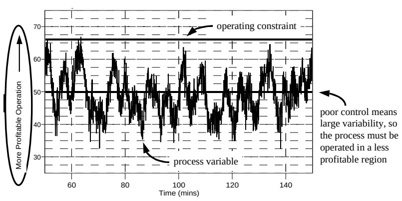
Fundamental Principles of Process Control

Class 2

1. Motivation for Process Control

- Safety First:
  - people, environment, equipment
- The Profit Motive:
  - meeting final product specs
  - minimizing waste production
  - minimizing environmental impact
  - minimizing energy use
  - maximizing overall production rate

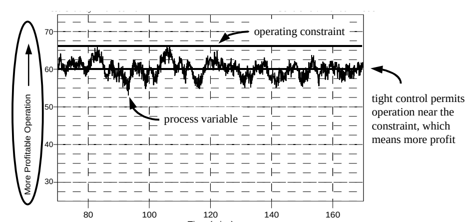
"Loose" Control Costs Money



Examples

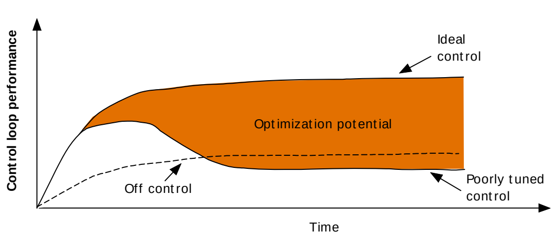
- It takes more material to make a product thicker, so greatest profit is to operate as close to the minimum thickness constraint as possible without going under
- It takes more processing to remove impurities, so greatest profit is to operate as close to the maximum impurities constraint as you can without going over

Tight Control = Most Profitable Operation

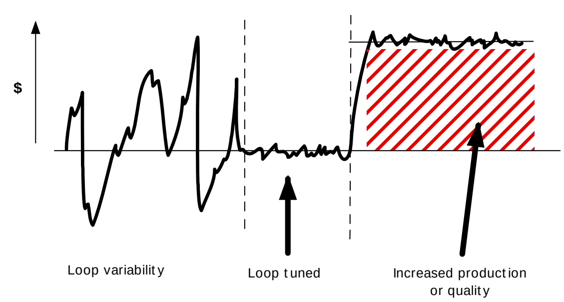


- A well controlled process has less variability in the measured process variable, so the process can be operated close to the profitable constraint

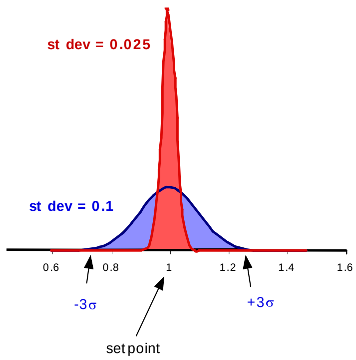
Poorly Maintained Control Loops Can Compromise Product Yield, Quality, and Throughput



Profitability of the Process Can Be Improved by Reducing Variability in the Control Loop



Standard Deviation Provides a Benchmark for Controller Performance



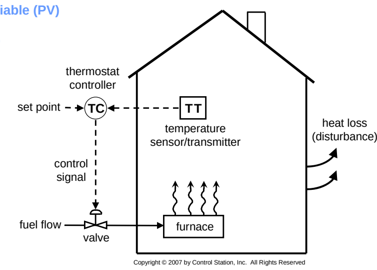
In-Class Activity

Answers

(on board)

Terminology for Home Heating Control

- Control Objective
- Measured Process Variable (PV)
- Set Point (SP)
- Controller Output (CO)
- Manipulated Variable
- Disturbances (D)



10

Automatic Control is *Measurement → Computation → Action*

- Is house cooler than set point? ($T_{Setpoint} - T_{house} > 0$)

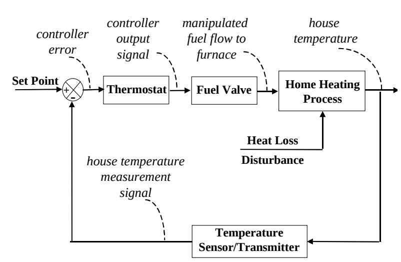
  Action → open fuel valve

- Is house warmer than set point? ($T_{Setpoint} - T_{House} < 0$)

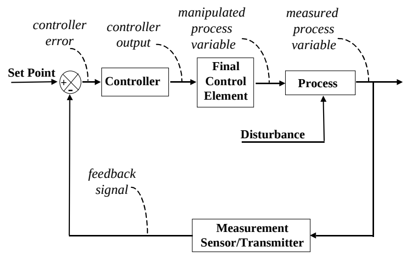
  Action → close fuel valve

Components of a Control Loop

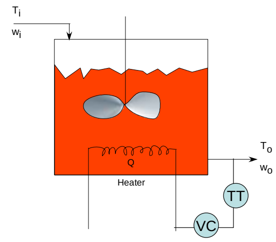
Home heating control block diagram



General Control Loop Block Diagram

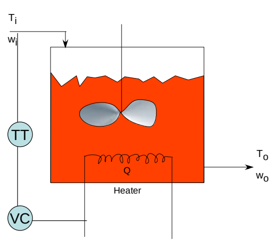


Example: Heated Tank



- Controlled variable:
  - T_o
- Feedback
  - Measure T_0
  - Control voltage to heater

Example: Heated Tank



- Controlled variable:
  - T_o
- Feedback
  - Measure T_0
  - Control voltage to heater
- Feedforward
  - Measure T_i
  - Control voltage to heater

Other Definitions

- Final Control Element
  - Usually a valve or pump
  - Electricity (to heat or cool)
  - Solenoid valve (open or shut)
- SISO
  - Single input, single output
- Nomenclature