Model Predictive Control

Pavilion Technologies’ Model Predictive Control delivers results.

Due to global competition, customers have more supply alternatives than ever before. The most successful manufacturers respond quickly to changing customer demands and minimize the impact of rising energy and material costs.

Is your company positioned to capitalize on growth while maximizing operational efficiency?
“We have some models in our MPC solution that have been online for more than 10 years with little maintenance. Pavilion’s MPC technology is very robust, allowing us to operate within a wide range of production rates to meet customer demands or price pressures. As a result, the total cost of ownership is small, relative to the millions of dollars in value we are realizing from the solution.”

Dennis Yieh
Assistant Manager, Control Systems
Sterling Chemicals

The Challenge

Today’s manufacturing companies contend with intense global competition, reduced technical and operational resources, higher raw material and energy costs, stricter environmental regulations and growing customer demands. To stay competitive in the industry, manufacturers must transition from product-driven to customer-centric operations.

Complex industrial processes make it challenging to be both market-driven and run profitable operations. Manufacturers must reformulate their production methodology – introducing a greater variety of higher value products, more frequent changeovers and shorter production runs. They must ensure maximum uptime and more efficient transitions with less waste. In addition, manufacturers are facing stronger public demand to reduce their environmental impact and operate within strict emissions limits. Most importantly, manufacturers must find new ways to increase their agility in order to quickly respond to changing demand and profitably capitalize on new market opportunities.

The Solution

Leveraging the Pavilion® software platform, Pavilion Technologies’ Model Predictive Control (MPC) technology is an intelligence layer on top of basic automation systems that continuously drives the plant to achieve multiple business objectives – cost reductions, decreased emissions, consistent quality and production increases – every production minute. Pavilion’s MPC technology is packaged to address the unique characteristics of a process and powers the industry-specific control and optimization solutions delivered by Pavilion. Within these industry solutions, Pavilion’s MPC technology continuously assesses current and predicted operational data, compares them to desired results and computes new control targets to reduce in-process variability and improve process performance.

Robust process models are critical to any MPC-based solution. Pavilion’s MPC technology uses hybrid modeling capabilities that enable each model to incorporate all available knowledge about the process to deliver the most accurate, highest fidelity models possible. Pavilion uniquely provides a single solution that can handle both nonlinear and linear processes simultaneously, providing consistent results across a wide range of process technologies.

To ensure that economic benefits are maintained, Pavilion MPC-based solutions include built-in controller performance metrics that continuously monitor key indicators such as utilization, time at constraints and deviation from target. These metrics allow product quality, production and efficiency to be measured directly against MPC utilization and performance to ensure the maximum value is derived from the control application.
Greater Model Accuracy

Features
» Hybrid modeling based on empirical data, first principles equations, operator knowledge or any combination
» Soft Sensors® integrate with Model Predictive Control providing timely in-process measurements to increase accuracy of control actions
» Patented, Extrapolated Gain Constrained Neural Networks (EGCNN) to ensure model accuracy beyond the normal operating range

Benefits
» Expedites deployment by using all available information to create accurate models
» Minimizes need to adjust models as process range is extended
» Improves product quality through faster response to target changes or large process disturbances

Tighter Control Over a Wider Operating Range

Features
» Incorporates changing process dynamics (dead-time, time constants and gains) over wide process operating ranges
» Parametric model representation provides compact, computationally efficient controller model without sacrificing accuracy

Benefits
» Improves product quality and flexibility for new grade and product development
» Increases transition efficiency with less off-spec product
» Tightens control over a wider operating range

Maintain Controller Performance at Higher Levels

Features
» Controller replay capability maintains a contextual history of control actions and controller trajectories
» Embedded controller performance metrics measure utilization, time at constraints and error from targets

Benefits
» Allows quick identification and resolution of model mismatch or tuning parameter errors for improved controller performance
» Assesses historical controller performance
» Achieves predictable, sustainable performance through continuous controller monitoring

Model Predictive Control – Continuously Drive Your Plant to Achieve Multiple Business Objectives

Tighter Control Over a Wider Operating Range

Maintain Controller Performance at Higher Levels
Pavilion's Model Predictive Control technology uses multivariable models and current plant measurements to determine future control actions that will result in operations that satisfy all independent and dependent variable constraints. These dynamic, predictive models differentiate MPC from other types of Advanced Process Control (APC) technologies.

**Hybrid Modeling – Key to Robust Process Models**

Robust process models are critical to any MPC-based solution; they define how the control solution should respond to changing process targets and disturbances. Based on innovative hybrid modeling techniques, Pavilion's MPC technology produces accurate, high-fidelity process models, offering an unparalleled ability to handle the full spectrum of simple to complex industrial processes.

MPC models may be fundamental, empirical or a combination of both. In practice, pure fundamental models require hundreds of equations to be solved in an iterative manner at each execution cycle. This requirement limits the control application's size and speed. When little or no first principles knowledge is available, empirical models can be derived using only historical process data. These models are extremely accurate over the operating range represented by the historical data, but they may not perform as well when extrapolated beyond this range.

A hybrid modeling approach combines the best of both techniques. With this type of model, MPC-based solutions use process knowledge in the form of a mathematical equation or known constraints in model development. Pavilion's MPC technology combines empirical modeling techniques (such as neural networks), process data and first-principles equations to give manufacturers more robust, accurate models across the entire range of operations. Pavilion's hybrid modeling approach offers a parametric representation of a process that allows for fast control execution even in highly complex manufacturing environments, without sacrificing accuracy.

**Dynamic MPC Drives Operational Excellence Across Full Product Portfolio**

In today's customer-driven environment, manufacturers are increasing product portfolios and embracing mass customization. As a result, manufacturers are grappling with more product transitions and in-process variability. Unlike solutions that require different technology to solve different phases of production, Pavilion's dynamic MPC technology can tackle the full product spectrum.

Built on an integrated, comprehensive control architecture, Pavilion8 dynamic MPC uniquely provides a single, parametric controller architecture that can handle the full range of industrial processes – from simple to very complex (4 to 100+ variables), linear and nonlinear, as well as fixed or variable dynamics. The controller includes dynamic and steady state optimization to ensure any number of objectives and constraints are met at every execution, including hard limits, soft or ‘fuzzy’ constraints, desired value targets, maximization or minimization of selected variables and rate of change constraints. The MPC technology provides flexibility to adjust production schedules to meet new orders, regardless of what is currently being produced.
Dynamic MPC Drives Operational Excellence Across Full Product Portfolio

Built-in, real-time Controller Performance Metrics allow engineers to easily view key indicators such as control utilization and time at constraints for individual variables, ensuring maximum benefits.

Only Pavilion8 MPC provides historical access to predicted controller trajectories (blue) as well as actual responses (gold), providing identifiable opportunities for performance improvement.

All performance metrics can be aggregated over product grades, production shifts or other defined categories.

ValueFirst Performance Metrics provide real-time insight into key performance indicators such as production, quality and energy to provide continuous assessment of ROI.
Pavilion8 is a modular software platform and the foundation for Pavilion’s industry-specific solutions. Leveraging a powerful modeling engine at its core, Pavilion8 includes modules to model, control, analyze, monitor, visualize, warehouse and integrate that are combined into high-value applications. Based on a modern Service-Oriented Architecture (SOA), the Pavilion8 platform is implemented in J2EE and is “Powered by SAP NetWeaver®” certified. The platform’s scalability, flexibility and ease of integration with existing business and plant infrastructure provides a lower total cost of ownership than alternative technologies.

About Pavilion Technologies
A division of Rockwell Automation Inc., Pavilion Technologies’ model-based software drives profitability for leading manufacturers like Cemex, Dyckerhoff AG, Glacial Lakes Energy, NOVA Chemicals, Nestlé, SABIC Europe and TOTAL Petrochemicals. Based on the most powerful predictive modeling software in the industry, Pavilion’s solutions improve production processes to facilitate quick response to market demands, continuous reduction of costs, consistent achievement of quality targets and enhanced environmental quality. With a commitment to delivering the highest ROI in the industry, Pavilion’s ValueFirst® customer engagement methodology delivers predictable results.