



Technology That Loves Complexity

aspenONE Advanced Process Control Update

June 1st, 2018

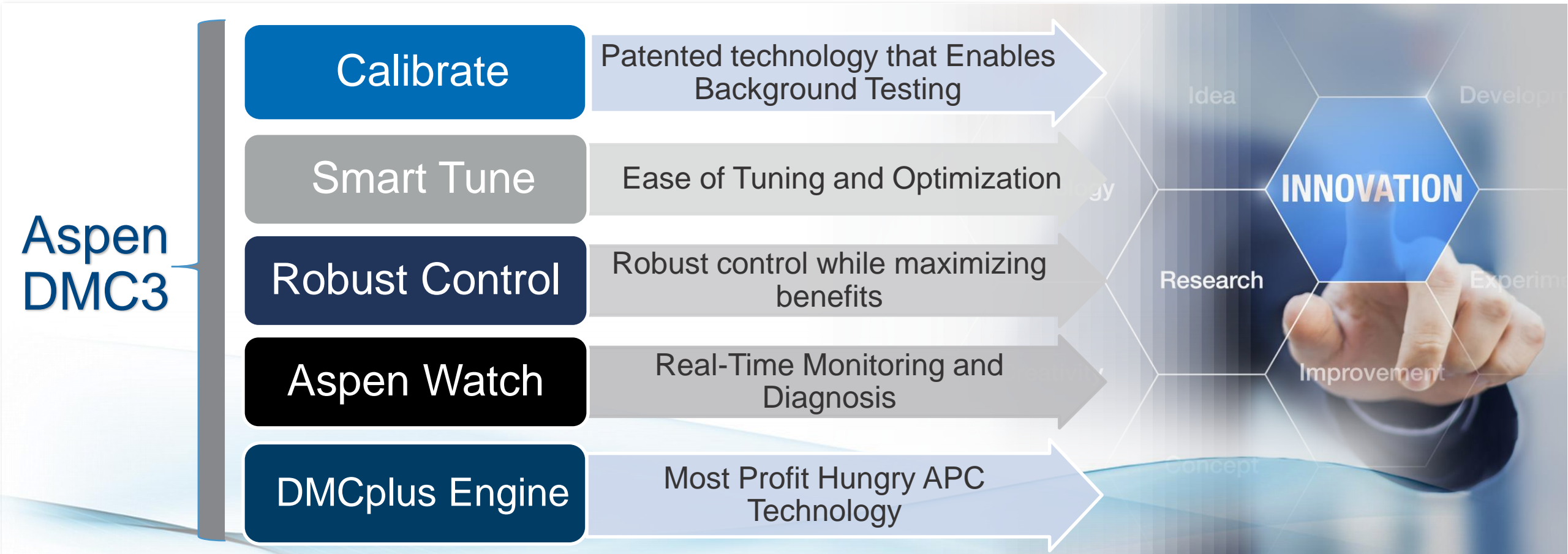
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The Following slides are modified for distribution

Aspen DMC3 - Adaptive Process Control Technology Overview

State of the art Adaptive Process Control solution to build and maintain controllers



Why do companies choose Aspen DMC3 – Adaptive Process Control

Keeping models up to date

Adaptive Process Control enables continuous background maintenance

Optimizing while testing in the background

Testing is disruptive and difficult to schedule

Calibrate maintains benefits while testing

Control benefits are turned off for testing/updates

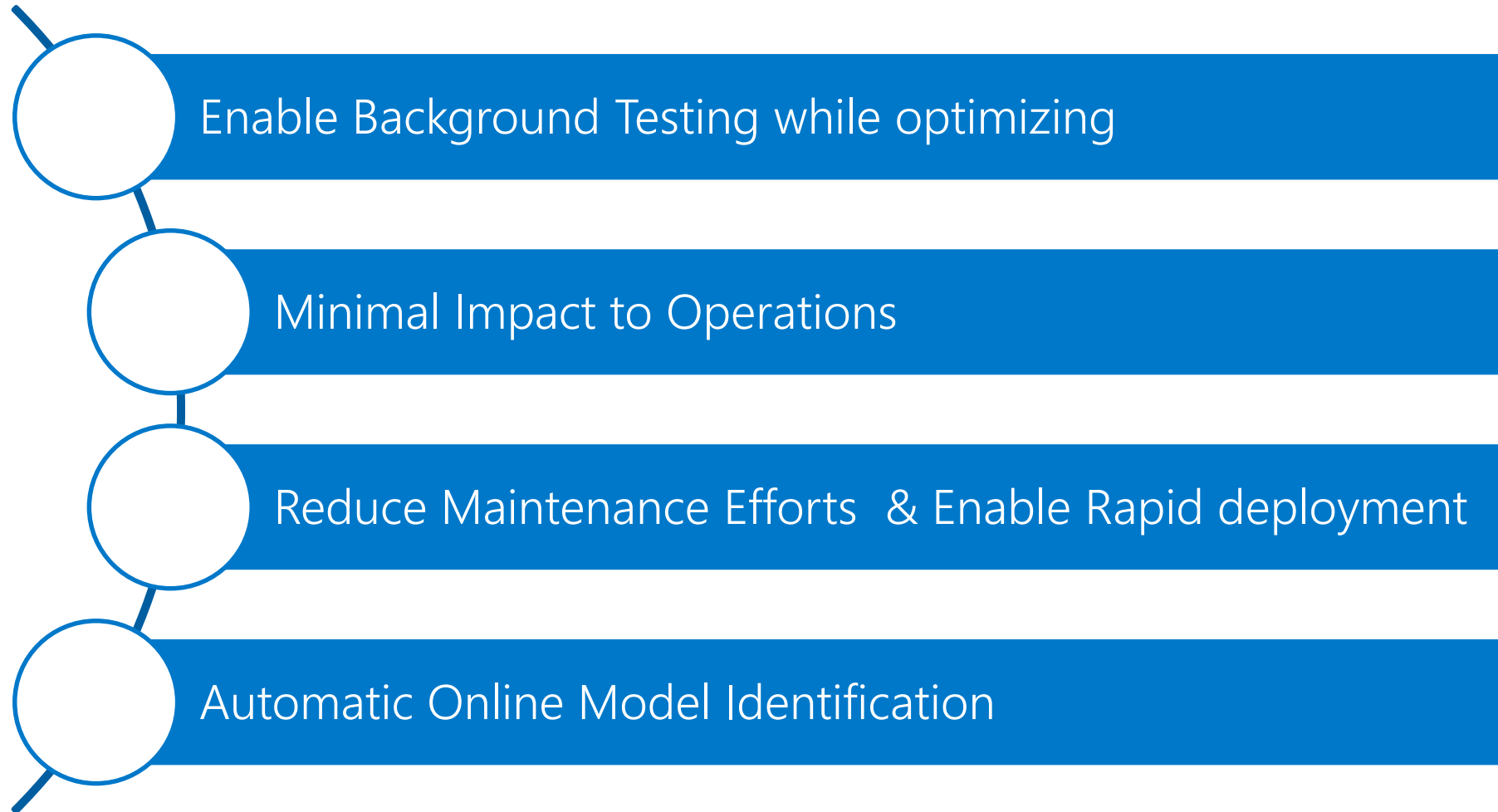
Lower APC footprint leading to low benefits

Minimal maintenance efforts and rapid deployment enables footprint expansion

Ease of use, powerful tools, simplified tuning

Too few/experienced APC resources

Aspen DMC3 – Calibrate Technology



Calibrate: Enables Background Model Updates

Optimizing Control while testing

Non-Invasive Approach

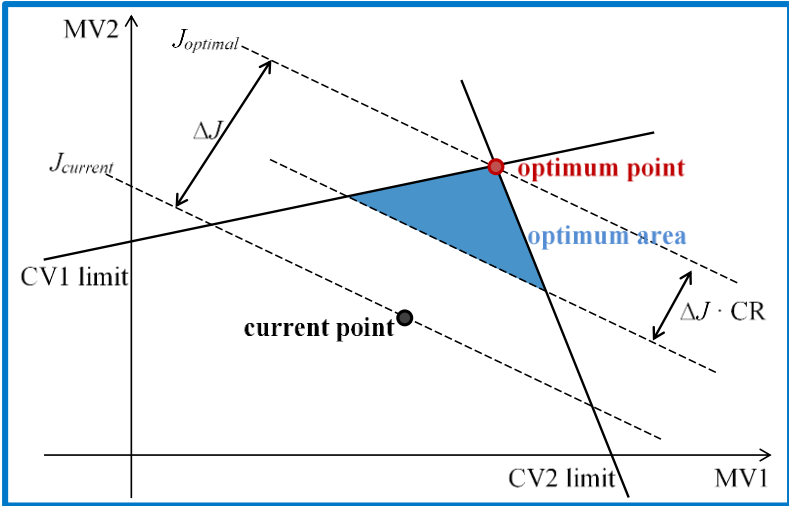
The engineer decides the trade-off between optimal control and step testing

No operator intervention



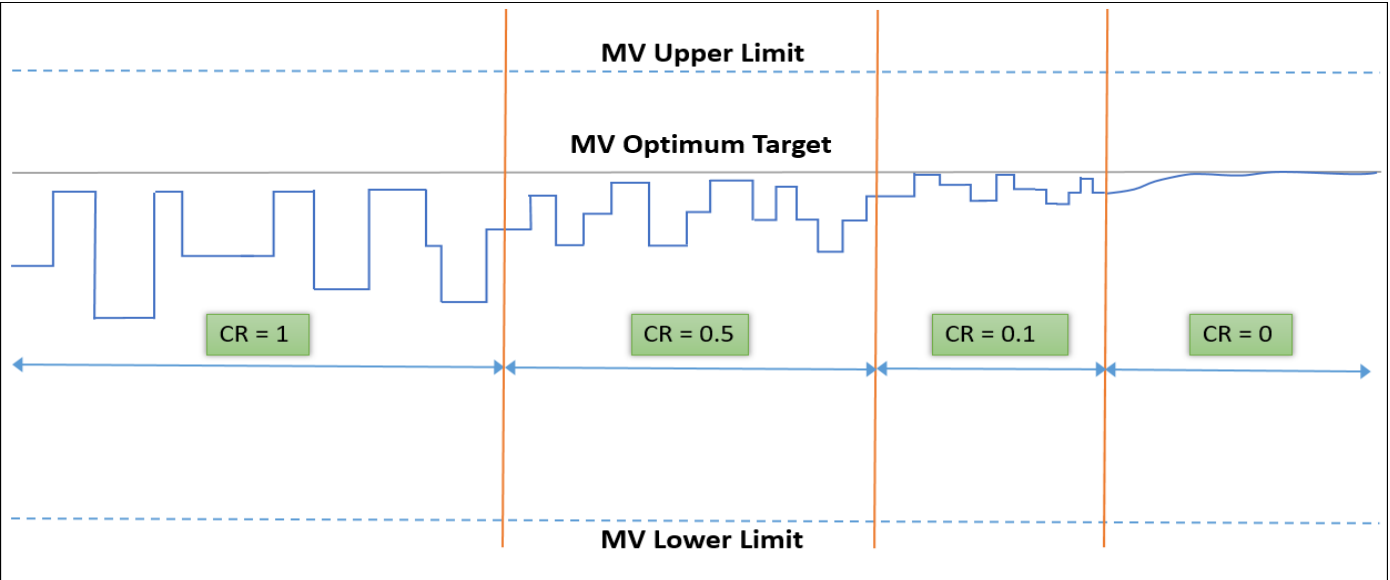
Test
(CR=1)

Control
(CR=0)



US009513610B2

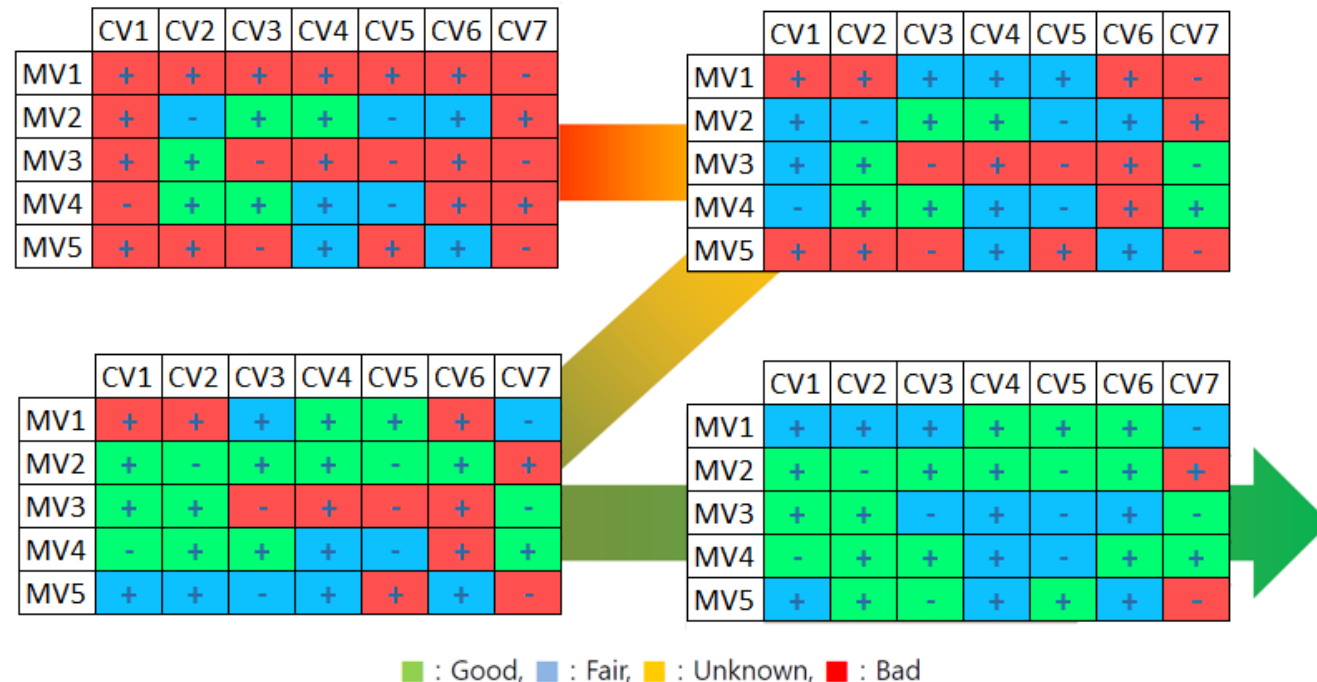
(10) Patent No.: US 9,513,610 B2
(45) Date of Patent: Dec. 6, 2016



Adaptive Model Quality Analysis (MQA)

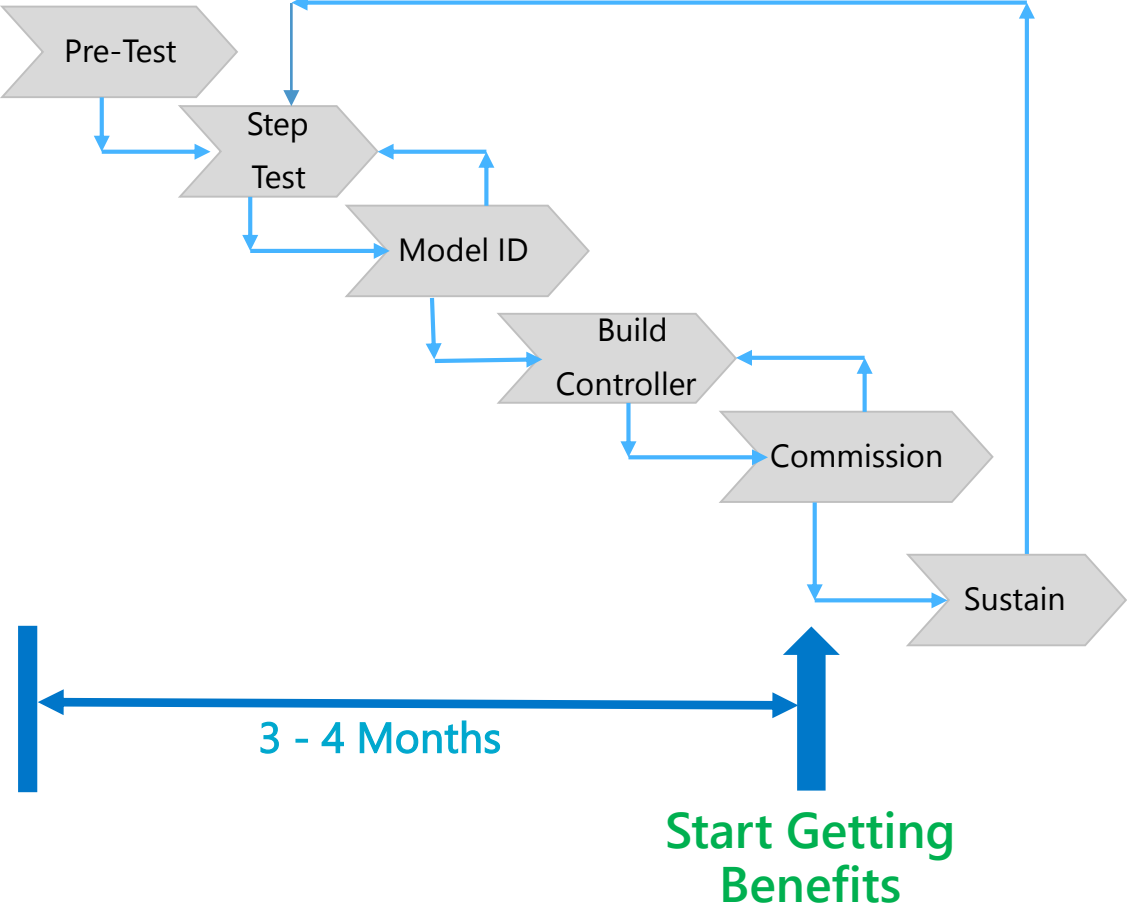
- **Reliable Model Quality in Closed Loop**

- Identifies root cause of poor performance
- Pin points troubled areas for focused Revamps
- Measures progress continuously
- Model Quality KPIs

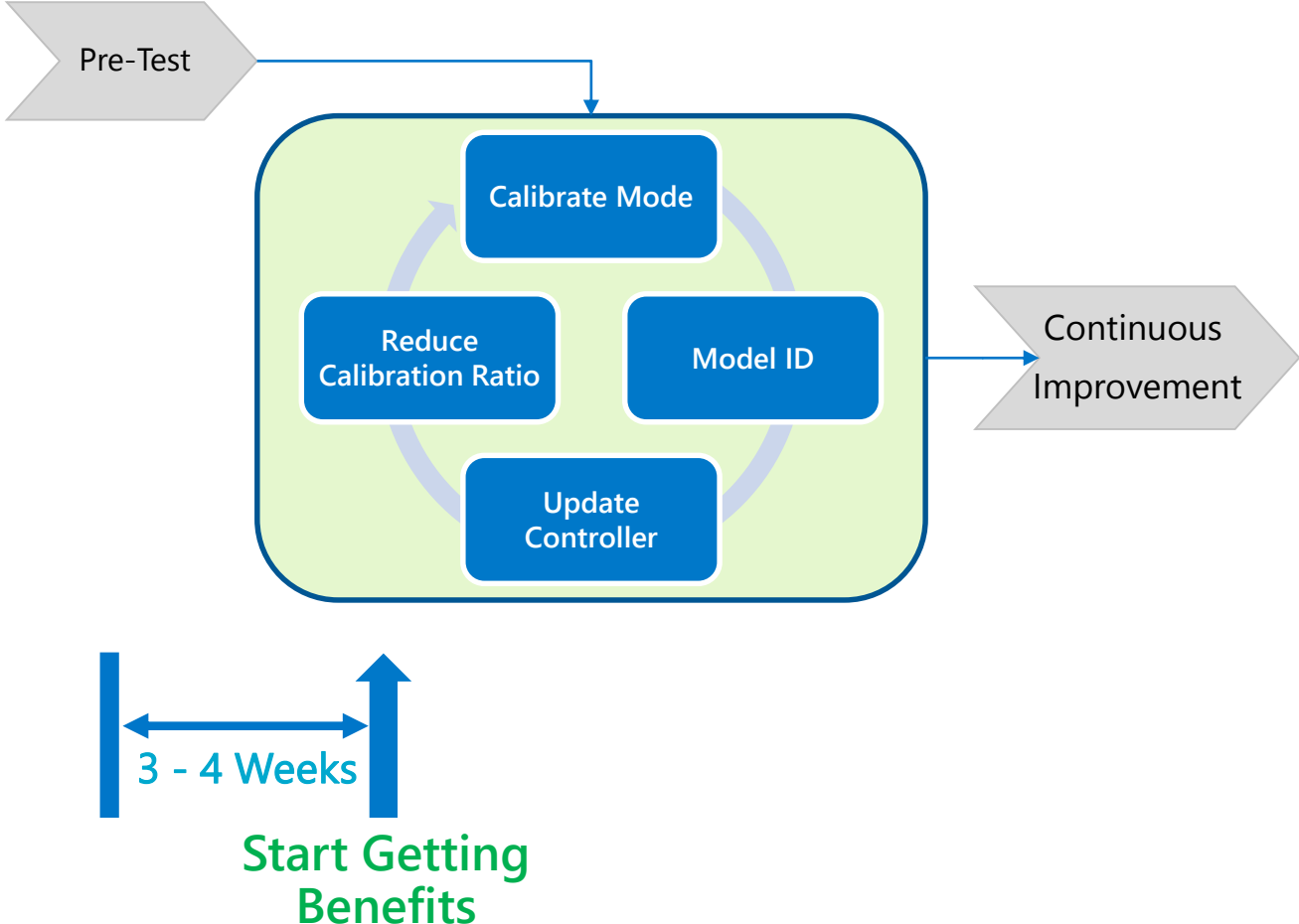


Aspen DMC3 Deployment and Maintenance Lifecycle

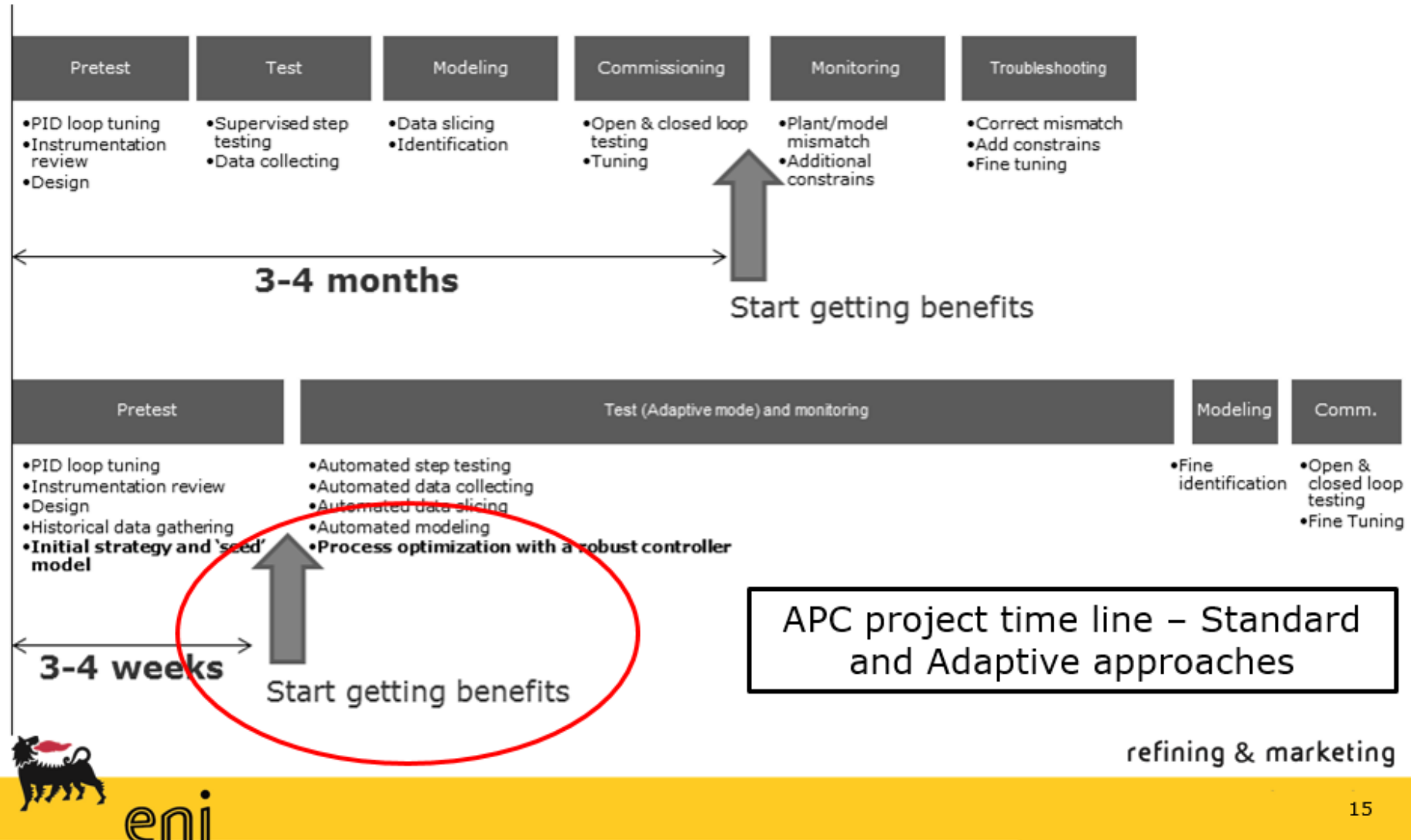
Traditional Work Flow



Aspen DMC3 Work flow



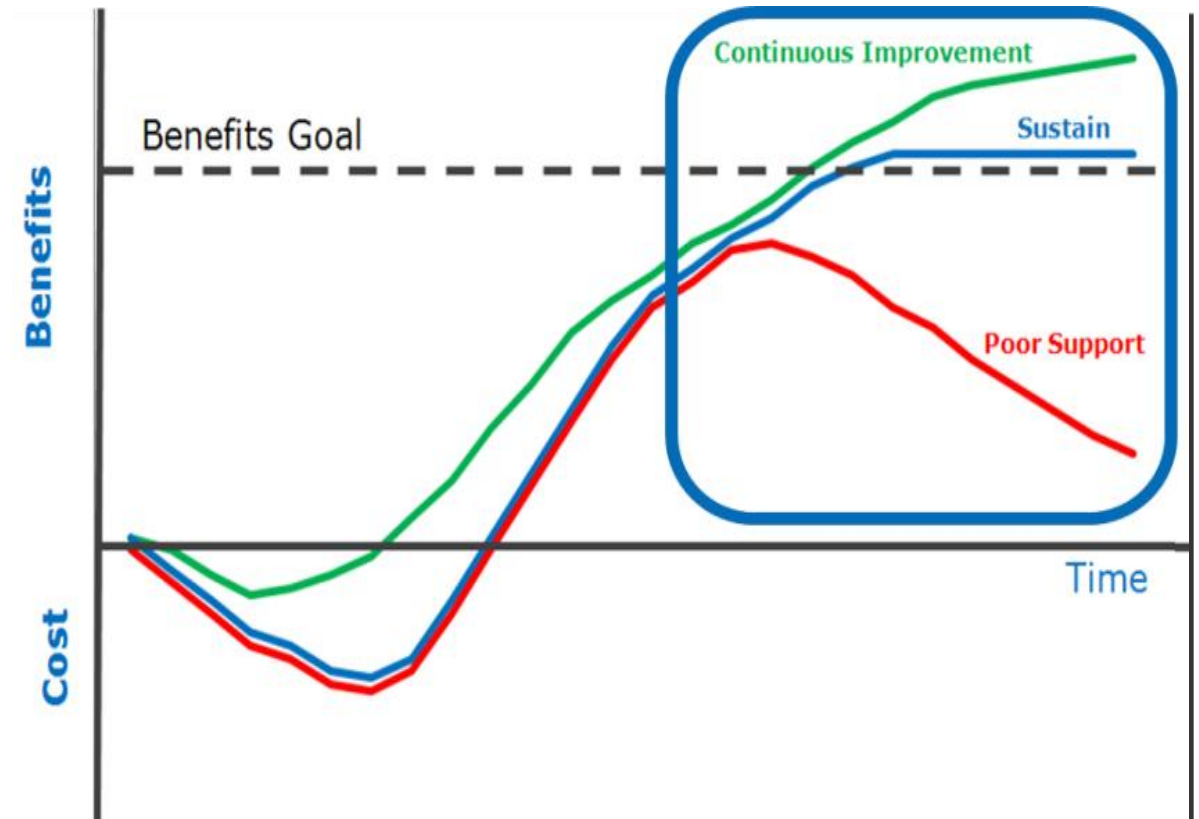
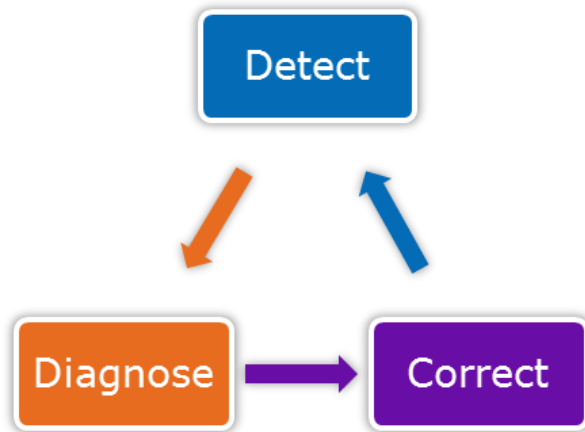
Adaptive for New Projects Faster Benefits Accrual



eni

Summary of Aspen DMC3 Benefits

- Maximize APC benefits through continuous background maintenance
- Enable faster project implementation
- Expand APC footprint to more units
- Enable more Engineers
- Significantly affect the cash curve!



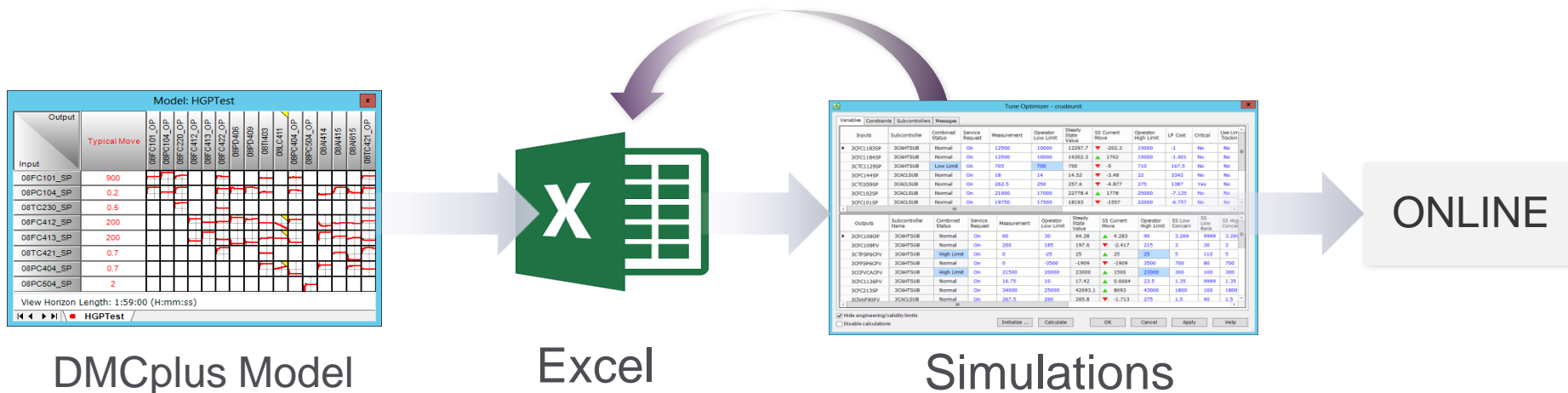
Aspen DMC3 - Smart Tune

Simplify Controller Tuning and Maintenance



Challenges in LP Tuning

- Trial and error used to set tuning parameters
- Requires experienced APC engineer to setup and modify
- Tuning becomes increasingly challenging as number of variables increase
- Tuning must be updated to account for changes in model, process or economics



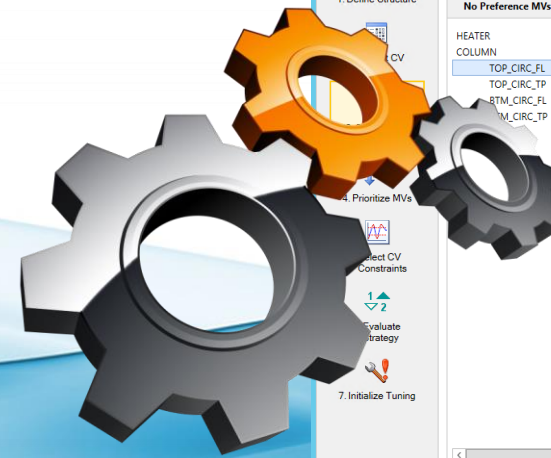
What is Aspen DMC3: Smart Tune

A New Sequential Multi-Objective Optimizer

Simplify LP tuning by directly specifying objectives

Setup wizard to effortlessly configure the optimizer

Provides visual view of the controller strategy online



Smart Tune Configuration - crudeunit

This page allows you to specify the preferred economic direction for each MV. MVs must be set to one of the following choices: Maximize, Minimize, Minimum Movement or No Preference. For MVs set to No Preference the optimal direction will be determined by the desired CV constraints selected in a later step.

No Preference MVs

MV Name	Subcontroller	Description	Units
HEATER			
COLUMN			
TOP_CIRC_FL	TOP_CIRC_TP	Top Circulation Flow	
TOP_CIRC_TP	TOP_CIRC_TP	Top Circulation Temperature	
BTM_CIRC_FL	BTM_CIRC_TP	Bottoms Circulation Flow	
BTM_CIRC_TP	BTM_CIRC_TP	Bottoms Circulation Temperature	

Maximize MVs

MV Name	Subcontroller	Description	Units
FEED_1	HEATER	Feed Pass 1 Flow	BPD
FEED_2	HEATER	Feed Pass 2 Flow	BPD
FURN_COT	HEATER	Furnace COT	DEG F
JET_FLOW	COLUMN	Side Cut 01 (Jet Flow)	BPD
LD_FLOW	COLUMN	Side Cut 02 (Light Diesel)	BPD
HD_FLOW	COLUMN	Side Cut 04 (Heavy Diesel)	BPD

Minimize MVs

MV Name	Subcontroller	Description	Units
OVH_TEMP	COLUMN	Ovhd Temperature	DEG F

Minimum Movement MVs

MV Name	Subcontroller	Description	Units
OVH_PRESS	COLUMN	Ovhd Pressure	PSIG

Previous Next Finish Cancel

DMC3 Smart Tune: Setup Wizard

Step by step wizard to setup optimizer

Effortlessly setup controller tuning

Smart Tune Configuration - crudeunit

This page allows you to specify the preferred economic direction for each MV. MVs must be set to one of the following choices: Maximize, Minimize, Minimum Movement or No Preference. For MVs set to No Preference the optimal direction will be determined by the desired CV constraints selected in a later step.

Smart Tune Workflow

1. Define Structure
2. Select CV Ranks
3. Select MV Preferences
4. Prioritize MVs
5. Select CV Constraints

No Preference MVs

HEATER	
COLUMN	
TOP_CIRC_FL	Top Circulation Flow
TOP_CIRC_TP	Top Circulation Temperature
BTM_CIRC_FL	Bottoms Circulation Flow
BTM_CIRC_TP	Bottoms Circulation Temperature

Maximize MVs

MV Name	Subcontroller	Description	Units
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FURN_COT	HEATER	Furnace COT	DEG F
JET_FLOW	COLUMN	Side Cut 01 (Jet Flow)	BPD
LD_FLOW	COLUMN	Side Cut 02 (Light Diesel)	BPD
HD_FLOW	COLUMN	Side Cut 04 (Heavy Diesel)	BPD

Minimize MVs

MV Name	Subcontroller	Description	Units
OVH_TEMP	COLUMN	Ovhd Temperature	DEG F

Set Priority for MVs

Priority	Input	Description	Units
4	OVH-PRESS	Ovhd Pressure	PSIG
3	OVH-TEMP	Ovhd Temperature	DEG F
1	JET-FLOW	Side Cut 01 (Jet Flow)	BPD
2	LD-FLOW	Side Cut 02 (Ligh Diesel)	BPD
2	HD_FLOW	Side Cut 04 (Heavy Diesel)	BPD

Next Finish Cancel

DMC3 Smart Tune: Online Controller Strategy View

Easily simulate, troubleshoot and modify controller strategy online

Visually see simulated scenarios and how variables will be effected

Gain greater insight into controller strategy online

Legend

			FEED_PR_VLV	FEED_PRESS	DELTA_TEMP	DELTA_FLOW	FEED_TARGET	FUEL_GAS_PR	REFLUX_ATM	NAPHTHA_90
Manipulated Variables	Original Priority	New Priority	Lo Hi	Lo Hi	Lo Hi	Lo Hi	Lo Hi	Lo Hi	Lo Hi	Lo Hi
HEATER	1	1								
+ FEED_1	1	1	▲ 2	▼ 2	▲ 2	▼ 1	▲ 2	▼ 2	▲ 3	▼ 8
+ FEED_2	1	2	▲ 1	▼ 1	▲ 1	▼ 2	▲ 2	▼ 2	▲ 2	▼ 7
+ FURN_COT	2	3						▼ 1	▲ 3	▼ 6
COLUMN	2	2								
= OVH_PRESS	4	4								▲ 1 ▼ 2

Gain: -0.0016
Low: 2 → 1

Smart Tune Difference

Objective Function

Aspen DMCplus

- 1 Feed Pass 1
- 1 Feed Pass 2
- 1 Furnace COT
- 1 Jet Flow
- 1 Light Diesel
- 1 Heavy Diesel
- 1 Overhead Temp
- 1 Overhead Press
- 1 Top Circ. Flow
- 1 Top Circ. Temp
- 1 Bottom Circ. Flow
- 1 Bottom Circ. Temp

Aspen DMC3

- 1 Feed Pass 1 (Max)
- 1 Feed Pass 2 (Max)
- 2 Furnace COT (Max)
- 3 Jet Flow (Max)
- 4 Light Diesel (Max)
- 4 Heavy Diesel (Max)
- 5 Overhead Temperature (Min)
- 6 Overhead Press (Min Move)
- 7 Top Circ. Flow (No Preference)
- 7 Top Circ. Temp (No Preference)
- 7 Bottom Circ. Flow (No Preference)
- 7 Bottom Circ. Temp (No Preference)

Value of Aspen DMC3 Smart Tune

Smart Tune

Simplify Controller Tuning and reduce efforts and complexity



Quickly adapt controller to changing economic conditions with minimal efforts



Less need to revisit tuning after model update or if objectives change



Higher operator acceptance with greater visibility into controller strategy



Lower barrier to controller design and maintenance



Aspen DMC3 Builder Platform –Powerful, Modernized & Easy to Use

One powerful integrated platform used to build and deploy controllers, from start to finish

Modernized Interface

Ribbon based, workflow oriented design

Collinearity Analysis

Integrated and powerful collinearity analysis & repair

Constrained Identification

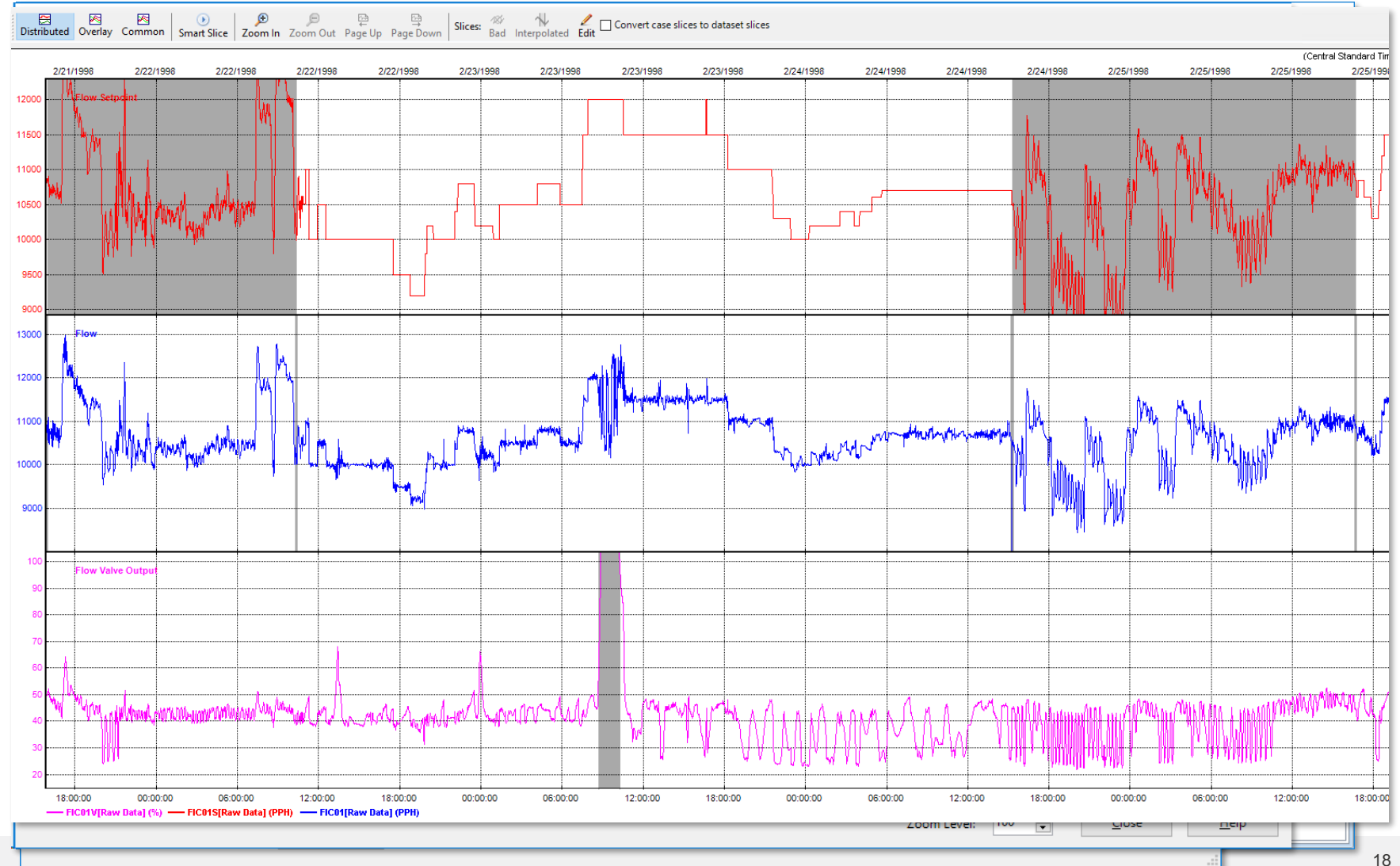
Embed Process Knowledge on models and cases

Visual Transform

Simple and powerful way of defining transforms

Smart Slicing

Automatic bad data slicing enables easier pre-processing of data



What's new in aspenONE[®] APC V10



aspenONE APC V10 Features

Scaling Dynamics and Variable Dead-time

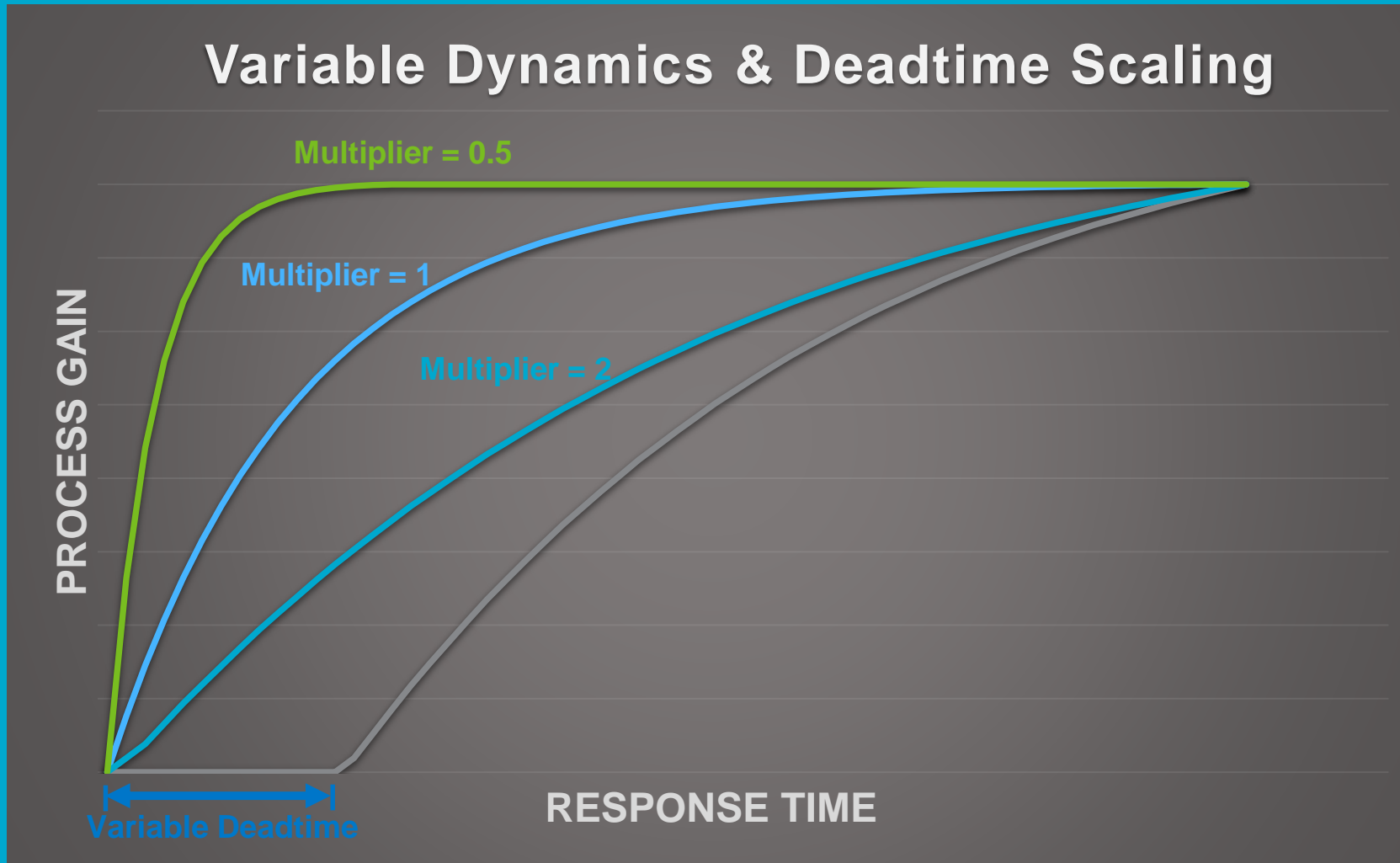
Smart Tune Includes CV Optimization

Aspen DMC3 Builder Enhancements

Models for Prediction Only

Variable Deadtimes and Scalable Dynamics

Easily adjust model dynamics and deadtimes online in closed loop

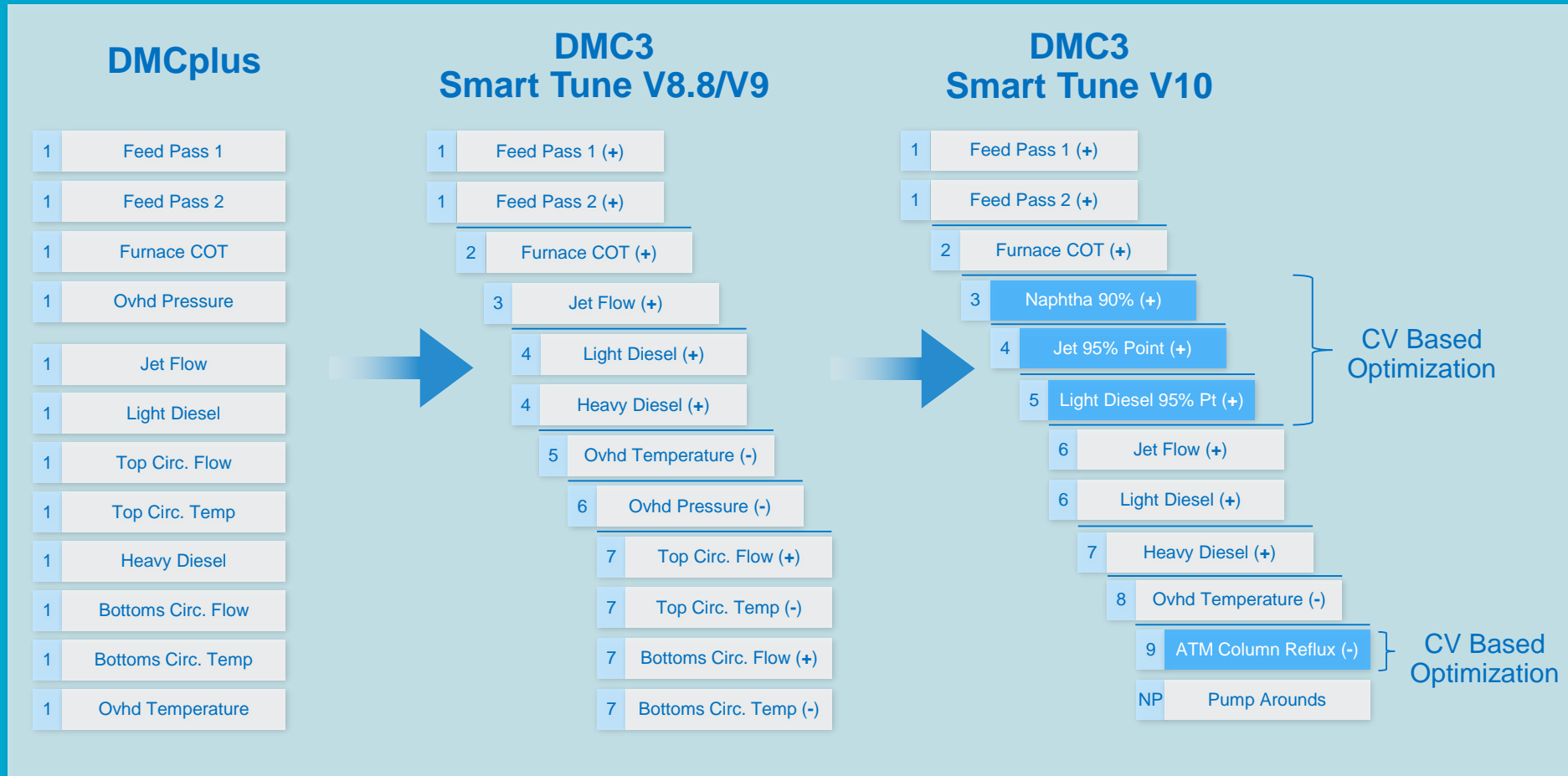


✓ Avoid switching models

✓ Accurate models across operating range

V10 Smart Tune Includes CV Based Optimization

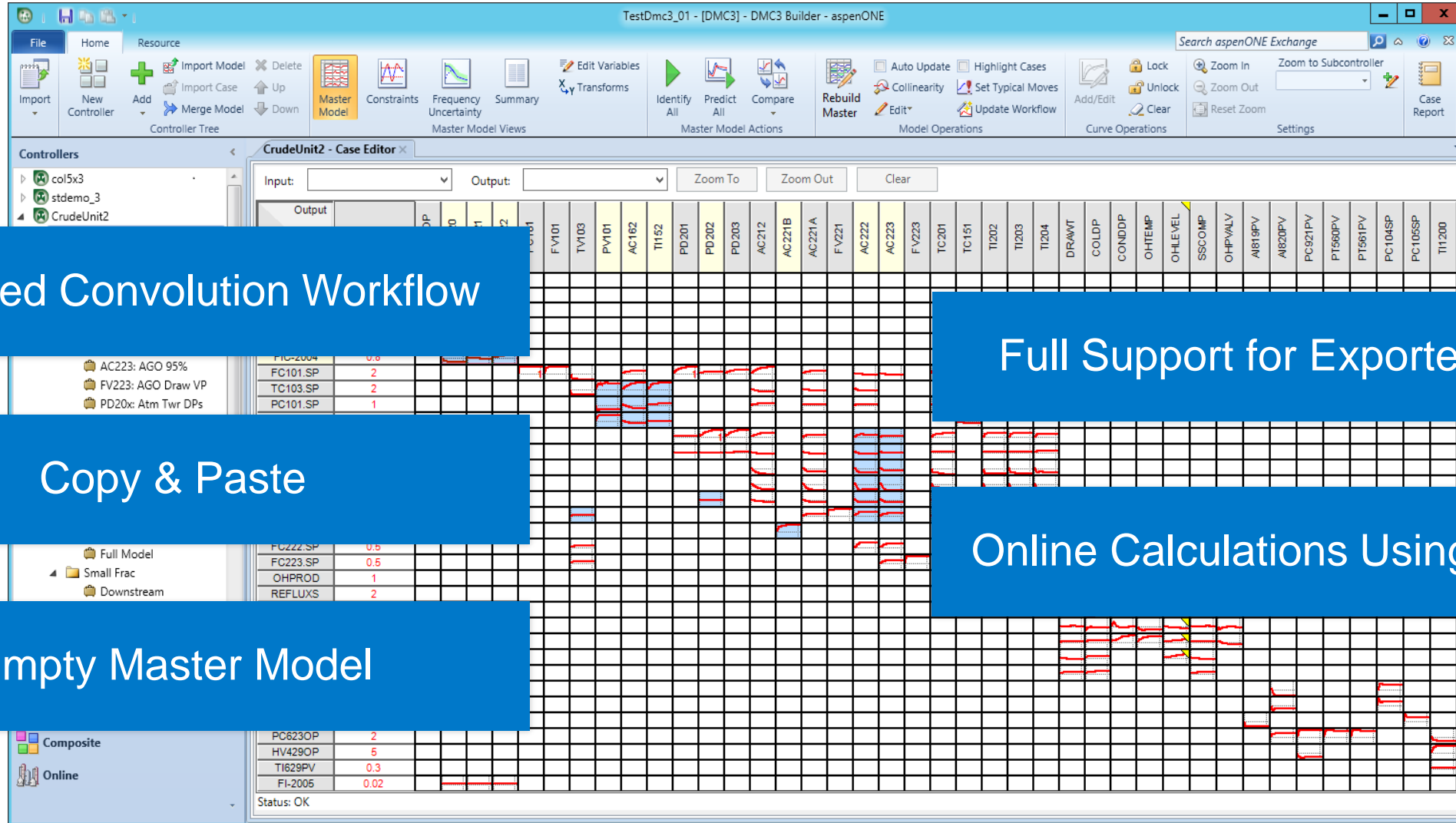
Flexibility in specifying CV and/or MV based optimization strategy



✓ CVs and MVs based Optimization

✓ Specify Priority and Optimization direction

Aspen DMC3 Builder Enhancements



Improved Convolution Workflow

Full Support for Exported .dpa

Copy & Paste

Online Calculations Using Arrays

Empty Master Model

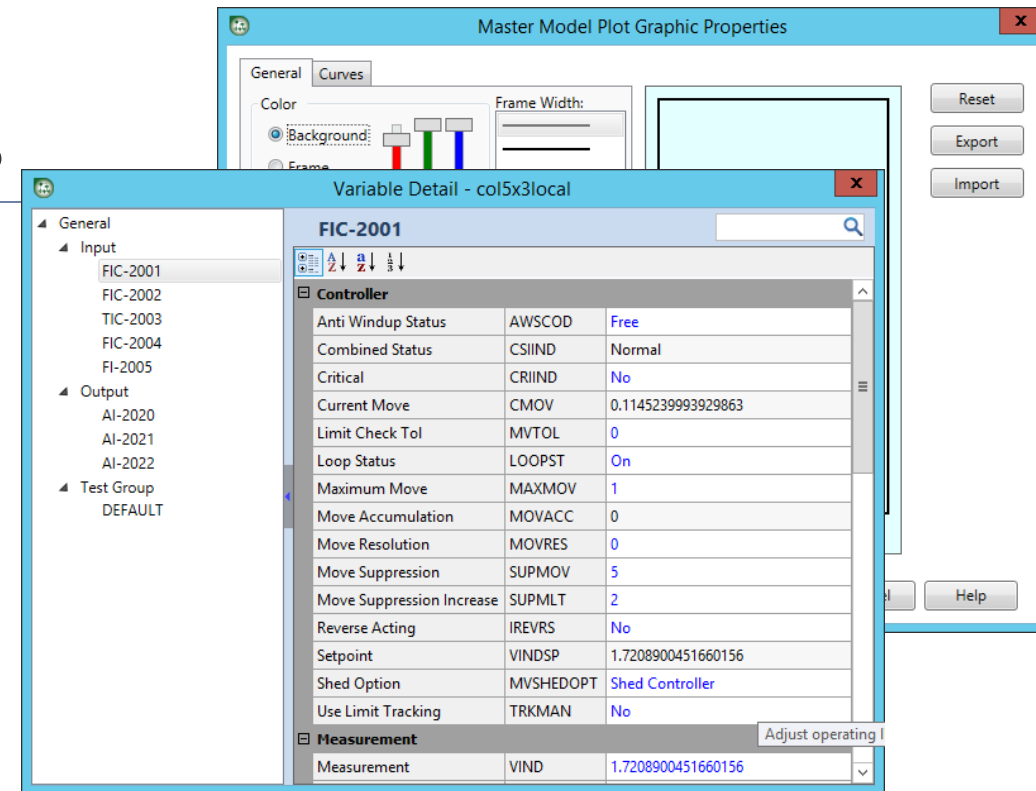
Aspen DMC3 Builder Enhancements

- Overall performance improvements
- Graphic option to customize colors and fonts
- Custom Messages to Operators

- Write calculations like this:

```
array=[10,2,0.1,5,4]
  if value=array[3] then
    switch=1
  else
    aux1=0
    for i=1 to array.length
      aux=array[i]+aux1
      aux1=aux
    next
  end if
```

```
if Feed_TGT < 23000 then
  SendMessag((cvName & " has dropped
below 2000 barrels"))
end if
```



Aspen DMC3 - Models for Prediction Only

The screenshot displays the Aspen DMC3 Builder interface. The main window shows a process flow diagram with several control loops. A 'Curve Overrides' dialog box is open, showing a table of model settings for various outputs. The 'Prediction Only' setting is highlighted for several models. A 'Model Ind: REBBTU - Dep: CONDDP' window is also visible, showing a graph of the model's response and its parameters.

Output	AI0001.PV	TI0001.PV	AI0002.PV	PDI0001.PV	PIC0001.OP
Input	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
FIC0001.SP	Prediction Only	Prediction Only	Prediction Only	Always Use	Prediction Only
FIC0003.SP	Always Use	Always Use		Always Use	Always Use
PIC0001.SP		Always Use			Always Use
TIC0001.SP	Always Use	Always Use	Always Use		

Description	Value
Typical Move	200.000
Gain Multiplier: CONDDP	1.000
Curve Override Switch: CONDDP	Prediction Only
Time Constant Multiplier: CONDDP	1.000
Variable Deadtime: CONDDP	0.000

✓ Specify Models for Prediction and not Control

✓ Avoid redundant Feed Forward independents