CHOOSING PERFORMANCE ASSESSMENTS

Tom Kinney
ExperTune Inc.
Hubertus, WI 53033

For performance monitoring to produce easily identifiable and useable results, it must provide a comparison of loop health from loop to loop. This enables the promise of powerful analysis available through performance monitoring for each of the following areas: control loop, unit operations, the plant, the entire site or the entire corporation. Each level in the hierarchy may be of interest to different parties in the corporation and each level benefits from defining the appropriate performance assessments or KPIs (Key Performance Indicators) that will make up the definition of health.

The benefits for each of the areas (control loop, unit operations, the plant, the entire site or the entire corporation) are:

- Prioritization - to see where to focus work efforts for the greatest return
- Performance tracking - historical tracking to see effects of different grades, feeds, and ambient conditions
- Historical comparison - to see the effects of improvements

All of these efforts require choosing performance assessments that make up loop health.

TWO EXAMPLE OPTIMIZATION CAMPAIGNS

This paper will explore looking at two different example sets of performance assessments based on two different optimization campaigns. The first or "Basic Campaign" is designed to get the system in automatic and off of limits so the plant can be optimized. The second is an "Asset Management" campaign designed to augment an asset management system or replace the analysis portion of an asset management system.

BASIC CAMPAIGN

In the basic campaign we choose simple performance assessments or KPIs (Key Performance Indicators) designed to get the plant up and running in automatic mode. For this basic campaign we choose these assessments or KPIs:

Percent of loops not in a normal mode more than a specified percent of the time
Percent of loops where "output at a limit" is over a certain percent
Percent of loops oscillating

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In this basic campaign a benefit is that the KPIs or key assessments are easily understood by all the plant personnel and people involved in the plant.

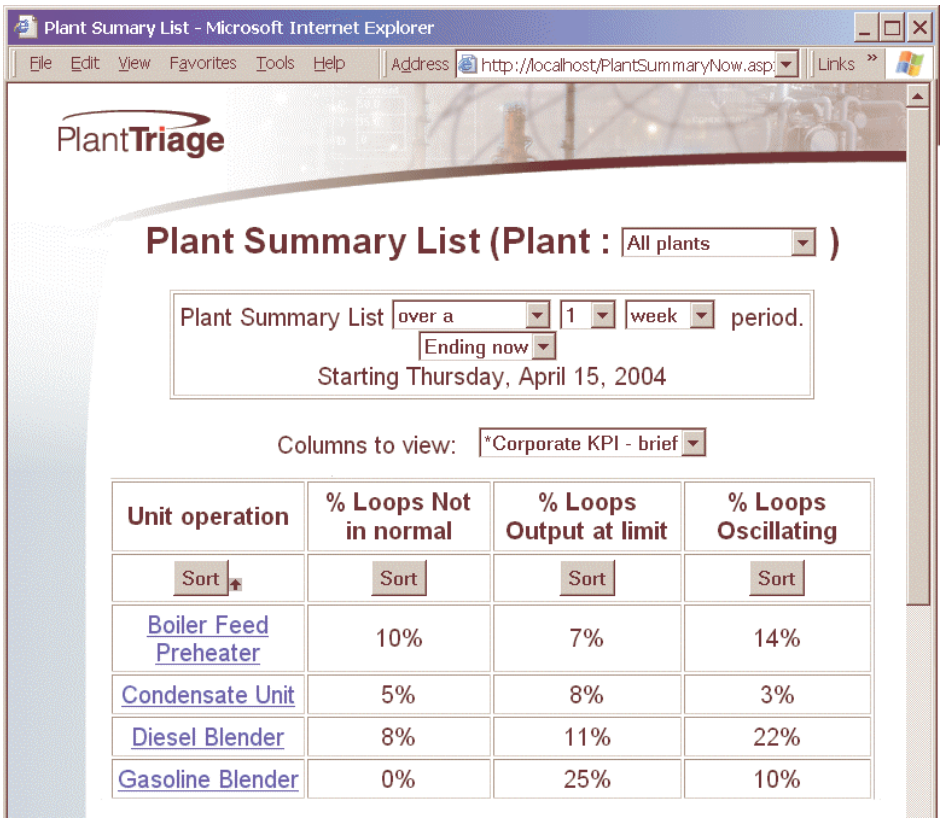

FIGURE 1: BROWSER INTERFACE SHOWING BASIC OVERALL CORPORATE KPIS FOR SPECIFIC PLANT UNITS.

PERCENT OF LOOPS NOT IN A NORMAL MODE MORE THAN A SPECIFIED PERCENT OF THE TIME

This assessment tells us if the loop is operational as intended. If the loop is consistently not in normal mode then this indicates a problem: 1) the design is incorrect, 2) the control loop is located incorrectly, or 3) the loop is unnecessary.

For example if a valve is sized incorrectly (incorrect design) operations may leave the loop in manual for much of the time. The loop may go unnoticed by engineering. A loop in an incorrect location may be in manual because it could not physically control the process variable.

Under normal operating conditions, manual operation may not a problem, but if an upset occurs this may cause problems. By tracking loops in normal mode this uncovers hidden problems.

PERCENT OF LOOPS WHERE "OUTPUT AT A LIMIT" IS OVER A CERTAIN PERCENT

If the loop is at a limit, the control is not sufficient. This control loop may be the limit or bottleneck to increasing capacity. This problem may occur after capacity was increased and the loop was forgotten. This assessment uncovers hidden bottlenecks.

PERCENT OF LOOPS OSCILLATING

Oscillations are often problematic in plants. Oscillations could be limiting capacity, or oscillations may be keeping the plant far away from an operating specification, wasting expensive active ingredients or energy.

ASSET MANAGEMENT - ANALYSIS CAMPAIGN

This campaign is designed to get the most out of your current control system assets. It can be used to augment or replace the analysis portion of an asset management system for the control system assets, mainly valves, sensors, and controllers.

The goals are to keep the plant as close to specification as possible (crowd the specs), keep the plant oscillation or swing-free, increase valve life, and do this with only the maintenance required - reliability centered maintenance. Running as close to spec as possible will often save profits on key ingredients or energy usage. Usually the greatest profits are made if the plant runs as close as possible to spec, but without going off spec.

This campaign uses these key assessments or KPIs (Key Performance Indicators):

Average Absolute Error
Setpoint Crossings
Output Standard Deviation
Harris (normalized)
Oscillating
Oscillation due to the Valve
Valve travel

These assessments are found by the performance monitor using process data collected via OPC or OPC HDA. See "Plantwide Performance Monitor Bridges Resource Gap", by Tom Kinney, ISA, Houston, October 2003. Combine these key assessments or KPIs using a weighted average to yield one number for overall loop health. See "Prioritizing and Optimizing Problem Loops Using a Loop Monitoring System," by John Gerry, ISA, Chicago, October 2002.

DEFINITION AND JUSTIFICATION OF KEY ASSESSMENTS OR KPIS

Average Absolute Error is the average absolute value of the error between the process variable and the setpoint. This calculation is the sum of the absolute errors (in percent) divided by the number of points assessed. The Average Absolute Error is an inferential quality variable. The lower this value the more we can crowd the spec.

Setpoint Crossings is the number of times the PV crosses the Setpoint in one day. Setpoint Crossings is also an inferential quality variable. Setpoint crossings for key quality variables relates to the amount of off spec product produced as a result of controller tuning and the type of disturbances these key quality variables are subjected.

The Output Standard Deviation is the standard deviation of the controller output. Output Standard Deviation is an inferential quality variable and it also is an indicator of valve movement or movement of slave loops. Lower values are generally better. Although flow loops may give larger values under normal operation.

The Normalized Harris Index will vary as a number between 0 and 1. The smaller the value, the better the performance of the loop. A value of 0 is perfection or minimum variance control. This is also called the CLPA or "Closed Loop Performance Assessment." It is based on the Harris Index that is defined as the ratio between the error (PV - SP) variance during this assessment over the variance achievable by a minimum variance controller. Normalized Harris Index or CLPA is a problem indicator for some types of problems.

Normalized Harris Index (CLPA) = 1 - 1/(Harris Index)

Figure 2: Normalized Harris Index or CLPA (Closed Loop Performance Assessment)

Oscillating: Oscillation analysis detects that an oscillation is present. If present, "Oscillating" will tend to be towards the upper end of a range with the maximum being 100%. If no oscillation is present, "Oscillating" will be nearer 0%. Oscillating is a problem indicator. Loops that are oscillating are degrading performance of the unit.

Oscillating due to the Valve: The root cause diagnosis of the oscillation is suspected to be from a hardware non-linearity like valve stiction or hysteresis. Values towards 100% indicate higher confidence that the oscillation is caused from the loop's hardware or valve. Valve stiction will always cause cycling and is a common cause of troublesome cycles in process plants.

Valve Travel is the total distance the controller output moves during the assessment period normalized to be on a 24-hour basis. Valve travel is a direct indication of valve wear.

CHOICE OF ASSESSMENTS

Average Absolute Error and Setpoint Crossings, are inferential quality variables. For example, they may represent how close the plant can push up against constraints or specifications.

Output standard deviation and valve travel for many processes can be an indication of an opportunity to achieve the same performance with less valve movement, reducing maintenance costs.

The Harris (normalized) index, Oscillating, and Oscillating due to the Valve, are all problem indicators. Oscillating due to the Valve puts more emphasis on valve stiction and hysteresis as potential problems

CONCLUSIONS

Different KPIs or key assessments can be chosen depending on the goals of the plant and the current condition of plant maintenance and optimization. Two different key assessment or KPI families introduced here have benefit for plants either just starting to optimize or those desiring to move their operation to the next level of performance.