Module # 1.1.1

INTRODUCTION
Control: Why and How

Lectures on

CHEMICAL PROCESS CONTROL
Theory and Practice

Why do we need to control a system

- To stabilize an inherently unstable system
  - Examples:
    - Bicycle
    - Stick on palm
    - LCA Tejas (India’s own fighter aircraft)
    - Unstable nonisothermal CSTR
- To deliver minimum performance guarantees for a system
  - Examples:
    - Petrol is octane number 92 or more
    - To produce X tph of commercial grade propylene
    - Missile strike accuracy guaranteed within 2 m radius
    - Driving a taxi in a manner that minimizes fuel consumption…

Day-to-Day Control Examples

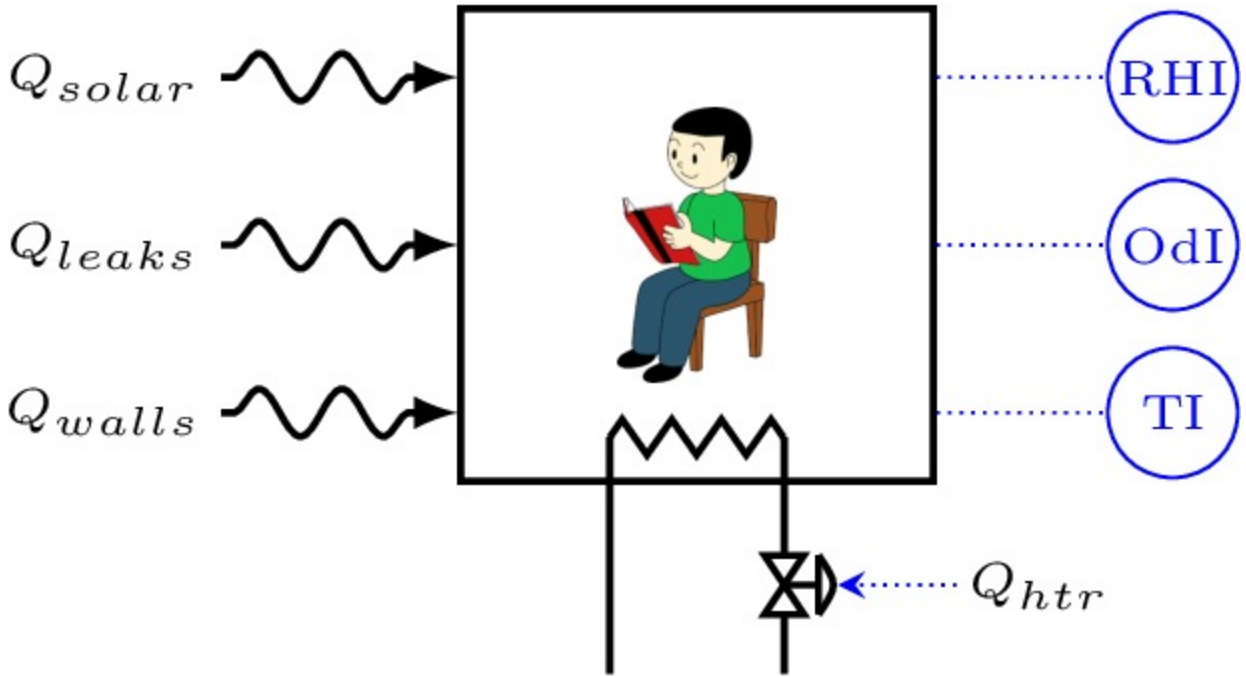
Tuning Guitar Strings

Balancing a Stick

Grocery Weighing

Pictures from google images

Room Example



PROCESS VARIABLES

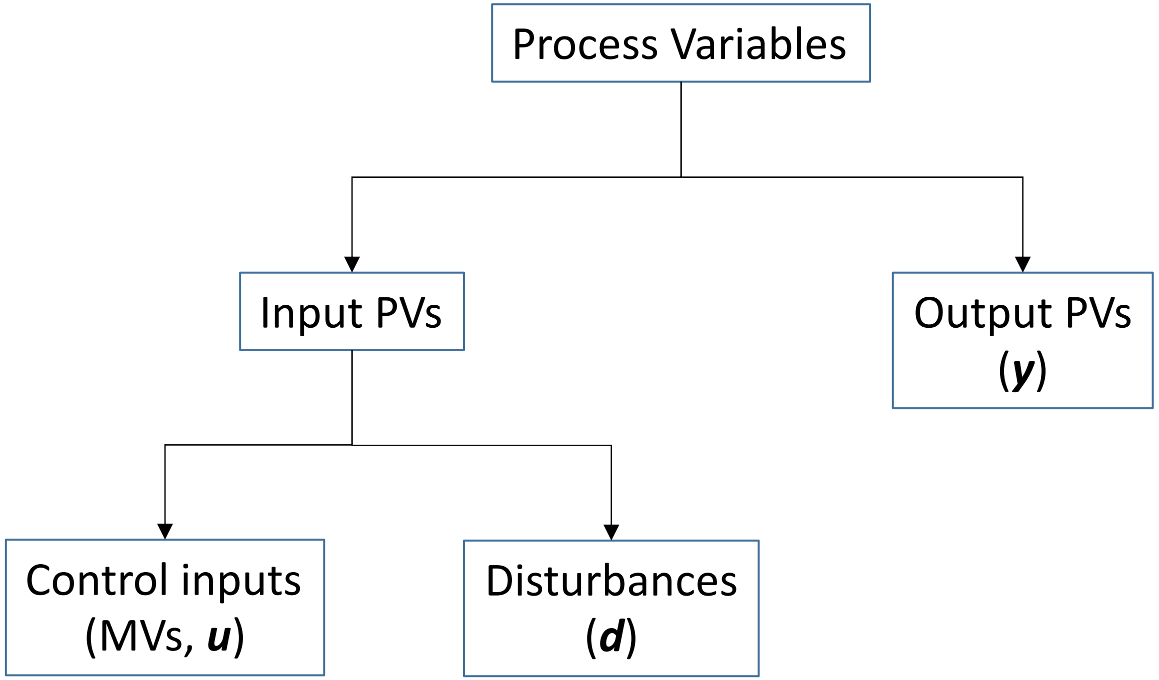
Temperature	T
Odor	Od
Relative Humidity	RH
Heater Duty	Q_{htr}
Solar heating rate	Q_{solar}
Heat leak rate	Q_{leaks}
Wall heat loss rate	Q_{walls}

Q_{htr}
Manipulated Variable
Control dof
Control Input

Q_{solar}, Q_{walls}, Q_{leaks}
Disturbances

Q_{htr}, Q_{solar}, Q_{leaks}, Q_{walls} Input PVs
T, RH, Od Output PVs

PV Classification



Input PVs affect output PVs through cause-and-effect relationships

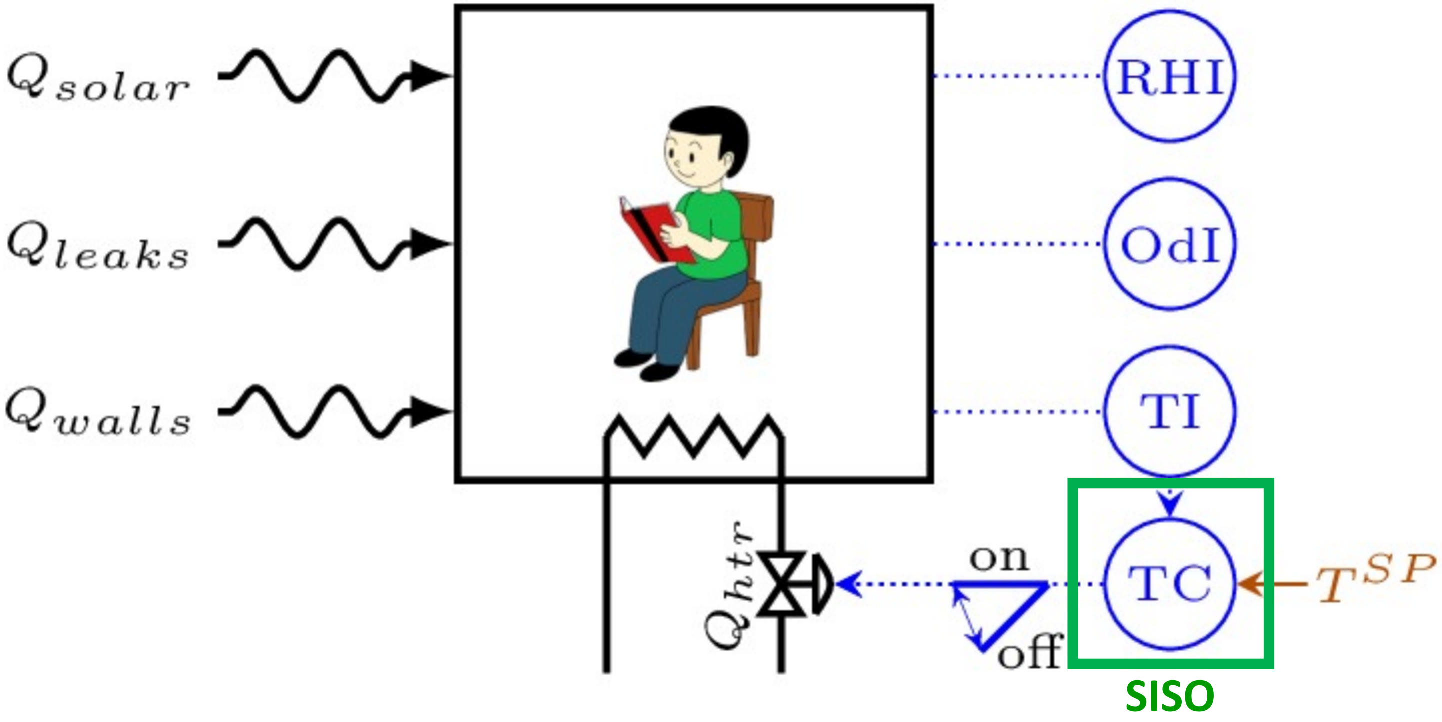
An MV with ‘strong’ effect on a PV can be adjusted to control the PV

M >> N

Output PVs: Several. May be designed

MVs: Limited. Fixed by process design

SISO Feedback Control



Feedback Loop Open

Operator specifies MV (Q_{htr})

CV (T) floats

Feedback Loop Closed

Operator specifies CV setpoint (T^{SP})

MV (Q_{htr}) floats

FEEDBACK

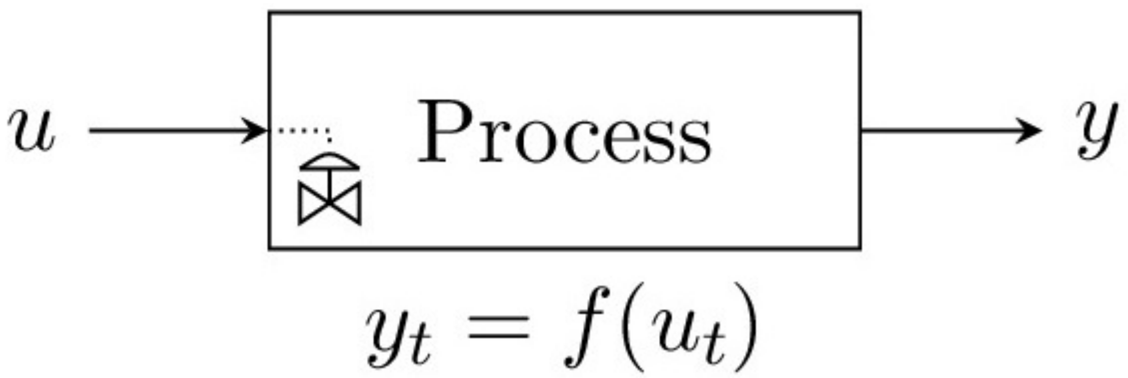
Adjust MV based only on CV values (current and past) to drive CV to CV setpoint (desired value)

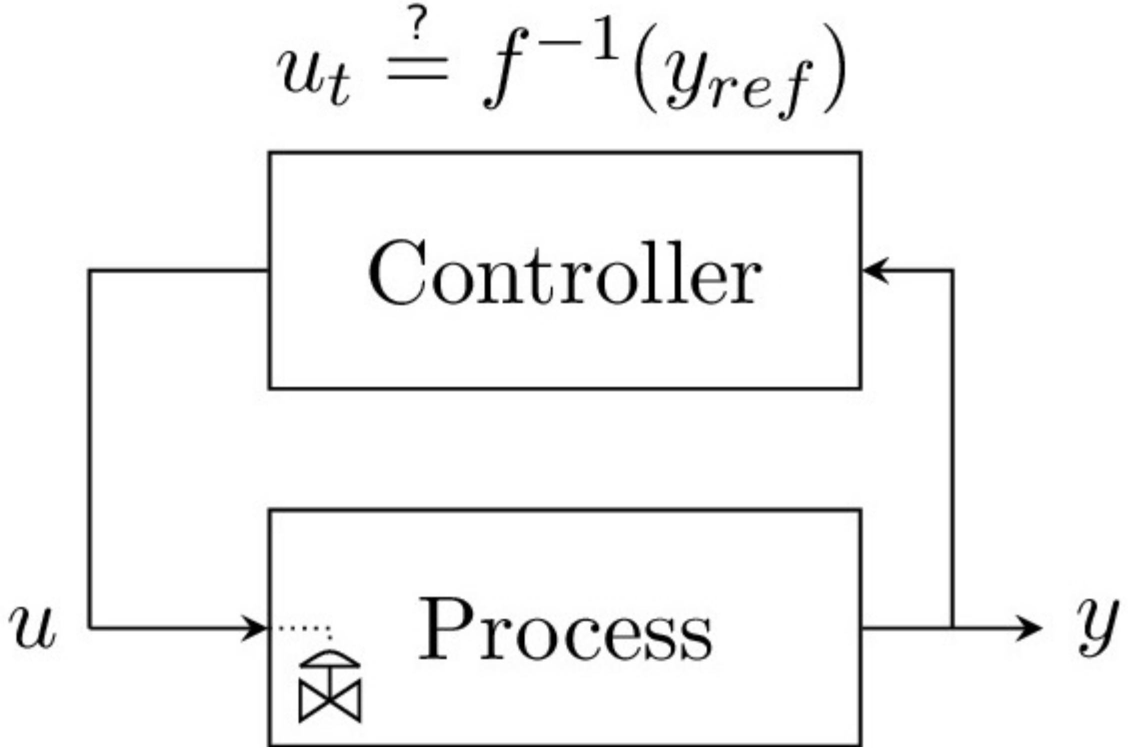
SINGLE-INPUT-SINGLE-OUTPUT (SISO)

Controller Input: Single PV measurement

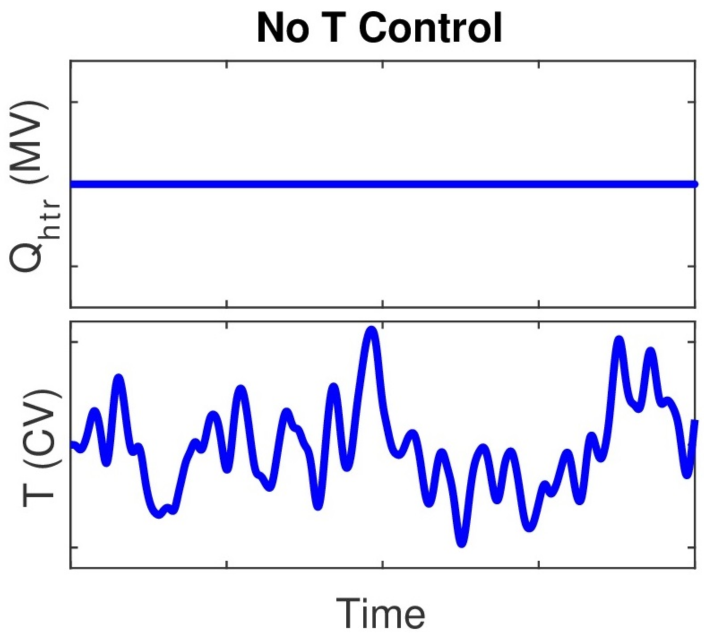
Controller Output: Single MV signal

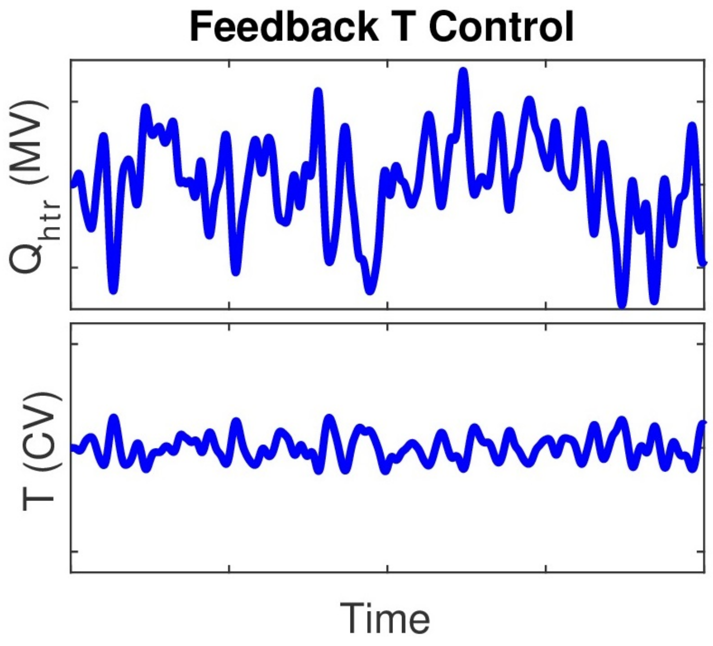
Control Inverts MV-CV Relation

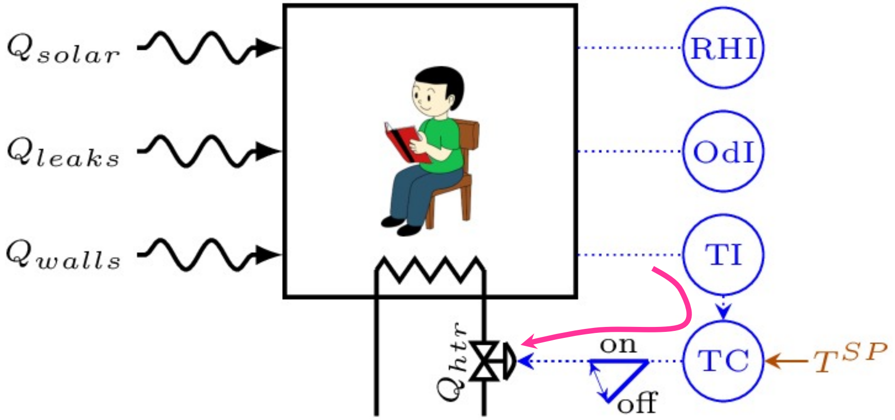




Control as Transformation of Variability



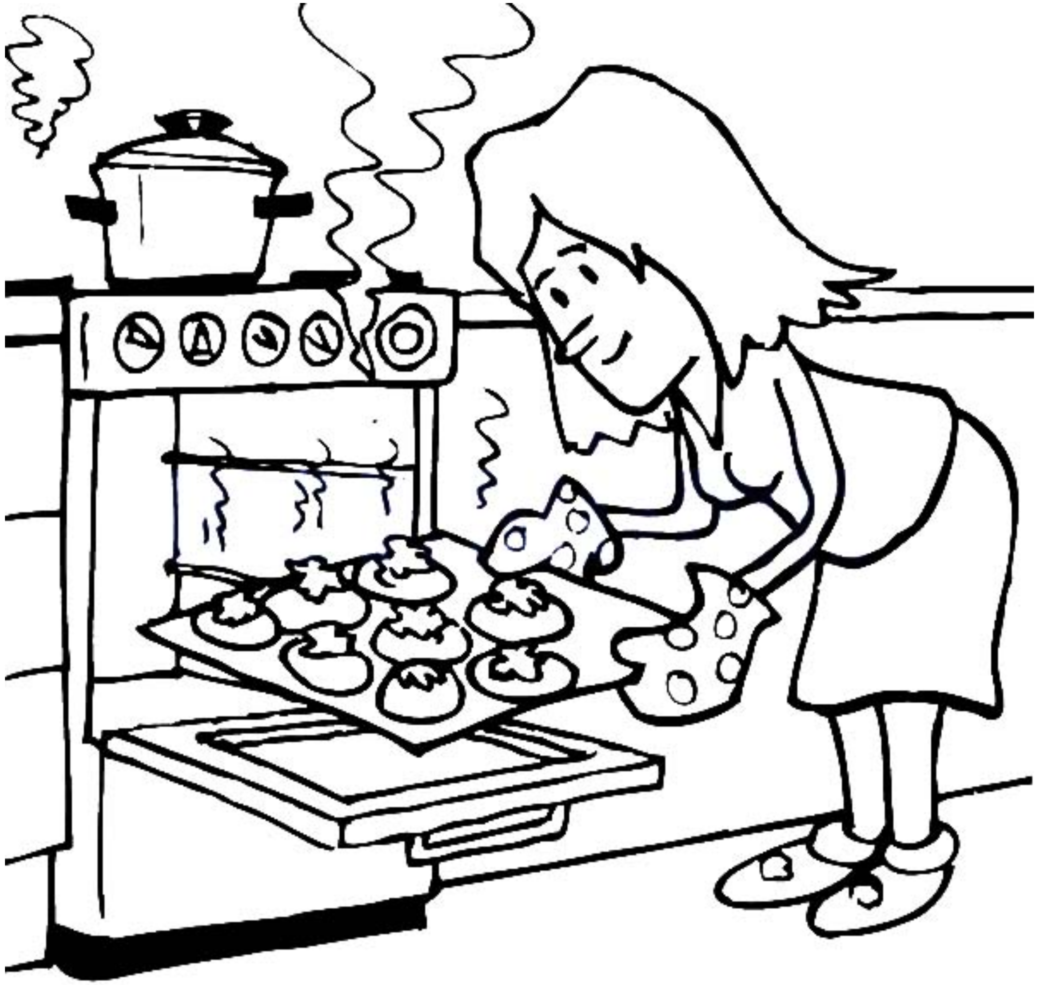




CV Variability ⇨ **MV Variability**

Alters dynamic characteristics of the process to more desirable

PVs of Interest?



PVs of Interest?

Process Control

- Alters dynamic characteristics of a process
  - Transforms variability from CVs to MVs
  - Altered characteristics are ‘desirable’
    - Safety, stability, economics, performance guarantees
- PV feedback a powerful mechanism for control
  - Inverts MV-CV relation
- Several available PV measurements
- What PV to control and how tightly to control it is a key decision
  - Requires process understanding