Control loop performance monitoring solutions were supposed to facilitate optimization of a plant’s PID controllers. Difficulty with real-world process data and limits on their ability to provide meaningful recommendations hampered effectiveness. Those speed bumps have been removed and real-time optimization is now on the fast track.
Express Lane Ahead

Just now an opportunity to further optimize production came and went. An operator adjusted the Set Point of one of the facility’s countless PID control loops. The change was an activity of little consequence. It occurs countless times each day and – more often than not – fails to warrant a note in the shift’s log. Even though unnoticed the process responded to the operator’s modification, sending the Process Variable in pursuit of its newly assigned control target. The loop’s process data was steeped in important details – increased stiction in the valve from excessive packing, slower heat transfer due to a new feedstock, and the temperature sensor’s increasingly noisy readings. On queue the plant’s data historian collected the data whether all of it or some compressed version of it. Like so many other SP changes that could be used to improve control loop performance, this data set was stored away without ever being evaluated. With industry’s need for process improvements and its push toward profit, an important question to ask is: Why?
Control Loop Performance Monitoring

The majority of control loop performance monitoring (CLPM) solutions were first introduced over the past decade in direct response to industry’s need for improved awareness of issues affecting regulatory control. In his study of control loop performance, David Ender found that most PID control loops within the average production facility were operating inefficiently. With 85% of loops operating inefficiently while in closed-loop and 65% of them cited as either poorly tuned or de-tuned so as to conceal other PID-related problems, the study underscored the need for improved regulatory control. CLPM solutions stepped in to help process manufacturers to identify the bad actors. Valuable as that information seems, what manufacturers sought went beyond simple awareness. They required both greater insight into loop interaction and recommendations for corrective action.
Inefficiencies with PID Control Abound

David Ender’s Analysis

David Ender’s analysis of process control performance were first published by Control Engineering Magazine in September 1993. Ender’s assessment was based on experiences at hundreds of production facilities and highlighted widespread performance issues associated with the PID controller. Insights from his analysis include:

- Systems Improperly Configured to meet their unique control objective
- Controllers Operating in Open-loop (i.e. manual mode)
- Controllers Poorly Tuned or de-tuned to conceal PID-related problems
- Controllers operating inefficiently while in closed-loop (i.e. automatic mode)

CLPM solutions are a direct outgrowth of traditional process modeling and PID controller tuning technologies. Rather than examining control loops one at a time, CLPM solutions can simultaneously evaluate each of the many loops located across one or more production facility. Using various key performance indices (KPIs) these solutions work to identify performance challenges associated with mechanical issues and architectural constraints. They also help to identify controller optimization opportunities, automatically identifying SP and Controller Output (CO) changes, and generating a model of the associated process’ dynamics. These functions...
are performed in near real-time and provide production staff with timely awareness of issues that may negatively affect production.

Until recently CLPM solutions were limited in their abilities to model complex process dynamics and to recommend adjustments to PID controller tuning parameters. Like the majority of commercial tuning software, CLPM solutions failed to accurately model noisy, oscillatory process data. What’s more, the data capture and modeling functions within CLPM solutions were typically incompatible with integrating processes. These constraints put the value of CLPM solutions in question. So, what has changed?

Limitations of State-of-the-Art Modeling

Tuning software utilizes step test data to model a PID control loop’s process dynamics and to calculate tuning parameters. In order to generate an accurate model traditional ‘state-of-the-art’ tuning software required a steady-state condition at the start and end of the step test. This limitation was carried over into the model capture capability of early CLPM solutions.

Shown on the right are two different step tests and their corresponding process models generated by PID controller tuning software previously considered ‘state-of-the-art’. The step test shown at the top begins and ends at a steady-state, resulting in an accurate model (red line) of the process’ dynamics (black line). In contrast, the step test displayed at the bottom began and ended in the midst of a transition. The resulting model (red line) fails to accurately describe the loop’s dynamics.

Overcoming the complexity of data

In 2013 select CLPM solutions gained important ground through the application of a proprietary non-steady state (NSS) modeling innovation. The innovation enabled accurate modeling of highly dynamic process data that is typical of industrial process manufacturing. First introduced in 2008 the innovation was applied narrowly to traditional PID controller tuning software. The novel approach to modeling eliminated the need for a steady-state condition.
Further, it supported both integrating and non-integrating processes. Noisy, transitional, and otherwise oscillatory data no longer served as a deal breaker when individual regulatory control loops required tuning. Since its introduction the innovation has been adopted by global OEMs including Rockwell Automation and Yokogawa.

More recently the innovation has been adapted for use with select CLPM solutions. Broadly deployed to process manufacturers located around the globe, the enhanced capability accurately models the troublesome dynamics that are commonplace in industrial applications. Like their controller tuning predecessor, CLPM solutions equipped with the NSS modeling innovation proved capable of automatically capturing and modeling data from integrating and non-integrating processes alike. Even so, finding opportunities for process optimization solved only a portion of the problem.

NSS Modeling

Industrial Strength Innovation for Everyday Process Data

CLPM solutions like PlantESP automatically identify Set Point changes. Utilizing the NSS modeling innovation these solutions can address complex process dynamics such as noise and oscillations that are commonplace in industrial applications.

Shown above are process data trends automatically captured by a CLPM solution. Each trend highlights one or more changes to Set Point (red lines). The associated Process Variables (green lines) exhibit typical levels of variability. The trend at the top can be seen in the midst of a transition when Set Point is adjusted. Visual examination of each process model (purple lines) confirms that they accurately describe control loop dynamics.
Innovations that deliver insight

More than accurate modeling is required to provide actionable benefits to process manufacturers. Even basic CLPM solutions utilize KPIs to identify loops with controller tuning issues. To be sure, they alert users to loops that are not operating in the proper or normal mode. Mode changes often result when operations staff lack confidence in a given loop’s ability to maintain safe, effective control – a proxy for sub-optimal controller tunings. Excessive levels of error or oscillation often indicate a need for retuning of the PID. Although each is a valuable source of insight, these basic metrics fall short of actionable information. Advanced capabilities have become a requirement.

A small set of CLPM solutions go beyond diagnostics and offer recommendations for corrective action specifically related to controller tuning. These solutions compare each newly generated process model relative to the corresponding loop’s historical performance. The resulting analysis clarifies the effectiveness of existing controller tuning coefficients, offering graphical evidence that the controller is either performing satisfactorily or requires tuning.

In cases where tuning is required, these CLPM tools provide ready access to the process data that’s needed to refine tuning parameters for optimal performance. The feature assures that the new coefficients are consistent with the PID loop’s unique control objective. Control loop diagnostic capabilities such as this streamline the process of issue identification, isolation and correction on a plant-wide basis.

NSS Modeling

Industrial Strength Innovation for Everyday Process Data

Select CLPM solutions compare the performance of existing tuning parameters versus proposed parameters, enabling users to visualize potential gains in control in the context of recent historical loop performance.
Real-time modeling and diagnostic capabilities within a select group of CLPM solutions are now delivering value that lives up to the promise. In particular a select group of CLPM technologies address the complexities of real-world process dynamics by excelling at the following core capabilities:

**Find**
Everyday changes to Set Point (SP) or Controller Output (CO) present an opportunity for modeling a process’ dynamics. CLPM solutions like PlantESP utilize proprietary technology that can process noisy, transitional, and oscillatory data.

**Model**
Process models provide the basis for calculating PID controller tuning parameters. Solutions equipped with NSS modeling innovation can model both integrating and non-integrating processes.

Two parallel trends showcase a range of control loop performance for both the Proportional (upper) and Integral (lower) terms as well as relative to the existing tuning coefficients. Shown over a 14-day period using historical data the existing Proportional term (green line) can be seen within the recommended range during the designated time of operation. In contrast the current value for the Integral term (red line) is well below the recommended range. Ranges recommended by the CLPM solution can be adjusted for conservative to aggressive controller responsiveness.
With 100s of PID control loops at the typical production facility the dual goals of first achieving and then maintaining profitable production presents a significant challenge to the average engineering and operations staff. It’s clear that controller tuning is key to fulfilling that goal, but it is also worth noting that tuning is just one in a long line of tasks assigned to a plant’s production staff. Advancements to CLPM solutions address this challenge head on. A small number of CLPM solutions simplify process optimization by providing actionable answers. While many acknowledge that their control loop performance issues are widespread, most are hard pressed to designate scarce resources to investigate and correct them. The time required to isolate the root-cause of issues affecting performance often outweigh the perceived gains. Those manufacturers operating CLPM solutions equipped with NSS modeling capabilities have no need to perform such time-intensive investigative research and root-cause analysis. From actively monitoring loop performance and identifying SP changes to modeling the loop’s complex dynamics and comparing the results against historical performance, today’s CLPM solutions have streamlined real-time process optimization.

**Compare**
A simple test is to evaluate the new model and determine if performance can be improved. PlantESP graphically depicts how a new model would affect the values of the PID controller settings.

**Recommend**
Automated alerts with recommendations simplify analysis and accelerate decision-making. PlantESP is one of a small group of CLPM solutions that notify end-users of specific opportunities to optimize PID controller performance.

**Enabling Real Time Optimization**

With 100s of PID control loops at the typical production facility the dual goals of first achieving and then maintaining profitable production presents a significant challenge to the average engineering and operations staff. It’s clear that controller tuning is key to fulfilling that goal, but it is also worth noting that tuning is just one in a long line of tasks assigned to a plant’s production staff. Advancements to CLPM solutions address this challenge head on. A small number of CLPM solutions simplify process optimization by providing actionable answers. While many acknowledge that their control loop performance issues are widespread, most are hard pressed to designate scarce resources to investigate and correct them. The time required to isolate the root-cause of issues affecting performance often outweigh the perceived gains. Those manufacturers operating CLPM solutions equipped with NSS modeling capabilities have no need to perform such time-intensive investigative research and root-cause analysis. From actively monitoring loop performance and identifying SP changes to modeling the loop’s complex dynamics and comparing the results against historical performance, today’s CLPM solutions have streamlined real-time process optimization.
Most production processes are highly dynamic and constantly changing, so much so that it’s not hard to stumble upon issues that hamper performance. The real challenge for practitioners is prioritizing limited time around their facility’s most pressing issues. To optimize their effectiveness practitioners need access to information that is both accurate and insightful. That applies equally to their facility’s PID controllers as it does to process instrumentation. If you require improved awareness of your facility’s production performance issues, look no further than PlantESP!

- Plant-Wide Control Loop Monitoring
- Timely Alerts and Detailed Reports
- Targeted KPIs and Advanced Forensic Tools
- Actionable Recommendations for Corrective Action

Contact us today to learn how PlantESP is enabling manufacturers across the process industries to accurately diagnose complex control loop performance issues and to quickly correct them for increased production and enhanced efficiency.