Optimize IT Inferential Modeling Platform
Rise of Data Driven Modeling

- Wide spread availability of data historians and lab information systems has made data a commodity.
- Plants are “data manufacturers” with hundreds of thousands of data points stored each day.
- Historical data are a valuable asset for better control, management decision support and process optimization, but extracting useful information requires discriminating tools.
**Key Reasons Spurring Inferential Applications**

- Data-driven modeling is a flexible and powerful tool that transforms data into valuable process information.
- Inferential sensors are an established and mature technology.
- Process industry applications of inferential technology deliver significant benefits.
- Inferentials are complementary to Multivariable Process Controls for many applications.
- Statistical process Control (SPC) and MultiVariate Statistical Process Control (MvSPC) are valuable technologies to keep process under control.
Optimize\textsuperscript{IT} Inferential Modeling Platform

- Inferential Modeling Platform: a comprehensive toolkit for data-driven modeling
- All the steps required for the development and implementation of models are executed inside the platform.
Project Execution Steps

1. Collect Data
2. Validate/Distill Data
3. Model
4. Deploy model
5. Collect Process Data
   - Clean live data from wrong/misleading data
6. Extract useful information
7. Use extracted information

Project execution path
Inferential Modeling Platform - Architecture (1)

Data source (DCS, PIMS and/or Lab) → IMP Model Builder

1. Data Pretreatment and Analysis
2. Model Development and Validation

IMP

IMP Online

Model Online Implementation

- Offline environment for data import, data pretreatment, data analysis, model development and validation
- Online environment for real-time deployment of models; monitoring and supervision of implemented models
Integration of the best technologies

Software

Theory

Neural Nets

MVSPC

Platform approach

Inferential Modeling Platform
Phase 1: IMP Model Builder
Modeling - The Concept

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\begin{bmatrix}
FIC - 100 (t_1) & PI - 12 (t_1) & \ldots & \ldots & TIC - 100 (t_1) \\
FIC - 100 (t_1) & PI - 12 (t_2) & \ldots & \ldots & TIC - 100 (t_2) \\
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Kero_{ASTM} - 95\% (t_1)
\end{bmatrix}
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Inferential Modeling Platform

Off-line Package

On-line Package

Model Structure and Parameters
Offline Environment - The Concept

DCS

Plant

Lab

IMP Model Builder

Data Repository

Inferential Modeling Platform

Inferential Sensor Model
**IMP Model Builder - Technical Details**

- An open software platform, that integrates the best technologies on the market.
- Highly automated tools allow quick and easy model building and validation; building models takes a fraction of the total project effort.
- Easy and effective data import; outlier detection is provided through automatic built-in functions and wizards.
- Data treatment is executed through a visual approach (preview function).
- Data treatment is performed with a step-by-step approach; execution of steps can be undo and automated through a scripting language.
- Built-in functions to tackle process delays and merge data files.
Data Preparation

- Data Preprocessing
- Data Analysis
IMP Model Builder - Advantages

Ø Combines Neural Networks, Statistical Regressions and Advanced Statistical Analysis (MVSPC) in a single environment

Ø Modeling functions are provided by proven, field-tested, latest generation routines.

Ø Model development is executed through Wizards, to reduce effort for inexperienced users

Ø The Model Explorer facility allows off-line use of models for engineering purposes
Online Environment - The Concept (1)

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\begin{bmatrix}
FIC -100(t_{\text{actual}}) & PI -12(t_{\text{actual}}) & \ldots & \ldots & TIC -100(t_{\text{actual}})
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Off-line Package  On-line Package

Inferential Modeling Platform

\(Kero_{ASTM}^{\text{predicted}} -95\% (t_{\text{actual}})\)

Predicted Quality Value
Online environment - The Concept (2)
IMP OnLine - Technical Details

- A unique deployment environment for real-time use of models statistical monitoring, featuring different technologies:
  - Neural Networks
  - Statistical Regressions
  - PLS
  - Locally Weighted Regressions
  - MVSPC
  - Equation-based models
  - Custom-based models (DLLs)

- The Platform is designed to allow straightforward integration of existing client models through use of DLLs.
IMP Online: Advantages

- Quick and effective real-time implementation on different DCS through OPC;
- Single window interface is achieved by writing back through the OPC Server;
- Configurable filtering of inputs and outlier removal strategies;
- Direct connection to Laboratory Information Management Systems;
- Built-in functions for periodic recalibration (Bias calculation).
Quality Control

Monitor effect of the inferential application on the quality variable with SPC
MvSPC Example

- Process Performance Monitoring: an example with Bivariate $T^2$ (MVSPC)

Standard operative zone: inside ellipse
Abnormal condition: outside ellipse
The Multivariate SPC Process

From Start to Process Improvement

- Establish Baseline Condition
- Monitor Process against baseline
- If a signal occurs, process has changed
- Determine why process changed
- Determine if change is “good” or “bad”
Solutions

- Typical solutions based on IMP:
  - Inferential measurements
  - Sensor validation
  - Predictive Emission Monitoring
  - Quality Monitoring
  - Process Performance Monitoring
  - Maintenance Trigger