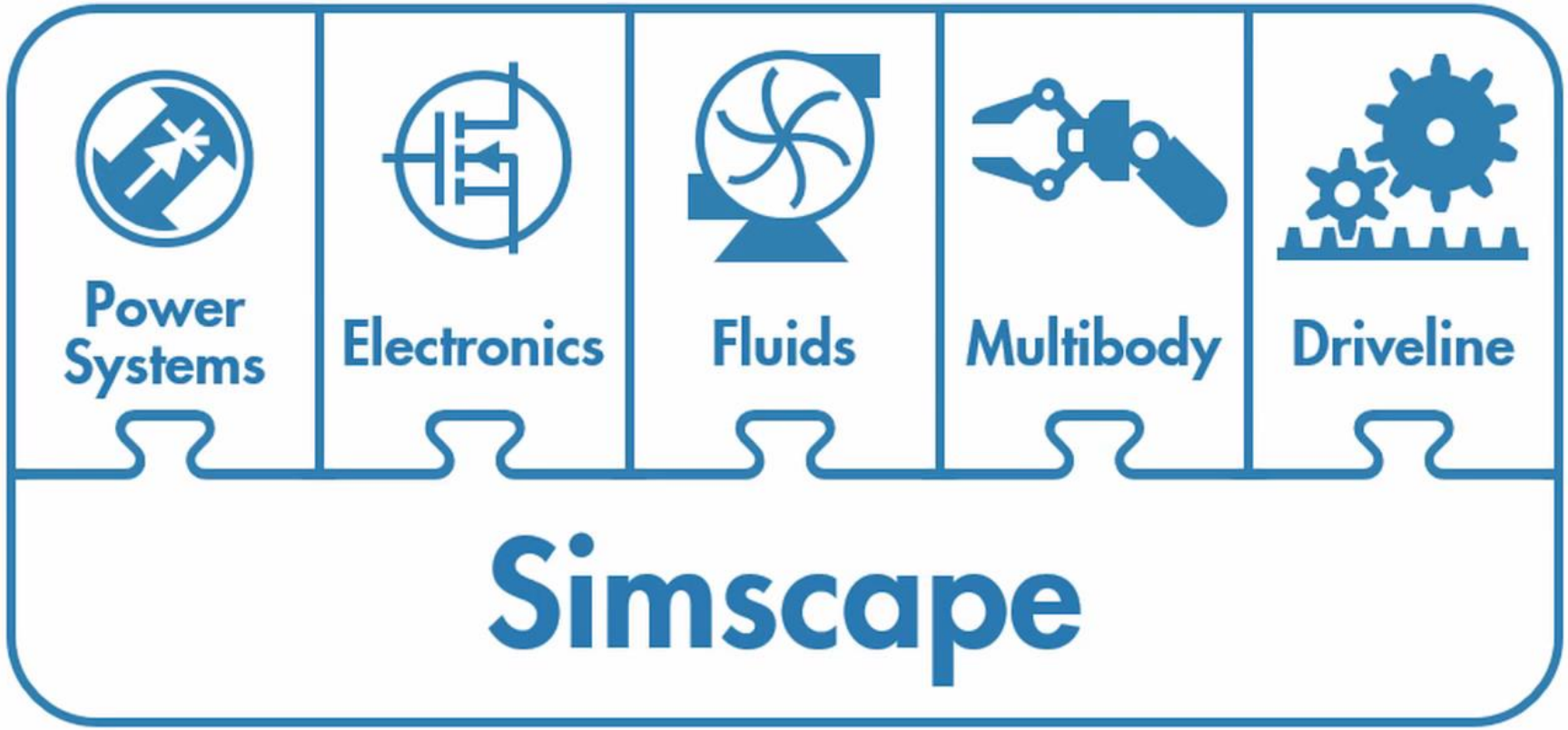
$$w = integral \{ 1/J * (Kt * i - T - b * w)\}$$



Different Approaches for Modeling Dynamic Systems

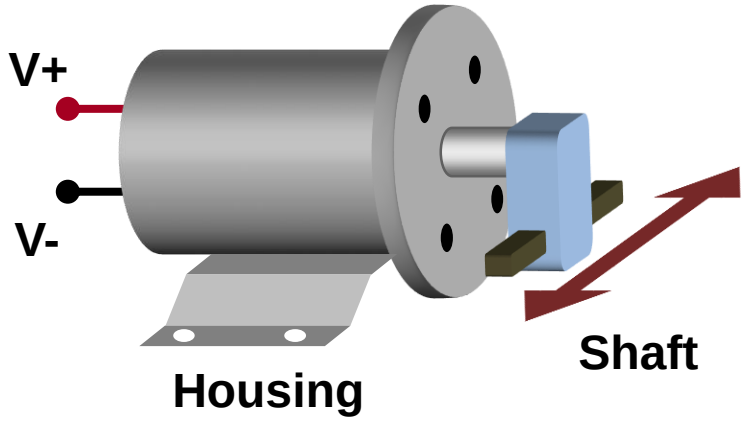


Introduction to Simscape



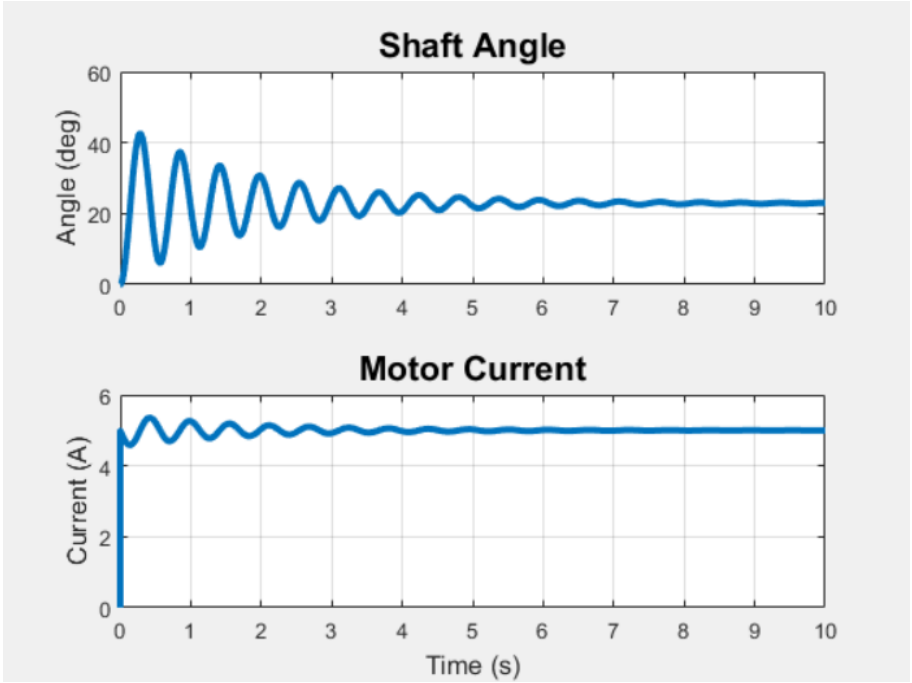
Modeling a DC Motor

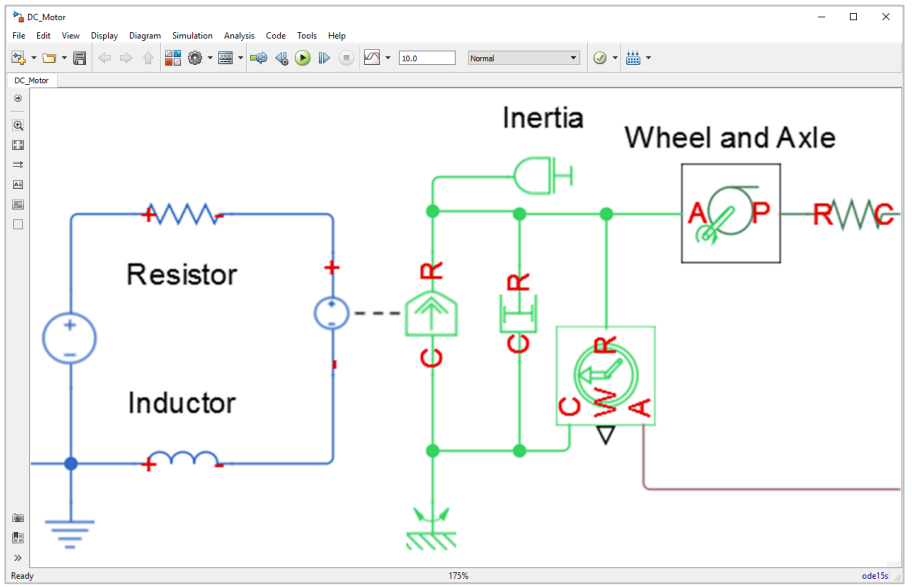
Model:



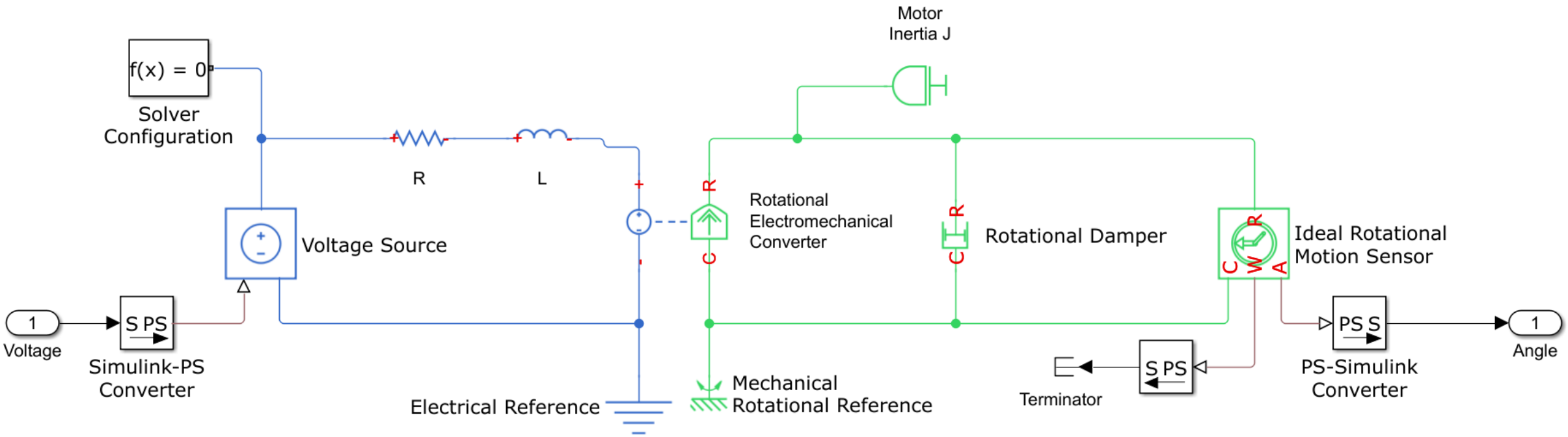
Problem: Model a DC motor with electrical and mechanical effects

Solution: Use Simscape to model the electromechanical system as a physical network





DC Motor in Simscape



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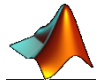
  - Various approaches of modeling
  - Example: DC motor



Model the Scissor Lift
  - Hydraulic actuation system
  - Mechanical System

- Developing control strategy

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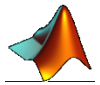
  -  Hydraulic actuation system
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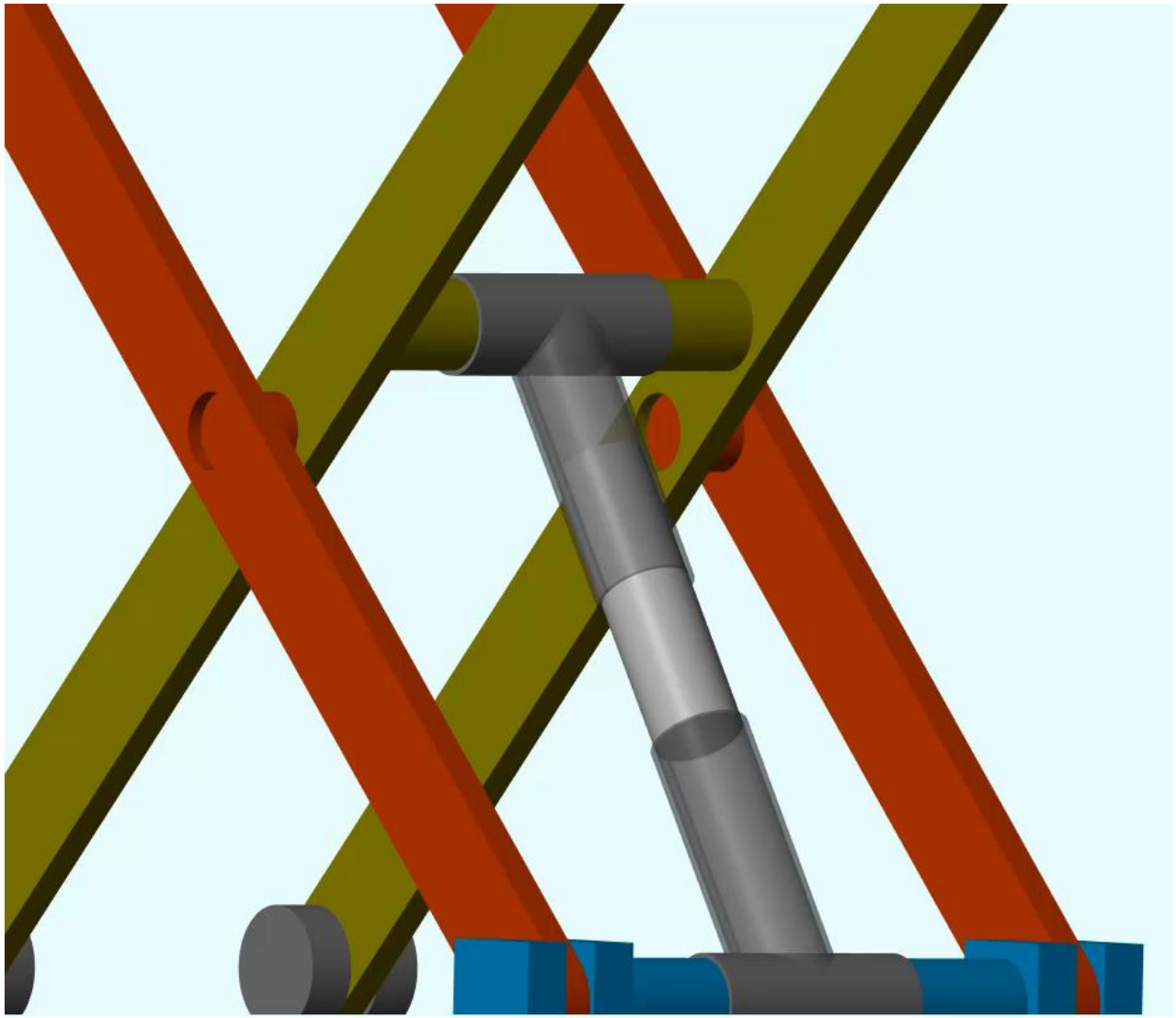
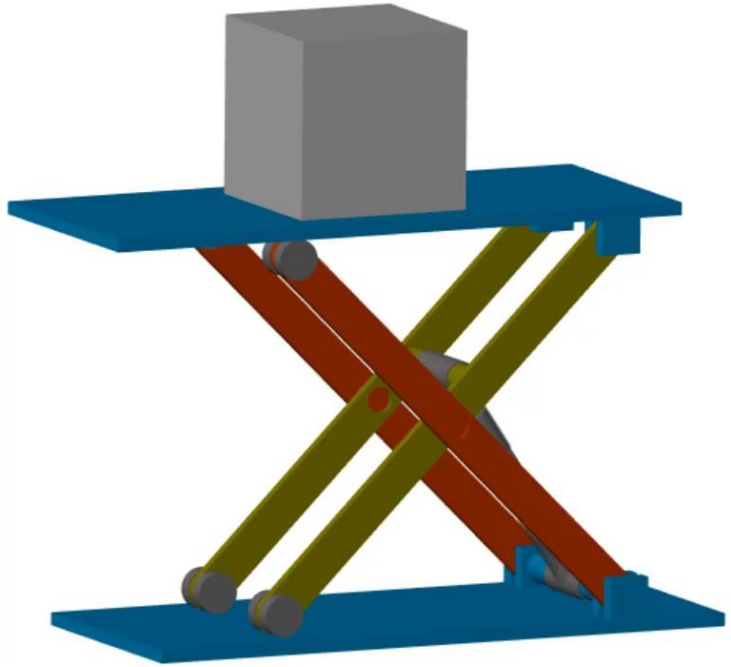
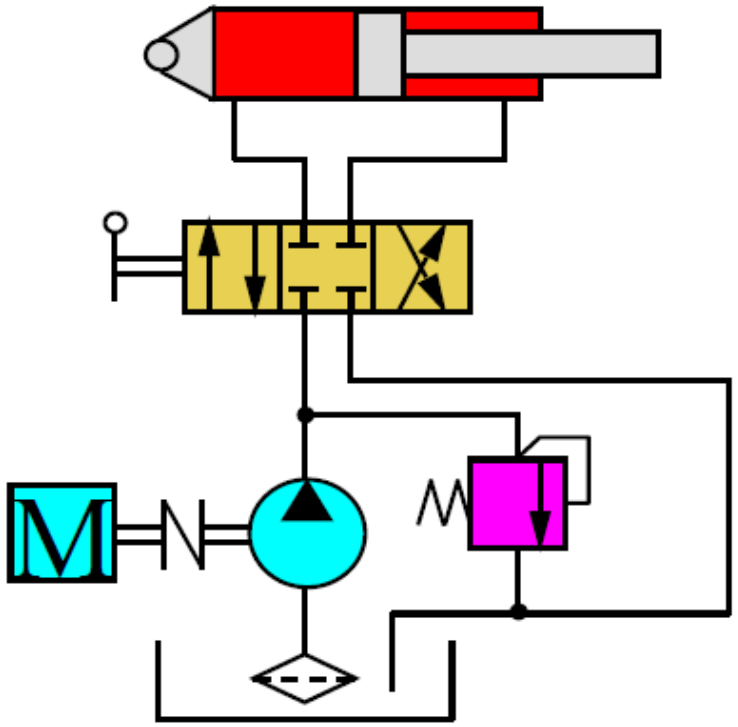
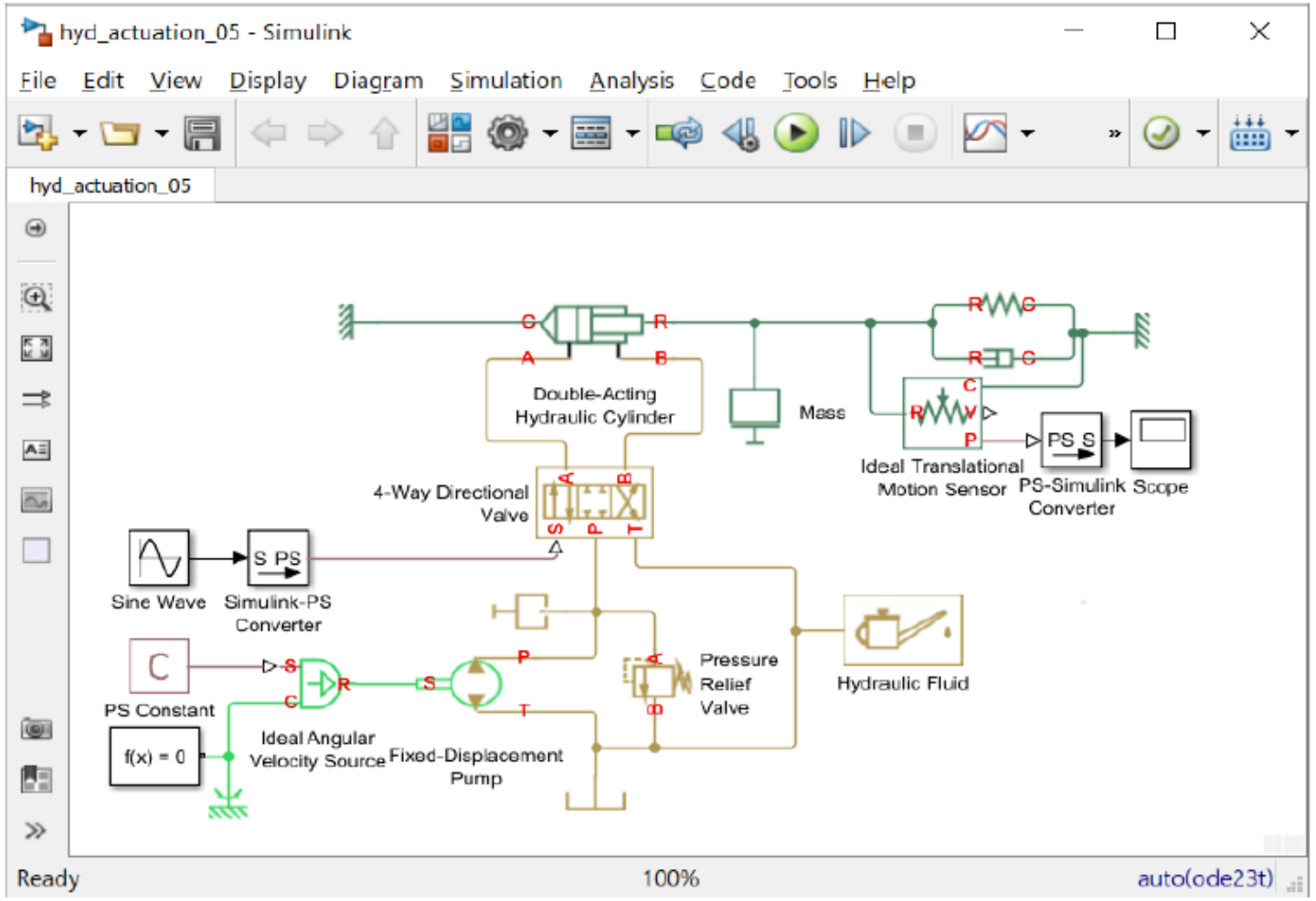
Hydraulic actuation





Hydraulic actuation circuit





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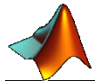
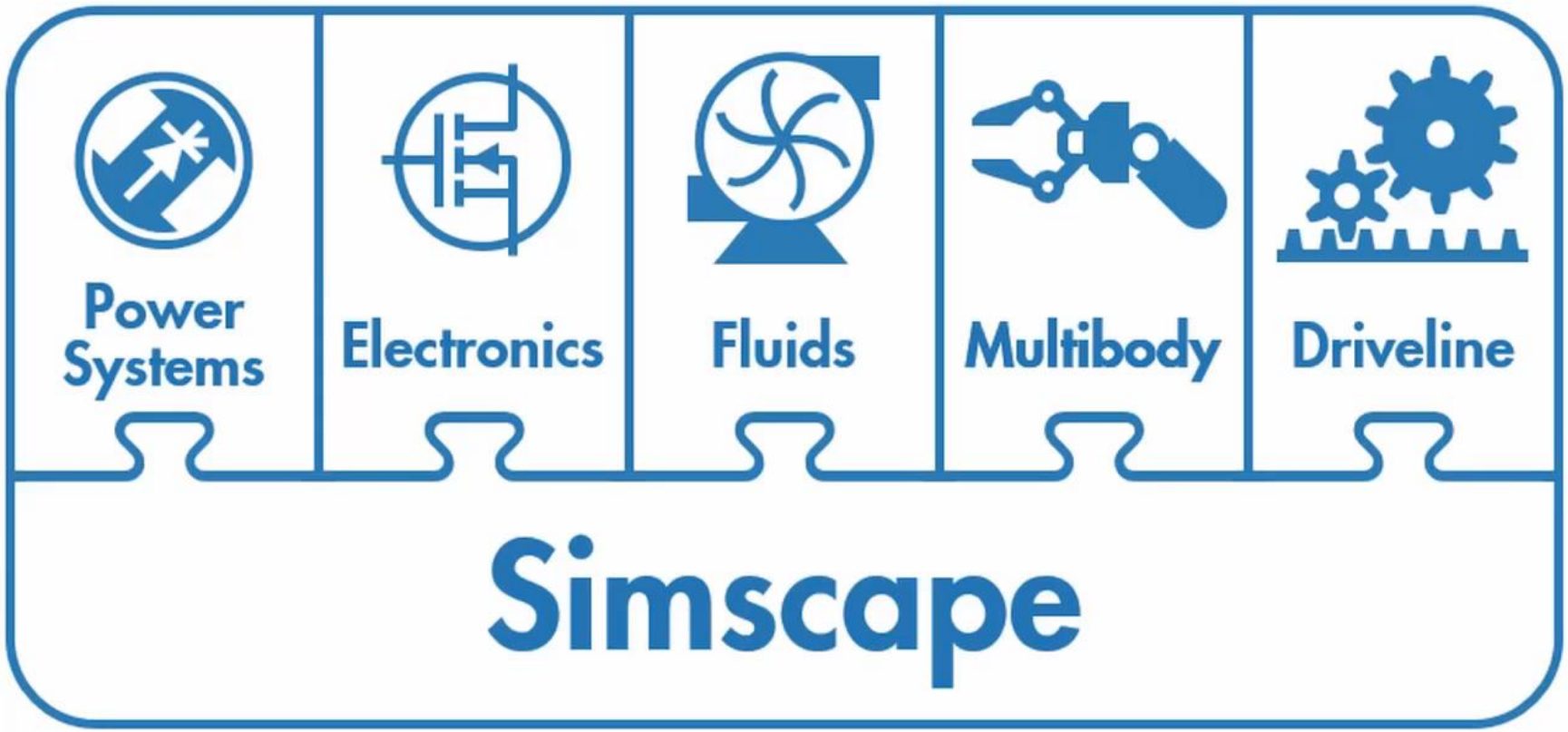
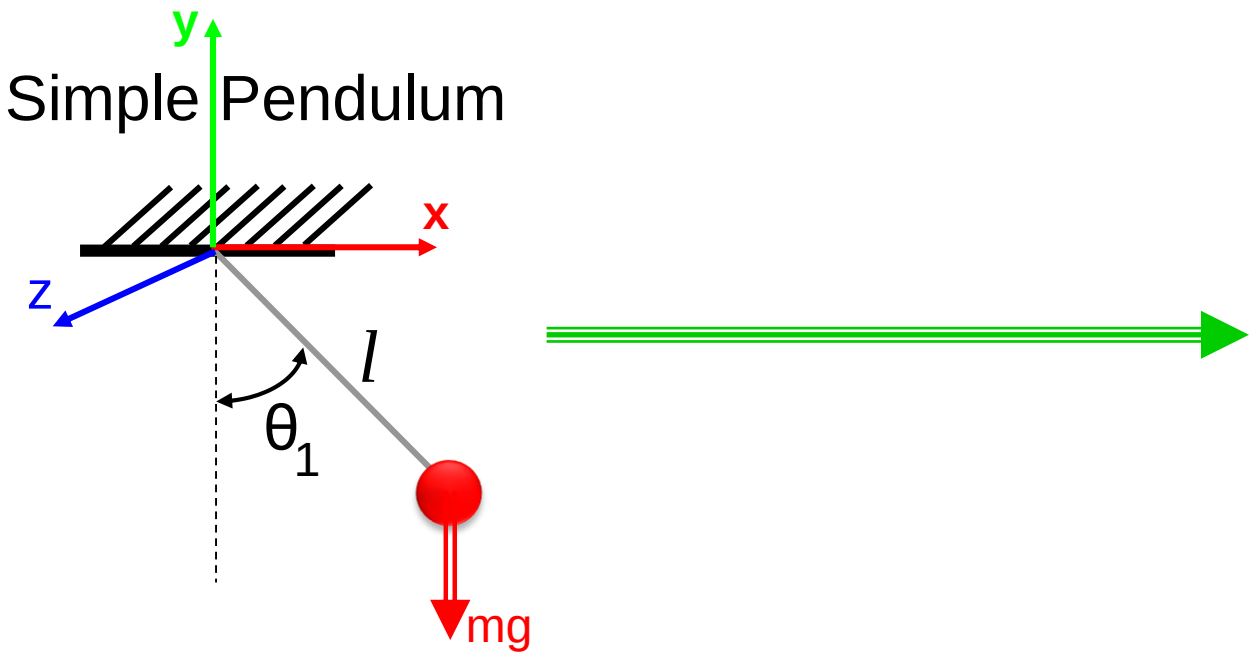
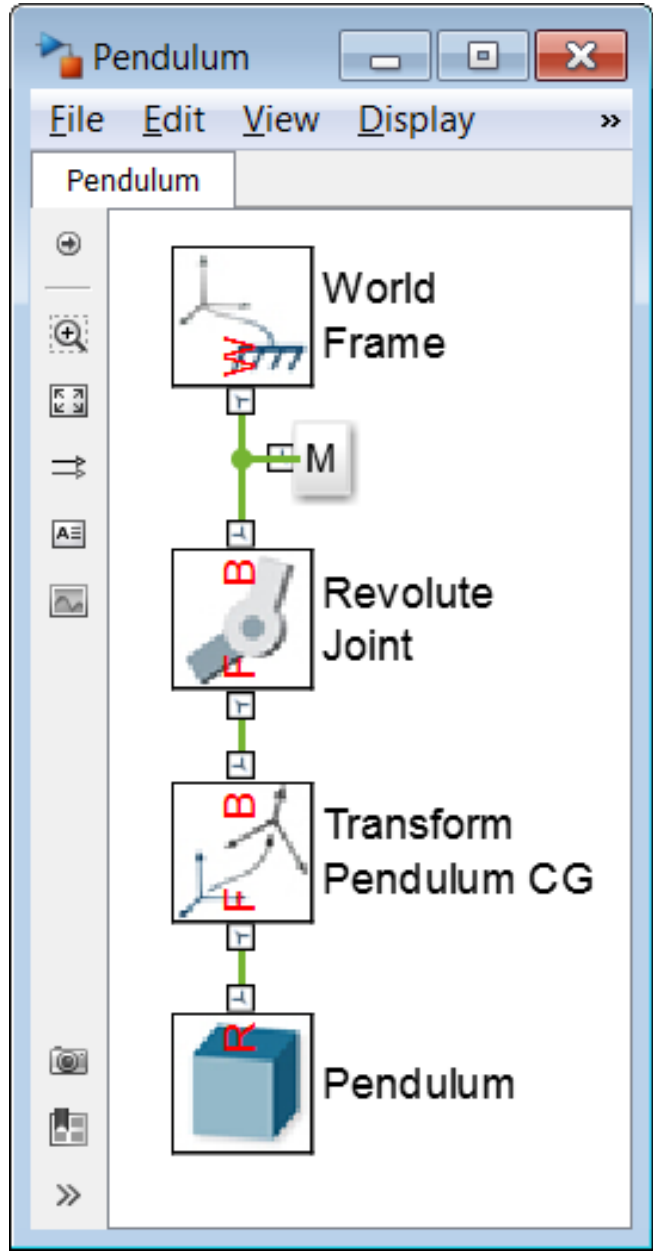
  -  Mechanical System
- Developing control strategy


Power Systems
Electronics
Fluids
Multibody
Driveline
Simscape

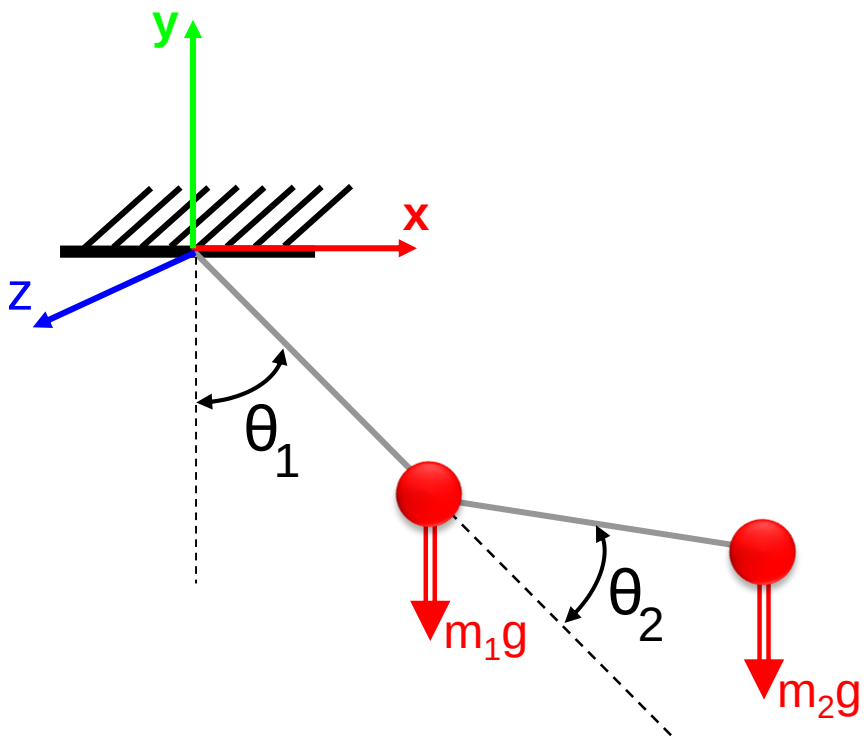
Example: Single Pendulum



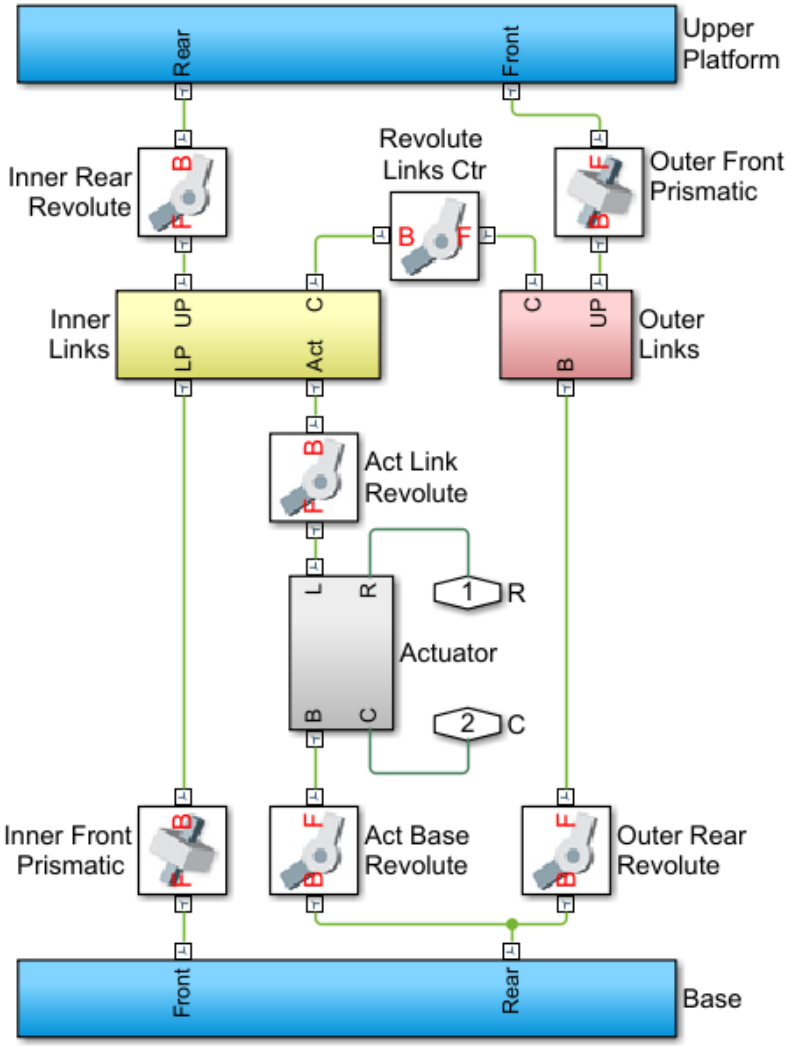


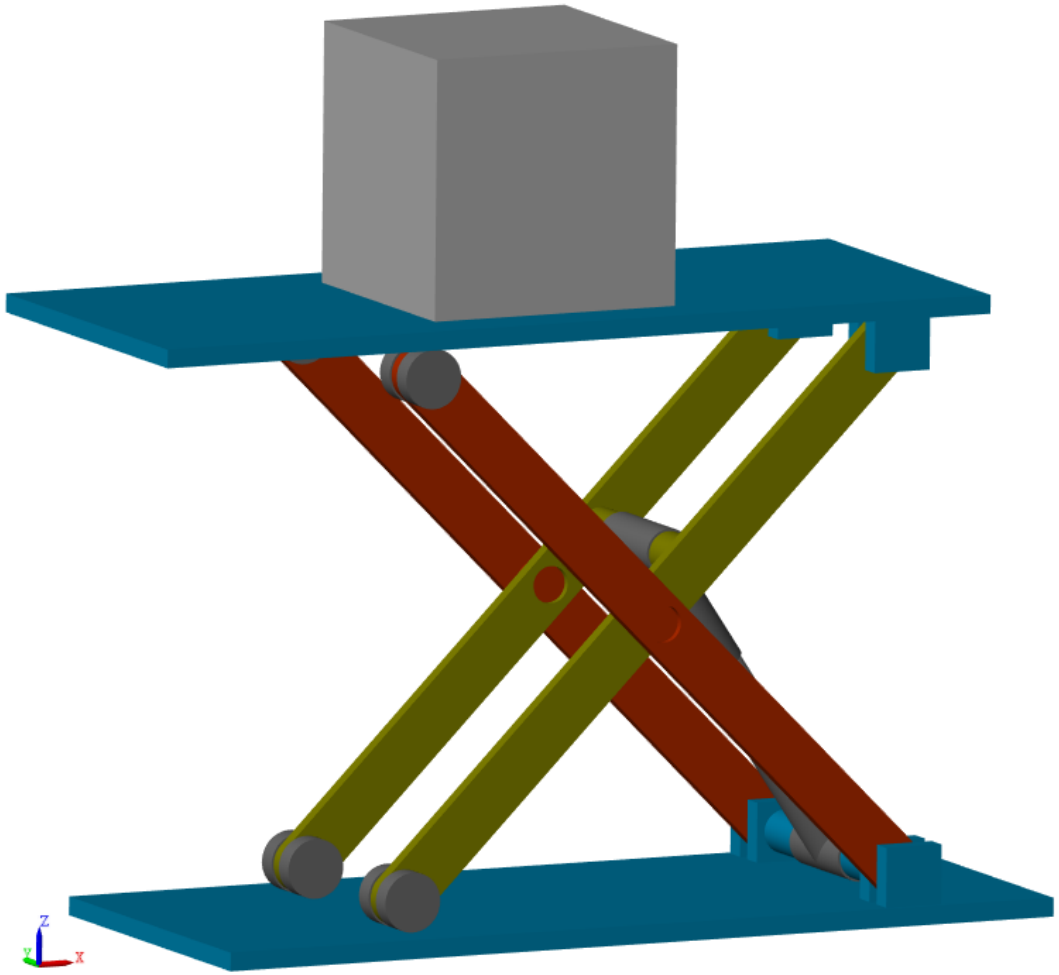
- Simscape Multibody model advantages
  - Easier to read than equations
  - Quicker to create
  - More intuitive – easier to explain to other engineers

Exercise: Double Pendulum



Mechanical system

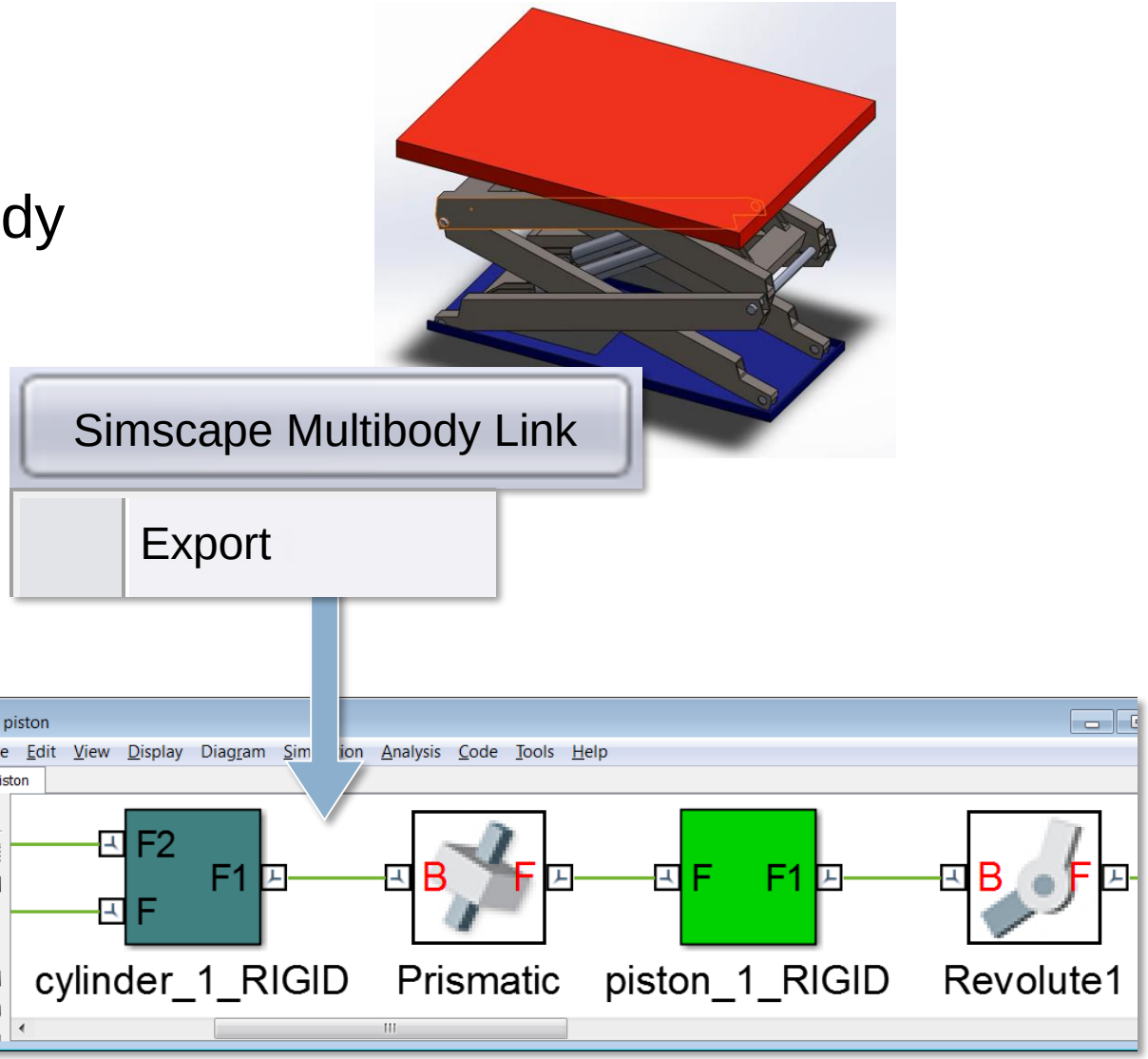




DEMO

Import CAD Data Using Simscape Multibody Link

- Automatically create Simscape Multibody models from a CAD assembly
  - Converts mass and inertia to rigid bodies
  - Converts mate definitions to joints
  - Creates STEP files for use with Simscape Multibody visualization
- Directly connects SOLIDWORKS, PTC Creo® (Pro/ENGINEER®) and Inventor
- Free download from **www.mathworks.com**
  - Requires MATLAB



Simscape Multibody Link:
Convert CAD Assembly to Simscape Mutibody

- Use Simscape Multibody Link plugin to export from CAD to XML
- Import XML file into Simscape Multibody (**`>> smimport`**)

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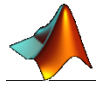

Developing control strategy

Call to action

- Aileron Actuator Development with Model-Based Design
- Modeling an Engine Cooling System

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% Thank you
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