Controller Performance Monitoring

A typical industrial process, as in a petroleum refinery or petrochemical complex, includes thousands of control loops. Instrumentation technicians and engineers maintain and service these loops, but rather infrequently. Routine maintenance of such loops can result in significant savings. Controller performance monitoring (CPM) can identify and diagnose incipient problems. CPM implementations have been successfully deployed in large sites and have substantially improved the performance of control loops.

Source: BASF SE

Identifying and Fixing Control Loop Problems

Studies indicate that on average only 40% of industrial control loops are delivering satisfactory or optimal performance. As many as 60% of control loops may have poor tuning or configuration or actuator problems and thus may be responsible for suboptimal process performance. As a result, monitoring of such control strategies to detect and diagnose the cause(s) of unsatisfactory performance has received increasing attention from industrial engineers. Specifically, the methodology of data-based controller performance monitoring is able to answer questions such as the following:

> "Is the controller doing its job satisfactorily, and if not, what is the cause of the poor performance?"

In many of today's plants, performance of the process control assets is monitored on a daily basis and compared with industry benchmarks. The monitoring system also provides diagnostic guidance for poorly performing control assets. Many industrial sites have established reporting and remediation workflows to ensure that improvement activities are carried out in an expedient manner. Plantwide performance metrics can provide insight into companywide process control performance. Closed-loop tuning and modeling tools can also be deployed to aid with improvement activities.

Industrial Implementations

CPM software is now readily available from most distributed control system (DCS) vendors and has already been implemented successfully at several large-scale industrial sites. Large-scale industrial implementations of CPM technology provide clear evidence of the impact of this control technology and its adoption by industry.

Operational Applications of Controller Performance Monitoring

- As part of its OPAL 21 (Optimization of Production Antwerp and Ludwigshafen) excellence initiative, BASF has implemented the CPM strategy on more than 30,000 control loops at its Ludwigshafen site in Germany and on more than 10,000 loops at its Antwerp production facility in Belgium.
- As part of its process control improvement initiative, Saudi Aramco has deployed CPM on approximately 15,000 proportional-integral-derivative (PID) loops, 50 model predictive control (MPC) applications, and 500 smart positioners across multiple operating facilities.

***Contributors:** Sirish L. Shah, University of Alberta, Canada; Marcus Nohr, BASF SE, Germany; and Rohit Patwardhan, Saudi Aramco, Saudi Arabia*

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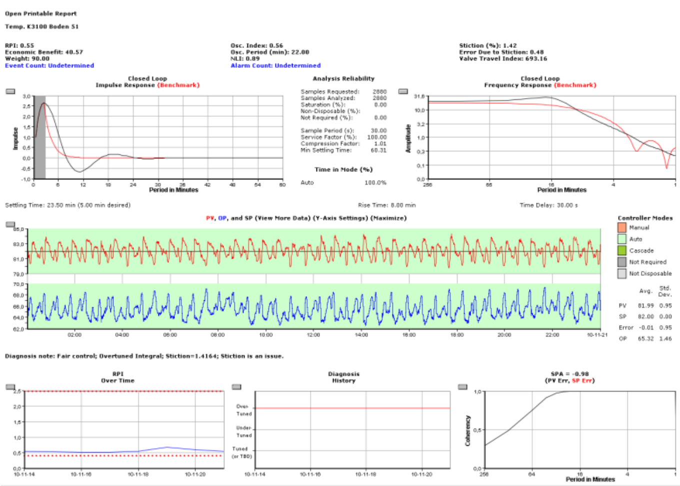
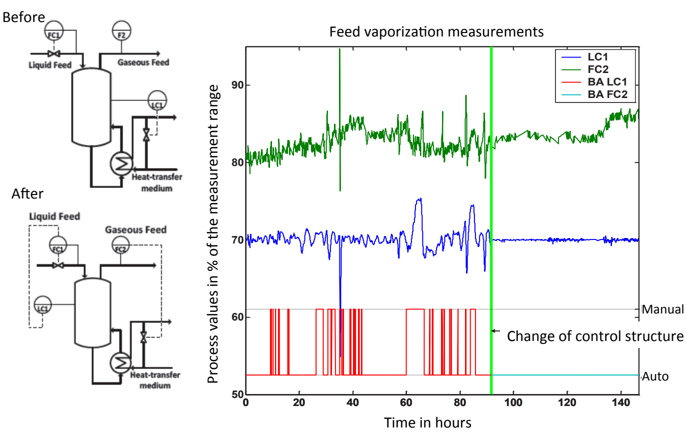
Plantwide Performance Assessment

The key to using this technology effectively is to combine process knowledge, basic chemical engineering, and control expertise to develop solutions for the indicated control problems that are diagnosed in the CPM software. The operational philosophy of the CPM engine is incorporated in the continuous improvement process at BASF and Aramco, where all loops are monitored in real time and a holistic performance picture is obtained for the entire plant. Unit-wide performance metrics can be displayed in effective color-coded graphic forms as shown at right. Detailed reports can be accessed for every loop in units that require attention followed by diagnosis of poor performance, as shown below.

Color-coded graphics for plantwide CPM. The tiled rectangles refer to plant subsystems (e.g., units); the size of each rectangle can be proportional to energy consumption, alarm counts, or a user-defined property. Colors indicate the current assessment of each subsystem. (Source: BASF SE)



Detailed diagnosis of individual loops. Several parameters are calculated and tracked to identify incipient performance or safety issues. (Source: BASF SE)



Remediation of poor performance of a feed evaporator in a petrochemical plant after CPM diagnosis (LC1/FC2: level/flow measurements under level/flow control; BA: manual or automatic controller modes) (Source: BASF SE)

CPM for Control Optimization

The main objective in implementing CPM is to facilitate controller optimization. CPM monitors performance and aids in the diagnosis and remediation of poorly performing loops. The figure at lower left shows results of controller reconfiguration attained through controller performance monitoring and subsequent diagnostic analysis. The reconfigured control loop is able to reduce variability, resulting in smoother process operation close to optimum constraints with increased throughput. Other ways to use the additional degrees of freedom from controller optimization are to allow for reduced energy consumption or improved product quality. The key benefit of this technology is improved performance from the regulatory and advanced control layers, resulting in:

- Improved plant stability,
- Reduced operator load,
- Reduced process variability and as a result closer operation to economic constraints, and
- Improved economic margins for the process.

For more information: B. Huang and S.L. Shah, Performance Assessment of Control Loops: Theory and Applications, Springer-Verlag, October 1999; F. Wolff, M. Roth, A. Nohr, and O. Kahrs, Software based control-optimization for the chemical industry, VDI, Tagungsband, Automation 2012, Baden-Baden, Germany; L.D. Desborough and T.J. Harris, Performance assessment measures for univariate feedback control, Can. J. Chem. Eng., vol. 70, no. 6, pp. 1186-1197, 1992.