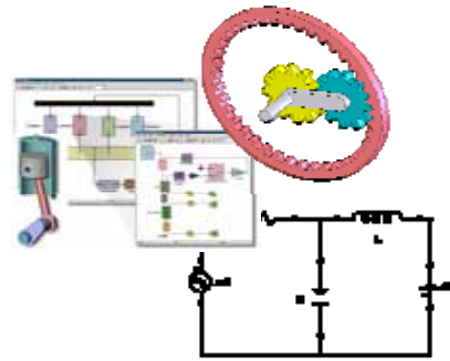


Modeling Multidomain Physical Systems in Simulink®

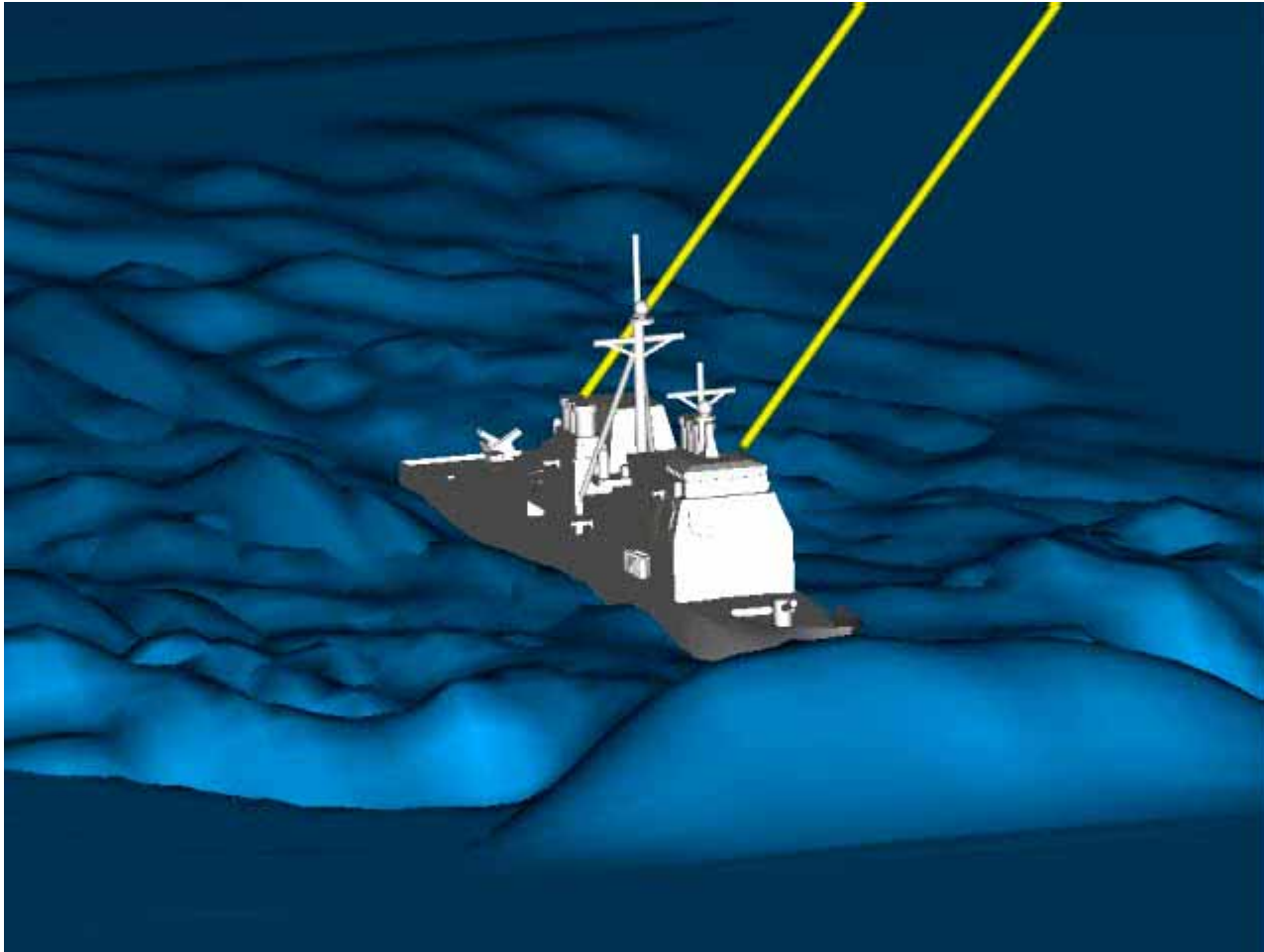
Terry Denery
Principal Applications Engineer
Motion Systems
The MathWorks



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Antenna Pointing

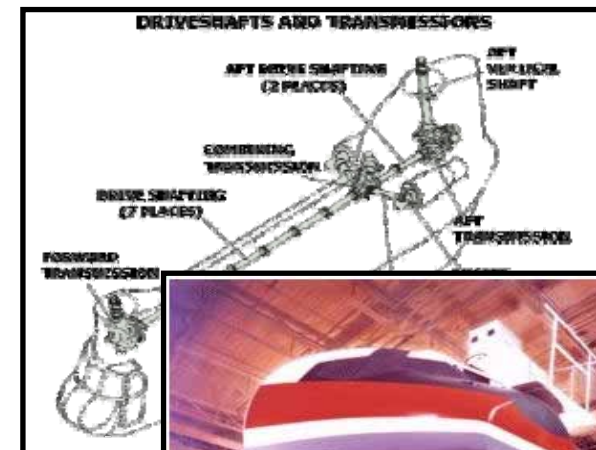
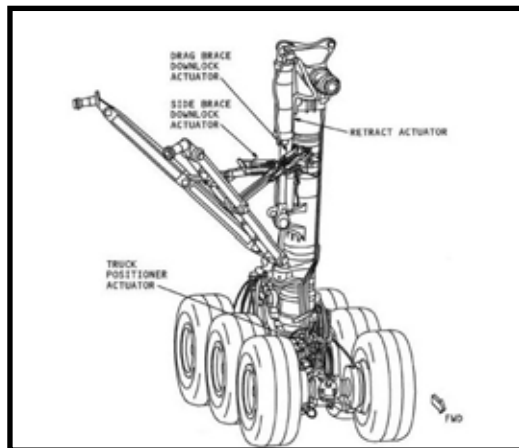


Mechanical Modeling in Simulink

- 3D Multi-Body Dynamics
- Driveline Mechanics

SimDriveline

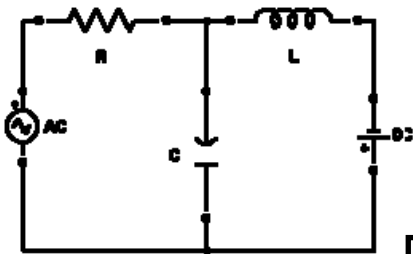
SimMechanics



Electrical Modeling in Simulink

- Electrical Circuits
- Motors and Actuators
- Power Systems

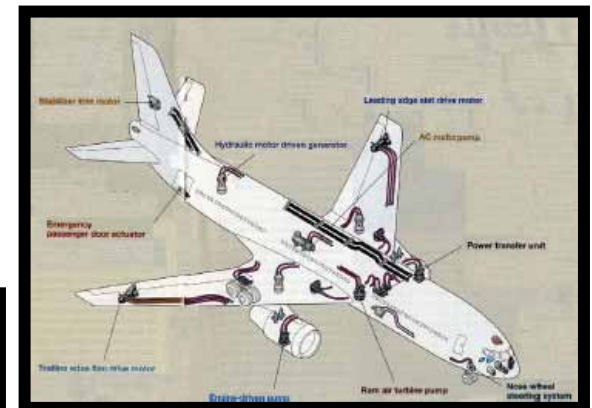
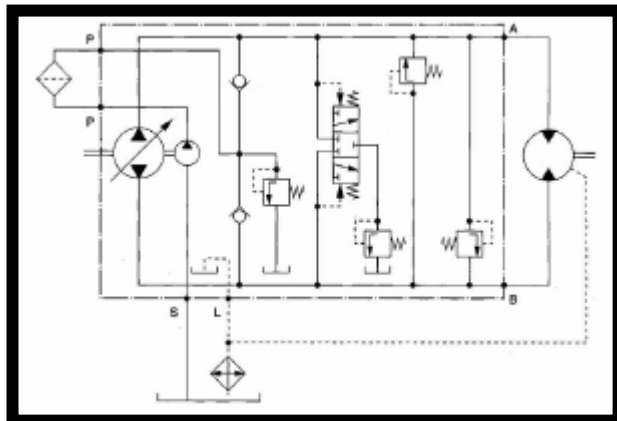
SimPowerSystems



Hydraulic Modeling in Simulink

- Hydraulic Circuits
- Motors and Actuators
- Power Systems

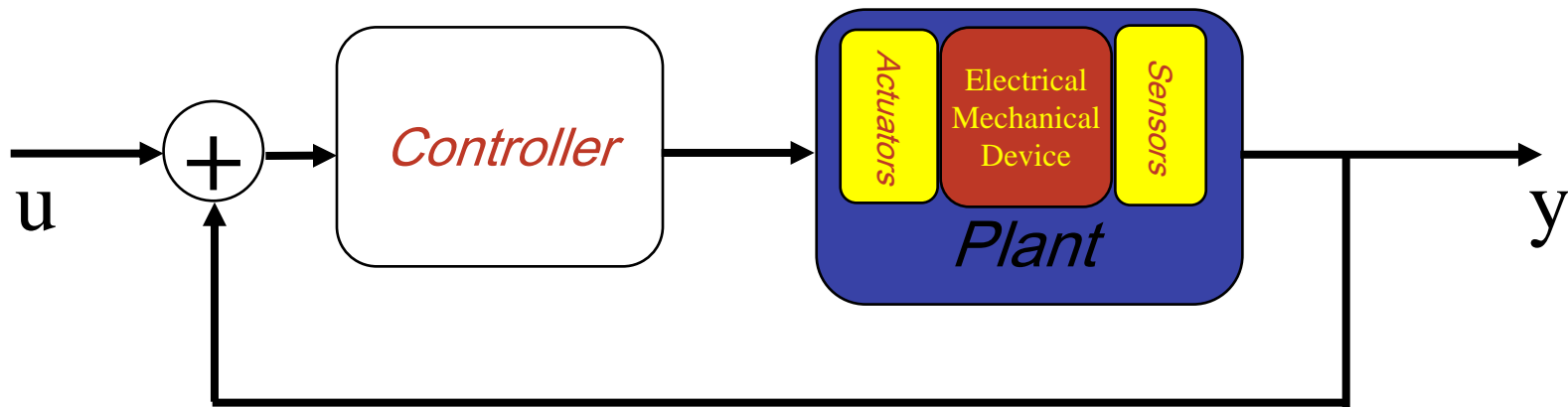
SimHydraulics



Control Software and Physical System Come Together in Simulink

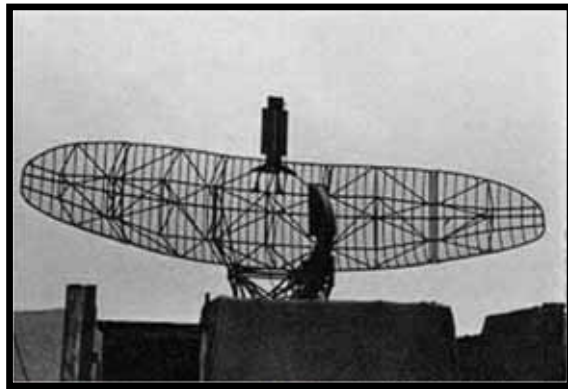
- Rich modeling environment
 - Physical
 - Behavioral
 - Data-driven
- Control system development tool
 - One environment for controller and plant
 - Code generation enables HIL testing
 - Easy access to control tools

Physics-Based Modeling Methods Improve Control System Design

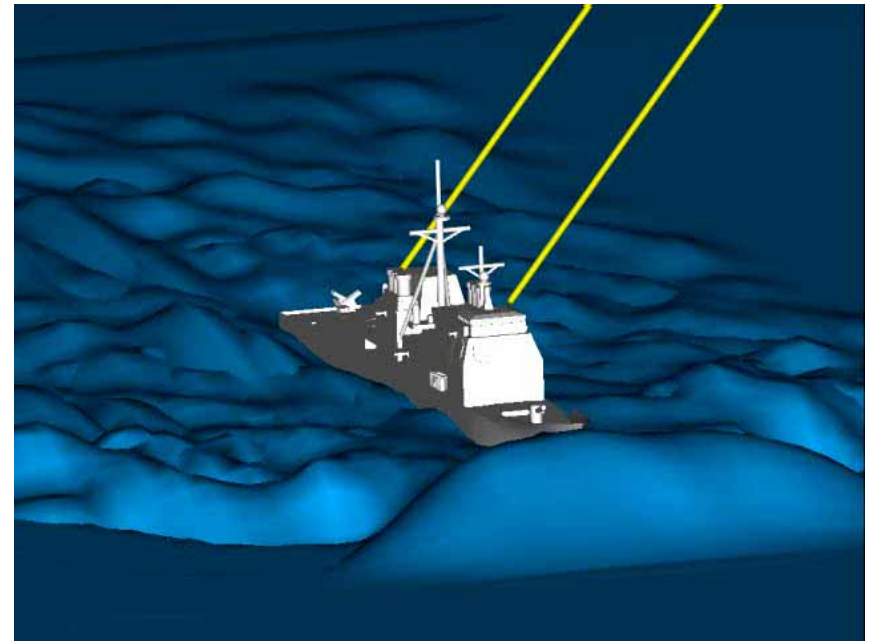


- Multidomain systems (mechanical, electrical, hydraulic, chemical, . . .)
- Successful controller development requires thorough and accurate understanding of plant

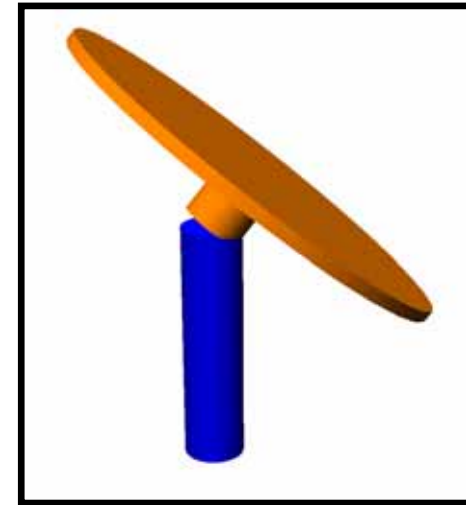
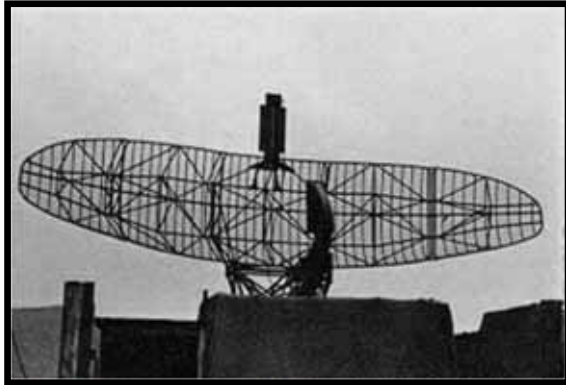
Simulation of Antenna Pointing



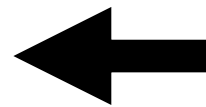
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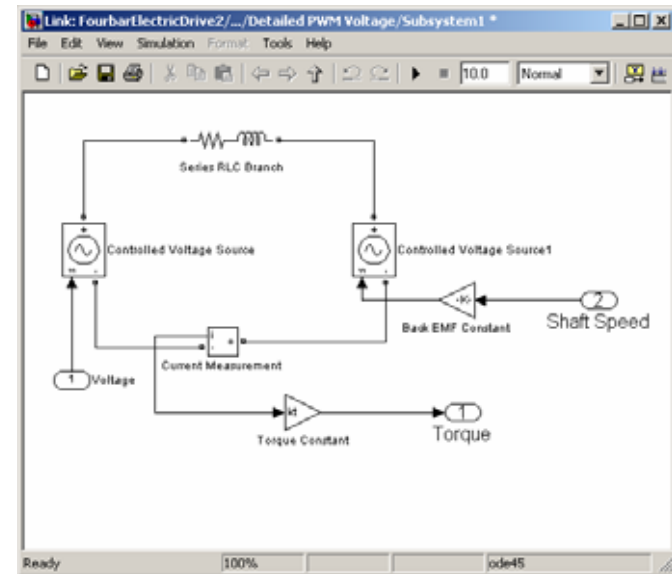
Antenna System



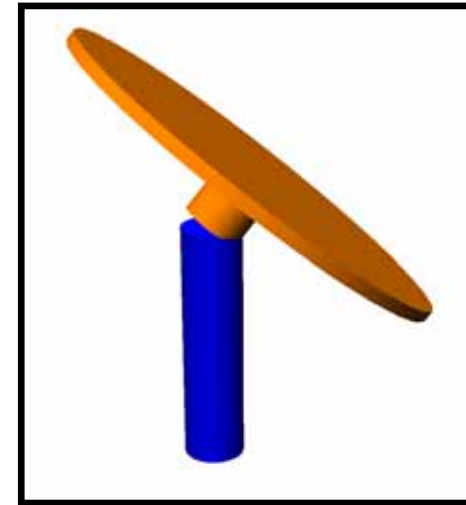
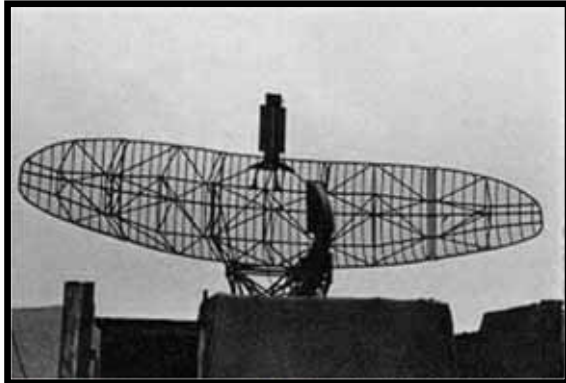
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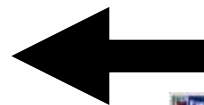
Electrical-Mechanical Motion System



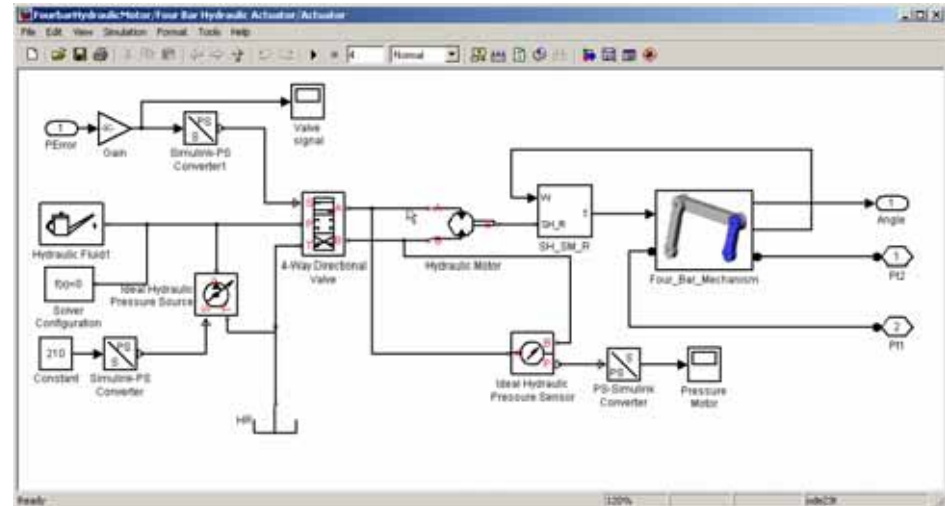
Antenna System



+



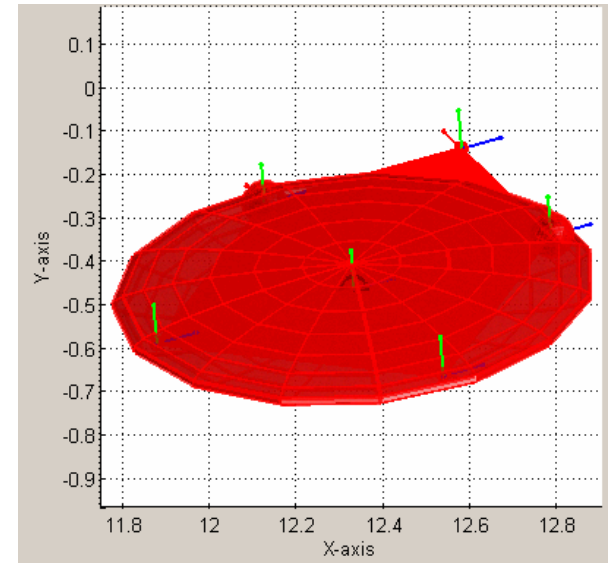
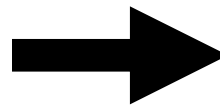
Hydraulic-Mechanical Motion System



Motion Platform



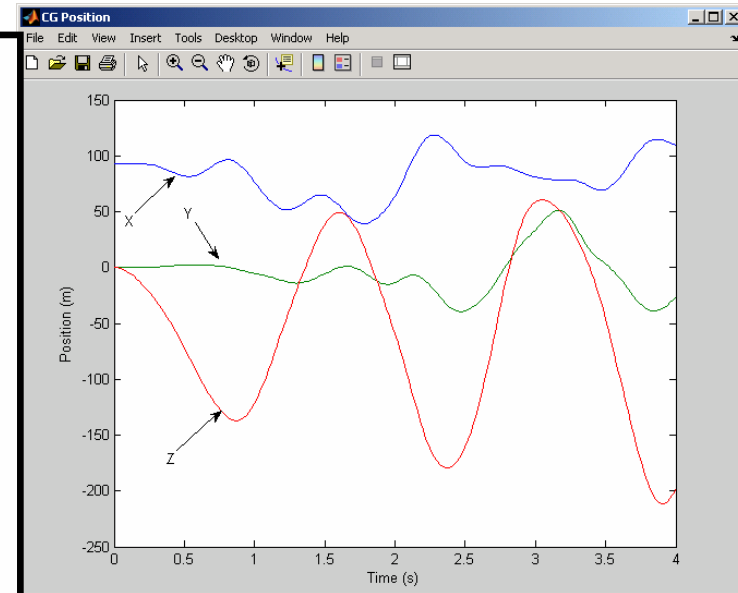
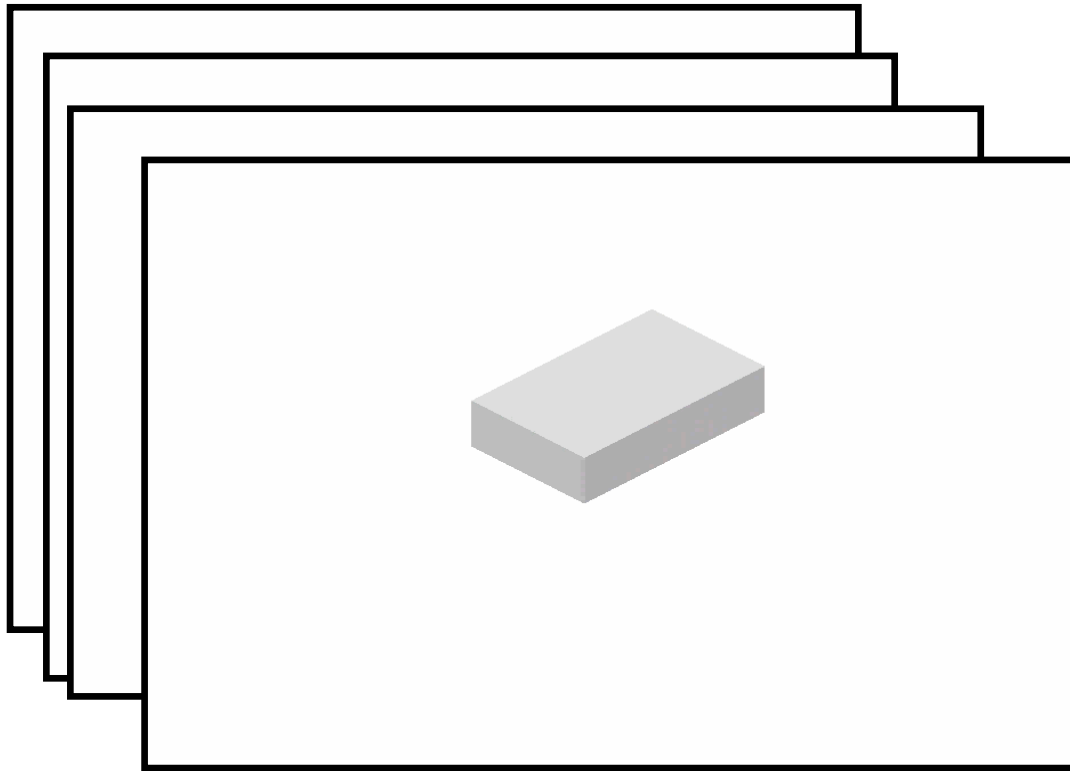
Accelerometer
Measurements



Real boat

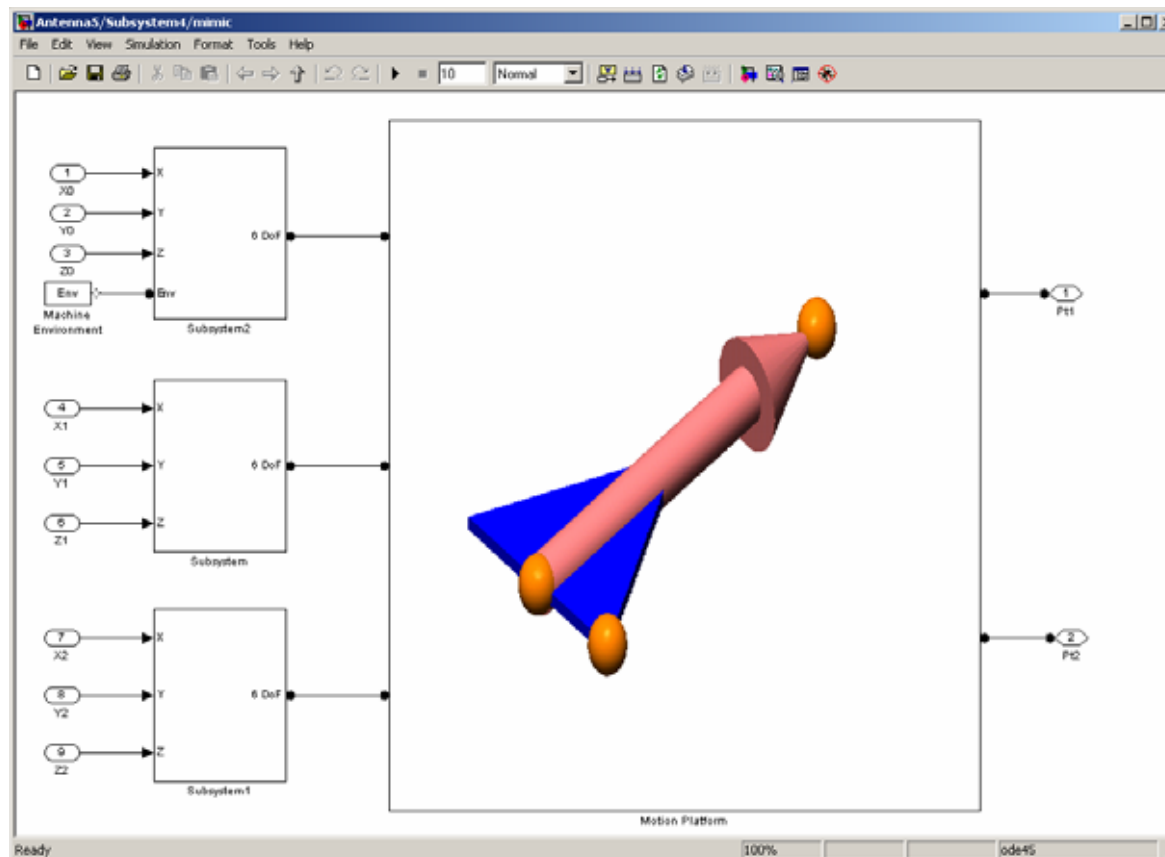
Simulation

Reconstructing Motion

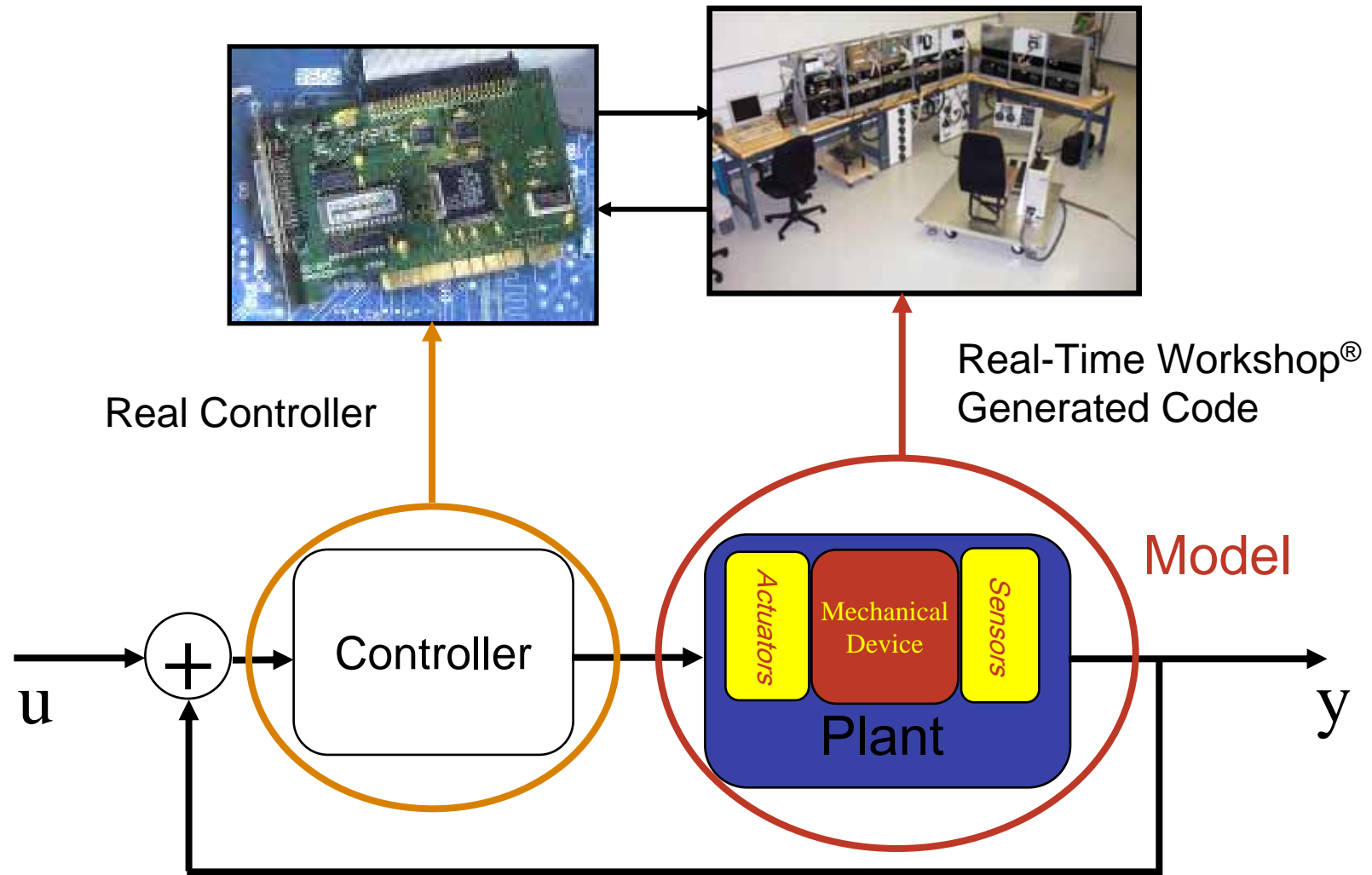


Three non-collinear points define position and orientation.

Reading Motion Data into SimMechanics



Hardware in the Loop (HIL)



Lockheed Martin Space Systems Uses SimMechanics with a Real-Time Simulator to Automate Mars Reconnaissance Orbiter Development

The Challenge

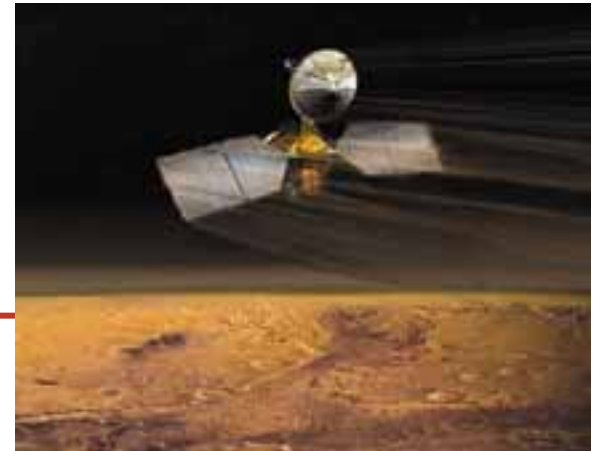
To develop the guidance, navigation, and control system for the Mars Reconnaissance Orbiter

The Solution

Use MathWorks tools to accelerate control design and automate the development of accurate, real-time spacecraft simulations

The Results

- Spacecraft pointing simulation modeled in days
- Interorganization communication improved
- Efficient code generated automatically



Artist rendition of Mars Reconnaissance Orbiter (image courtesy of NASA).

“Simulink®, SimMechanics, and Real-Time Workshop enabled us to autonomously go from an accurate CAD model of the MRO vehicle into C code that runs in real time.”

**Jim Chapel,
Lockheed Martin Space Systems**