Module # 1.2

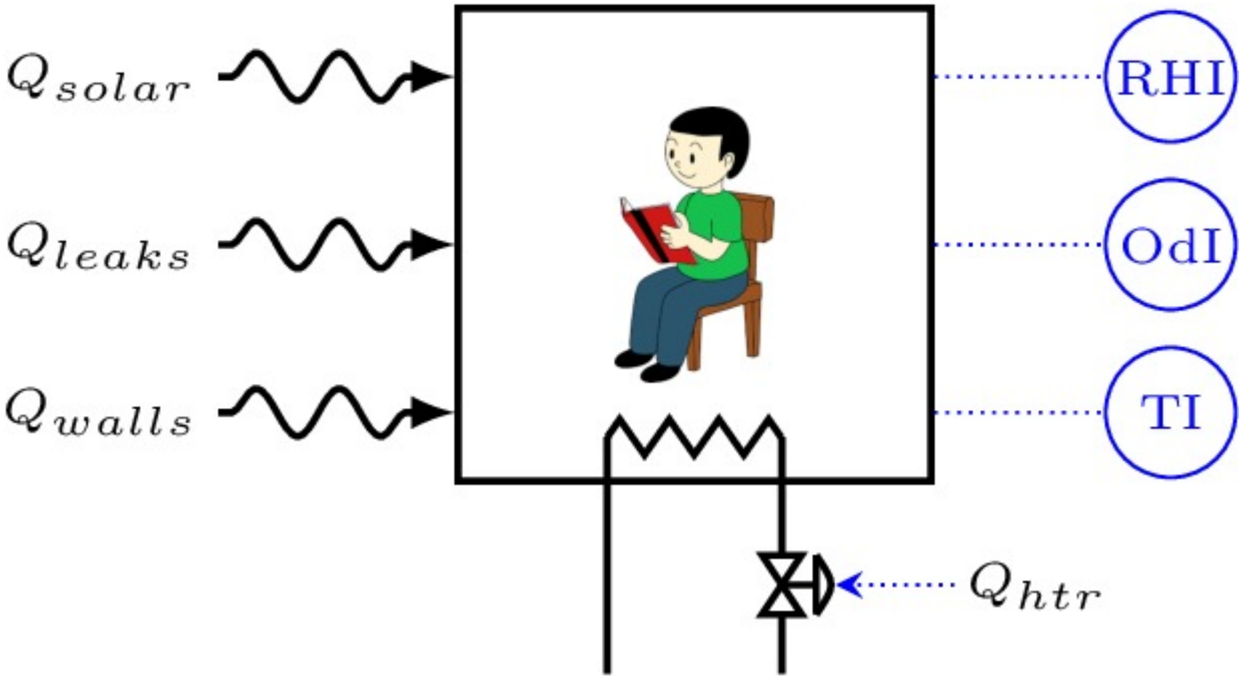
INTRODUCTION
What to Control?

Lectures on

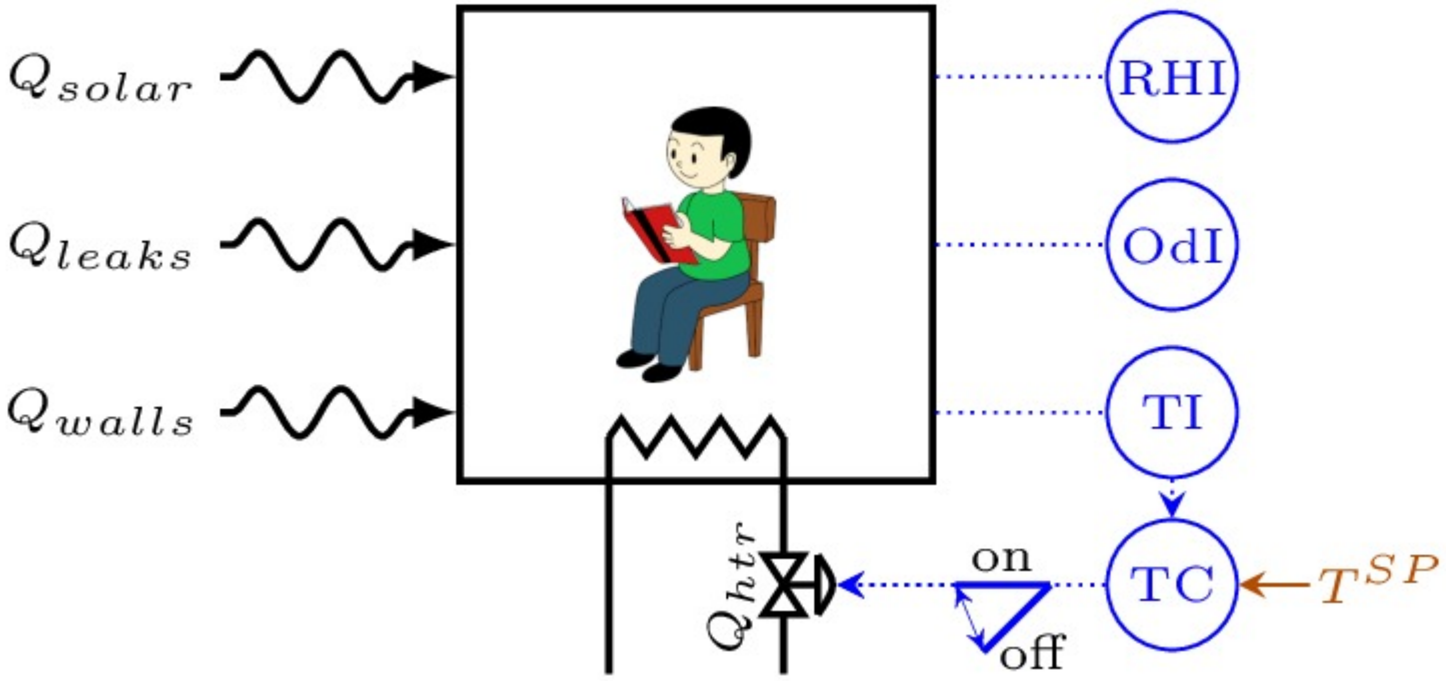
CHEMICAL PROCESS CONTROL
Theory and Practice

What to Control

- A key decision
- # of MVs in a process is fixed and limited
  - Limits # of PVs that may be controlled
  - N MVs control up to N PVs and no more
  - What PVs are controlled must be chosen ‘wisely’



SISO Feedback Control



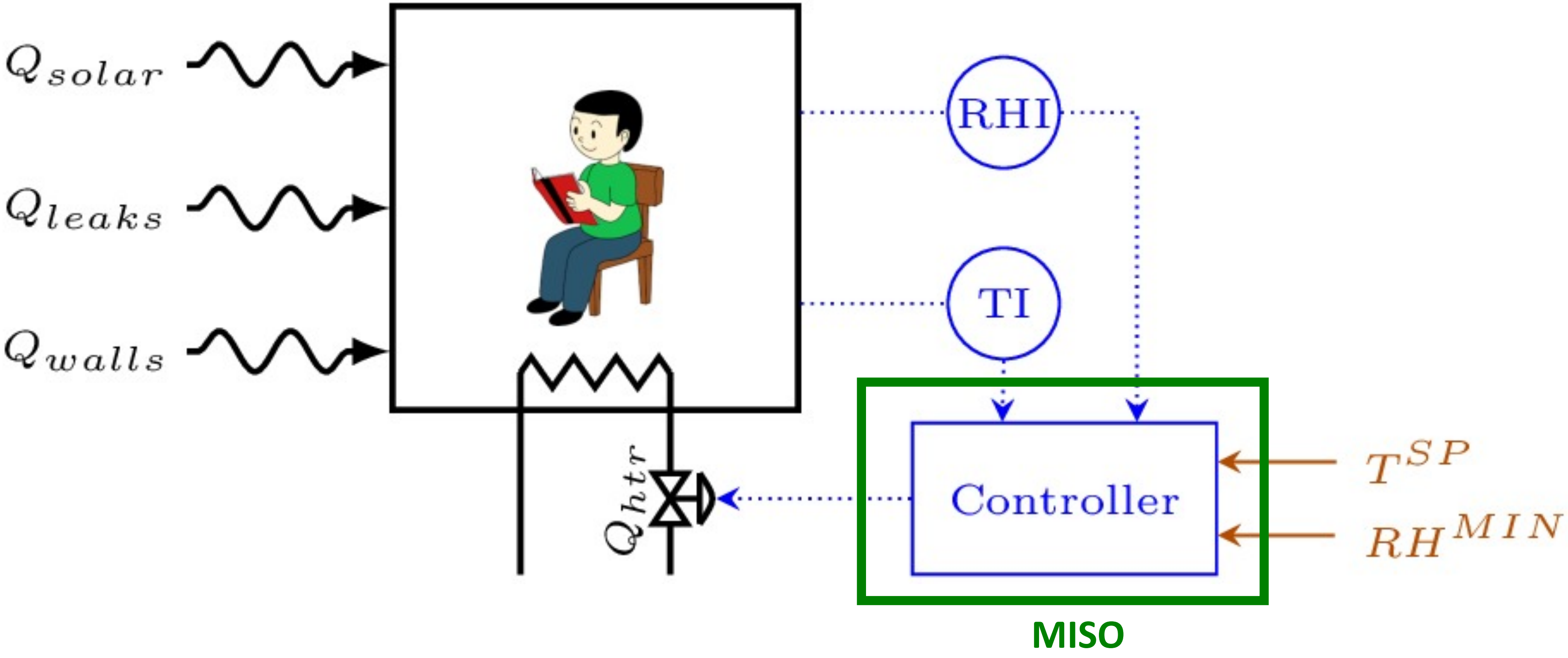
Single PV (input to controller)

controlled using

Single MV (output of controller)

More Complex Control: MISO

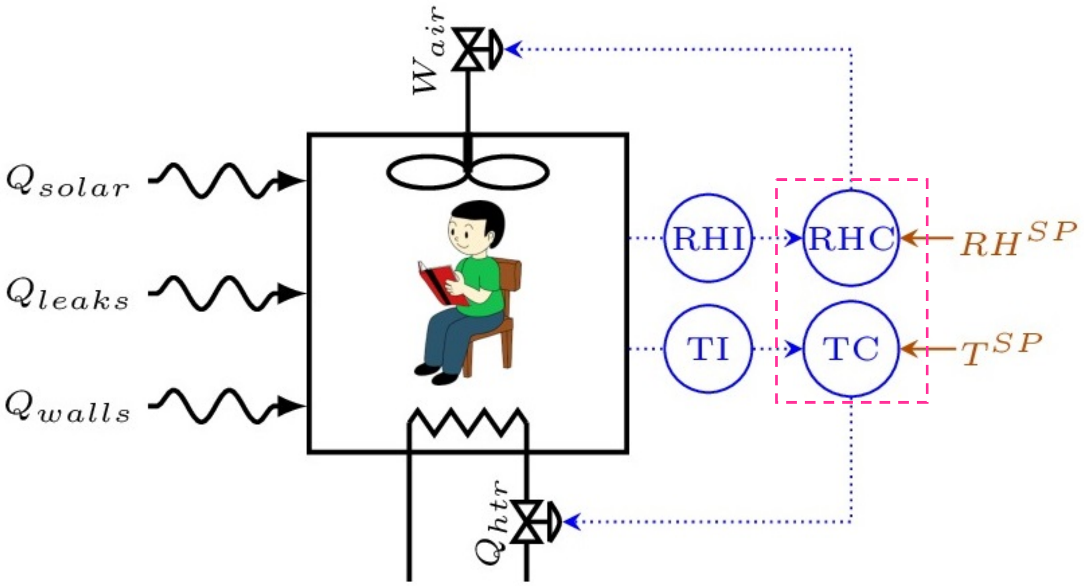
Control T but RH < RH^{MIN} not allowed



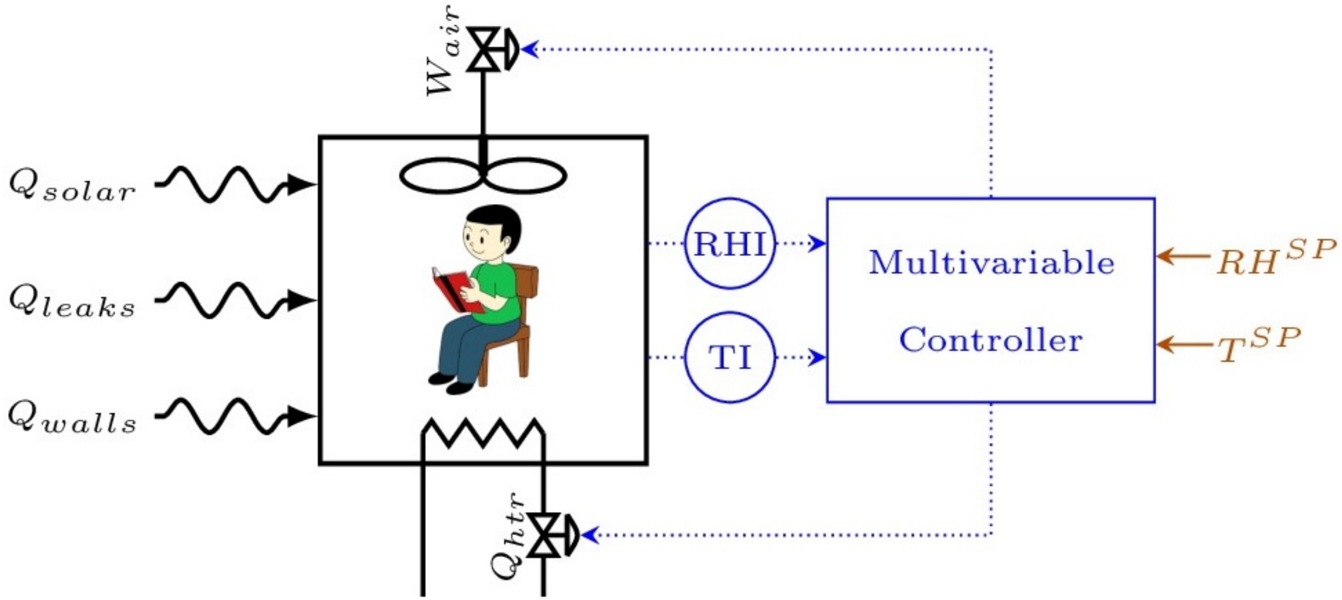
More Complex Control: MIMO

Control *both* T and RH
Need additional MV to hold RH

2 SISO Controllers



2x2 Multivariable Controller

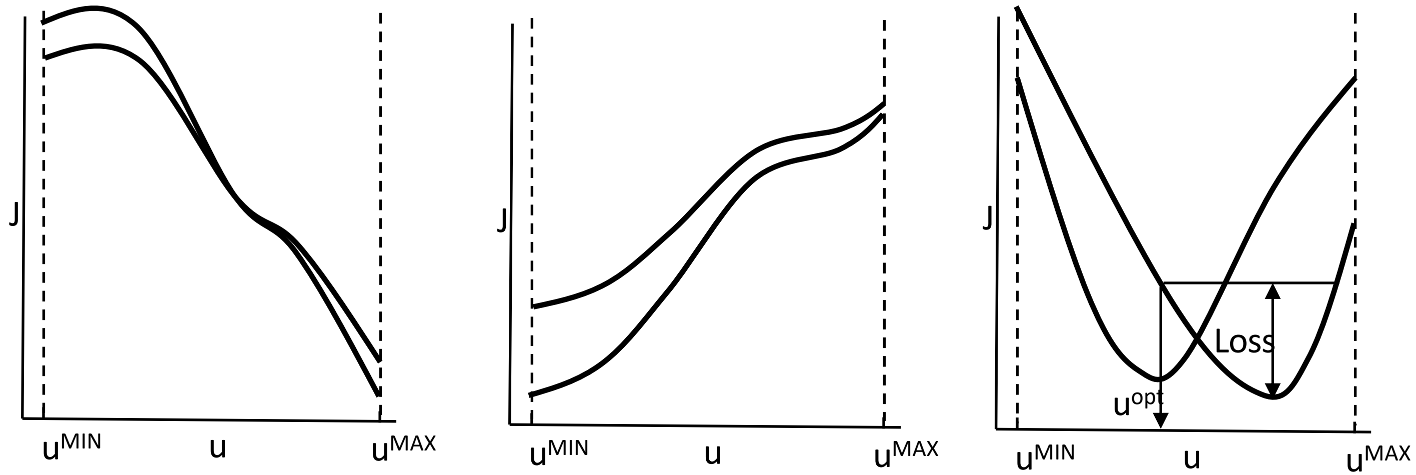


Control for Good Economics

ECONOMIC OBJECTIVE

MINIMIZE J over dofs **u**

subject to process contraints

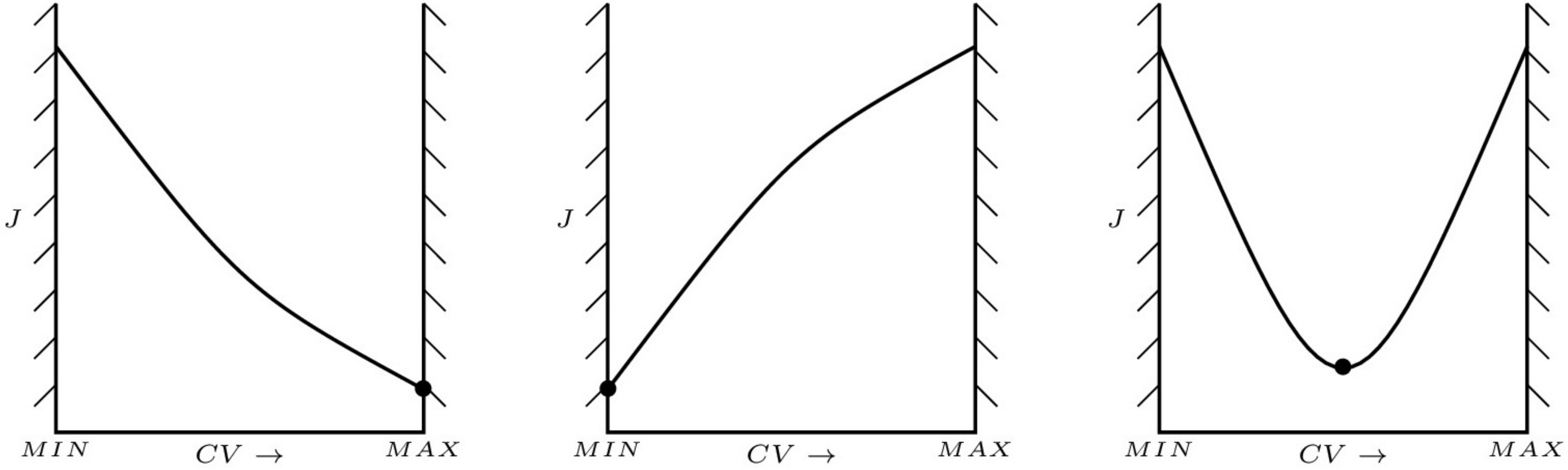


Operate at u^{MAX} always | Operate at u^{MIN} always | Operate at u^{opt}, u^{opt} changes

ROOM EXAMPLE

$T^{SP}=T^{MIN}$ & $RH^{SP}=RH^{MIN}$ minimizes utility bill

Control for Good Economics



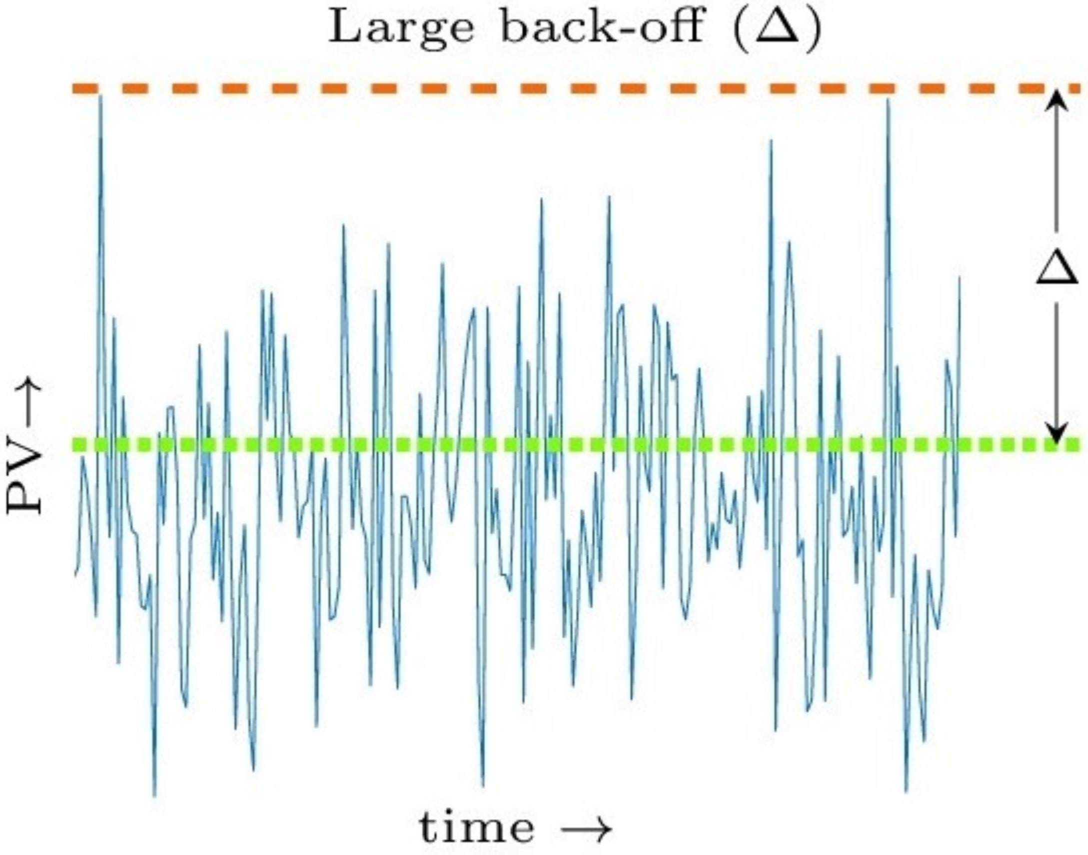
Tightly control active constraints

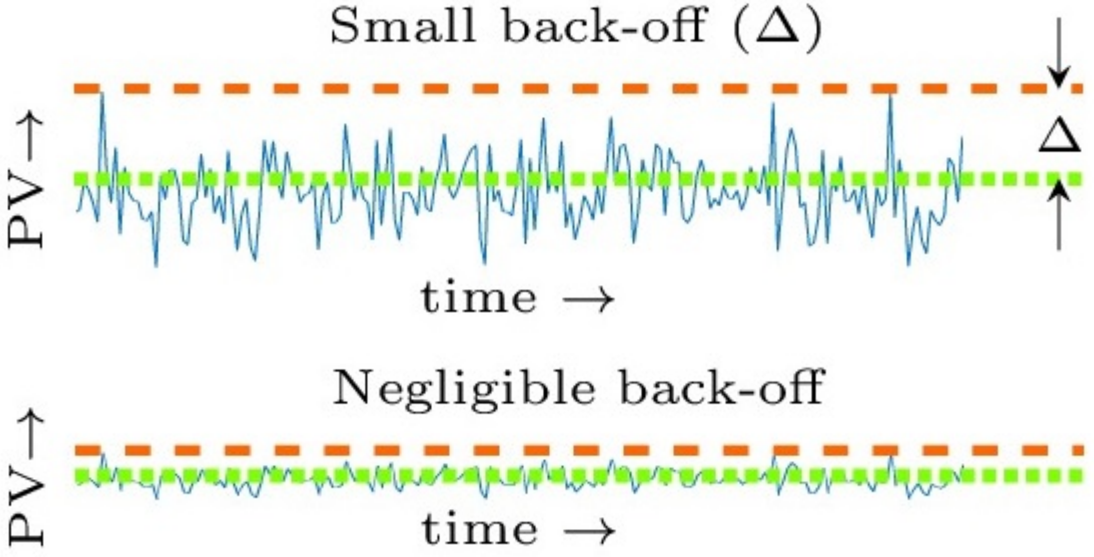
Choose their setpoint at constraint limit

Need back-off to avoid constraint violation

Track optimum value
for sharp curves

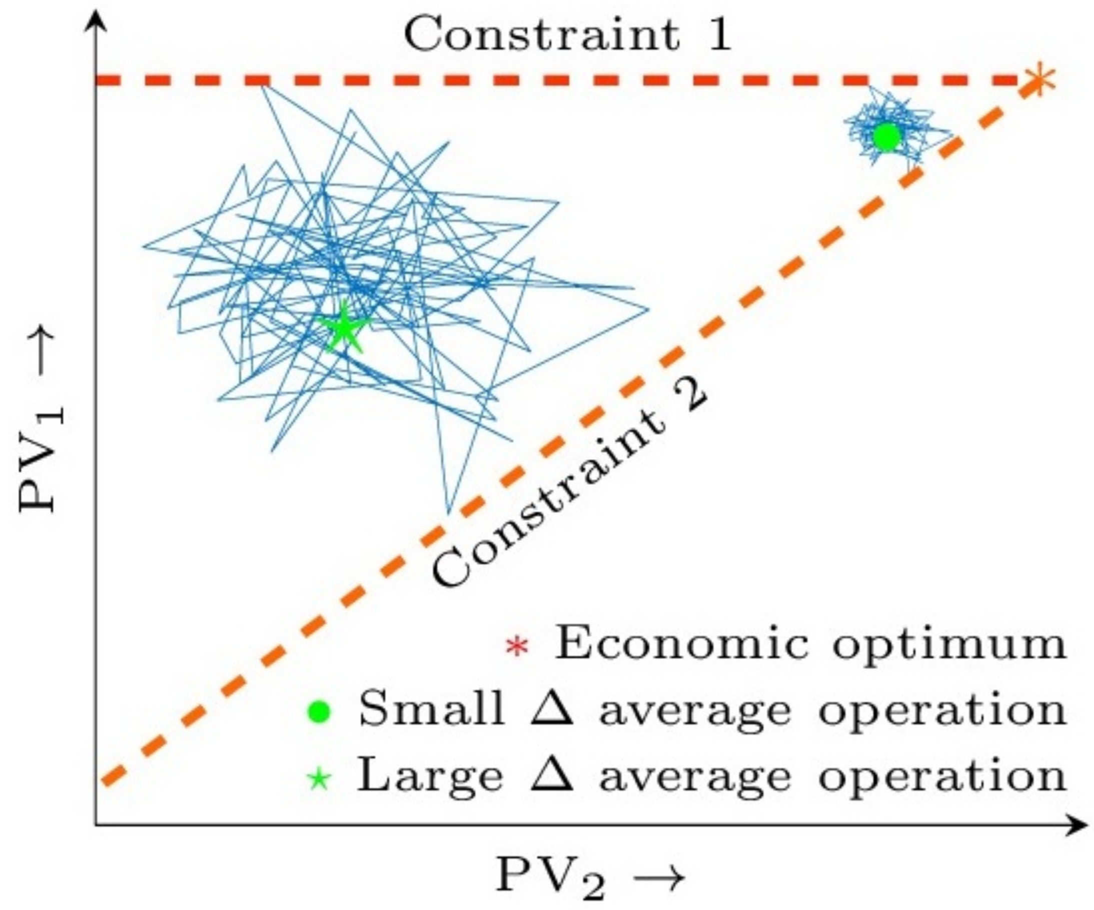
The Need for Tight Constraint Control



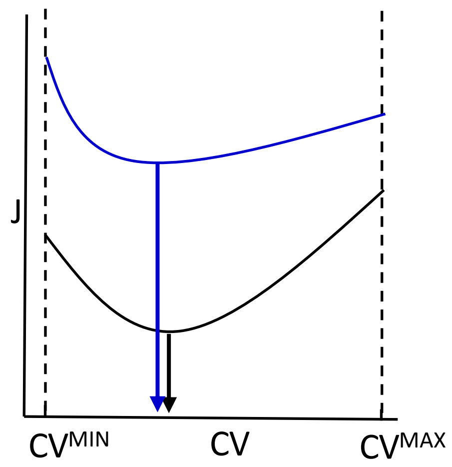


SQUEEZE & SHIFT

The Need for Tight Constraint Control



Managing Unconstrained Optimum



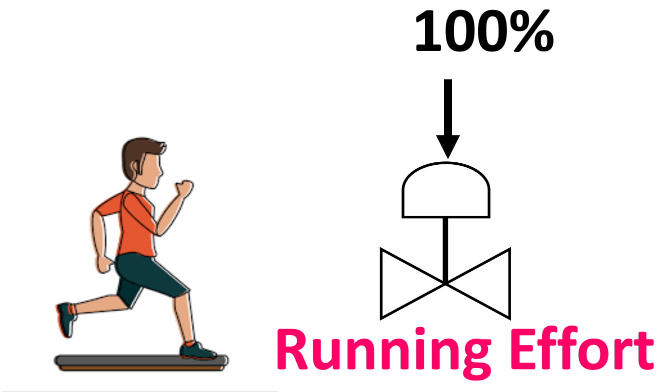
Optimum remains “nearly” the same

Find those “magic” PVs with invariant optimum

Constrained vs Unconstrained Optimum

100 m Sprint

J = min_u Race Completion Time



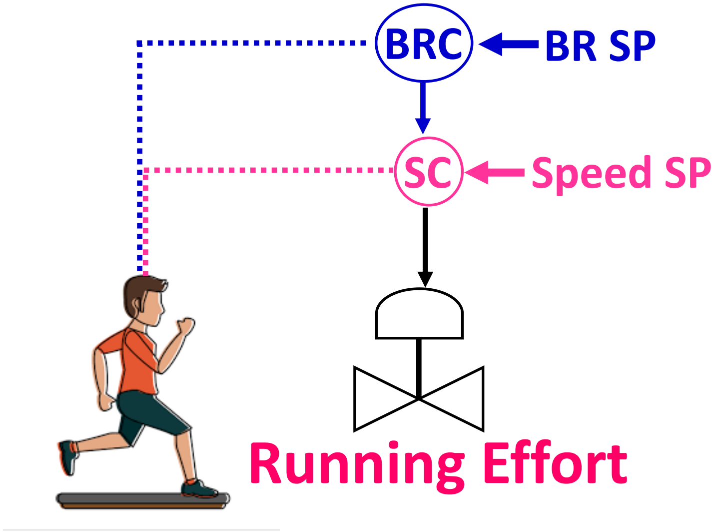
40 km Marathon

J = min_u Race Completion Time

~~Constant Effort~~

~~Constant Speed~~

Constant
Breathing Rate



The Skogestad Example

NEED PROCESS INSIGHT FOR DEVELOPING OPTIMAL OPERATING POLICY

Image taken from: https://www.vectorstock.com

Solving Process Control Problems

- What to control
  - Limited by # of MVs
  - What constitutes ‘desirable’ process behaviour
  - Control objectives and their prioritization
- Economics is usually a major consideration
  - Control all active constraints
    - Squeeze and shift
  - Control near ‘invariants’ for unconstrained dofs
- Process understanding is crucial