



# COLUMBO

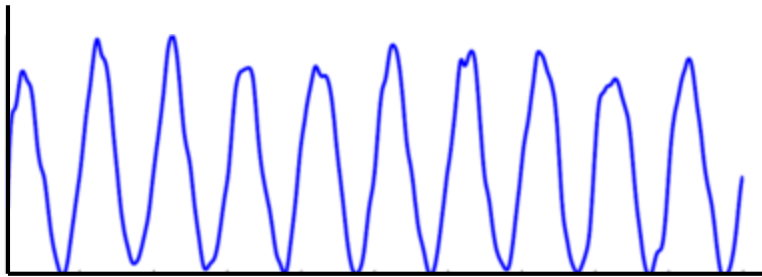
**C**losed **L**oop **U**niversal **M**ultivariable **O**ptimizer

Next Generation MPC Monitoring and Improvement Software Technology


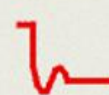







 **PiControl**  
Solutions

# Analysis of Bad Dynamic Models

Ugly Oscillations due to Bad MPC Models



Control Matrix

	TI105	PI608	LI901	ZY311
FC101				
FC385				
PC270				

- When MPC (model predictive controller) or APC (advanced process controller) deteriorate, oscillations start.
- The MPC matrix can have as many as 30 MVs and 100 CVs.
- Main cause of MPC oscillations is mismatch between dynamic models and real process dynamics.
- Identifying bad dynamic models is one challenge.
- Fixing the bad models is a bigger challenge.
- COLUMBO helps in confronting both challenges with unique technology unmatched by competitors.



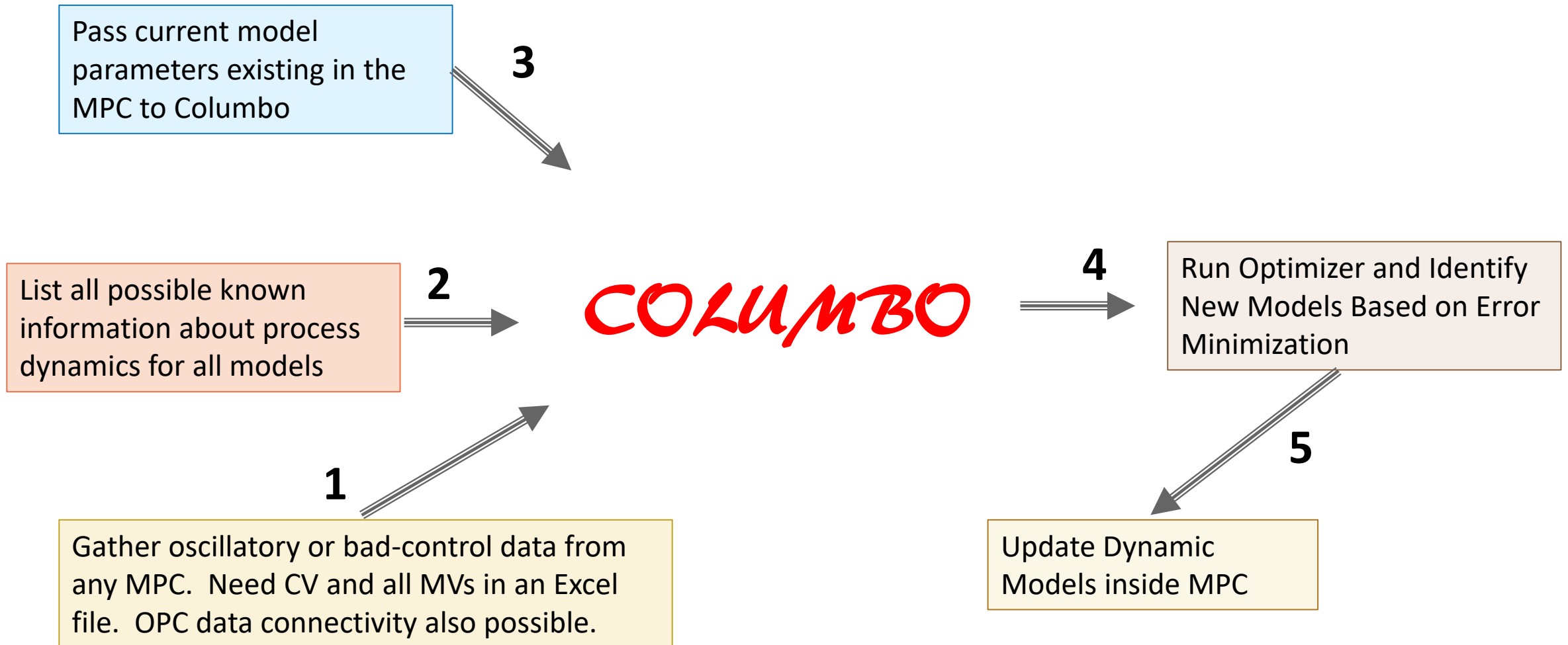
# Motivation to Develop COLUMBO

- MPC models were built in the 1980s and 1990s with round the clock step tests for days or weeks sleep depriving control engineers and harassing plant control room operators.
- Smart testing came around 2000 timeframe allowing automatic smart steps with minimal or reduced supervision.
- More recent technology allows “calibration” of models by superimposing automated step tests on top of MPC’s closed-loop control action followed by identifying new models.
- COLUMBO outperforms the above technologies with amazing new functionality not available in any current software or technology.
- COLUMBO reads current models based on step tests, analyzes complete closed-loop data, allows incorporation of process and engineering information and determines new accurate models.

# COLUMBO Unique Capabilities

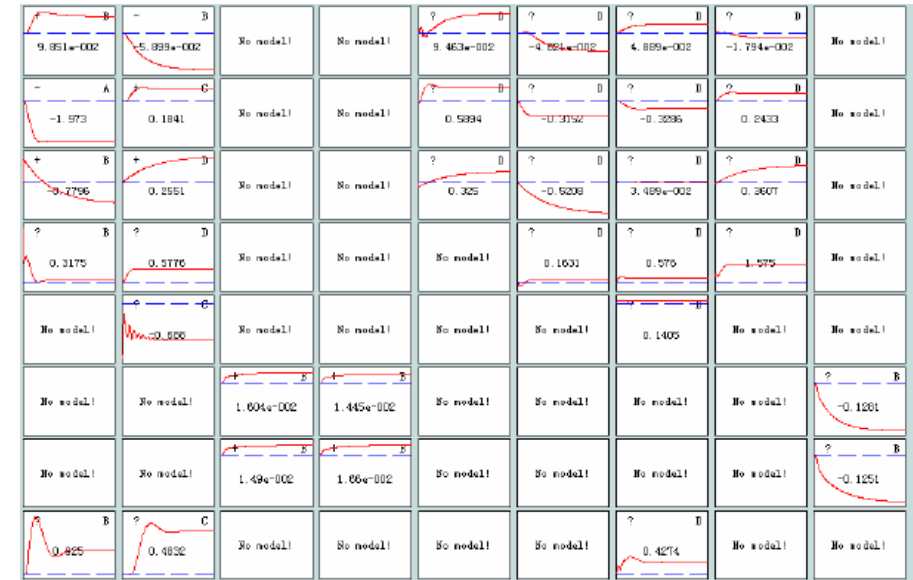
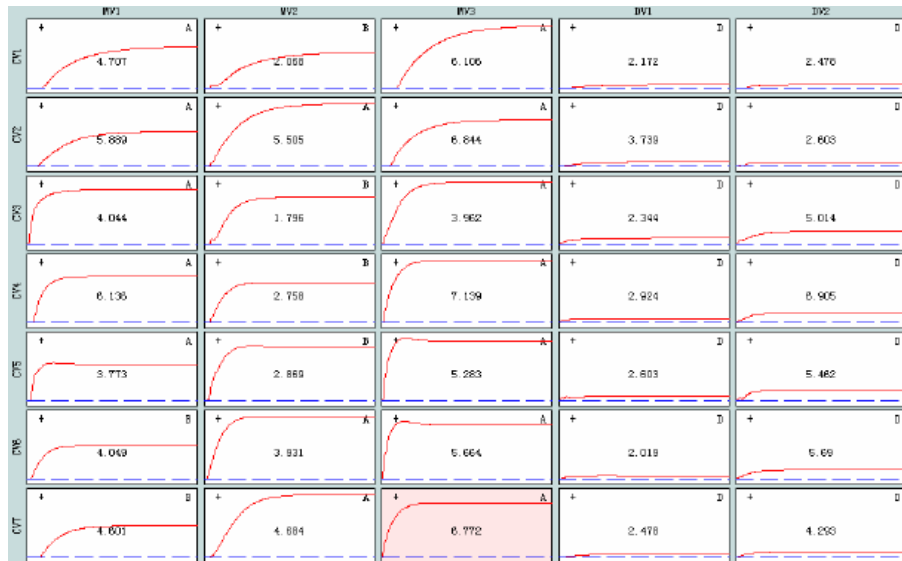
- Analyze complete closed-loop data with MPC in ON mode and all slave PID MVs in cascade modes.
- No need for intrusive step tests – manually done or automatically superimposed.
- Can process any sized MPC system – even large MPCs with a 30 x 100 matrix.
- Allows incorporating process knowledge and engineering information explicitly into the dynamic model building.
- Conducts what-if analysis to compare model prediction with real process CV data.
- Can process oscillatory data, ramped data or any data containing some CV target changes, FF disturbances or conventional open loop steps, though steps are not required.
- Remarkably compact and simple user interface! All calculations are done entirely in the time domain – no thick user manuals, no need for a PhD degree, no need for migrating in and out of Laplace or Discrete (Z) domains.

# Five Steps to Catch the Criminal Models and Improve MPC Control Action



# Big and Small MPCs can be analyzed and improved by COLUMBO

- COLUMBO improves MPC models based on complete closed-loop data.
- Data analysis and model building should be based on the closed-loop MV change size for producing maximum accuracy of model predictions.



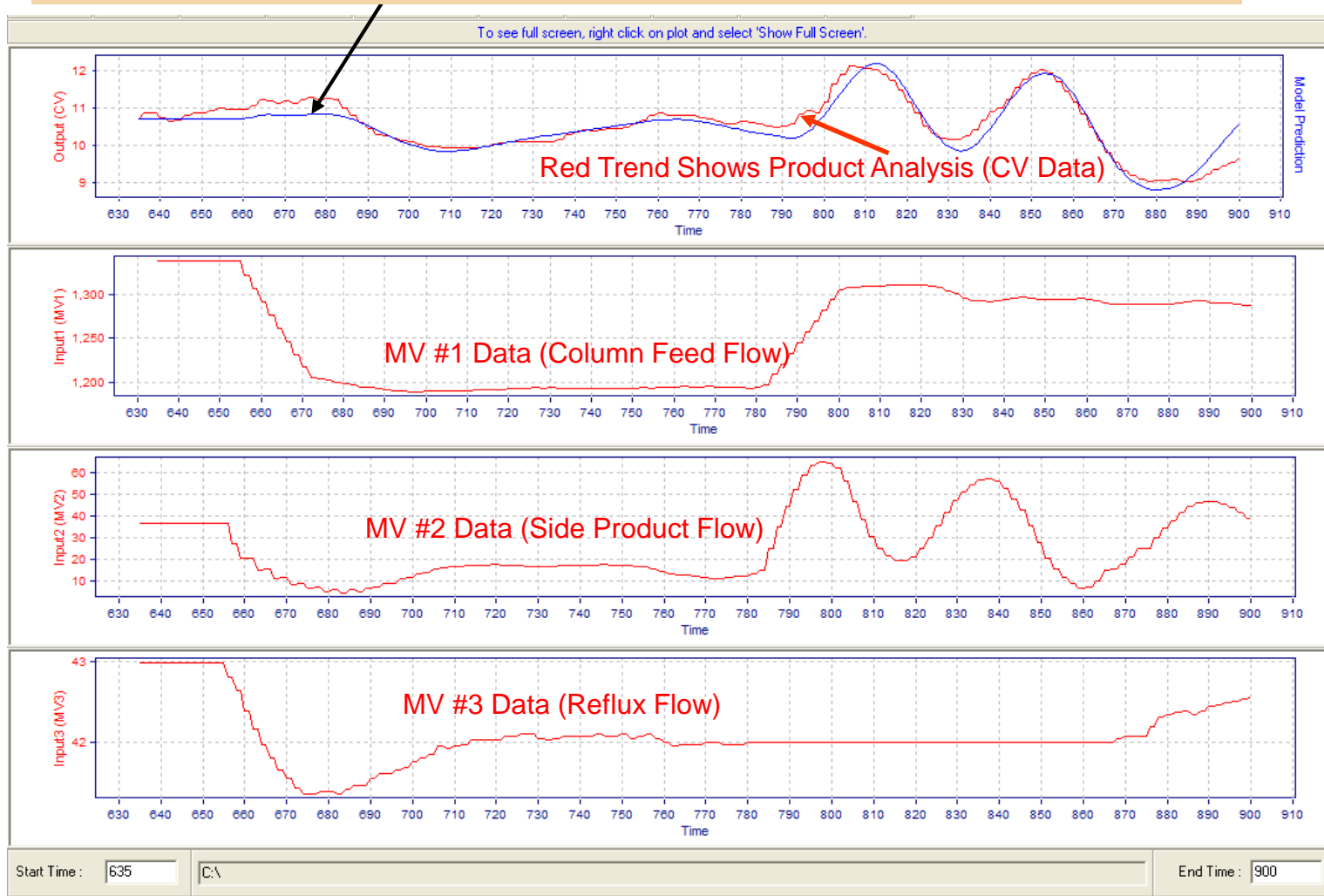
- Models based on tiny open-loop steps without simultaneous changes in other MVs produce models not truly reflecting the real dynamic behavior.
- COLUMBO helps to get the real models during full closed-loop mode and matches reality more accurately.

# COLUMBO confronts nonlinearity and correlated moves

- Conventional model identification methods all rely on step tests.
- The problem with step tests is that you cannot make step tests too large otherwise the process can be upset or you cannot hold the step for too long.
- During conventional old-fashioned step tests (manual, smart, automatic or in calibrate style), typical step size is normally 1-4 % of the MV value.
- However when the MPC is ON and during large CV target changes or changes in FF variables, the MV moves made by the MPC are much bigger.
- In this closed-loop mode, all MVs are moving simultaneously and making moves 2-20 times the size of the moves made during step tests and these factors lead to nonlinear effect.
- The MPC models amidst large MV moves and correlated MV moves (simultaneous MV moves) can be significantly different compared to the models identified based on typical small step tests.
- COLUMBO is the only software and technology capable of identifying more accurate models in these nonlinear and correlating environments.

# A Real MPC Improvement Illustration

Blue trend Shows a closed-loop multivariable CV prediction and optimization



MPC controller was ON here and CLUMBO identified the true models.

This Multivariable Closed-Loop Model Identification is based on purely Closed-Loop Data (No Step Tests) and with simultaneous correlated MV moves. Simultaneous correlated MV moves are a “NO-NO” based on existing teachings and technologies but not for COLUMBO. COLUMBO thrives on closed-loop data with MVs moving at the same time or different times.



# Modern Technology and Cyber Security

- COLUMBO can work completely offline using Excel files on computers not connected to the Level 3 process control network thus safeguarding against fears of virus, cyber security, OPC etc. OPC connectivity is also possible but offline Excel analysis is equally fast and with no cyber security risks.
- Analysis takes just minutes to hours – not days and definitely not weeks!
- Remote consulting with COLUMBO engineers saves time and travel costs.
- COLUMBO is compatible with all MPCs worldwide from any MPC vendor.
- Contact PiControl Solutions LLC today:
  - [Website: www.PiControlSolutions.Com](http://www.PiControlSolutions.Com)
  - [Email: Info@PiControlSolutions.Com](mailto:Info@PiControlSolutions.Com)
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- Don't run MPCs limping and struggling. Maximize plant benefits and Profits.

