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# Control System Design: From Concepts to Practice

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# Outline of the Course

Introduction

- I. Concepts and Tools**
- II. Design Methods**
- III. Problem Solving**
- IV. Advanced Techniques**
- V. Practical Optimization**

Hands on Experience w/ Matlab/Simulink

# I. Introduction

- What is Control?
- Examples
- History
- Questions
- Matlab/Simulink

# System Engineering

- Information
  - Information Processing
  - Communication
- Control
- Operation Research

# Control System

- Dynamic Process  
Mechanical, Electrical, Biological, ...
- Sensor and Actuator
- Controller  
Mechanical, Electrical (Analog, Digital)

# Control Theory

- Science
- Engineering
- Technology
- Art

# Open or Closed Loop ?

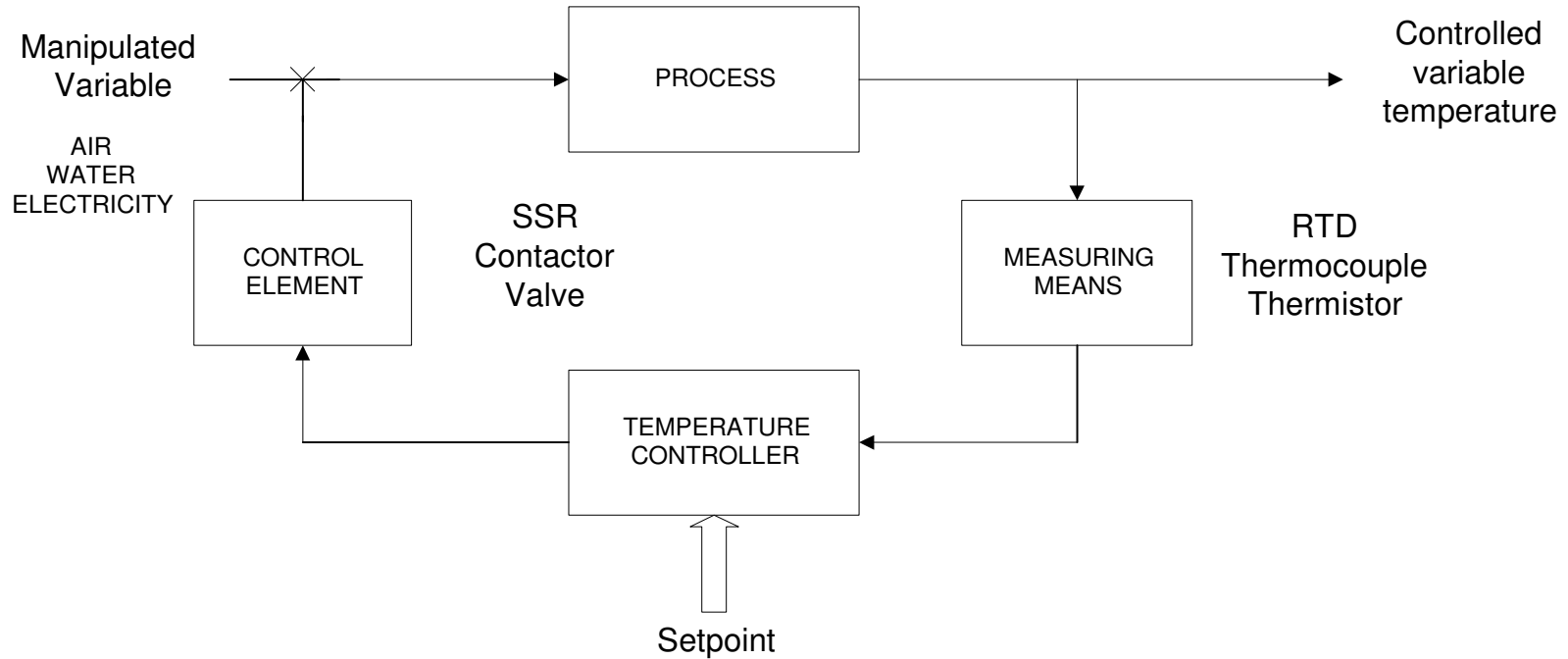
- Feedback(Automatic) Control Examples
  - Fluid Level Control
    - Measure the fluid level
    - Compare it to the desired one
    - Turn on or turn off the valve(s)
  - Oven, Refrigerator, Human Body
- If not feedback, what?
  - Open Loop
  - Actuation is INDEPENDENT of the output
  - Popup Toaster, Stepper Motor

# Control Objectives

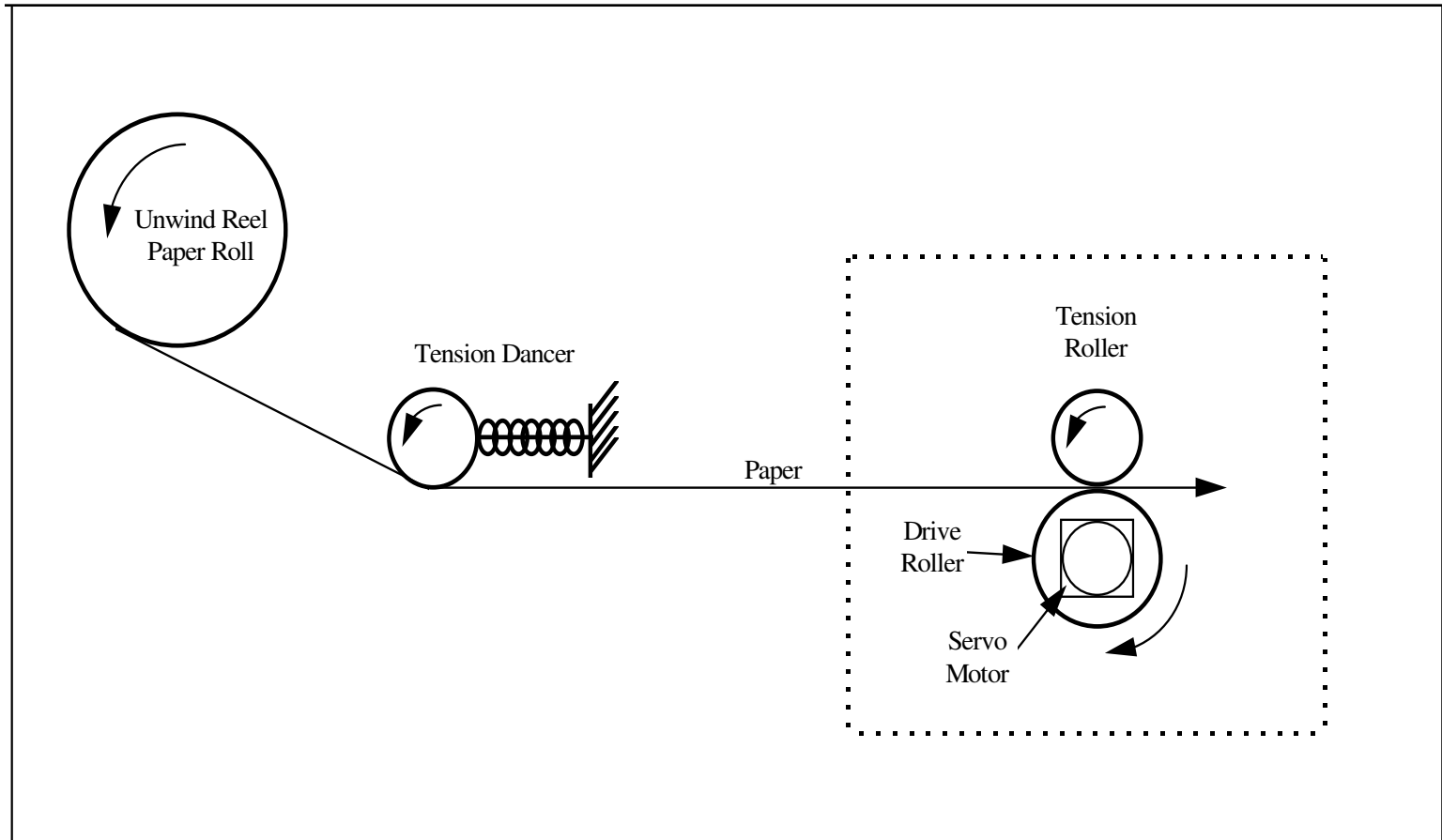
- Regulator
- Servo
- Sequential Logic



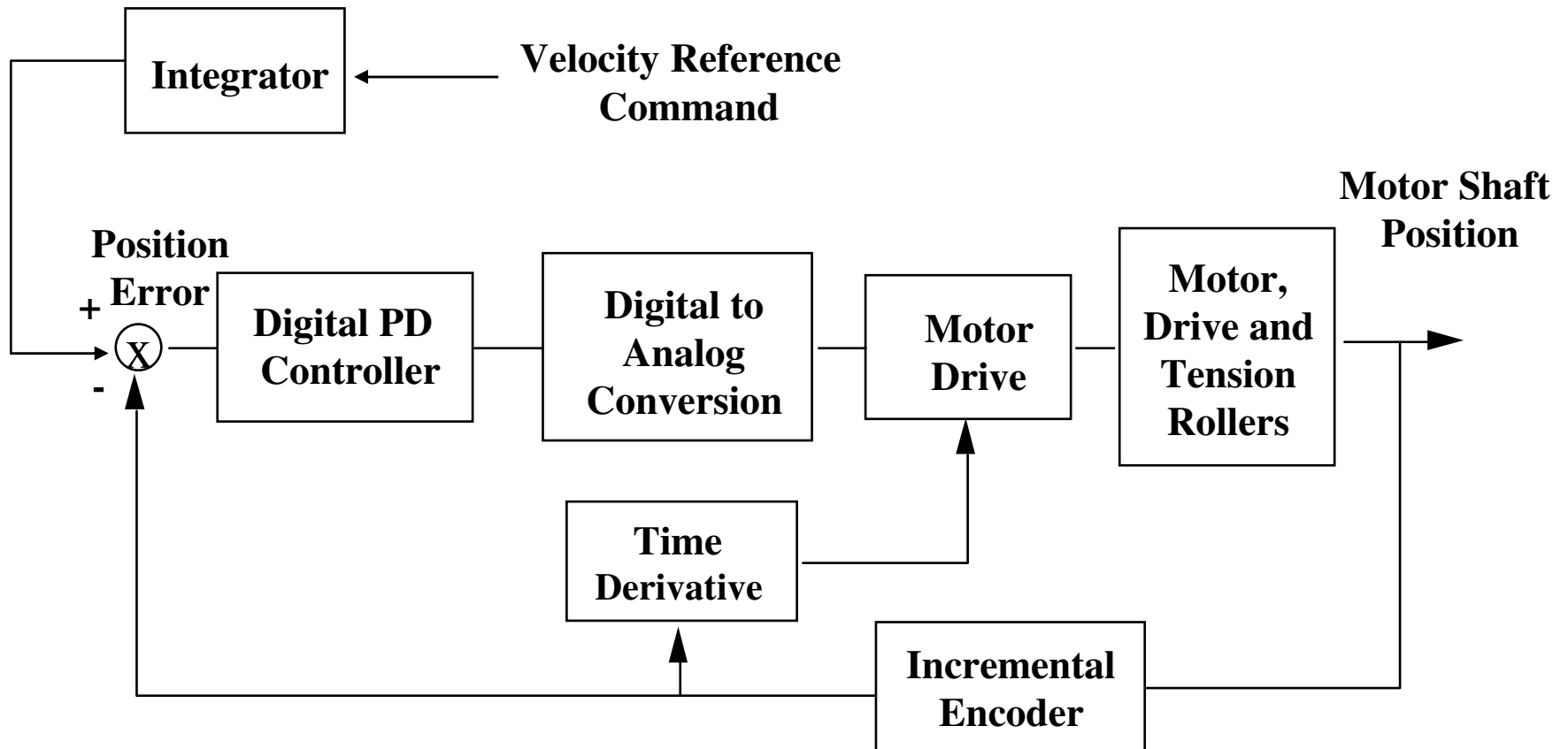
# A Temperature Regulator



# An Industrial Servo Control Problem

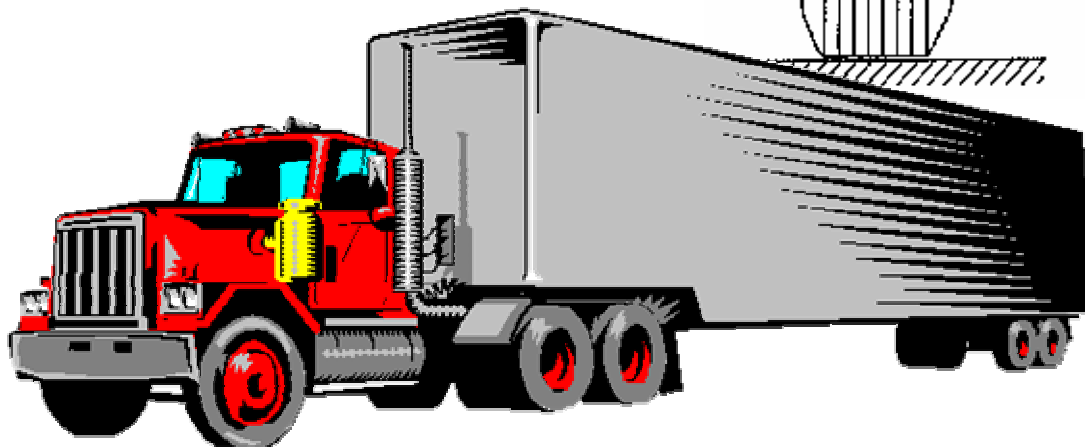
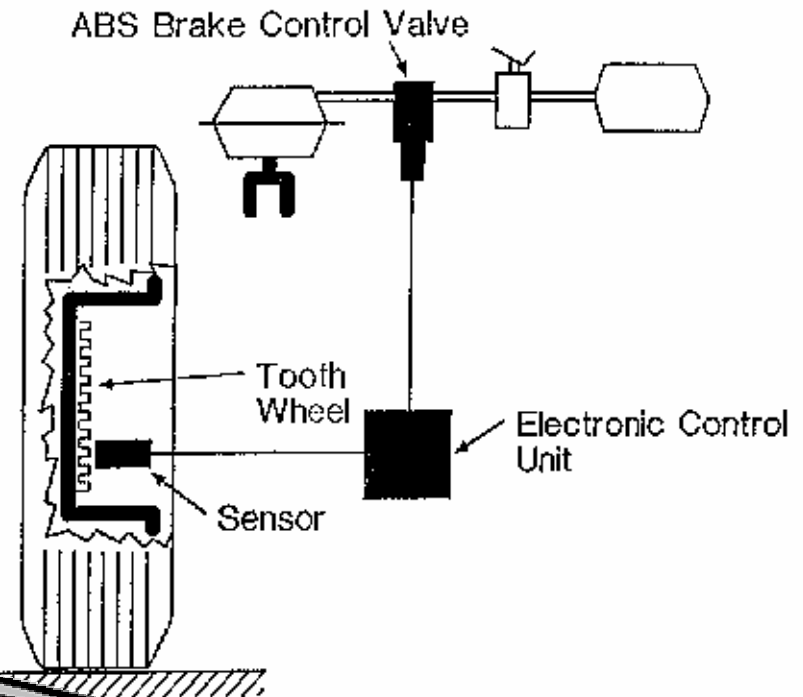


# Motion Control



# Truck Anti-lock Brake System

was treated as a sequential logic problem



# Why Feedback?

- Dealing with uncertainties
  - Disturbances (external)
  - Dynamic Changes (internal)
- Accuracy
- Speed

# A Little History

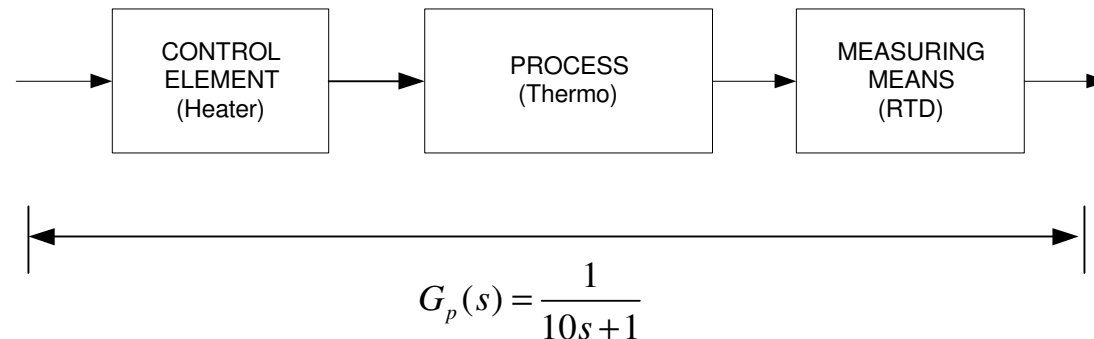
- Float Regulator, 300 BC by Greeks
- Temperature regulator, Cornelius Drebbel (1572-1633), Holland, 1609
- Pressure regulator for steam boilers, Dennis Papin (1647-1712), 1681
- First Automatic Feedback Controller used in an industrial process: Watt's flyball governor, 1769
- PID, Norm Minorsky, 1922
- Classical Control, 1940s
- Modern Control, 1960s-present

# Questions:

- How was control technology evolved?
- What is the state of art in controls?
- Why is the modern control theory not widely used?
- Is control design an art or a science?
- What makes a control engineer good?
- What are the essential knowledge and skills required?

# Loop Closing and Simulation

- Consider the Temperature Control Problem:



- Simulate the process in Matlab/Simulink
- Simulate a closed-loop control system