

# Plant Modeling for Powertrain Control Design

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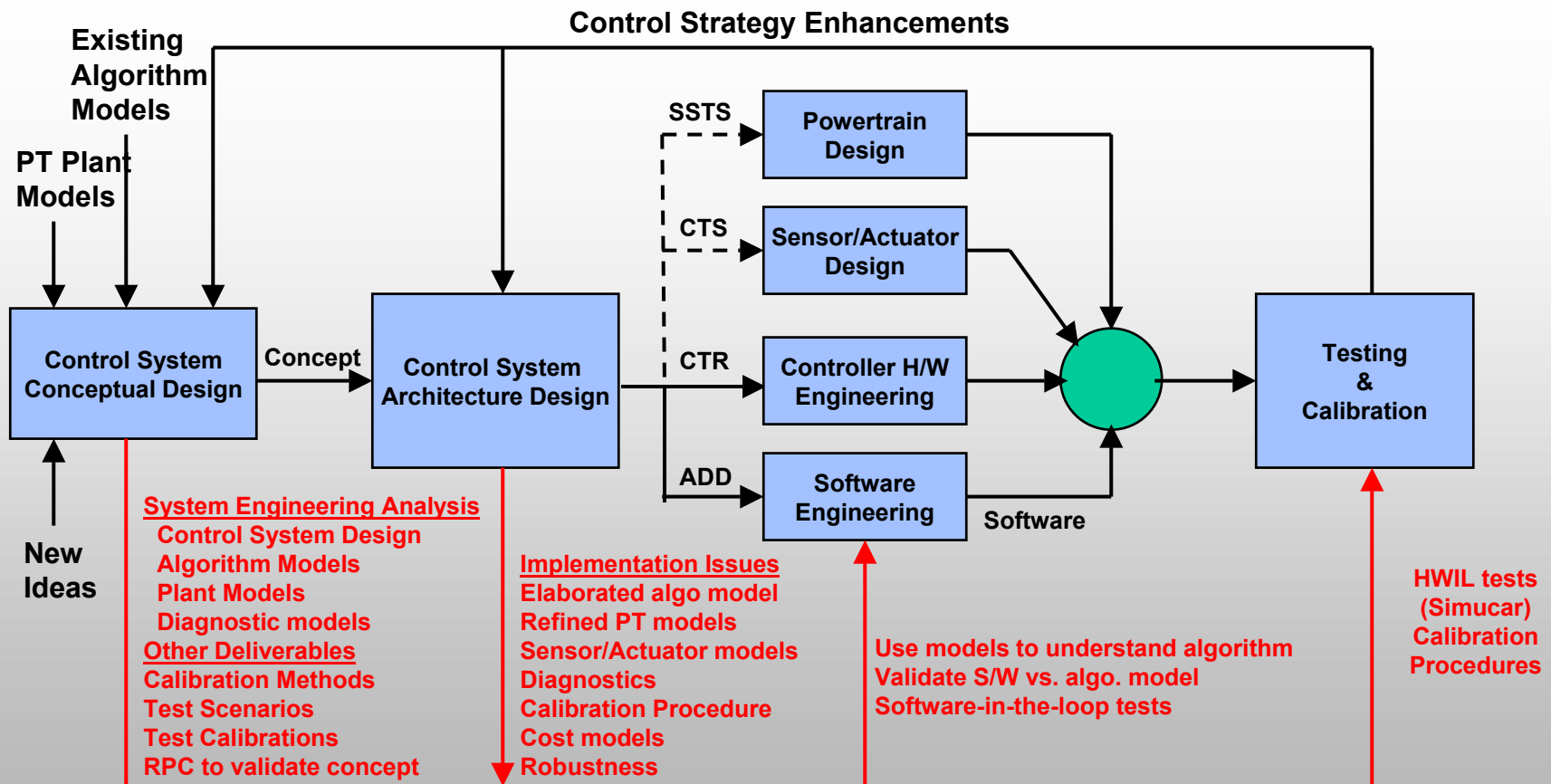
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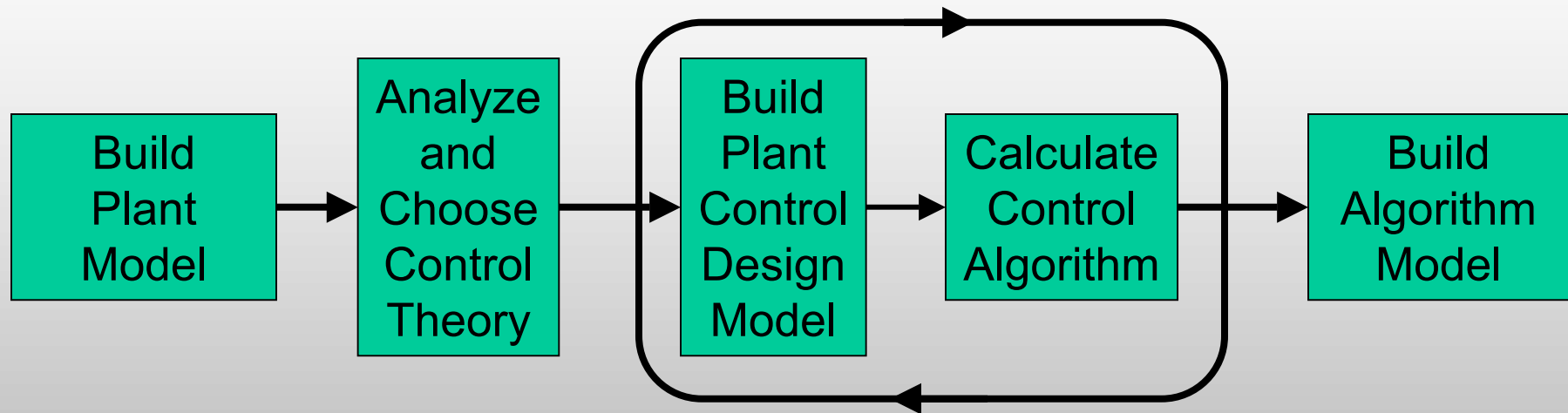
# Challenges in PT Control Design

- Control System Design starts late
  - Rush to develop algorithm and write code
  - Minimum opportunity to influence hardware
  - Sensors & actuators may already be determined
  - Cost is always a major factor
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# Model-Based PT Control Design Process



# Control Algorithm Design Process



# Types of Models

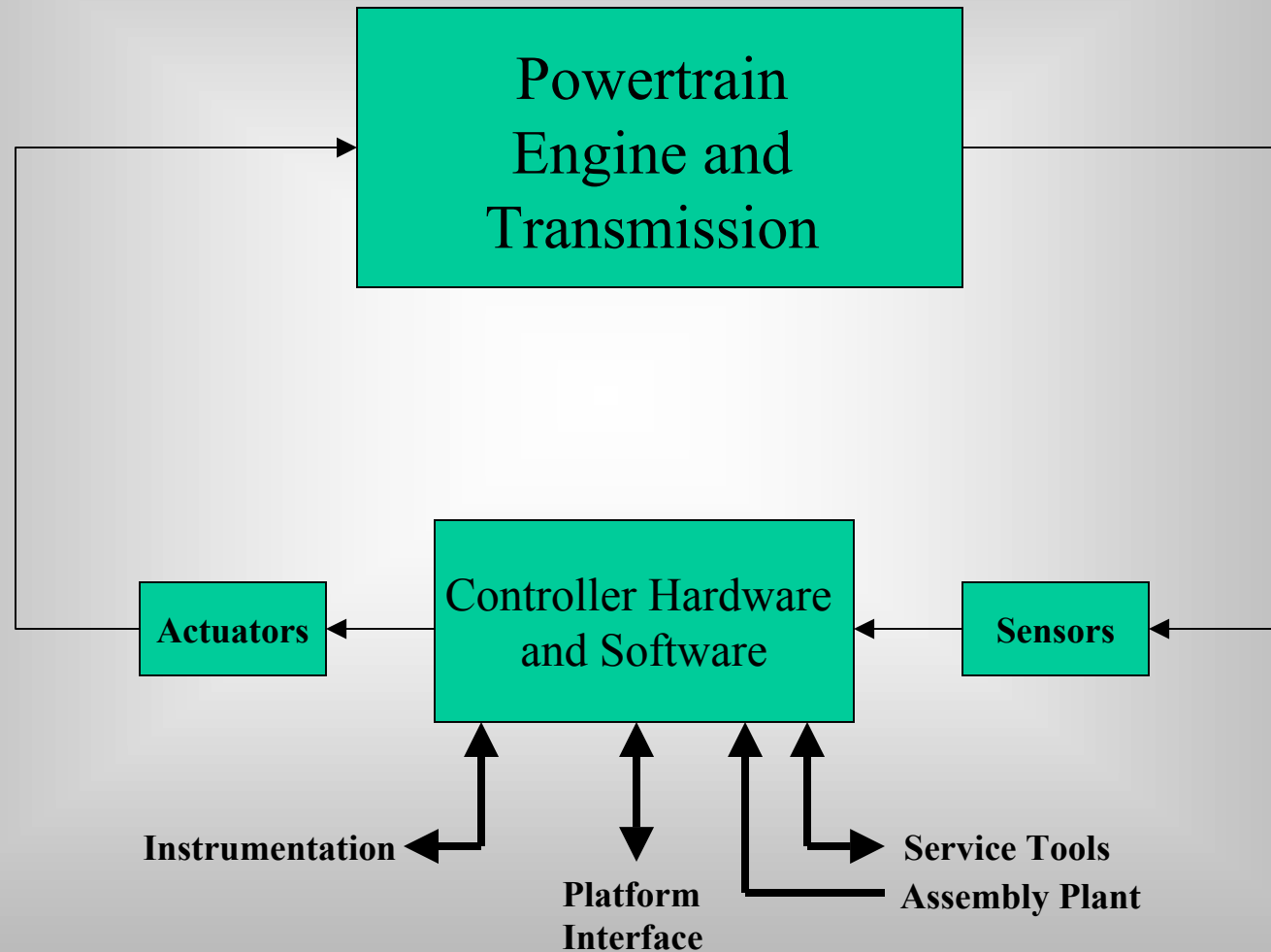
- Plant - physical system that is a major PT element of interest in a control problem, e.g., engine, transmission, EGR subsystem. It typically includes actuators, sensors, controller circuitry, wiring and environment
- Plant Model - physics-based or behavioral math model built to understand the problem and represent the dynamics of the system being controlled
- Plant Control Design Model - simplified plant model used to develop control algorithm via Control Theory, usually linearized model, possibly created from experimental data (System Identification)
- Algorithm Model - executable representation of an algorithm - equations, data flow diagram, state charts

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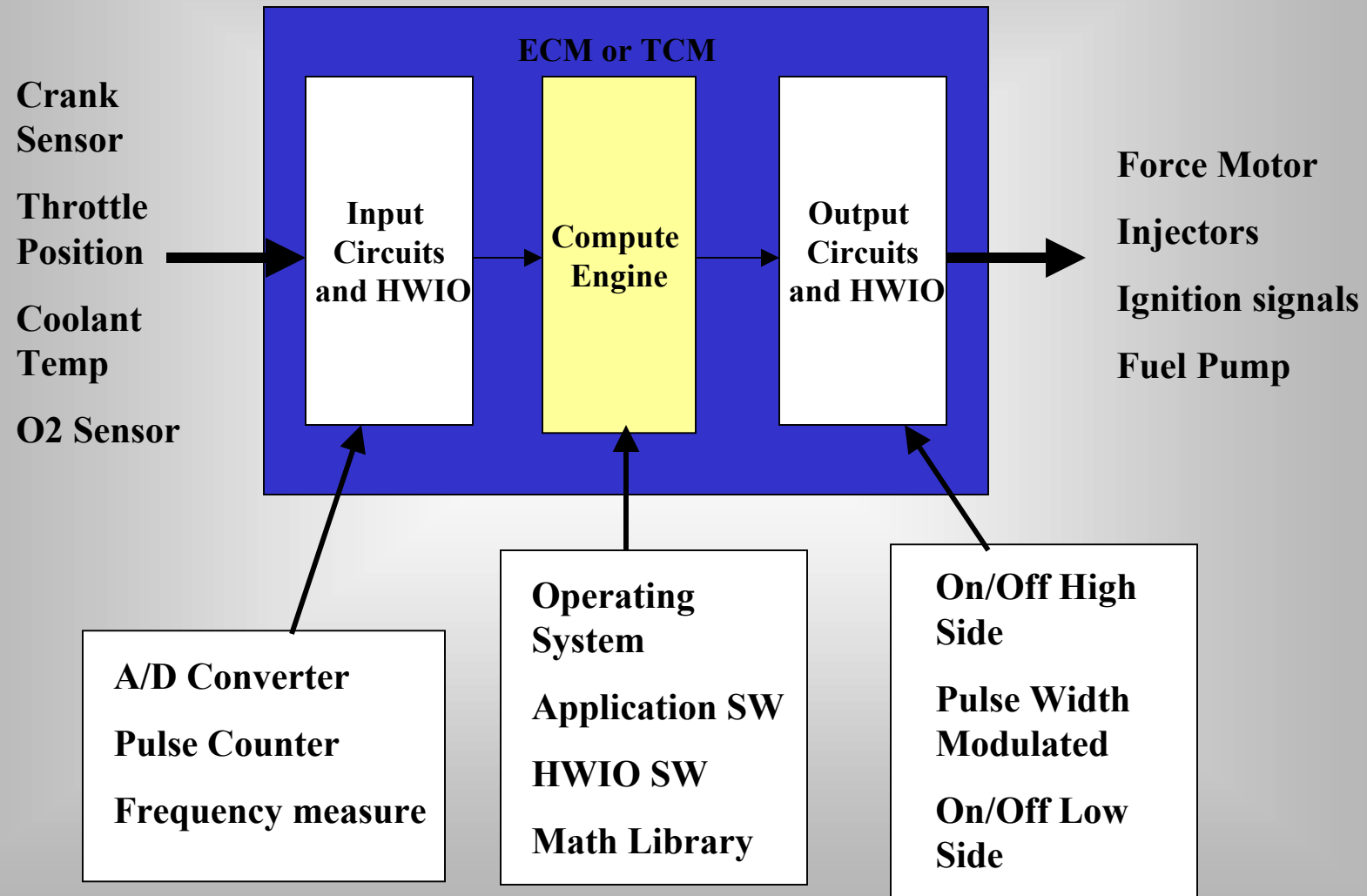
# Plant Modeling Issues

- Plant models may take long to develop
  - Many different models needed
    - Problem dependent
    - Fidelity and complexity
  - No standard plant model architecture
  - Need to validate model vs. hardware
  - Desire to reuse models
  - Different tools being used
  - Sensors, actuators, signal delivery system important
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# Powertrain Control System Block Diagram



# Controller Hardware & Software





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# Plant Modeling Strategies

- Specific model for problem-at-hand
  - One-size-fits-all model
  - Reconfigurable models for levels of complexity
  - Causal vs. a-causal models
    - Data flow diagrams
    - Topological models
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# Plant Modeling Tool Requirements

- Co-simulation with other tools
    - detailed engine & transmission models
    - algorithm models
    - sensor & actuator models
    - calibration tools
  - Capable of real-time simulation for HIL
  - Support for various levels of fidelity
    - e.g., model order reduction
  - Modular structure
  - Easily validated and correlated
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# Plant Modeling Tool Requirements

- Compatible with CM and version control tools
  - Support for libraries
  - Parametric configuration facilities
  - Enterprise support
    - documentation, readability, portability
  - Supports software-in-the-loop
  - Scripting capability
  - Web interface
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