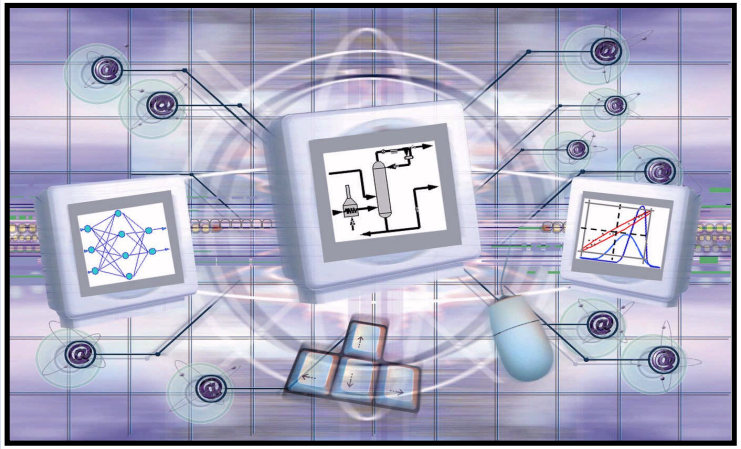
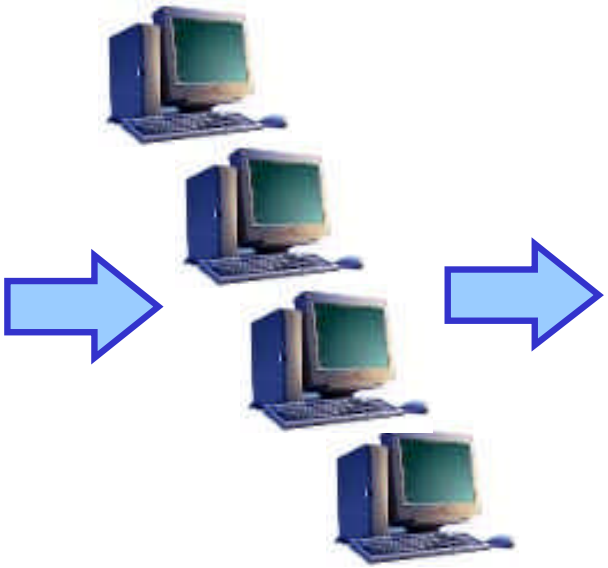
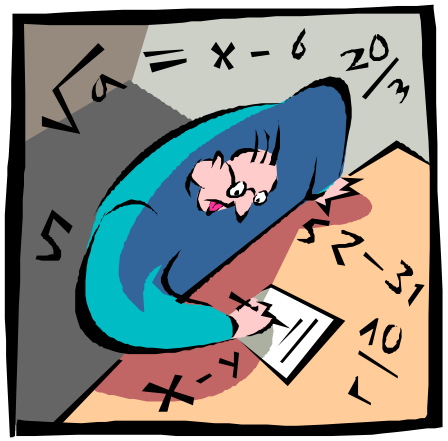
Optimize IT Inferential Modeling Platform



Rise of Data Driven Modeling

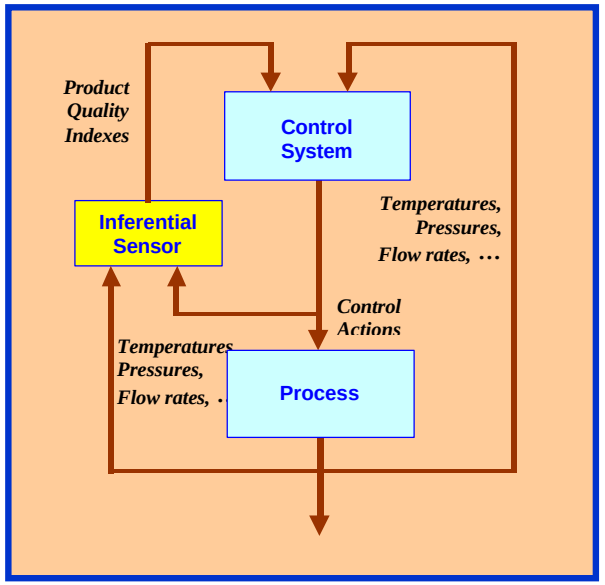
- Wide spread availability of data historians and lab information systems has made data a commodity
- Plants are “data manufacturers” with hundreds of thousands data points stored each day
- Historical data are a valuable asset for better control, management decision support and process optimization,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





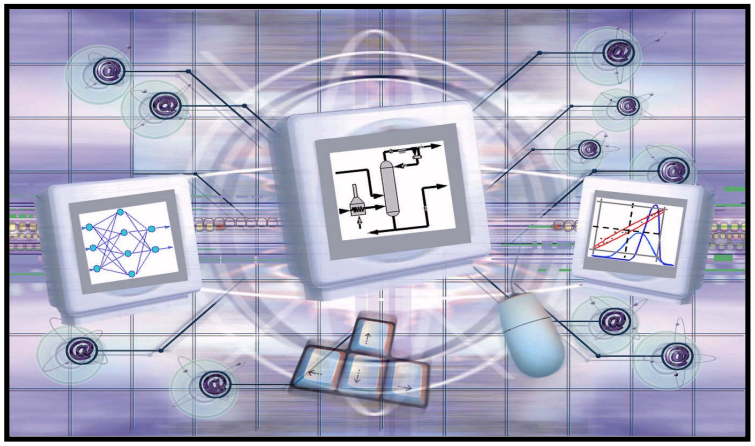
Key Reasons Spurring Inferential Applications

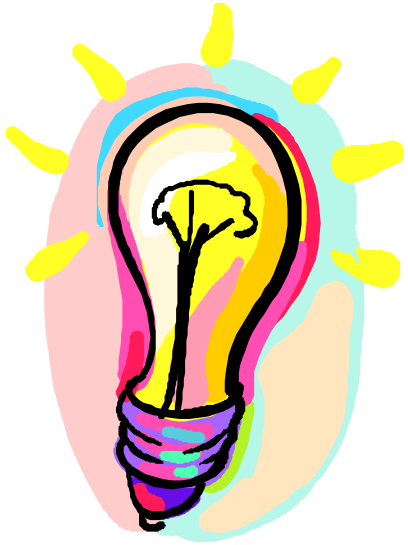
- Data-driven modeling is a flexible and powerful tool that transforms data into valuable process information
- Inferential sensors are an established and mature technology
- Process industry applications of inferential technology deliver significant benefits
- Inferentials are complementary to Multivariable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



Optimize^{IT} Inferential Modeling Platform

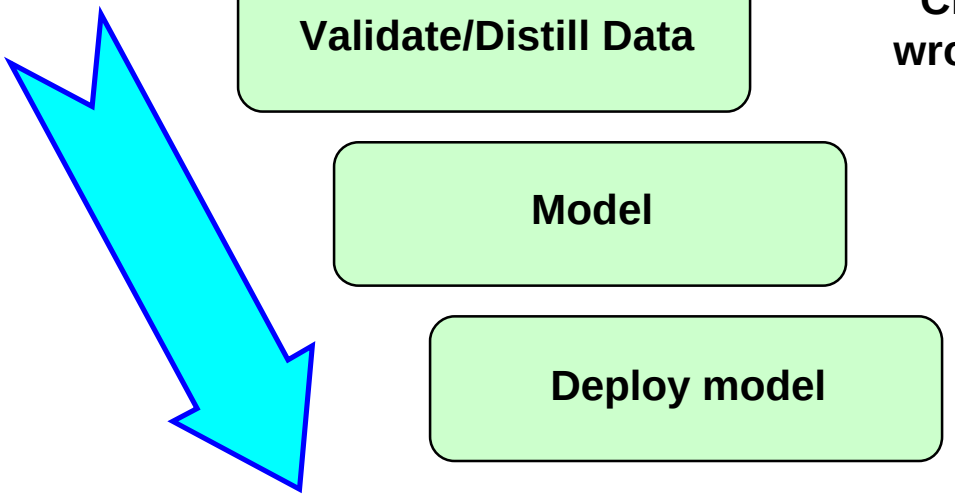
- Inferential Modeling Platform: a comprehensive toolkit for data-driven modeling
- All the steps required for the development and implementation of models are executed inside the platform.





IMP

Project Execution Steps



Collect Process Data

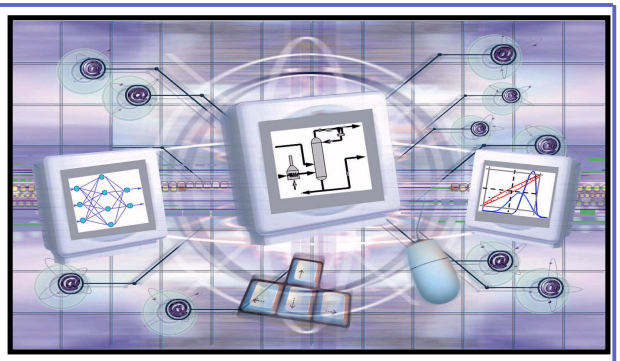
Clean live data from wrong/misleading data

Extract useful information

Use extracted information

[Project execution path]

Inferential Modeling Platform - Architecture (1)



IMP

Data source (DCS, PIMS and/or Lab)

IMP Model Builder

1

Data Pretreatment and Analisys

2

Model Development and Validation

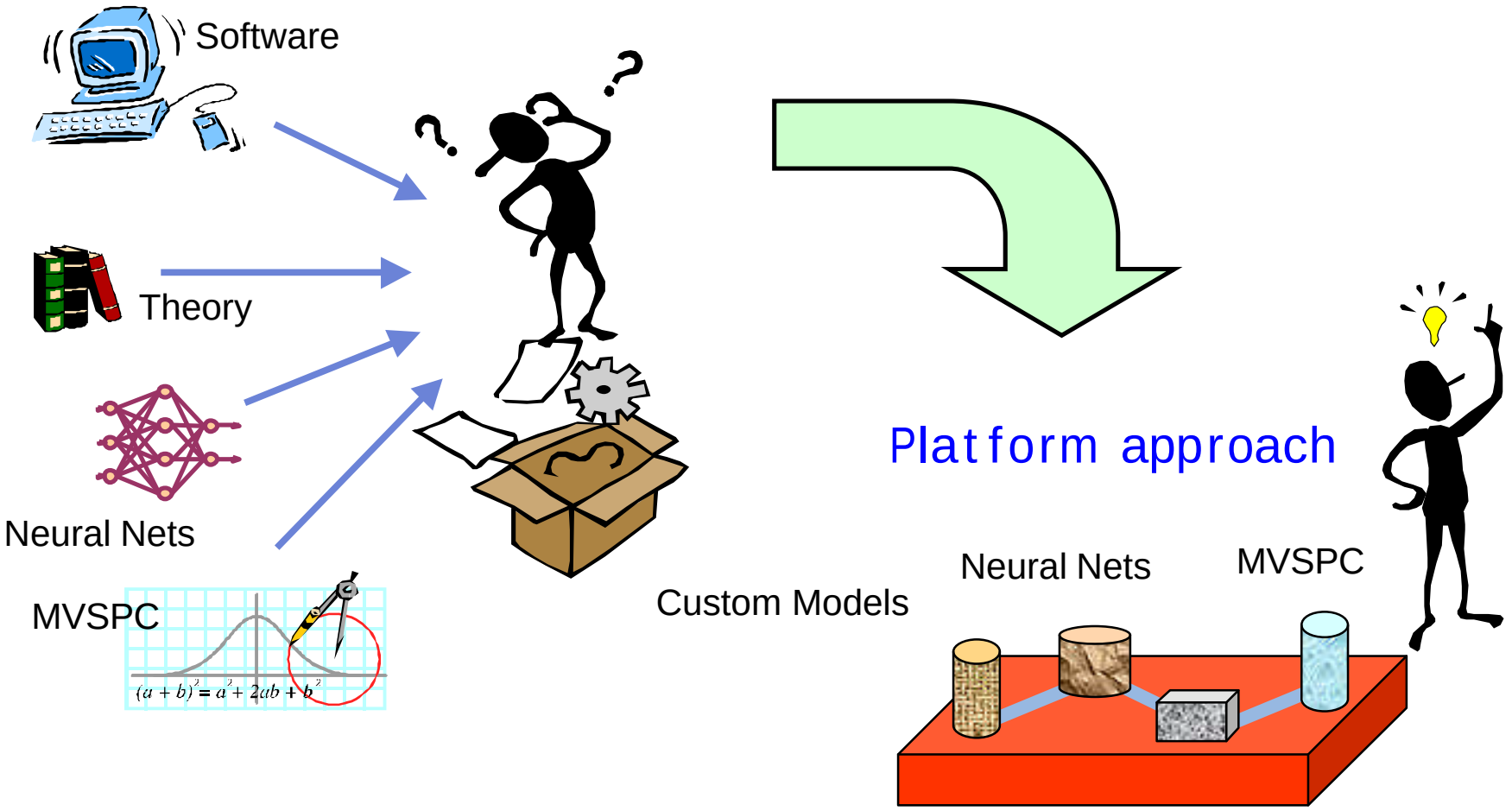
IMP Online

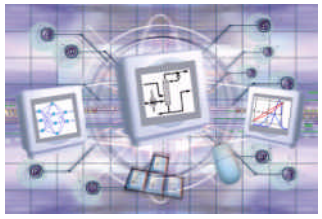
3

Model Online Implementation

- **<u>Offline environment</u> for data import, data pretreatment, data analysis, model development and validation**
- **<u>Online environment</u> for real-time deployment of models; monitoring and supervision of implemented models**

Integration of the best technologies

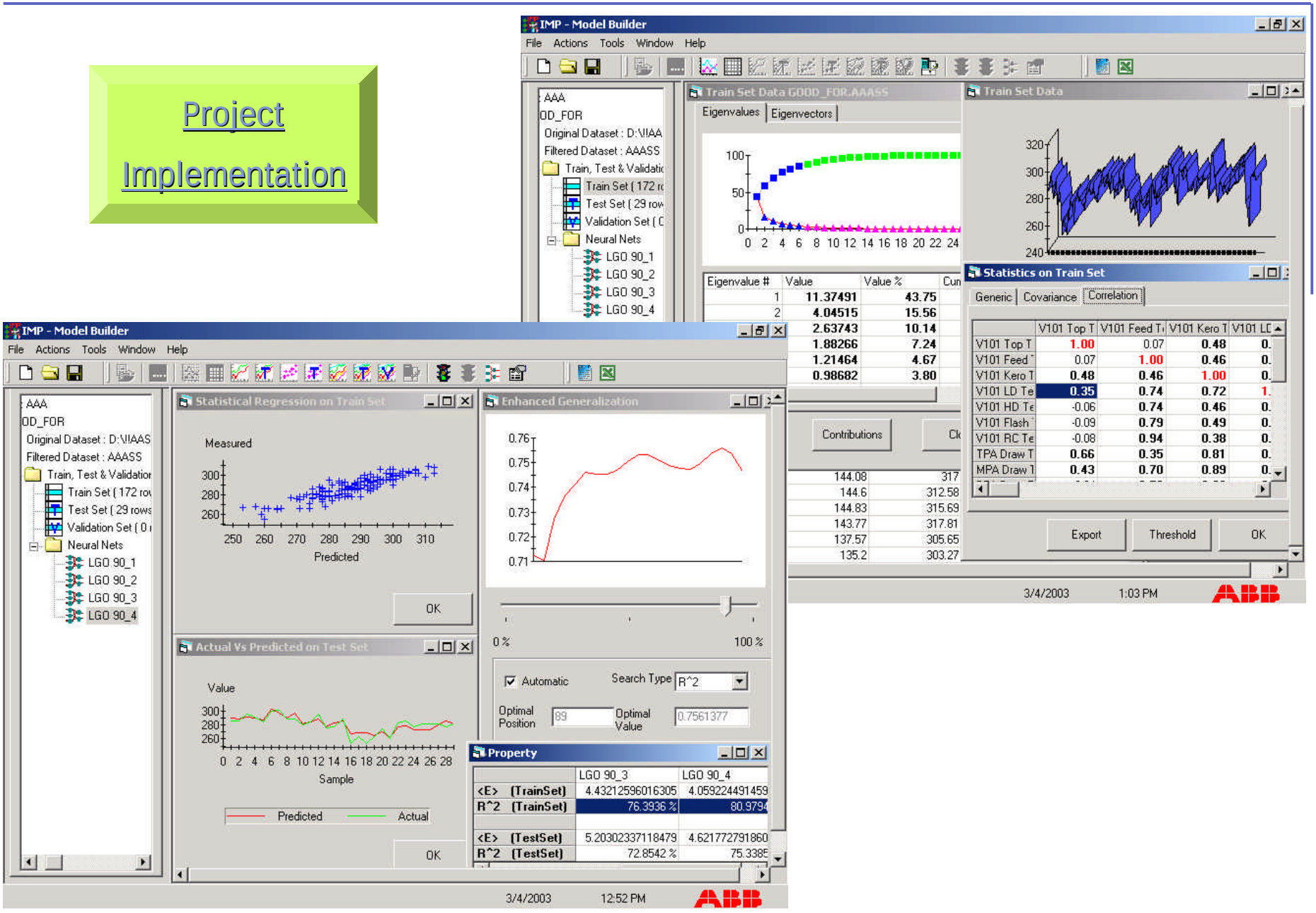




Inferential Modeling Platform

Phase 1: IMP Model Builder

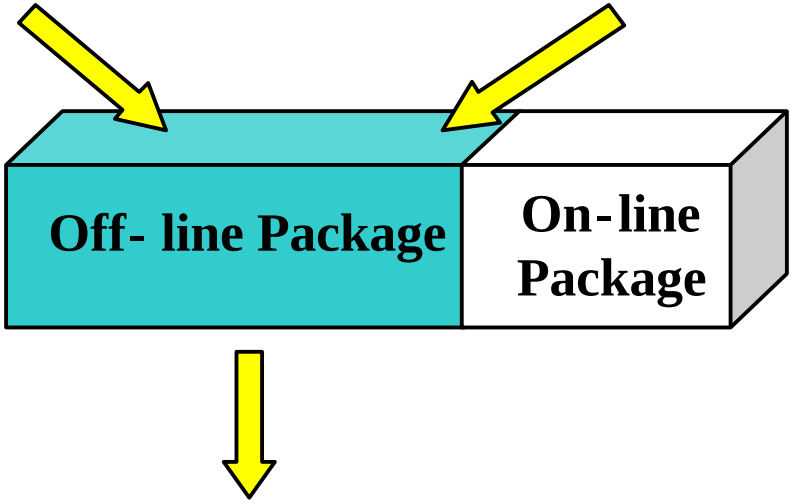
Project Implementation

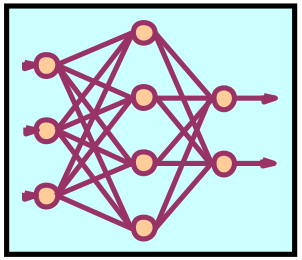


Modeling - The Concept

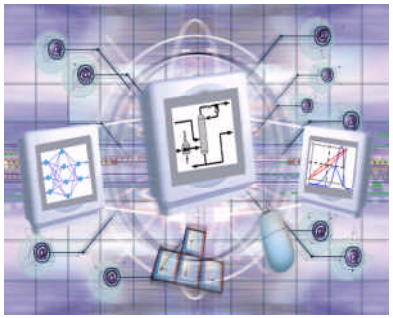
$$\begin{bmatrix} FIC\ -100\,(t_1) & PI\ -12\,(t_1) & \ldots. & \ldots. & TIC\ -100\,(t_1) \\ FIC\ -100\,(t_1) & PI\ -12\,(t_2) & \ldots. & \ldots. & TIC\ -100\,(t_2) \\ \ldots. & \ldots. & & & \ldots. \\ \ldots. & \ldots. & & & \ldots. \\ FIC\ -100\,(t_n) & PI\ -12\,(t_n) & \ldots. & \ldots. & TIC\ -100\,(t_n) \end{bmatrix} \qquad \begin{bmatrix} Kero_{\,ASTM\ -95\%}\,(t_1) \\ Kero_{\,ASTM\ -95\%}\,(t_1) \\ \ldots. \\ \ldots. \\ Kero_{\,ASTM\ -95\%}\,(t_1) \end{bmatrix}$$

Inferential Modeling Platform

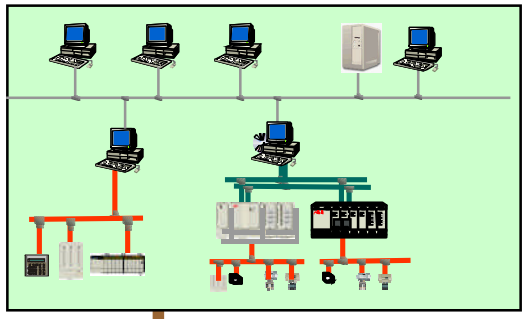




Model Structure and Parameters



Offline Enviroment - The Concept

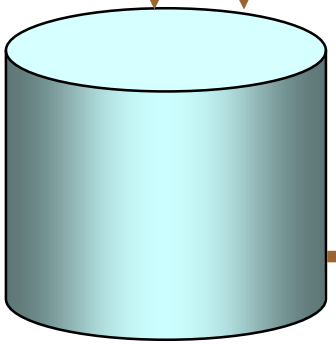


DCS

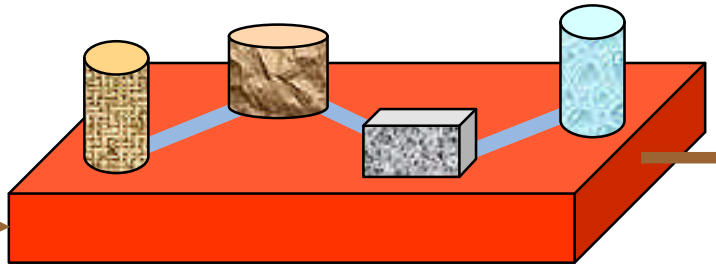
Plant

Lab

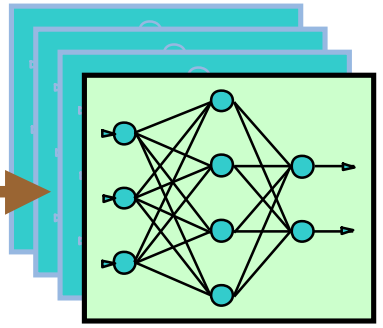
IMP Model Builder



Data Repository



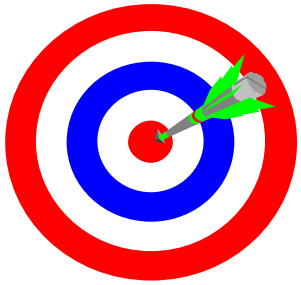
Inferential Modeling Platform



Inferential Sensor Model

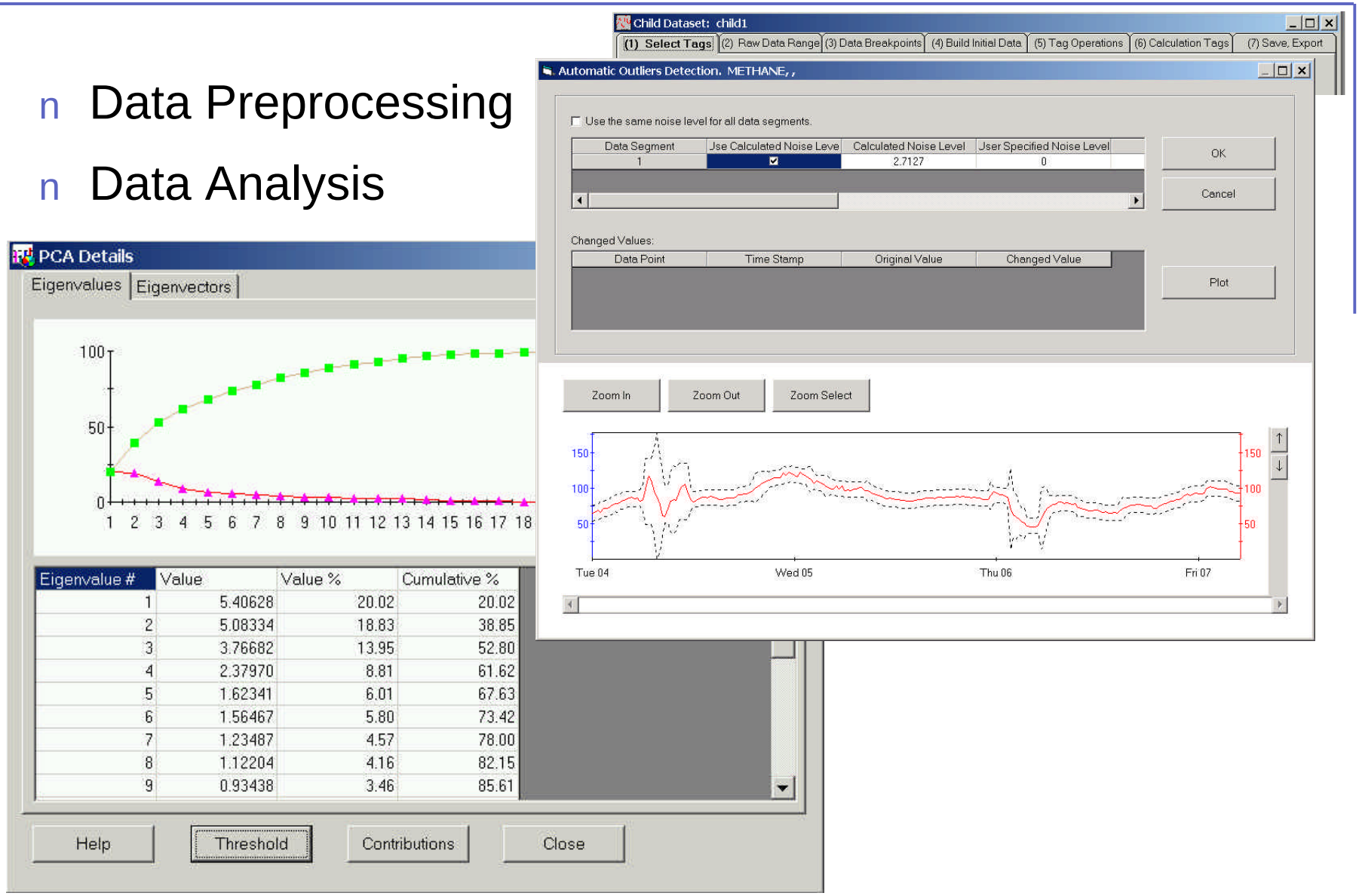
IMP Model Builder - Technical Details

- 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

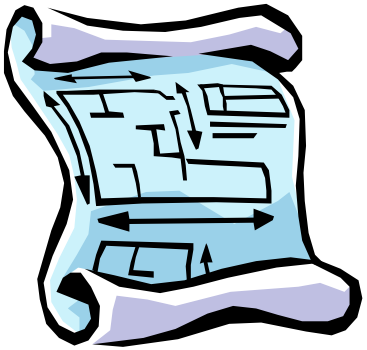


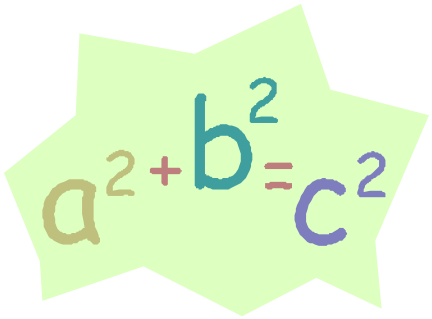
Data Preparation

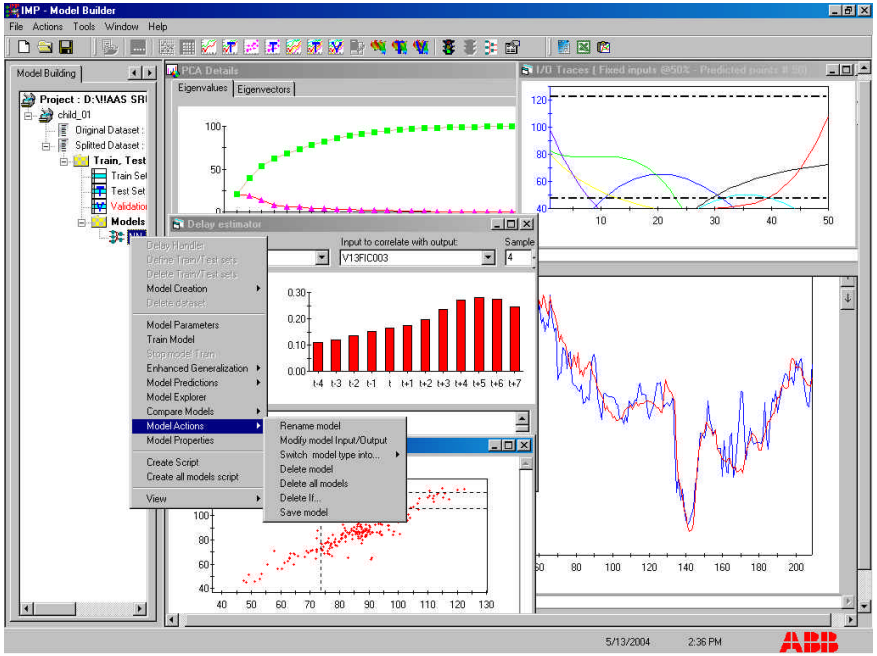
- Data Preprocessing
- Data Analysis



IMP Model Builder - Advantages



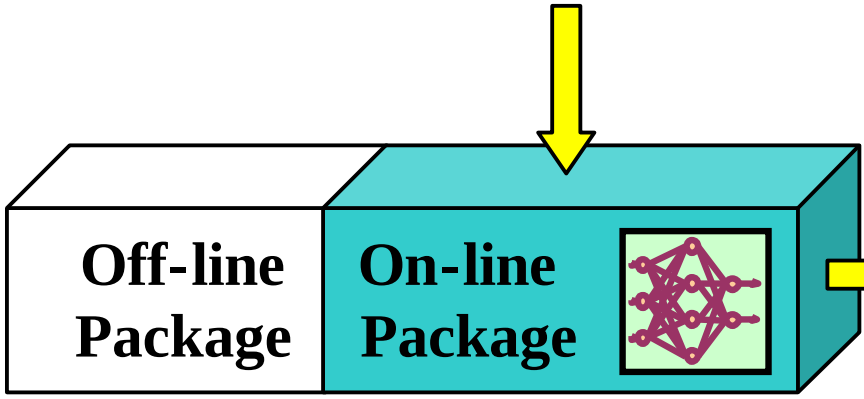




- Combines Neural Networks, Statistical Regressions and Advanced Statistical Analysis (MVSPC) in a single environment
- Modeling functions are provided by proven, field-tested, latest generation routines.
- Model development is executed through Wizards, to reduce effort for inexperienced users
- The Model Explorer facility allows off-line use of models for engineering purposes

Online Environment - The Concept (1)

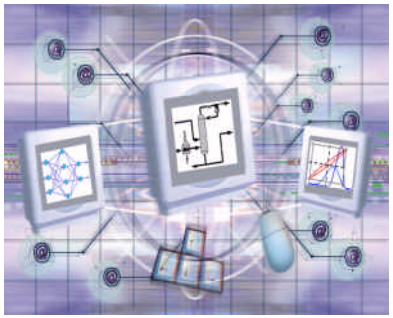
$$[FIC\ -100\ (t_{actual})\quad PI\ -12\ (t_{actual})\quad \ldots\ \ldots\quad TIC\ -100\ (t_{actual})]$$



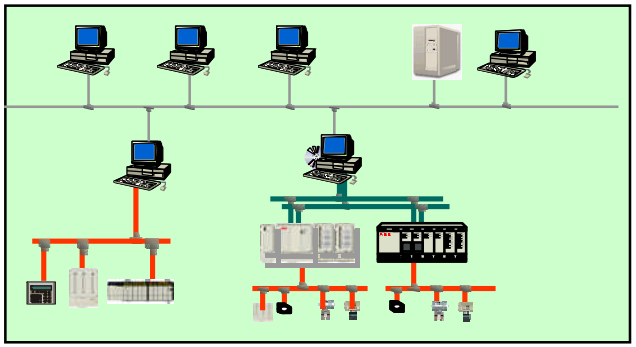
$$Kero^{predicted}_{ASTM\ -95\%}\ (t_{actual})$$

Inferential Modeling Platform

Predicted Quality Value



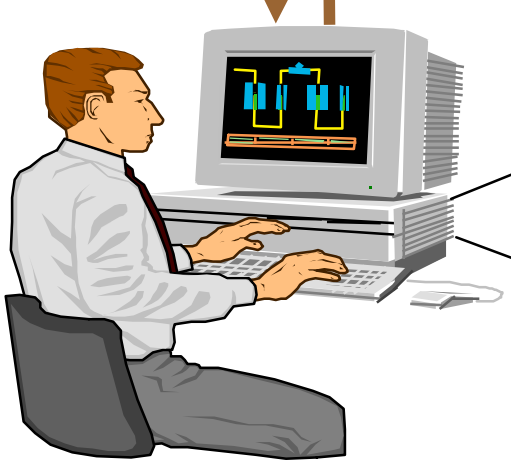
Online environment - The Concept (2)

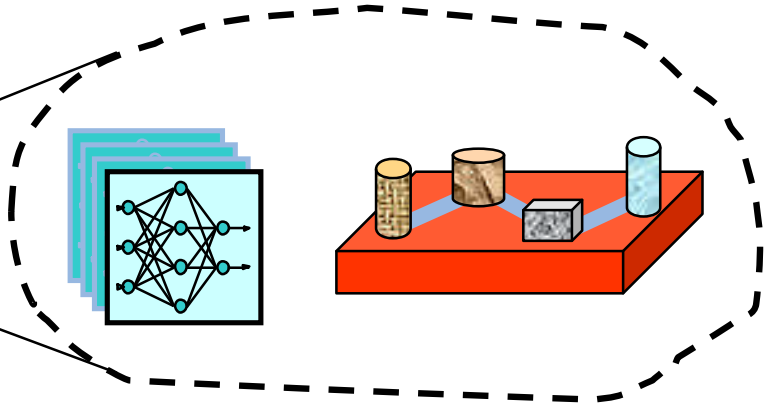


DCS

PLANT

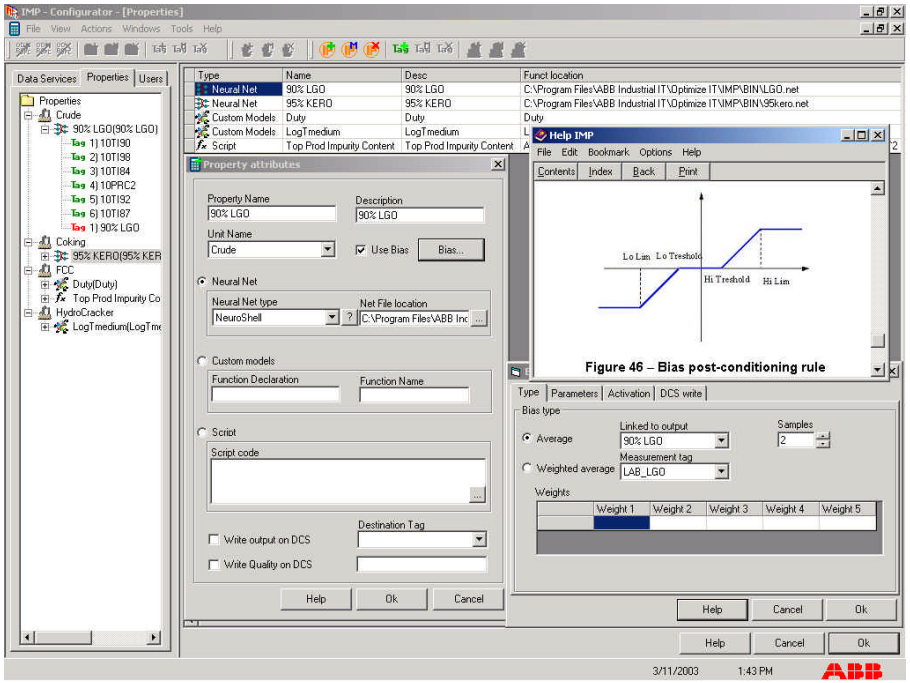
IMP On-line





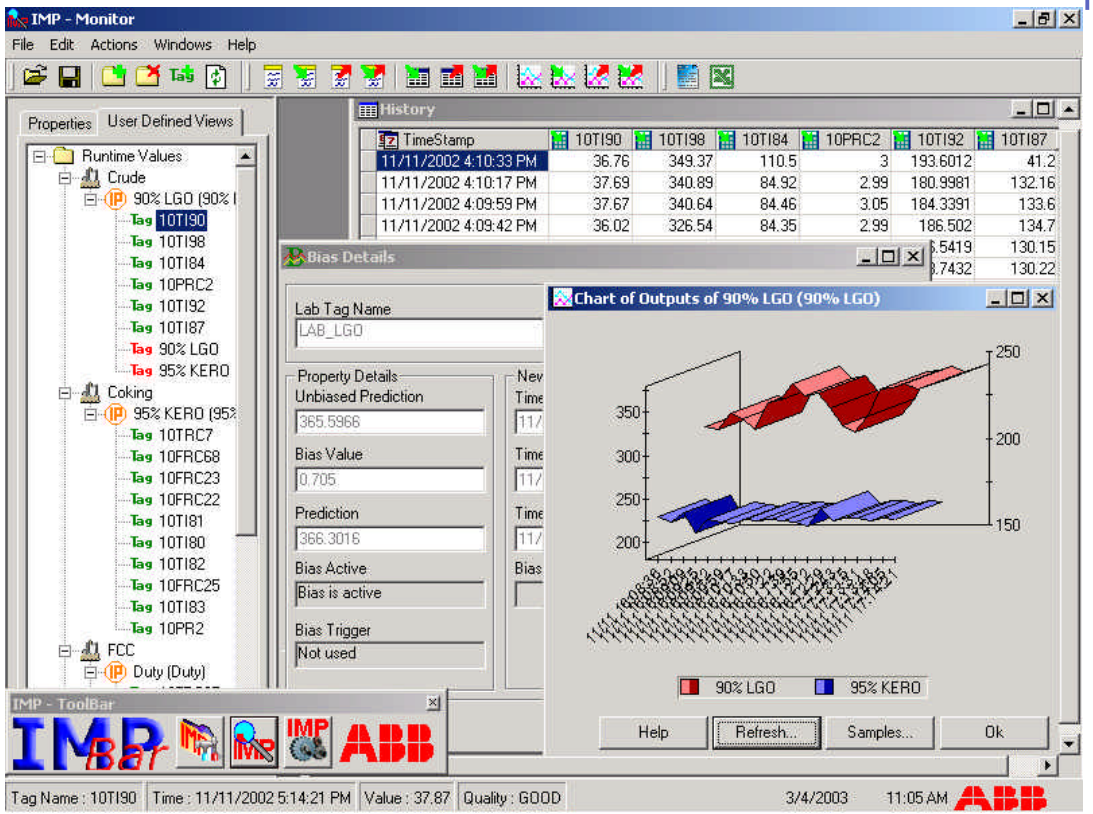
IMP OnLine - Technical Details

- 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.



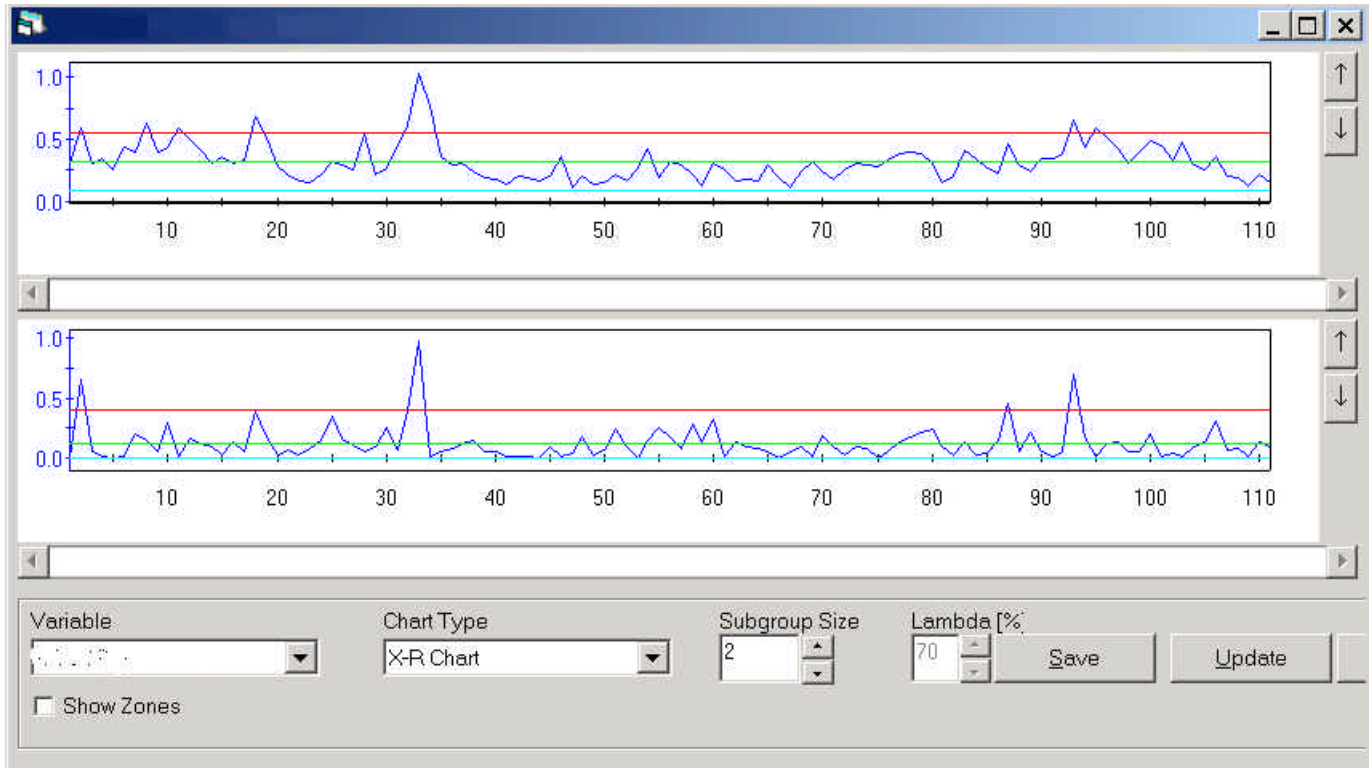
IMP Online: Advantages

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



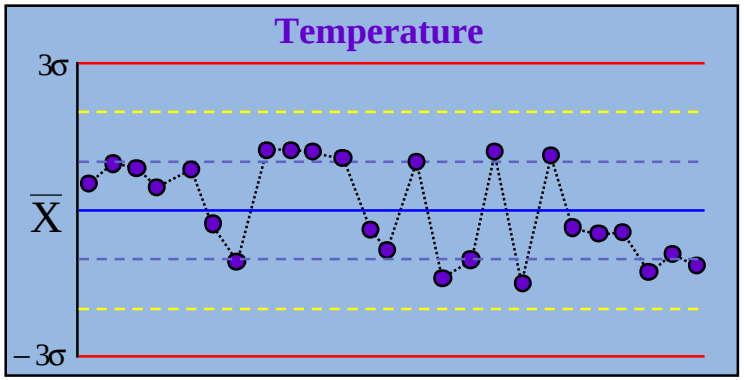
Quality Control

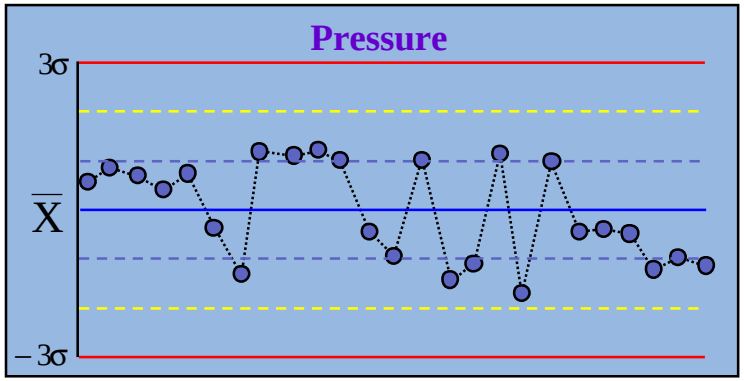
- Monitor effect of the inferential application on the quality variable with SPC

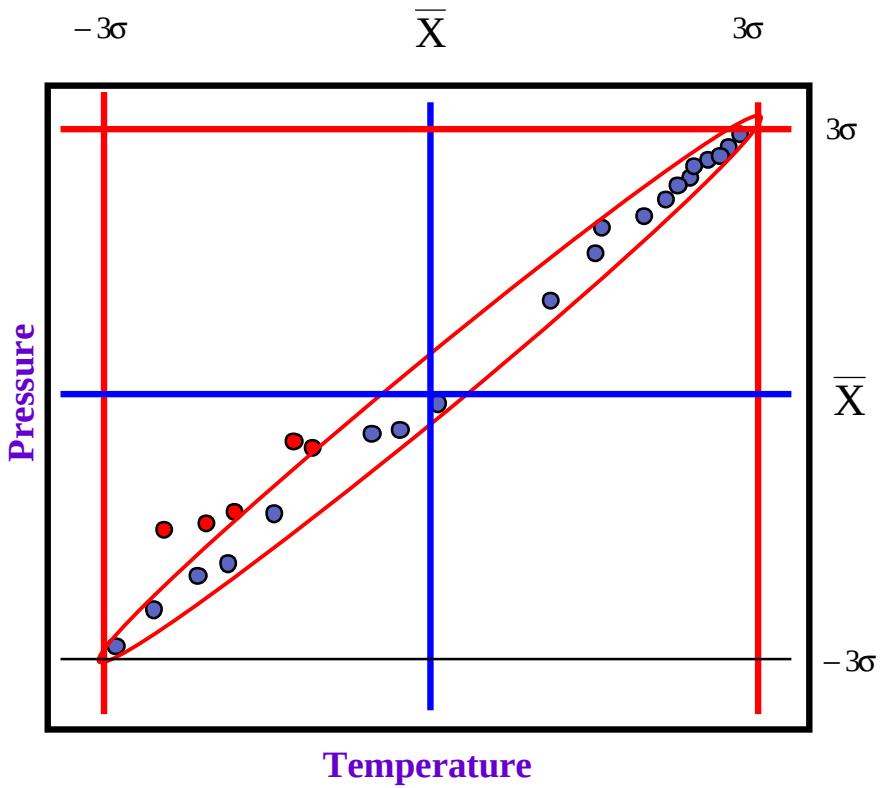


MvSPC Example

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







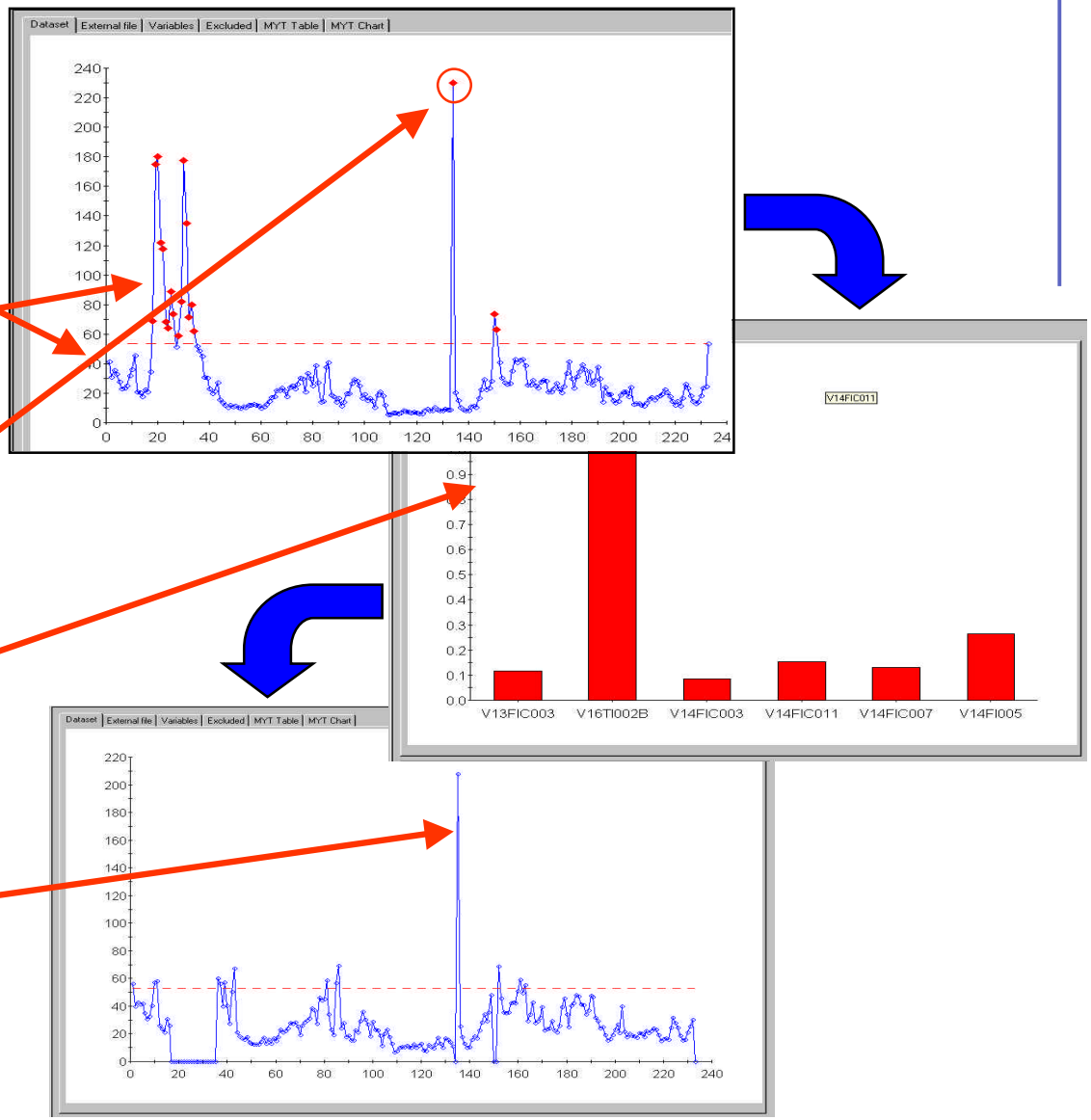
Standard operative zone: inside ellipse

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**