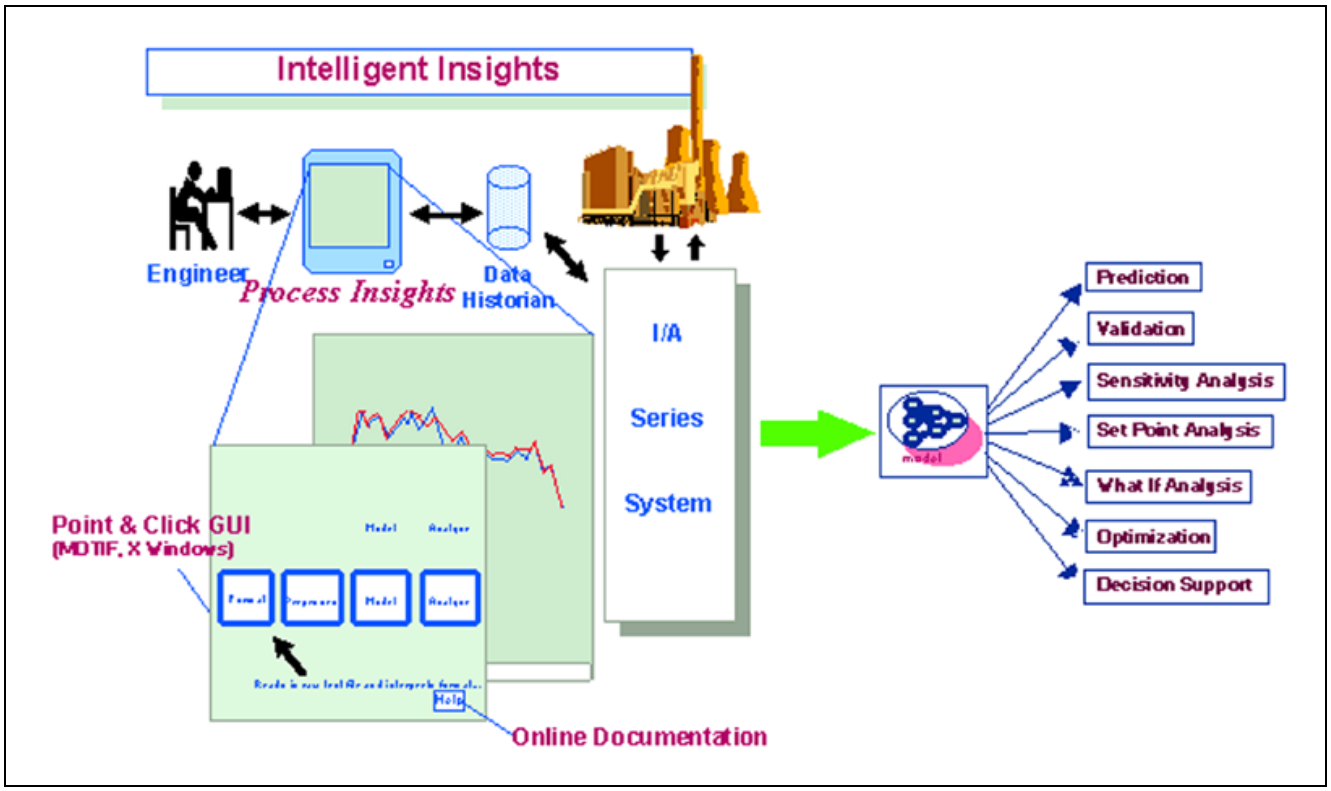
I/A Series® Software
Intelligent Insights Neural Net Modeling Solutions (Intelligent Insights)



The integration of Pavilion Technology's products into the I/A Series system adds a new dimension to our analysis, controls and decision support capability. We can now use the power of Neural Networks to easily build models using data from the I/A Series Historian. These "Intelligent Insights Models" can then be used for on-line analysis or deployed into I/A Series strategies to predict how the process will behavior and optimize it to minimize product variability, improve product quality and increase capacity.

OVERVIEW

The Process Industries have invested billions of dollars and continue to invest in the Intelligent Automation Series System in order to empower their employees with the information to make better decisions and improve productivity. But in many cases the volume data being delivered is far greater than can be assimilated. As a result the data relationships which can help improve performance are lost. This situation is further exasperated by the fact that the work force is rapidly changing and the intuitive knowledge of the process is moving on with the mature workforce. Modeling is an excellent way to reveal these data relationships and to capture the cause and effect that dictates the behavior of the process. Model development has typically been based on equations derived either empirically through step tests or from first principles. Either method can result in a mathematical and logical representation of the process in a computer usable format.

"Now, an exciting new; technology, Neural Networks, has arrived to simplify the process of model building. Neural Networks build their models from large amounts of standard process data. The kinds of data stored in the I/A Series Historian. Thus, Neural Nets are especially well suited for the data rich environment presented by the I/A Series. In addition, Neural Networks are inherently non-linear models so they can in principle model processes that are not easily handled by standard linear predictive models." They can also adapt to changing dynamics once deployed.

The Pavilion Neural Net Modeling Software was chosen for the I/A Series system because it does an excellent job of harnessing the power of the I/A Series system for the effective development on Neural network process models.

Unique features of this package include:

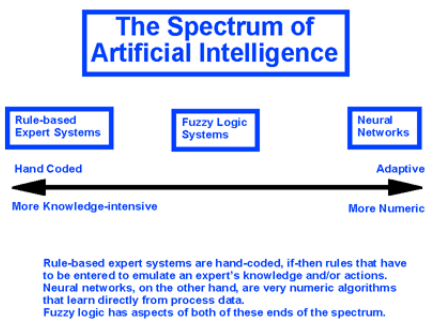
- A productized off the shelf software package
- A self-installable capability
- A point and click graphical user interface

Also:

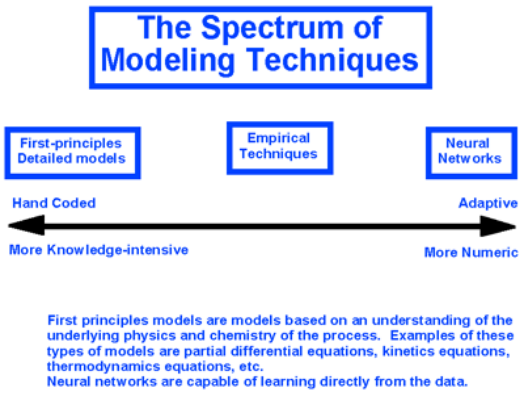
- No knowledge of Adaptive Technologies or Artificial Intelligence is required
- Classroom training is helpful but not required
- There are no process perturbations required to do process identification
- Implementation of a model is not people or time intensive

PERSPECTIVE

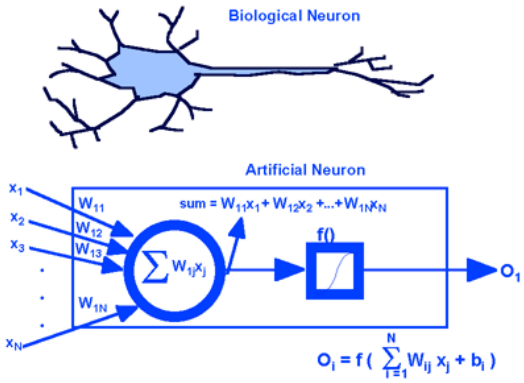
Neural Nets, Expert Systems and Fuzzy Logic are all disciplines of Artificial Intelligence. As you can see in the following figure, rule based systems tend to consist of hand coded, "if then" rules that have to be entered to emulate the expert's knowledge and/or actions. Neural Networks, on the other hand, are very numeric algorithms that learned directly from process data. Fuzzy logic has characteristics of both. Neural networks and rule based systems.



First principles models are based on an understanding of the underlying physics and chemistry of the process. Examples of these types of models are partial differential equations, kinetics equations, thermodynamic equations, etc. Neural Networks are capable of learning directly from the data.



There are a great deal of similarities between the human brain and the Neural Network built in the computer. Neural Networks are modeled after neurobiological systems and they perform many brain-like functions. They also are self-modifying and both learn from training and are taught by example. The real value of Neural Networks is they allow us to substitute a computer intensive function for a manpower intensive function.



OFF-LINE PRODUCTS

Data Insights – This is primarily a tool for analyzing the source data and preparing it for modeling. It formats any flat ASCII file and includes an editor. It also includes a Pre-Processor Spreadsheet that has been designed with essentially no limit on data file size and provides powerful data transforms, statistical calculations, cut and paste, time merge, correlation transforms and is built around an intuitive data flow architecture. Data visualization is provided with a fast, flexible plotter with plot types of Time Series, Row #, XY, probability, histogram, PCA and covariance.

Simulation Insights – This is primarily a process analysis tool providing sensitivity rank ordering, economically optimized rank ordering and model response curves. It does not support the deployment of models into runtime applications. Has the ability to model and analyze the relationships between multiple process measurements, their movement and the resulting process behavior. It automatically selects the model architecture, displays all relevant model statistics in real-time during modeling and also includes a validation test set. The model types that can be built are nonlinear predictive, Sensor Validation or custom linear regression.

Soft Sensor Insights – Supports the deployment of models into the on-line applications.

Process Insights – Includes all of the capability already discussed and also provides modeling for control, optimization, combinatorial constraints, setpoints, what-ifs and step response functions.

Comments:

- Simulation Insights, Soft Sensor Insights and Process Insights are only offered with the “Stiff Solver” option. This is an algorithm for quicker solutions on smaller problems.
- All licenses are single user floating.
- All off-line products include a unique tool that formats I/A Series Historian data for modeling.

ON-LINE PRODUCTS

RunTime Prediction Module – Takes prediction models built in either Soft Sensor Insights or Process Insights. This product includes the on-line transform processor but does require the Data Interface and Mapper.

Control & Optimization Module – Takes models built in Process Insights and uses them with a set of optimization functions. Also supports nested (cascaded) models.

Virtual On-Line Analyzer – Significantly enhances or substitutes for on-line hardware analyzers. It provides a powerful way to take a prediction model, built by Soft Sensor Insights or Process Insights, and places it on-line in a position which can accurately calculate analytical values (current unit performance) based on real-time transmitter data.

Sensor Validator – Monitors transmitter values and, prior to using the values in a model, approves or alarms "out of limit" values and, if necessary, reconstructs to correct value(s) based on a prediction model of transmitter relationships. Corrected values are then delivered to the run-time models.

Software CEM – This is a specialized model for prediction of emissions which may be certified by environmental agencies when correctly applied. Prediction calculations are based on process measurement. The solution incorporates sensor validation and data reconstruction if the sensors are found to be incorrect. There is also a specialized reporting package for compliance with federal and state regulations.

Boiler Optimizer (Boost) – This is a fully integrated stand alone package that has no other prerequisites (except of line built models). This package, when applied, will drive the boiler to a position of maximum production at minimum cost of operation while controlling combustion undesirables at a below target maximums (within equipment limits).

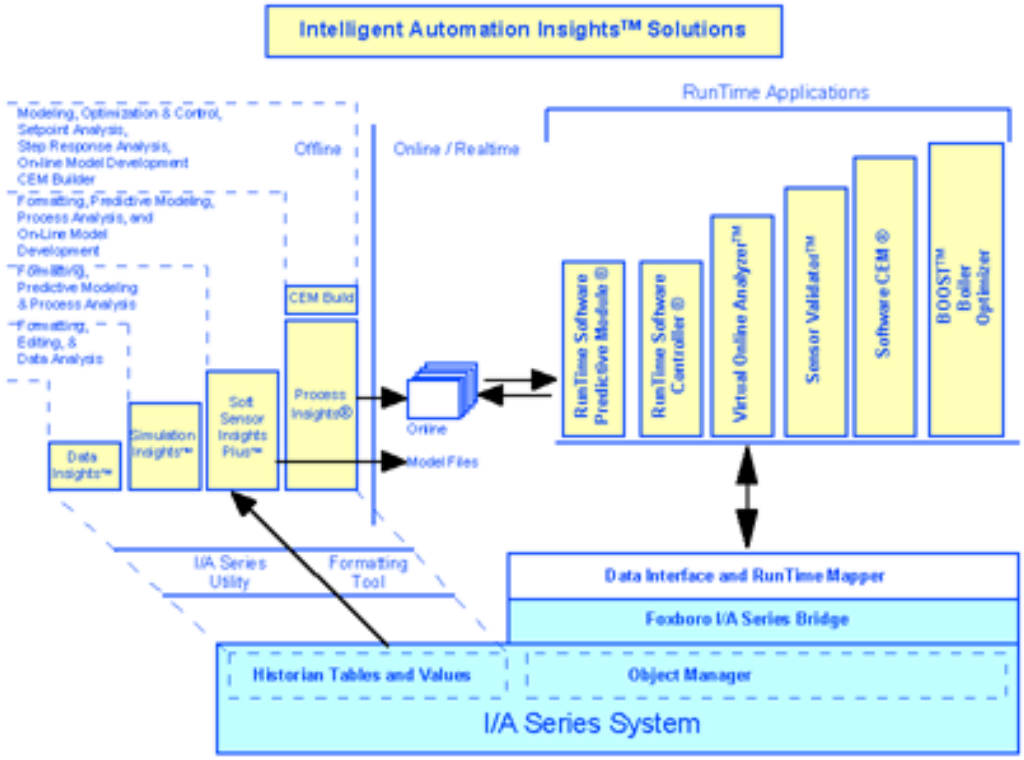
Pavilion Data Interface – The PDI is the primary real-time interface between the I/A Series Object Manager and the run time software model. Data/results movement is bi-directional. It includes the major syntax and mapping functionality. Other drivers can be connected to the PDI (one per server is required). See RunTime Mapper below for additional requirements.

RunTime Mapper – This is mapping software which provides the bridge between the I/A Series data structure and the PDI data structure.

Comments:

- The above products are server locked, not floating
- All on-line product require a Pavilion data interface and runtime mapper.

THE INTELLIGENT INSIGHTS PRODUCT SOLUTIONS



Off-Line Products

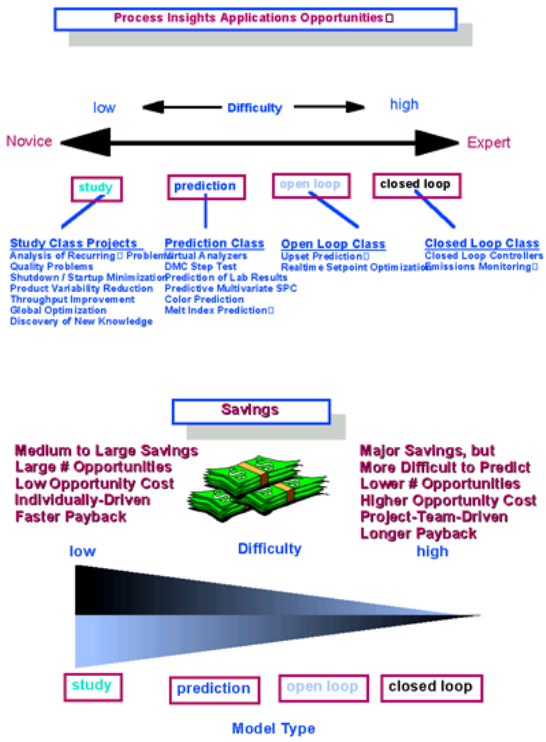
	Pavilion Identifier	Foxboro P/N	Edit	Format	Pre-Process	Model	Stiff Solver	Analyze	Save RunTime	Step Response Setpoint	Build CEM
Data Insights	DI-100	G03000L	X	X	X						
Simulation Insights W\Stiff Solver	PN-101	G03000N	X	X	X	X	X				
Soft Sensor Insights W\Stiff Solver	PP-101	G03000P	X	X	X	X	X	X	X	X	
Process Insights W\Stiff Solver	PI-101	G03000S	X	X	X	X	X	X	X	X	X

On-Line Products

	Pavilion Identifier	Foxboro P/N	Comments
Programless RunTime Prediction Module	RS-200	G0300GT	PD-100 required. No Pre-requisites, predictions only Includes Development Module (RS-100).
Programless RunTime Control and Optimization Module	RS-210	G0300GU	PD-100 required. Same plus can do control.
Virtual On-Line Analyzer	VA-100	G0300GV	PD-100 Data Interface Required. Includes Development Module (RS-100).
Sensor Validator	SV-100	G0300GW	PD-100 Data Interface Required. Includes RS-100 Development Module.
Software CEM	SC-100	G0300GX	RT-100 Training required.
Boiler Optimizer (Boost)	BO-100	G0300GY	RS-100, CM-100, PD-100, PD-001
Pavilion Data Interface and Mapper	PD-100 / PDM006	G0300GZ	One Per Server. Includes Flat File Interface. Supports multiple model applications (node locked).

APPLICATIONS AND BENEFITS

Applications are where the benefits are realized from any product and clearly there is a relationship between the type of application that is being addressed, the complexity and the possible benefit. The following figures show the relative difficulty for each class of application and its relative benefit.



It is important to understand that the Intelligent Insights products have a great deal of value as desktop analysis tools completely separate from their value as on-line products. In fact, as you can see in the preceding figures the predominant return can be in this area. Much of the benefit comes from the "ease of use" of these products. The following are application examples:

Operational Debottlenecking of Production Lines

Approach:

- Build a Prediction Model of the outputs
- Use this model to do sensitivity analysis in order to determine the relationship between objectives and constraints
- Use this to define operational problems
- Perform setpoint analysis to determine optimal operating conditions

Benefit:

- Improved throughout within operating and emissions constraints
- Reduced operating costs

Virtual Analyzer Applications

Approach:

- Build a Predictive Model using off-line lab results and on-line analyzer data extracted from the I/A Series Historian.
- Perform sensitivity analysis to determine the key variables and the interactions.
- Establish new operating guidelines as a result of the new insights.
- Place the model on-line and use for decision support for the operator and over time evaluate whether the loop should be closed on the model.

Benefit:

- More rapid response to out off-spec conditions.
- Smoother and more rapid start-ups and shut-downs.
- Less downtime, recycle and waste.

Sensor Validation

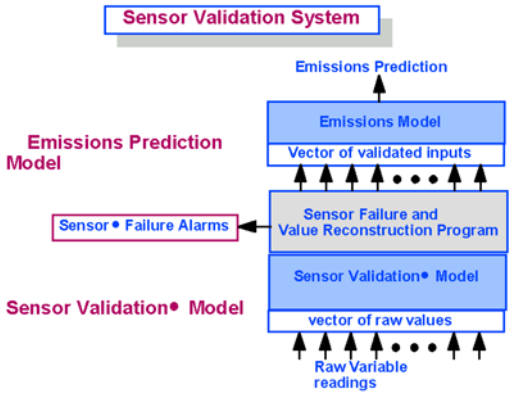
Approach:

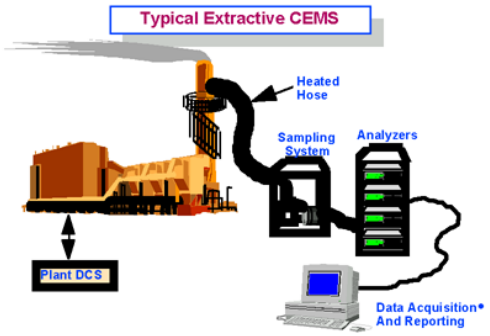
- Build a model of an array of sensors each as a function of the other.
- Run off-line “Sensor Health Check” tests to validate sensors.
- Install sensor models on-line to alarm operators of drift/failure and to automate “Sensor Health Check”.
- Use reconstructed values temporarily when sensors are off-line for repair or recalibration.

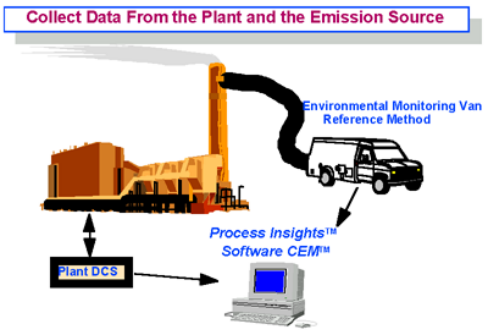
Benefit:

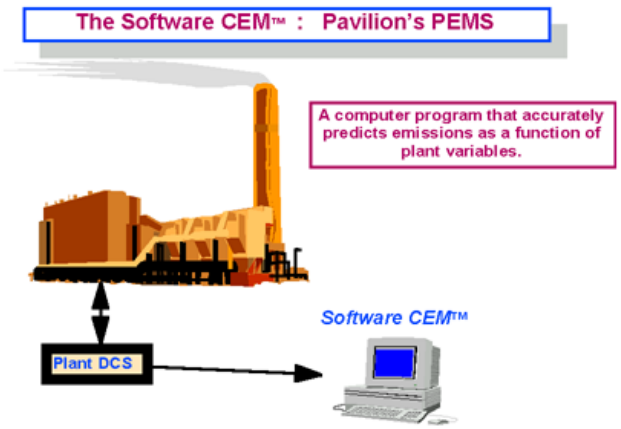
- Automate alarming of failing/miscalibrated sensors.
- Substitution of off-line sensor input while out of service.
- More accurate operational data to production.

Combustion Emissions Monitoring Systems









As a result of the Clean Air Act, many manufacturers are required to monitor fugitive emissions from combustion. Hardware NOx analyzers are most often used to satisfy the monitoring requirement, however this is also an opportunity for Intelligent Insights, not to replace the analyzer but for sensor validation and back up. OSHA allows manufacturers some freedom in terms of availability to accommodate time to repair and time to calibrate requirements. This only amounts to a few percent but OSHA allows manufacturers to bank this time if it is not used. This banked time could be tremendously valuable if needed to allow continued operation rather than shutting down to accommodate some catastrophic monitoring failure. This benefit can be enjoyed when the I/A Series system has the data and I/A Series Insights is used to model the NOx analyzer and back it up so even when the analyzer is out of service, emissions continue to be monitored, thus yielding 100% uptime and allowing the allowed down time to be banked.

Other possible uses of Intelligent Insights are:

- Off-Line Optimization
  - Find the optimal calculations
  - Find the recipe for a new product
- On-Line Look ahead SPC
  - Traditional SPC with predictive capability

- On-Line Open Loop Supervisory Control
  - Setpoint recommendations made to the operator
- Models for training simulation based on actual plant data
- Dynamic performance monitoring with optimized model running against actual plant or process data

A limitless number of applications are possible using the Intelligent Insights modeling capability now in the I/A Series system. It must be noted that the run time applications will all require application services. At the time of sale, it should be decided whether Foxboro will provide those services or the customer will.

HARDWARE REQUIREMENT

I/A Series Models AP/AW 51B or C
Dedicated 1.2 G Hard Disk (48 Mb main memory)

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