LISTEN. THINK. SOLVE.®

PlantPAx MPC Introduction
Powerful Embedded Model Predictive Control

Allen-Bradley • Rockwell Software

Rockwell Automation

Copyright © 2014 Rockwell Automation, Inc. All rights reserved.

MPC Drives Performance

Rockwell Automation

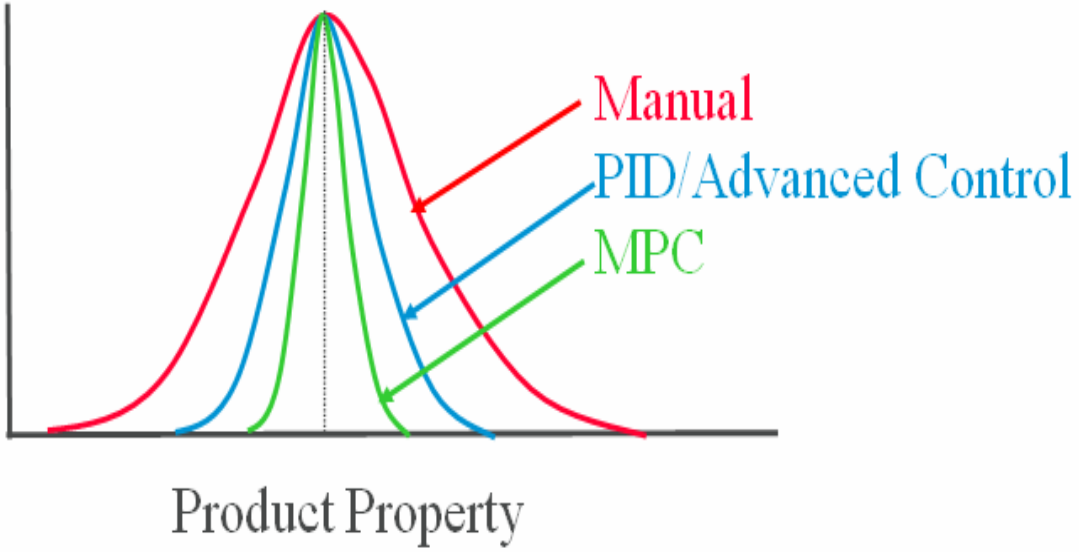
What would it mean to your business if you could:

- Increase Production
- Reduce Scrap
- Run Closer to Product Quality Targets and Limits
- Reduce Energy per Pound of Product
- Reduce Environmental Impact

Copyright © 2014 Rockwell Automation, Inc. All rights reserved.

MPC versus PID Control

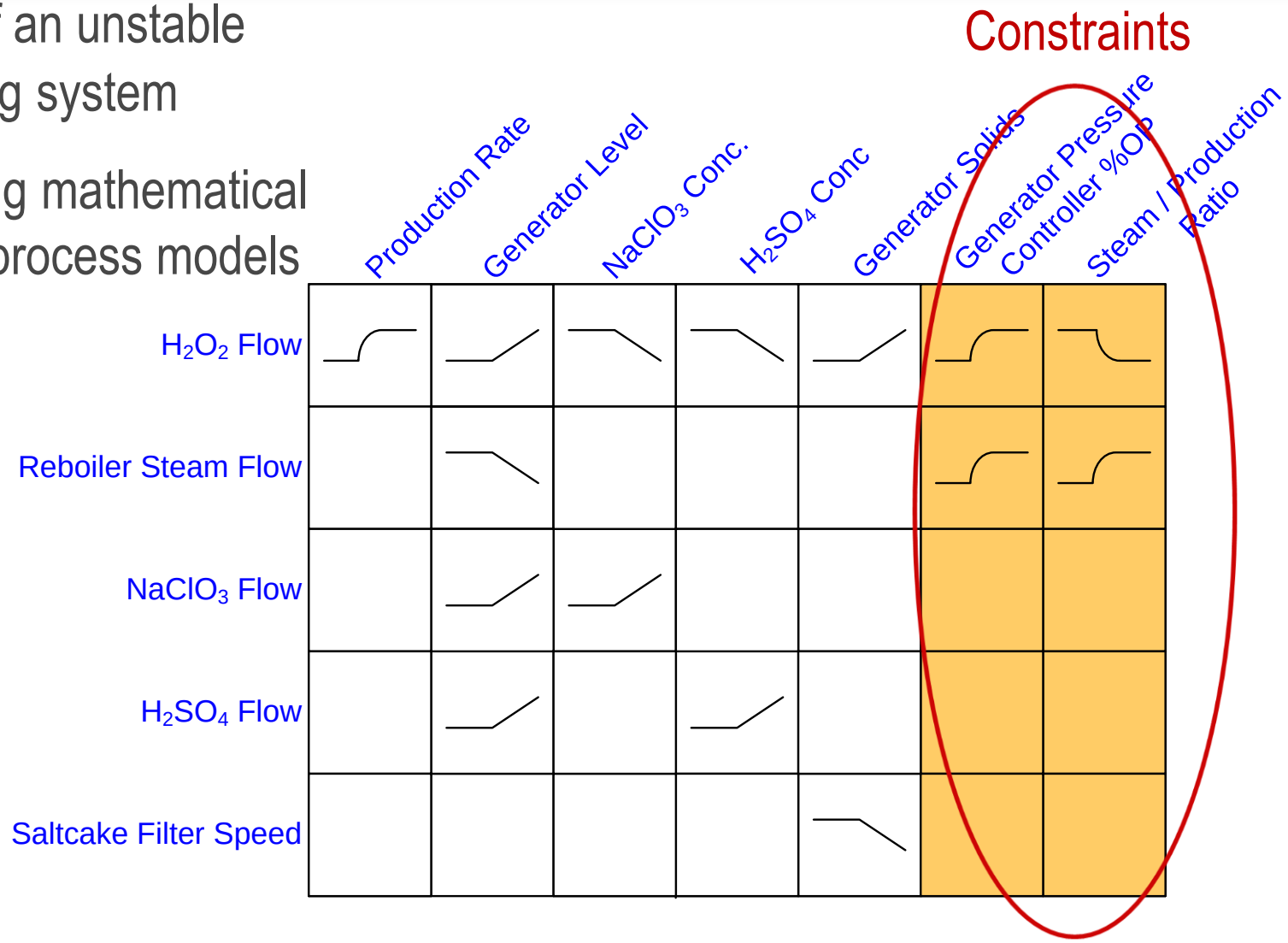
- Coordinate multiple interacting PIDs
- Predictably manage external disturbances
- Handle long or complex process dynamics
- Maximize performance up to process limits
- PID tuning is subjective and requires time and experience



Copyright © 2014 Rockwell Automation, Inc. All rights reserved.

ClO_2 Generation Example

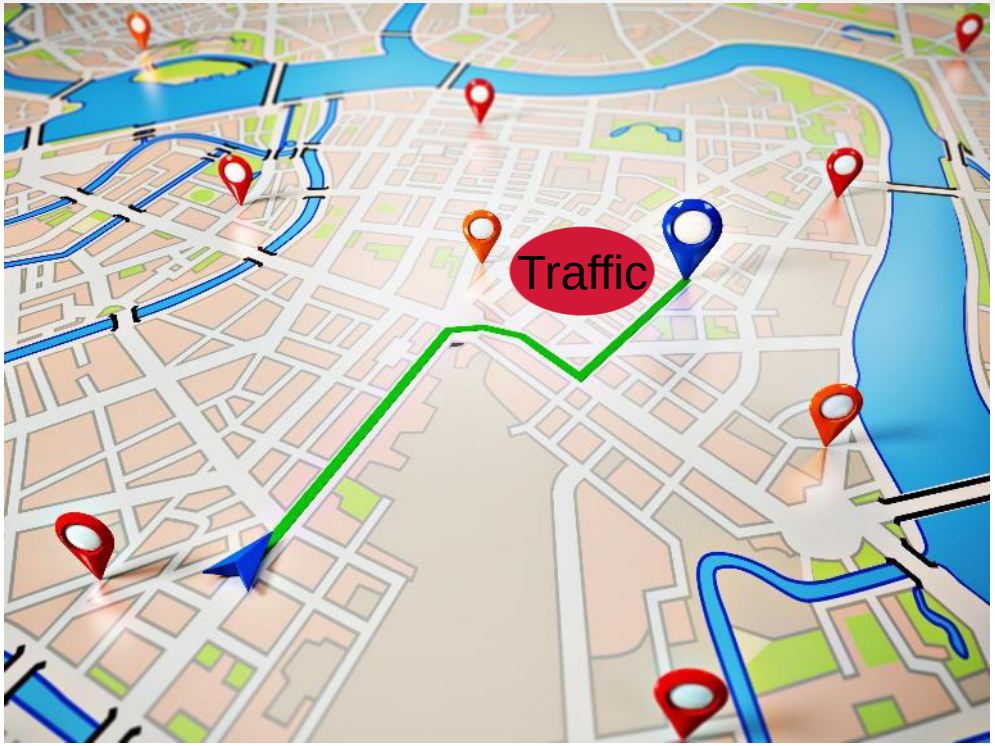
- Control of an unstable processing system
- Leveraging mathematical dynamic process models



Copyright © 2014 Rockwell Automation, Inc. All rights reserved.

PlantPAx has the only embedded MPC

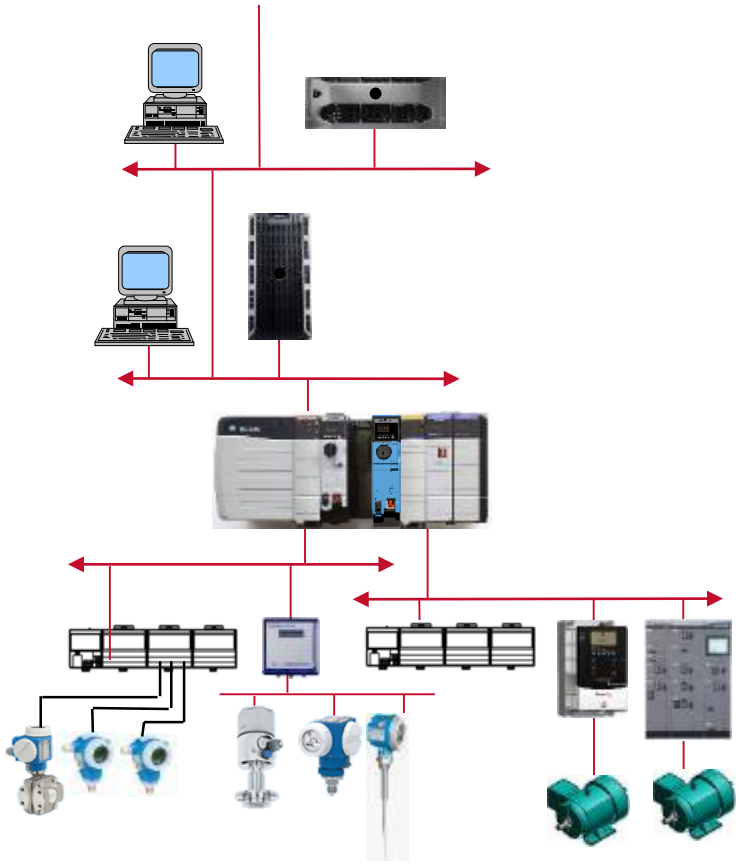
- That senses and reroutes your control when a bottleneck happens
- That allows closed-loop adjustment of all tuning & model parameters
- That leverages trajectory information fully on cascade controllers, on sequential controllers and on known disturbance paths.



- That supports up to 10 MVs, 10 CVs & 10 DVs
- And is fully embedded in PlantPAx: runs in controllers, complete faceplate integration, uses RA programming standards.

Copyright © 2014 Rockwell Automation, Inc. All rights reserved.

PlantPAx APC in Integrated Architecture



Workstation and Logix-based APC Products

FactoryTalk® ProductionCentre, FactoryTalk® Historian,
Pavilion® Real-Time Optimization™ …

Pavilion8® MPC, Software CEM®, VOA®, Asset Management, …

Rockwell Software Studio 5000®, **PlantPAx™ MPCBuilder, PlantPAx™ ModelBuilder**

- **PlantPAx® MPC**
- **IMC,CC,MMC**
- **FuzzyLogic**
- **SoftSensor® (AOI)**
- **PID,PIDE**
- Motion
- Discrete

Copyright © 2014 Rockwell Automation, Inc. All rights reserved.

Traditional MPC Limitations

Rockwell Automation

- One Control Platform
  - A Controller is a more reliable/robust platform (reduced maintenance)
  - A Controller is designed to easily integrate calculations and measurements (eases deployment)
- One Platform to Maintain
  - Some users are more comfortable with integration of measurements, outputs and MPC on a single platform.
  - One user interface is used for integrating MPC, support calculations and adding/configuring measurement integration.
- That acts faster
  - Online optimization has been slow and expensive
  - Execution cycles have been in minutes, not sub-second

Copyright © 2014 Rockwell Automation, Inc. All rights reserved.

PlantPAx MPC Capabilities

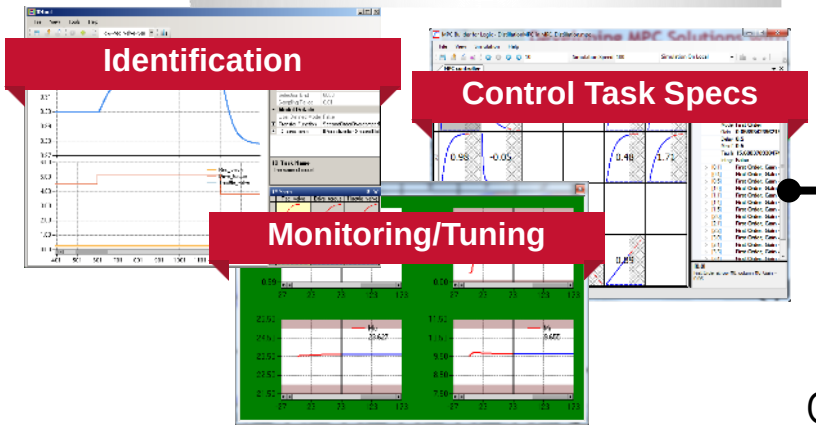
Rockwell Automation

- **Develop and implement MPC up to 10 CV's, 10 MV's and 10 DV's**
  - Calculation optimization up to 9 control moves (default 6)
  - Predictive horizon up to 200 controller steps (frequency is a user specification)
- **Execute up to five independent MPC applications on one MPC-module**
- **Fully functional MPC**
  - Incorporates a solver and dynamic constraint management
  - Allows on-the-fly model and tuning parameter adjustment
    - In open or closed-loop
    - Will slow calculation speed, so grade-based model scheduling, not every execution is recommended or anticipated.
  - Allows trajectory passing including most relevant parameters (targets, disturbances, constraints)

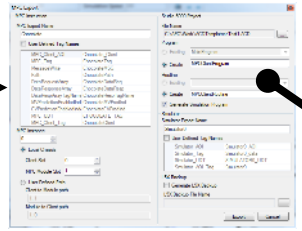
Copyright © 2014 Rockwell Automation, Inc. All rights reserved.

PlantPAx MPC – Solution Development

MPC Builder

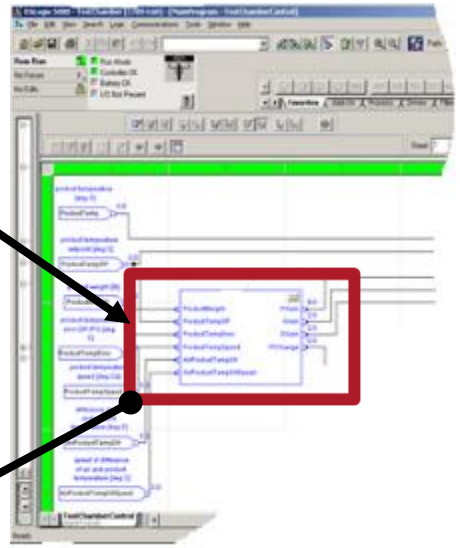


Export



Online change monitoring

Logix5000



Development cycle

1. Identify Process Parameters
2. Specify Targeted measurements & Limits
3. Generate MPC Shell AOI
4. Import and instantiate AOI
5. Download project to Logix
6. Monitor and tune

Logix5000 program download

Dedicated MPC-Module
(Co-Processor)
AOI on Controller

Copyright © 2014 Rockwell Automation, Inc. All rights reserved.

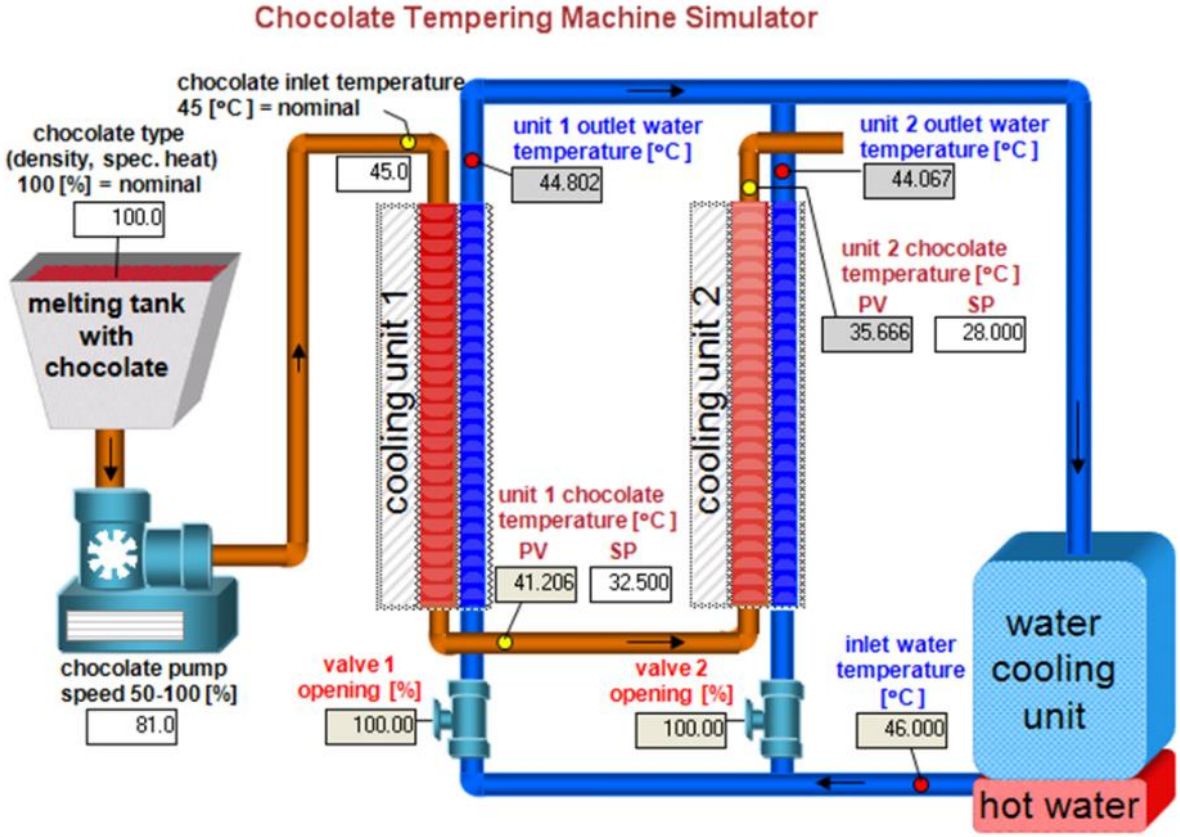
Chocolate Tempering Machine Control Task Demonstration

Rockwell Automation

- **Maintain Quality:** proper chocolate crystallization is achieved when maintaining the chocolate temperature at SP ±0.5 [°C] at the machine outlet

- **Maximize Yield:** maximize production and minimize the amount of chocolate. which has to bv recvcled

- Manipulated Variables:
  - unit 1 water valve opening [%]
  - unit 2 water valve opening [%]
  - chocolate feed rate [%]
- Controlled Variables:
  - unit 1 outlet chocolate temperature [° C]
  - unit 2 outlet chocolate temperature [° C]
- Disturbance Variables:
  - inlet water temperature [° C]
  - type of chocolate [%]
  - chocolate inlet temperature [° C]



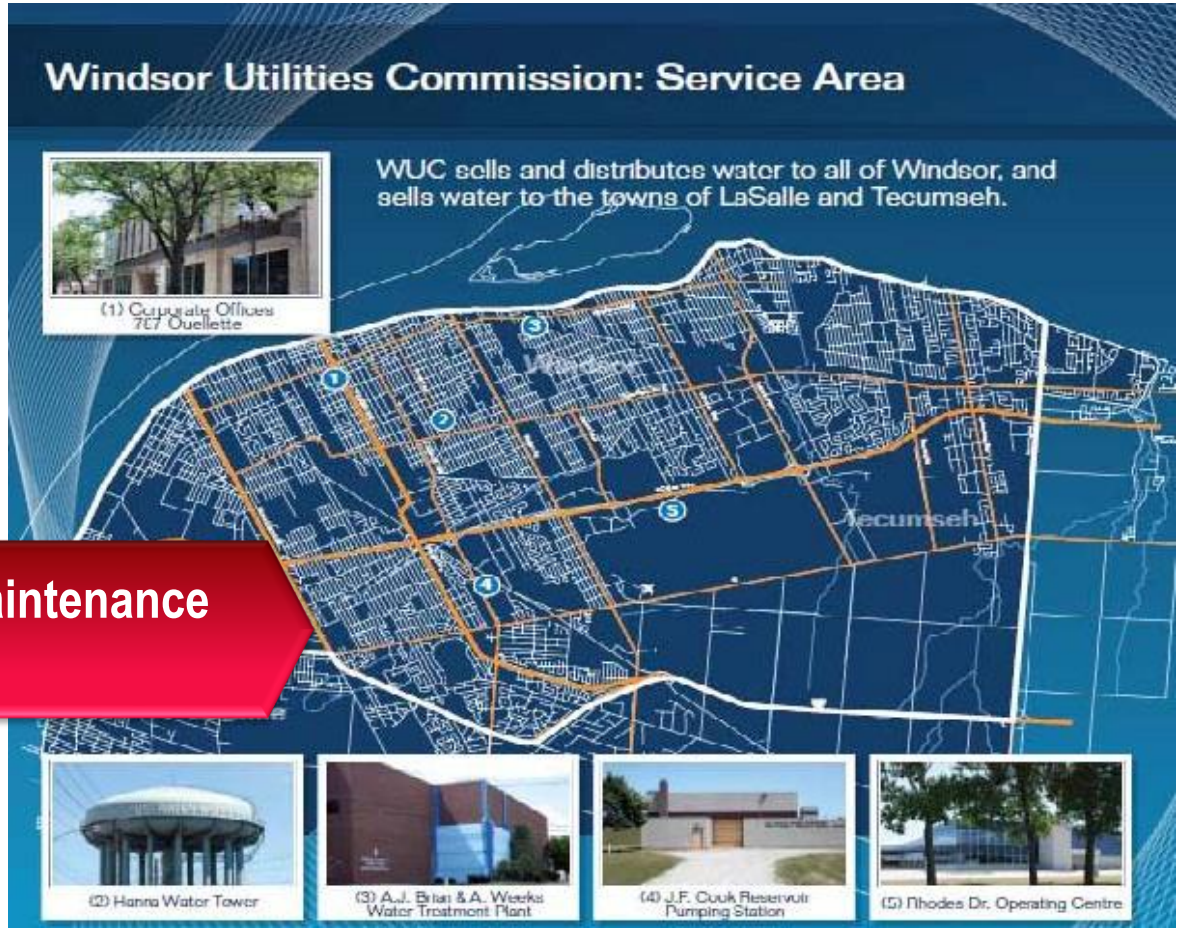
Copyright © 2014 Rockwell Automation, Inc. All rights reserved.

Installation 2: EnWin Water Pumping

Rockwell Automation

- **Minimize Pressure:** Achieve minimum requirements at the end of many lines – but reduce leakage and pipe breaks.
- **Coordinate Pumps**: Respond to pumps turning on and off to meet varied demands.
- **Adapt Model**: to different pump

21% reduced breaks and maintenance costs reported.

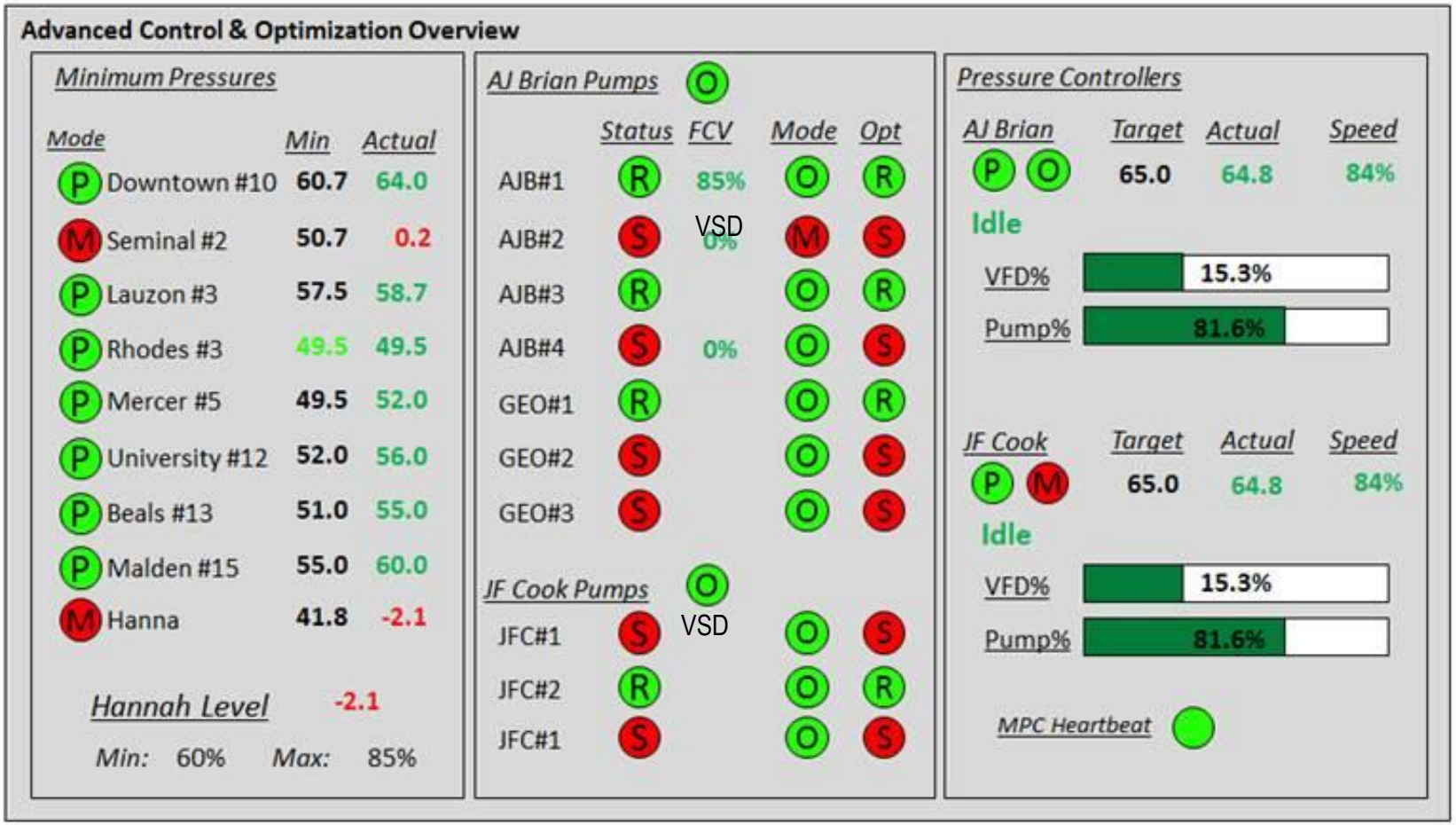


Copyright © 2014 Rockwell Automation, Inc. All rights reserved.

Custom APC Faceplate in FTView

P = Pressure Control **R** = Running **O** = Optimized

M= Manual Control **S** = Stopped **M** = Manual



Copyright © 2014 Rockwell Automation, Inc. All rights reserved.

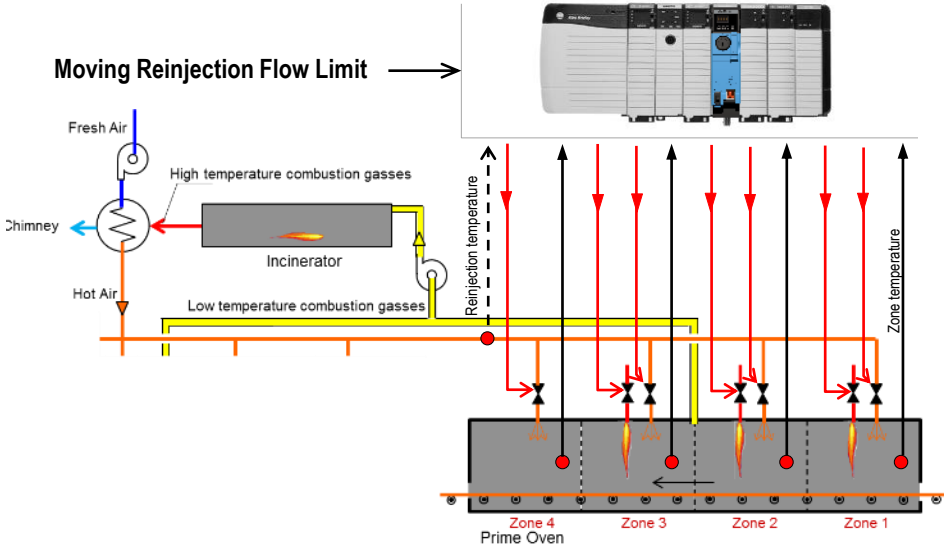
Applied PlantPAx MPC Coating Oven

Rockwell Automation

Classic Solution

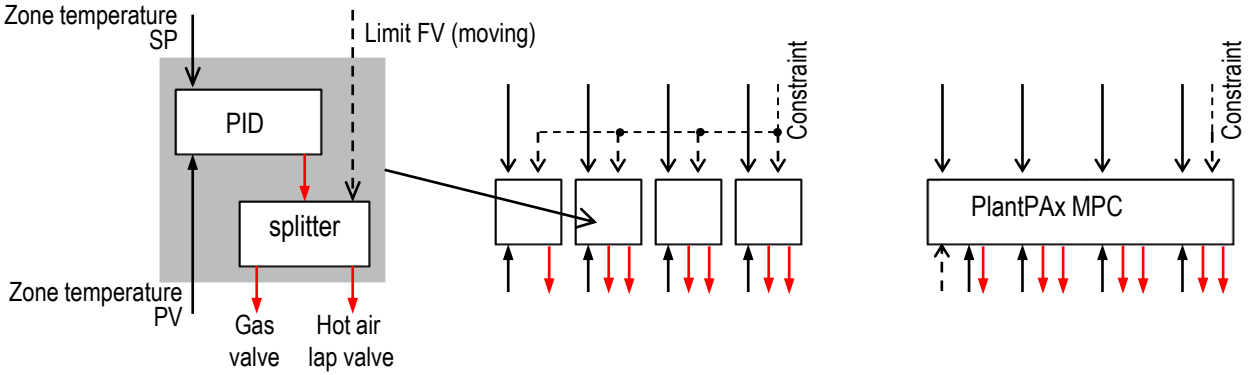
MPC Control

Organic Coating Oven



CV × MV × DV

4 × 7 × 2



Coordinate heat recovery valves & gas

Utilize all waste heat

Correct for feed & incinerator changes

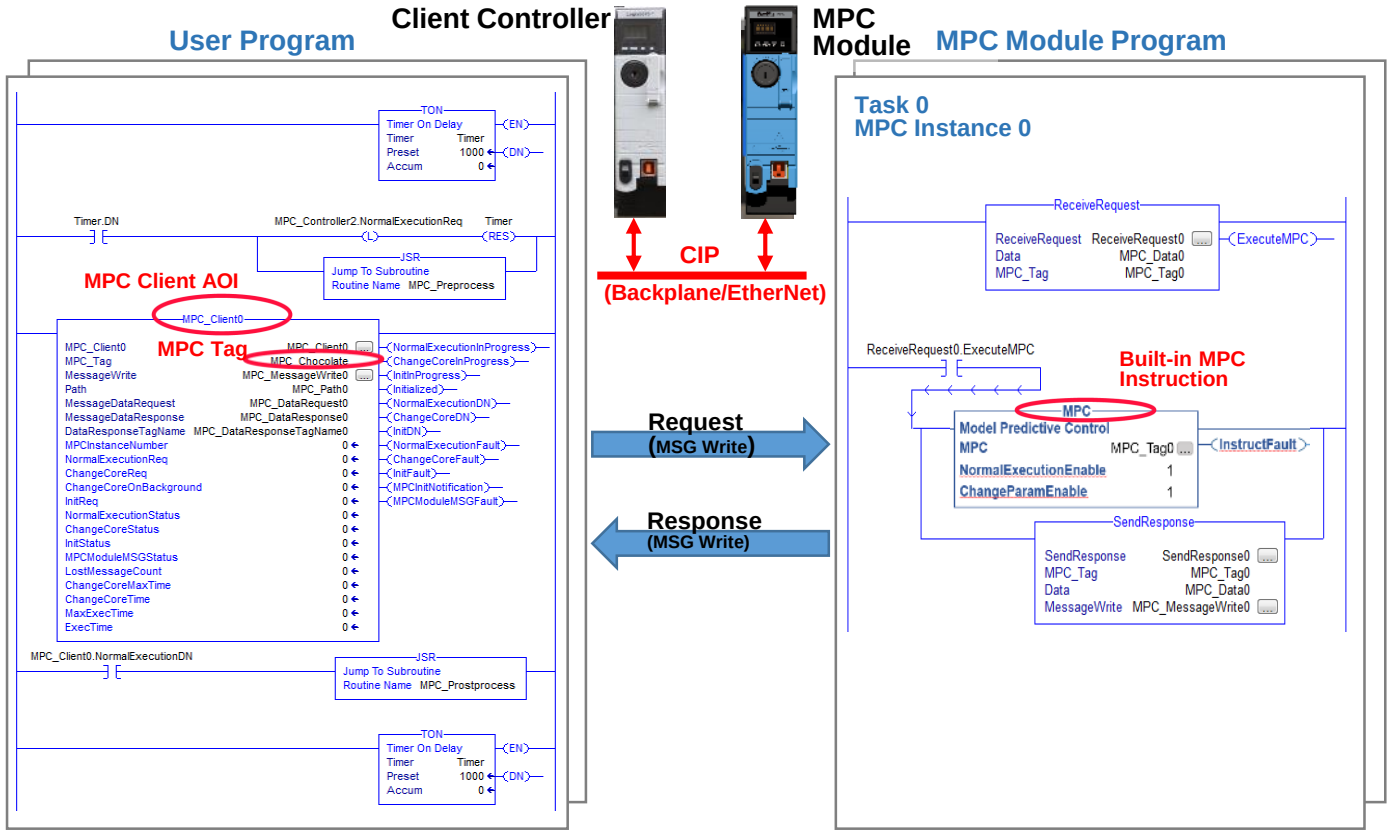
Copyright © 2014 Rockwell Automation, Inc. All rights reserved.

Application Candidates PlantPAx MPC

- Distillation
- Evaporation
- Drying
- Boilers
- Milling
- Aeration Decks
- Centrifuge Balancing
- Stripping Columns
- Compressor
- Reactor
- And many more

Copyright © 2014 Rockwell Automation, Inc. All rights reserved.

Client Controller and MPC Module Integr

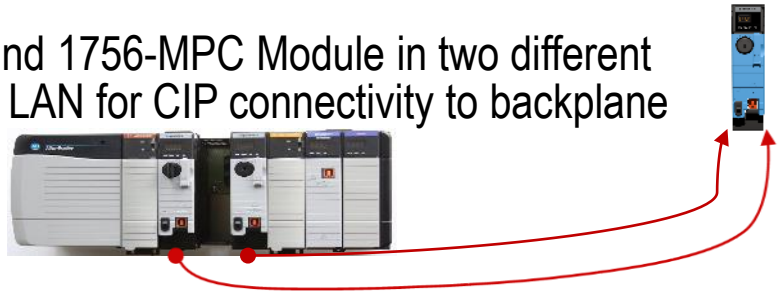


Copyright © 2014 Rockwell Automation, Inc. All rights reserved.

Use case : acceptable configurations

Option 1 – Logix Controller and 1756-MPC Module in one chassis. Ethernet on control LAN for CIP connectivity to backplane (workstation monitoring).

Option 2 – Logix Controller and 1756-MPC Module in two different chassis. Ethernet on control LAN for CIP connectivity to backplane (workstation monitoring).

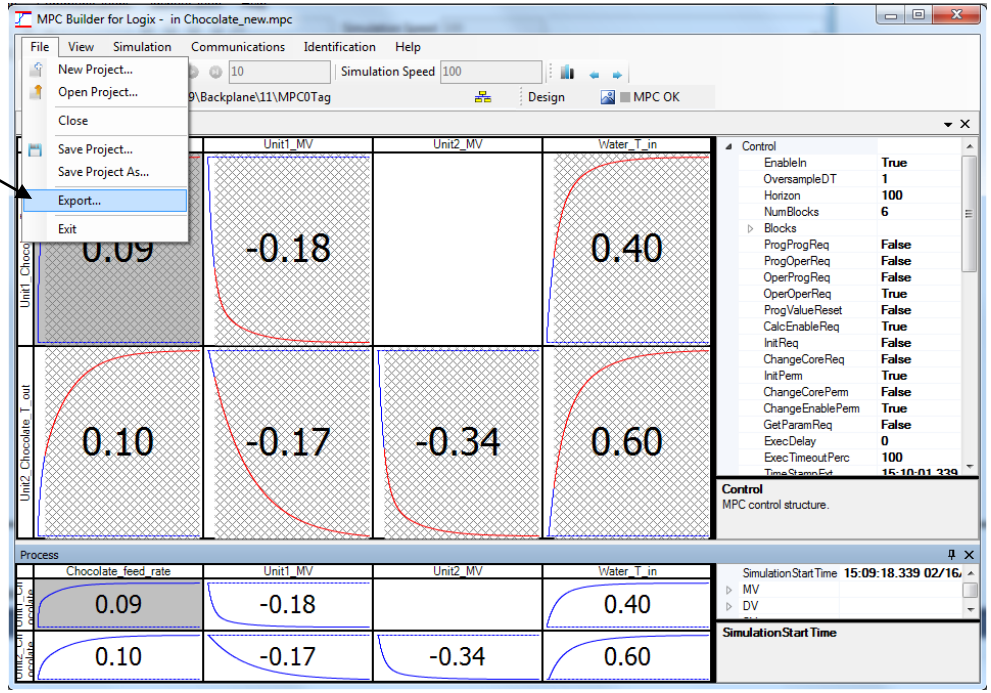


Option 3 – Logix Controller and multiple 1756-MPC Modules in one or more chassis.

Copyright © 2014 Rockwell Automation, Inc. All rights reserved.

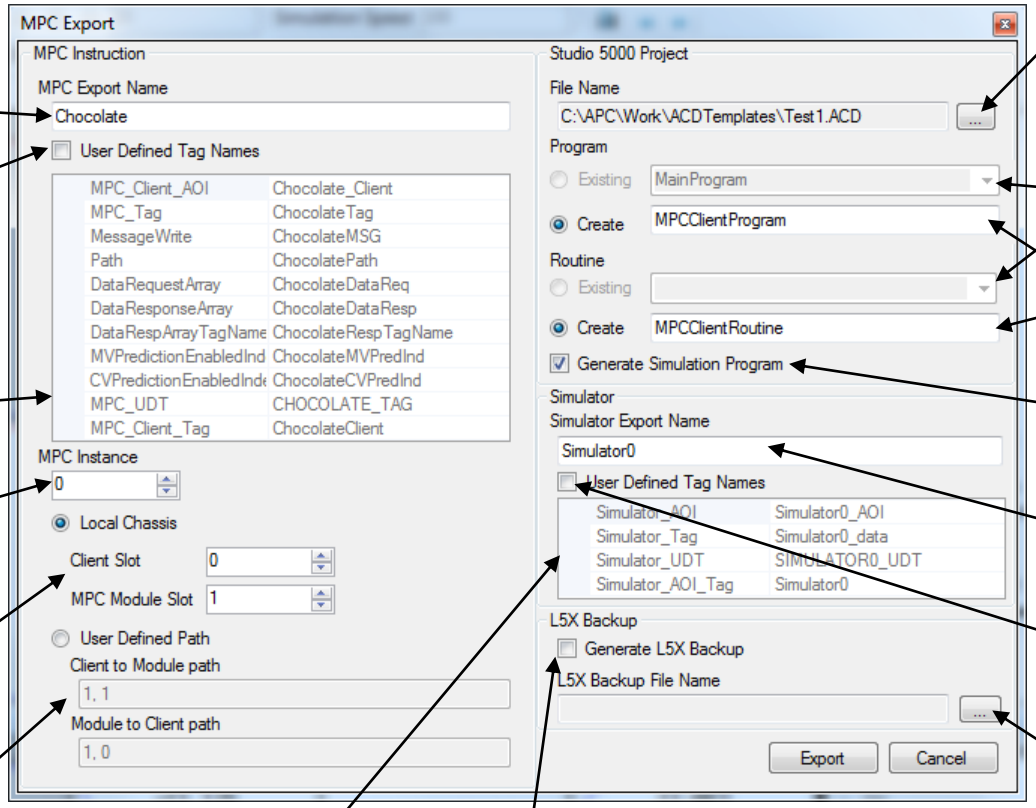
Use case : Export & Configure AOI

If clicked, Export dialog is shown



Copyright © 2014 Rockwell Automation, Inc. All rights reserved.

Use case : Export & Configure AOI



Export name used for generating default tag names

If selected, user defined tag names can be set

List of controller scope tags to be generated

MPC Module instance number (0 - 4)

Client Module & MPC Module slot numbers if both placed in one chassis

User defined CIP path if Client and MPC module are not in the same chassis

Selects .ACD file to which MPC will be added. ACD file cannot be opened in RSLogix.

List of existing Programs and Routines in the ACD file

New Program and Routine name if Create is set

If selected, process simulator with corresponding tags, AOIs and program is generated

Simulator export name used for generating default tag names

If selected, user defined simulator tag names can be set

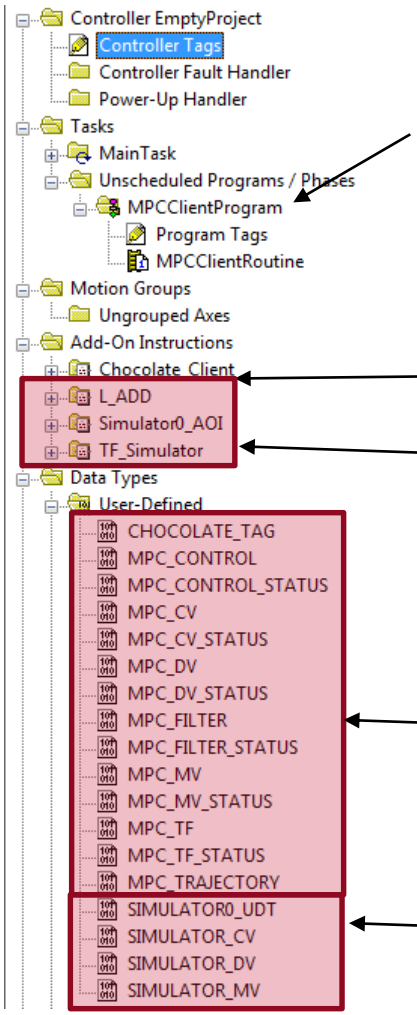
Defines path to L5x backup file

List of program scope simulator tags to be generated

If set, MPC is saved to L5X file for backup purposes or for online import

Copyright © 2014 Rockwell Automation, Inc. All rights reserved.

Use case : AOI in Studio5000



New program created during export. Placed to Unscheduled Programs. It must be placed to any fast periodic task (can't be placed in continuous task).

MPC AOI

Simulator AOIs

MPC UDTs added

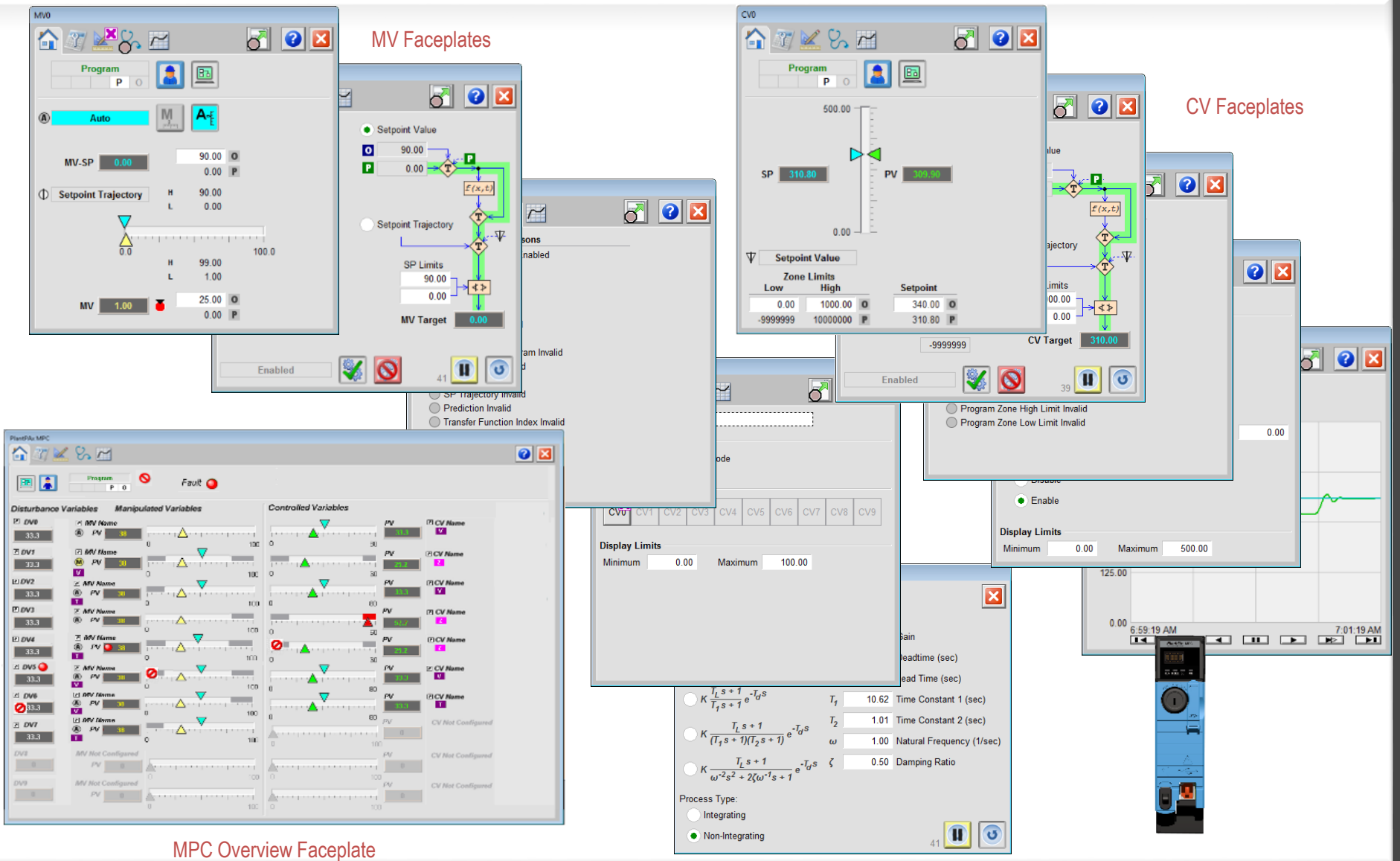
Simulator UDTs added

List of controller scope tags added to selected ACD project

Name	Alias For	B	Data Type
ChocolateClient			Chocolate_Client
ChocolateCVPredInd			INT
ChocolateDataReq			DINT[1006]
ChocolateDataResp			DINT[1006]
ChocolateMSG			MESSAGE
ChocolateMVPredInd			INT
ChocolatePath			STRING
ChocolateRespTagName			STRING
ChocolateTag			CHOCOLATE_TAG

Copyright © 2014 Rockwell Automation, Inc. All rights reserved.

PlantPAx MPC Faceplates



Copyright © 2014 Rockwell Automation, Inc. All rights reserved.

PlantPAx Better Process Control

LISTEN. THINK. SOLVE.®

Comments and Discussion

PlantPAx Model Predictive Control (embedded):

- Easy-to-use (graphical model-building, Studio5000 integration)
- Functional (full linear MPC, up to 10 by 10 matrix)
- Manages constraints, targets, trajectories and disturbances
- Model and control parameters adjustable on-line
- PlantPAx HMI Standard Faceplates

Follow ROKAutomation on Facebook & Twitter.
Connect with us on LinkedIn.

www.rockwellautomation.com

Allen-Bradley • Rockwell Software

Rockwell Automation

Copyright © 2014 Rockwell Automation, Inc. All rights reserved.