USING PERFORMANCE MONITORING AND OPTIMIZATION TOOLS FOR A PAPER MACHINE START-UP

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ABSTRACT
In today’s highly competitive worldwide market, it is becoming extremely important for the management people to make sure that all resources are affected where needed the most. In such a way, all resources are generating value added, process control equipments are maintained in an optimal state for best performance and final product is produced at least cost. Performance monitoring is the only way to ensure that everyone is working on top priorities toward the same common goal. This paper shows, using real case examples, how performance-monitoring software can help you prioritize loop according to economic significance, pinpoint and diagnose process control loop poor performance and equipment problems.

INTRODUCTION
With the proven OPC (OLE for Process Control) communication standard, it is now possible to easily interface with most platforms (proprietary communication protocol). Since most manufacturers (DCS, drives, scanners, etc.) now support OPC connectivity; we can access all instruments from the control room. This communication standard allows monitoring application and data collection; either from stored data in a historian or from a real-time raw format. This data can then be consulted in a raw format for three weeks and in a compressed format for at least two years without overloading the storage capacity of a standard server platform. With this OPC standard link, raw data can be sampled quickly enough to avoid aliasing phenomena (ghost frequencies) for most industrial dynamic encountered. The system also includes tools to analyze the process, optimize and tune loops. Advance tools such as : “power spectral density analysis, cross correlation, statistical analysis, … help experienced users to analyze more deeply the problems.

CONCEPT
Raw (uncompressed) data will be used by new technology monitoring software to assess and measure performance of the plant, unit operation process or single control loops. This performance is benchmarked according to the period of time during which the plant was considered to work at its optimum desired performance. An assessment period is defined as being the period of time after which KPI (key performance indicator) is calculated. For instance, an assessment period of time can be defined based on a work/shift duration. Many KPI can be calculated for each assessment period. However, not all of them are important for the plant. KPI will inform groups of users such as management, engineering, operation and maintenance of the plant, about the unit operation performance and control loops related to performance, the equipment availability, the presence and sources of problems as well as the equipment health or wear. The relationship between KPI, assets and users are shown in Fig.1. KPI gives health measurement of assets and informs users on the performance supplied by these assets allowing the users to increase their efficiency. The end results are that the users can focus their efforts where the impact on production quality and assets health gives the largest return on investment (ROI).

Figure. 1 New Cutting Edge Technologies Concept

PERFORMANCE MONITORING SYSTEM
A continuous performance monitor can identify which areas are under-performing and which of these will offer the greatest economic returns; the system will identify the controllers and equipment not performing well. The software digests real-time data coming from the plant and generates Emails, reports and lists of loops that are outside predetermined performance limits. It pinpoints areas to focus on, optimizing the efforts of your work force. The software also includes the tools to drill down and to analyze problems. The tools to optimize the process and to tune loops are also part of it.

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The start-up (or maintenance) becomes pro-active since the software prioritizes the areas, loops, and equipment needing attention.

**PAPER MACHINE START-UP**
Here below is a real case example of what has been made possible by using a performance monitoring software to audit and assist the loop tuning and optimization of the control loop during the commissioning of a large paper machine. The success of a paper machine start-up is insured by the execution of good engineering practices, according to the state-of-the-art, until the passage of the sheet on the machine. The contribution of every specialty involved is critical in order to reach the optimal performance criterions of the paper machine's finished product. We are looking here at the entire process, like the operating method and procedure, the equipment availability and finally, the process control strategies. Obviously, during the start-up, the process difficulties will first be considered: control strategy, control loops tuning, loop dynamic interaction, process inter-locks, etc. The software for the supervision and the audit performance, analysis and assistance to the tunings and diagnostics of the control loops was implemented to the system right from the beginning. It was decided that every control loop and main quality-measuring signal would continually be monitored and completed by a performance audit based on the performance indexes. The goal to achieve here is to direct all the efforts invested in the loop tuning and optimization, control strategies revision and debugging of the control loops, where the loops, areas or units operation are showing the most direct impact on the finished product.

**The first step** was then to install and properly configure the performance audit software.
**The second step** was to configure each controller with start-up tuning values robust enough to allow the passage of the sheet on the paper machine and prevent the process from being oscillatory during a load disturbance or a set point change.
**The third step** was to apply some performance indexes for each loop and use the performance report generated by the system in order to detect problems of equipment, correlation, oscillation, and direct the test progression toward the most important economical significance.

During the start-up, many events occur such as manual/auto transfer, valve manipulation, set point changes; the software will use the changes to analyze the dynamics and capture the process models. Hence when a loop requires tuning, the process model being known, the tuning parameters are instantly obtained for any performance criterion.

Some open and closed loop tests were done on every loop. These tests are useful for the identification of every loop process parameters, (process gain, dead time, time constant), the knowledge of the valves state (hysteresis, stiction, installed characteristic such as linearity of process gain at different operating zone), and the choice of the controller gain $K_p$ integral action $K_i$, derivative action $K_d$ and filter time constant $T_f$ tuning values, considering the interactions with the other control loops. Also, by referring to the performance report recommendations, some extras open or closed loops tests were also done in priority on every identified loops, i.e., being economically profitable. As a result, the overall effort to install, configure and set-up this software represents less than 2 days for 200 loops.

Here are few examples of problems identified and resolved, based on the performance audit reports and the usage of modern diagnostics and control loops tuning tools.

**EXAMPLE 1**
Problem with pumping capacity of a redundancy system, de-bottlenecking done in 20 minutes:
A performance report identifies a recently tuned loop as non-performing (Fig.2);
According to the Output at Limit Index, the output is at its limit 100% of the time at specific periods and according to the IAE Index, it is over 100% above the acceptable threshold;
The P&ID reading and the analysis of the archive signals lead to identify the loosing capacity of Pump No.2 as compared to Pump No.1 (Fig.3 and 4);
Later on, a defective gasket was identified.

![Figure 2 Physical arrangement of dual pumping system](image1)

![Figure 3 Real time trend (2days zoom window)](image2)
Figure. 4 Loop History from the web browser on intranet

EXAMPLE 2
The following figure shows the tuning of a glycol heating circuit in oscillation affecting the steam distribution of the paper machine. The case shows where the start-up tuning figures estimated were too aggressive. This group contains eight heating units.
According to the “Oscillation Index”, a group of loops from the same sub-system oscillate at 100%;
According to the “Oscillation period index”, the sorting by oscillation period regroups eight heating units and one glycol exchanger within the same oscillation period;
According to the “Oscillation strength index”, the glycol exchanger temperature TIC loop is the cause of this oscillation;

The tuning time of the whole system (nine loops) lasted 90 minutes.

Figure. 5 Physical Arrangement of glycol system
Fig.6 shows the successive TIC and heating units’ tunings;

Figure. 6 Real time trend (3 hours zoom window)
EXAMPLE 3
A consistency loop was identified as the worst performing loop. An analysis of the KPI metrics shows an increase of the standard deviation output as well as more valve travel and valve reversal. But at the same time, the variability of this loop remains low and there was no production or quality problem for the operation.
Maintenance technician went for a visual check of the valve. What he found was some valve linkage loose. If no repair were done, the valve steam would have been decoupled from the actuator and a shutdown of the paper machine would have occurred. Fixing the problem on the valve brought back the KPI of this loop to its optimum performance.

CONCLUSION
In conclusion, the start-up of the process performed with the assistance of a performance audit, diagnostic and control loop tuning software leads to a fast progression of troubleshooting, tuning and optimization work. This is based on the precise and meaningful performance report and a post-tunings analysis of the performances obtained.
These 3 examples illustrate how quickly problems are identified and how the plant can focus its resources where they are really needed.
These new technologies pay for themselves from the very beginning (start-up) and remain available for the normal operation. Therefore, the normal operation will for sure benefit from the performance monitoring software to follow-up process evolution and its performance. Furthermore, knowing that a loop tuning represents the biggest ROI in process control today, this re-enforces the idea of monitoring, assessing and
prioritizing strategic loops in order to tune them when required and to understand why new tuning is necessary. This entire ready to use information is derived from the automated data mining being done by the performance monitoring software in background. Finally, once problems are pinpointed, modern tools are available to solve them.

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