Process Control

by

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BS Chemical Engineering – University of New Mexico, 1985

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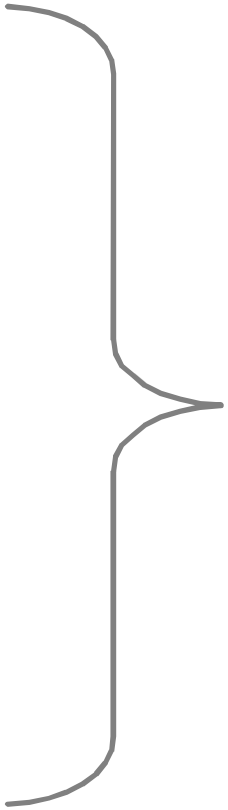
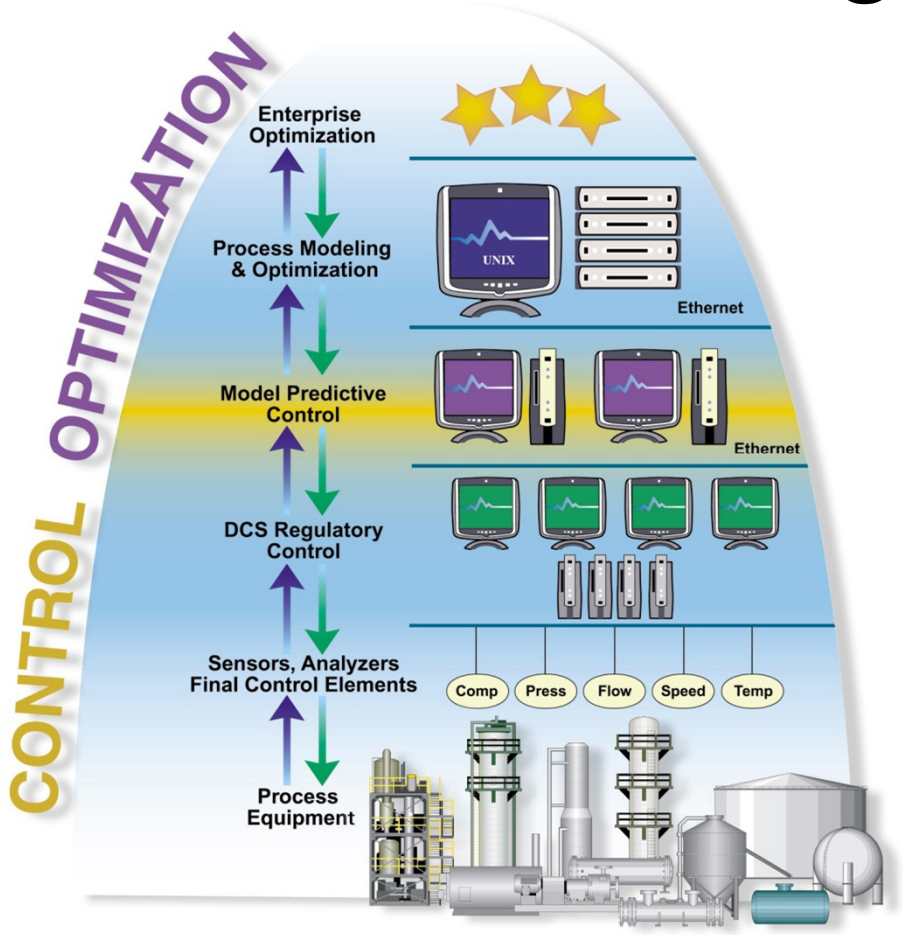
Why Do Process Control?

Quality
Throughput
Yield
Environmental
Energy
Uptime
Safety



Economics

Computer Control & Optimization
Understanding the Big Picture



Building a successful process control system is like building a house. You have to start at the foundation.

The foundation in control is the PROCESS.

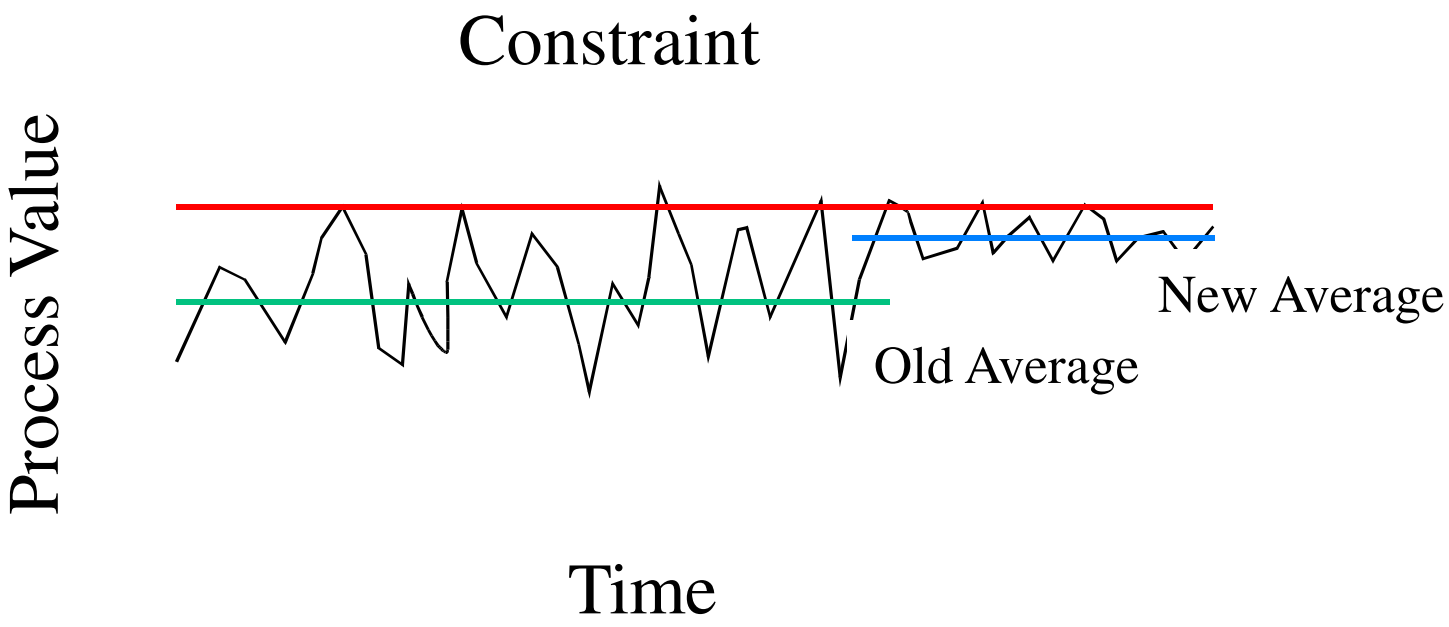
Process Characteristics

- ✓ The key to good process control is getting the process and the control to work together.
- ✓ Knowing the process characteristics is the first step in implementing good control and evaluating control performance.
- ✓ Processes with different characteristics require different control techniques and tuning. There is no one size fits all control technique.

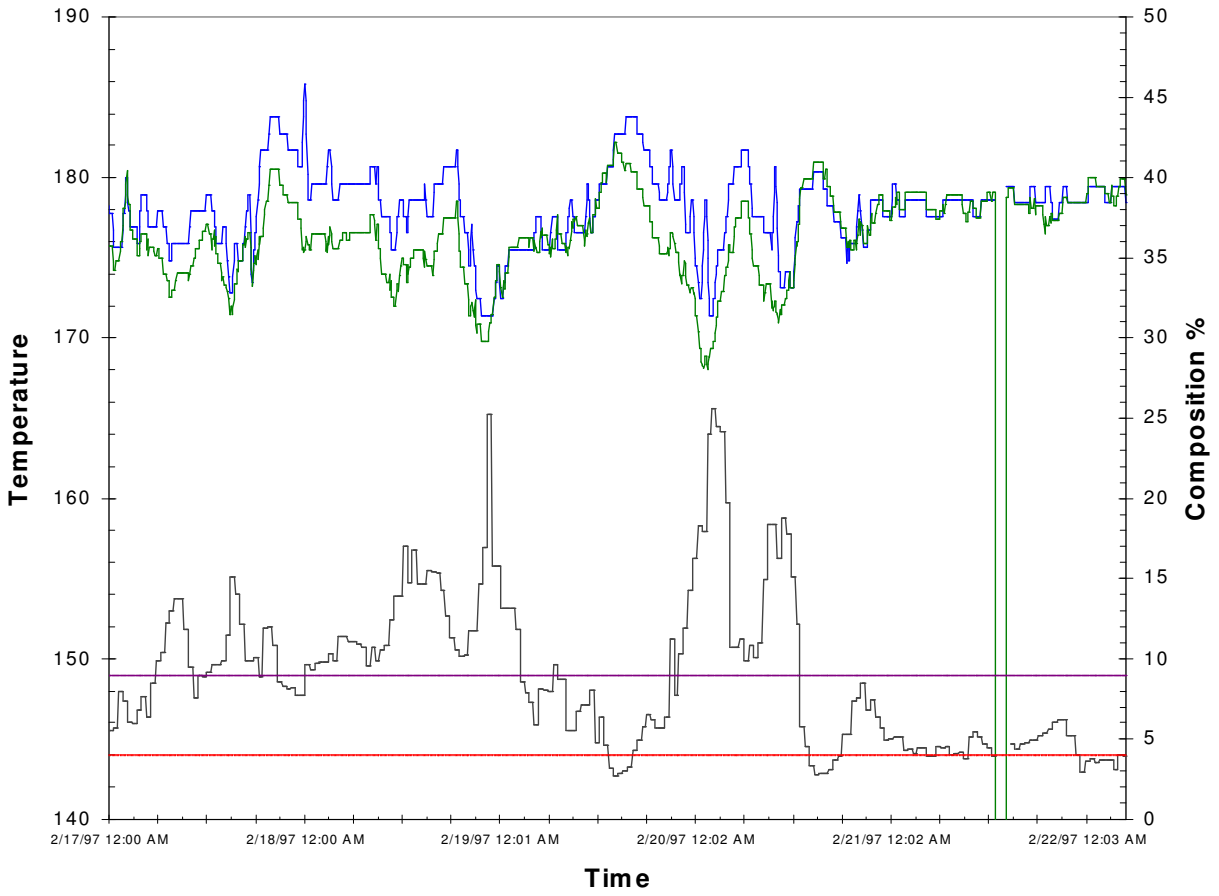
Goals of Process Control

- ✓ Stabilize Process
- ✓ Reject Measured & Unmeasured Disturbances
- ✓ Account for Process Interactions in Control Scheme
- ✓ Monitor and Act to Alleviate Process Constraints
- ✓ Where Possible, Linearize Process Through Calculations & Controllers
- ✓ Optimize Operation Where Possible

Reducing Variability



Example 1: Deisobutanizer Bottoms



Avg. 8.94% IC4
Target 4% IC4
STD 4.7%

Example 1: Economic Calculation Isobutane Give Away

Assume you can reduce the standard deviation by 50%
Reduce Loss of Isobutane by 2.3%

Avg Flow = 2800 BPD
Value of IC4 = $0.65/gallon (1995 Dollars)
Value of nC4 = $0.30/gallon

2800BPD (.023) (42gal/BBL) ($0.65 -$0.30) =
= $946/day
Assume 330 run days/yr = $312,000/yr

Example 2: FCC Propylene Splitter

Propylene production before control = 150 bbl/hr

@2500 ppm

Increase in propylene production 10-15 bbl/hr

@3500 ppm

(10bbl/hr)(213lb/bbl)($.145/lb)(24hr/day)

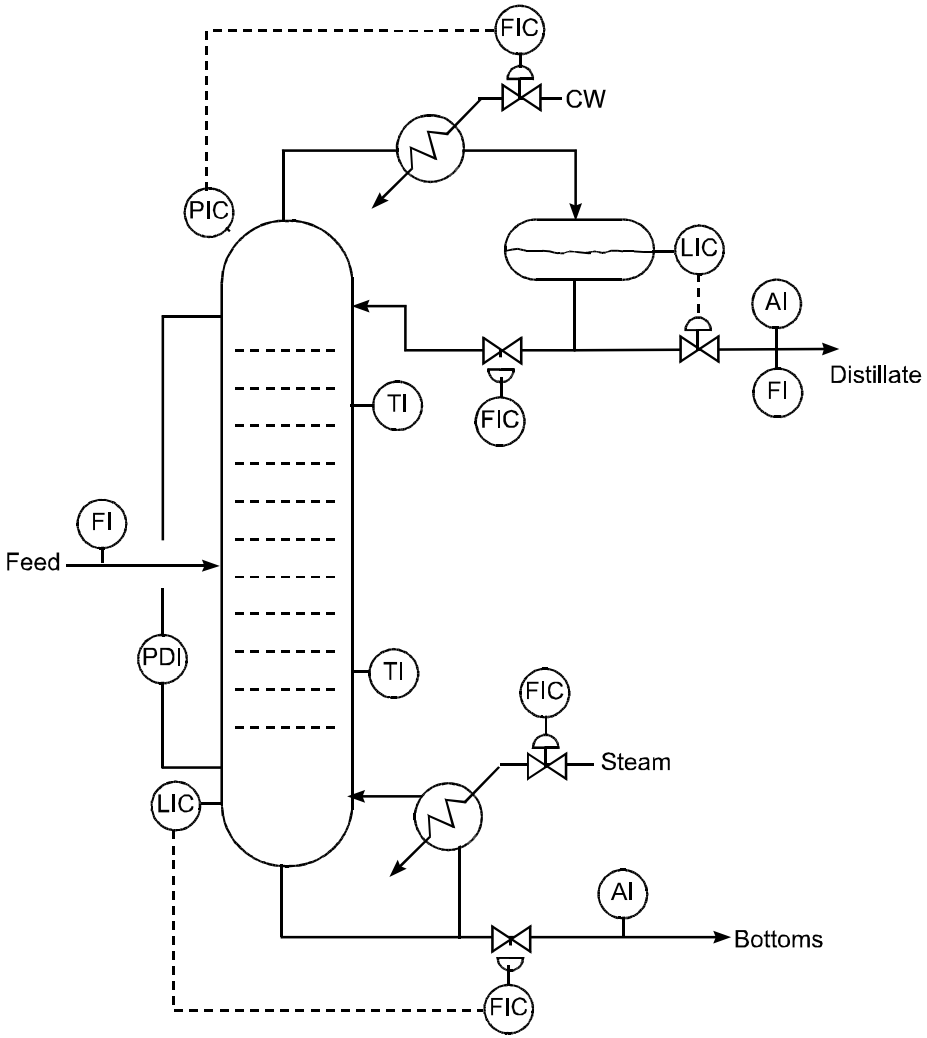
= $7412/day

Assume 330 run days/yr = $2,450,000/yr

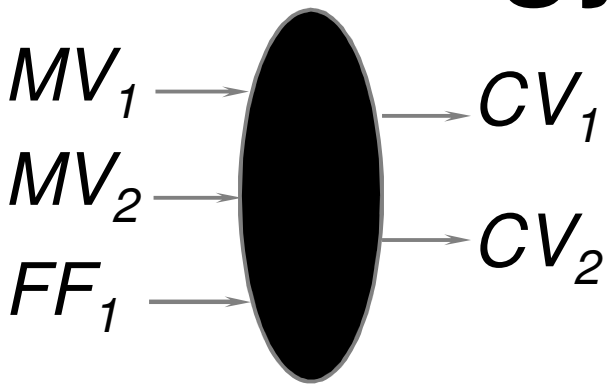
Characteristics of Multivariable Model Predictive Control (MMPC)

- Uses linear step response models
- Models are determined from process I/O data obtained from step tests
- Multivariable interactions automatically dealt with
- Large dead times are dealt with properly
- Built in constraint handling for both MV's and CV's
- Effects of measured disturbance variable can be included.

Distillation Column



Terminology



Independent Variables

- *Manipulated Variables*
- *Feedforward or Disturbance Variables*

Dependent Variables

- *Controlled Variables*

Dependent variable behavior can be described totally in terms of independent variable behavior.

$\delta CV_1 = f(\Delta I_1, \Delta I_2, \Delta I_3, \ldots)$

Prediction

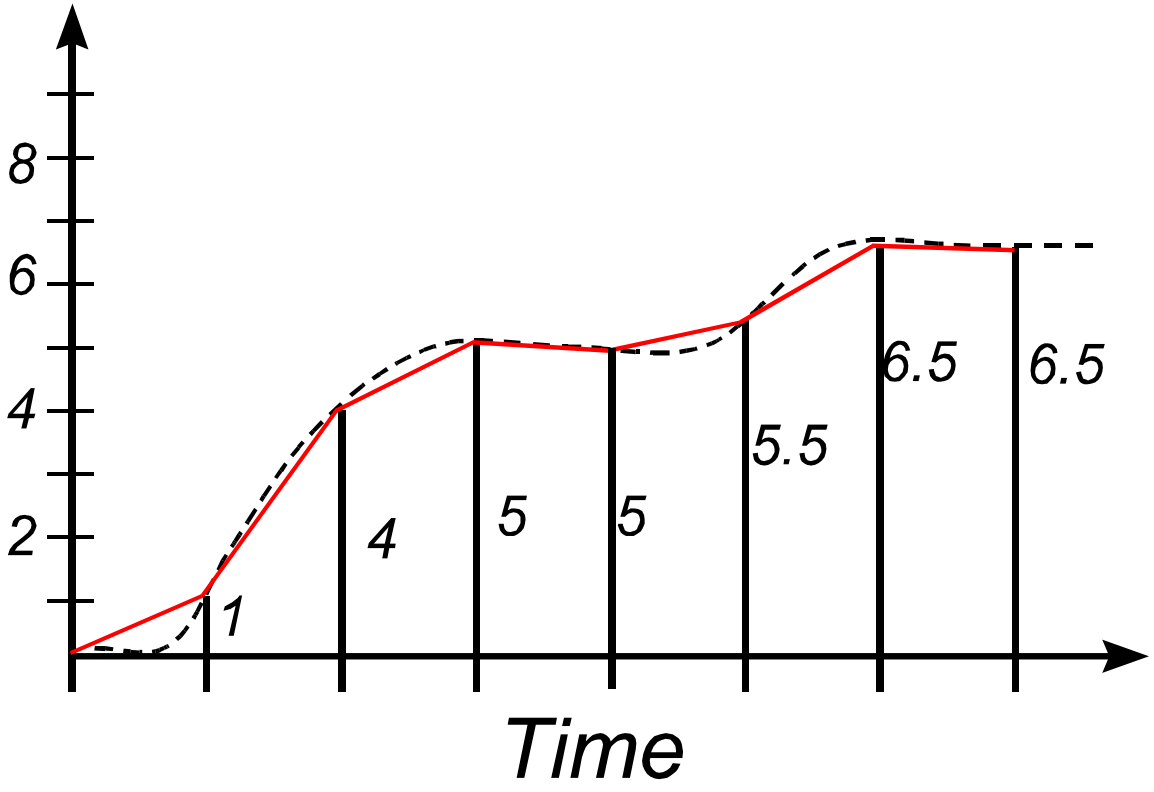
Requires a model

Assumes process is linear

- Effects of MV moves are additive
- Process gains & dynamics are constant
- Effects of MV moves can be scaled with MV move size

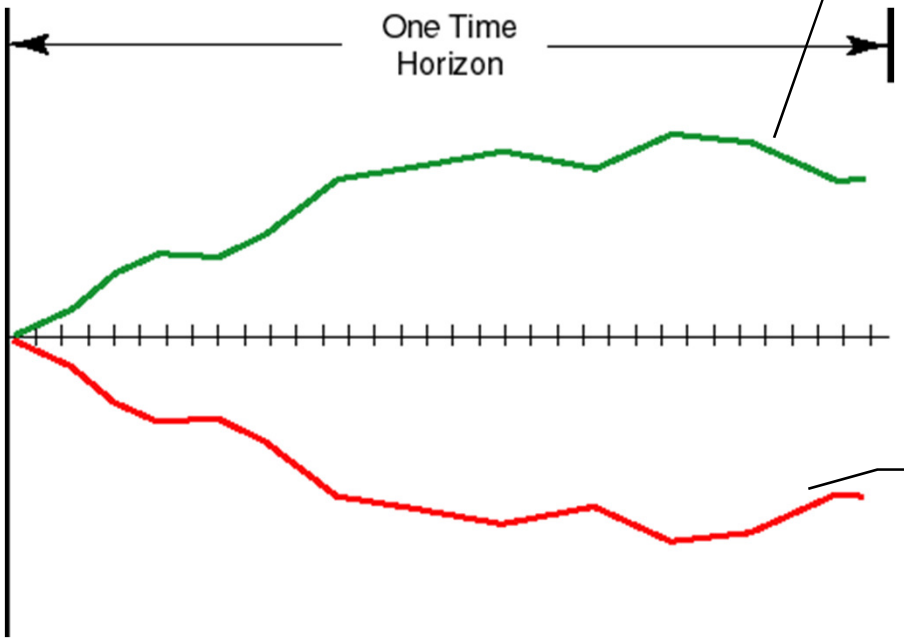
Step Coefficient Model

Process can be represented as a series of discrete values



Response to a unit change in the independent Variable

Calculation Problem



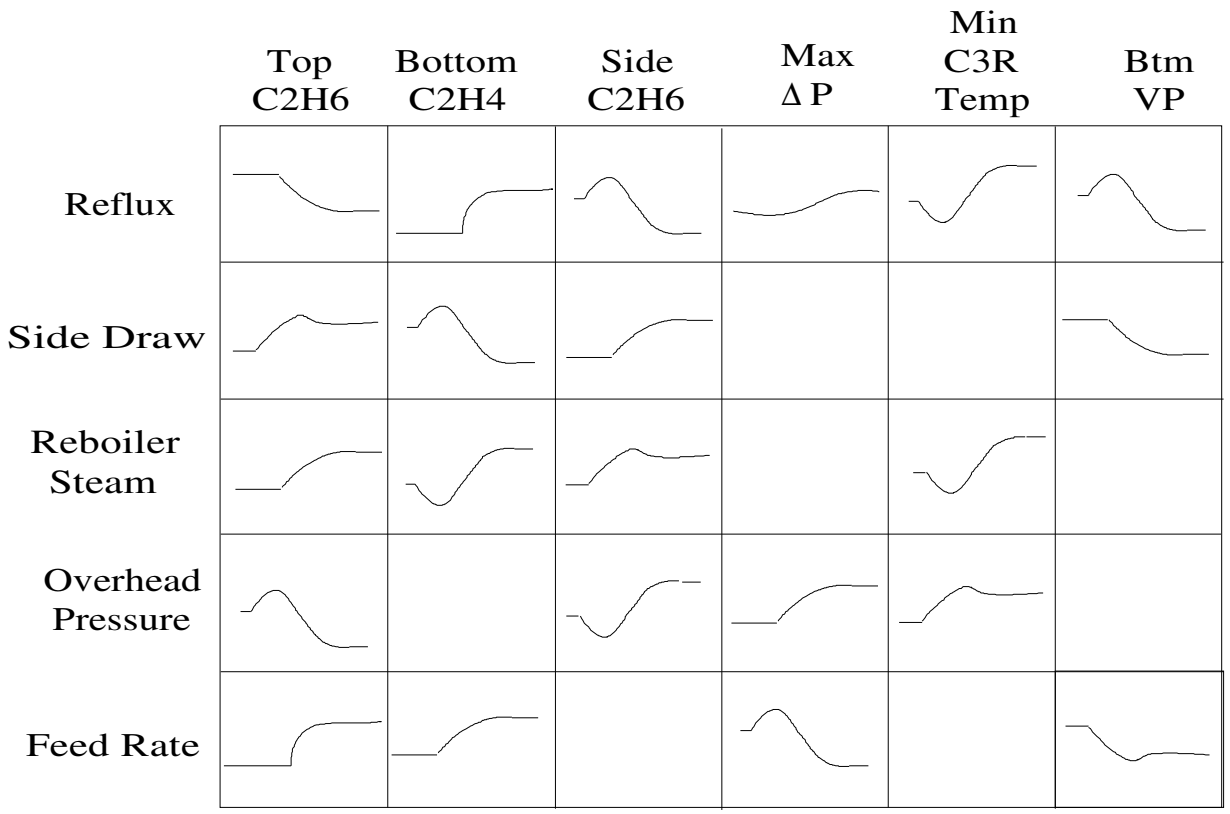
Predicted CV Trajectory Based on Past Moves Without Future Moves

Calculated CV Trajectory Based on Future Moves & no Past Moves

What set of MV moves will predict the red line?

Controller Model Matrix

Model Matrix



Thank You