New performance monitoring software cutting edge technologies

With a new paper machine recently installed in the Kruger Wayagamack mill at Trois-Rivières, QC, Jean-Guy Lagacé, instrument supervisor, took the opportunity to use available modern technology to ensure a quick and efficient start-up.

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Since all the equipment (DCS, drives, scanners, etc.) had OPC connectivity, performance monitoring software and FDT/DTM (Field Device Tool/Device Type Manager) to access all instruments from the control room were added.

With the new OPC (OLE for Process Control) communication standard, it is now possible to interface with any platform (proprietary communication protocol). This 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 raw format for three weeks and in 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). It can also be used with new technologies such as tuning software in order to improve plant, process and control loop performance and dynamic.

Raw (uncompressed) data will be used by new technology software to assess and measure performance of the plant, process and 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. More than 30 KPI can be calculated each assessment period. KPI will inform groups of users as management, engineering, operation and maintenance on plant, processes and control loops performance, equipment availability, presence and sources of oscillation and their strength and equipment health.

The relationship between KPI, assets and users are shown in Fig.1. KPI gives health measurement of assets and informs users on the quality of work supplied by these assets allowing users to increase the efficiency of these assets. The end results are that users can focus efforts where the impact on production quality and assets health gives the largest return on investment (ROI).

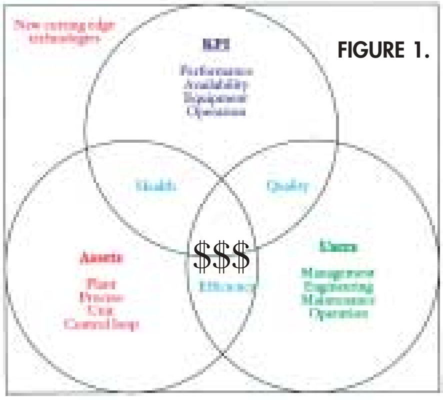


FIGURE 1.

Today's performance monitoring software comprises several modern tools such as cross-correlation, auto-correlation, robustness plot, hysteresis, stiction check, characterizer builder and power spectral density. These tools are used by the software to do the data mining; afterwards, it analyzes and prioritizes the problems.

Correlation

Whenever a signal is suspected to be inter-related with another, then cross-correlation is one of the best tools to figure out the degree of inter-action. Based on a scale from -1 to 1 vertical axis and horizontal time axis, the polarity of the relationship can be determined as well as the timing at which the interaction occurs. The closer the degree of correlation gets to either - 1 or 1, according

to their polarity, the more they are correlated to each other. On the other hand, the auto-correlation will tell us "Can the future behaviour of this closed-loop be explained by the present pattern?" Should the answer be 'yes', then chances are that the loop tuning is improper. This loop is unable to achieve fast load rejection and exhibits oscillatory behaviour. Also, the stabilizing time is long and corresponds to the time it takes to get into (and to remain there) the confidence interval of the auto-correlation plot.

You might have heard this next statement "appropriate loop tuning is based on the proper balance between performance and robustness".

Robustness plot

The robustness plot is the tool that pinpoints the perfect trade-off. It is a means to adjust the safety margin on the process gain and the dead time of the process. In other words, by what amount the process model could change before there is a trouble (oscillation cycles) with those tuning. The process model may change because of valve problems (stiction, hysteresis), new operation zone, new feed, etc.

Hysteresis and stiction checker

On the subject of valve problems, determining the nature of those flaws can be done with a hysteresis and stiction checker. This instrument is the appropriate tool to perform a thorough analysis of the potential mechanical looseness causing the valve problem due to the passage and friction of sticky material. In order to perform these tests, a simple typical valve movement pattern needs to be done and the software calculates the necessary information, based on the data that was collected.

Characterizer builder

In the event that the operating zone has been changed to a different level, the process gain may have changed as well. Since there is a larger turn-down ratio, an action needs to be taken to consider the variation of the process gain according to the operating zone or valve opening. Therefore, a characterization needs to be performed. To do so, the characterizer builder is the perfect tool to generate either an X Y pair list or hyperbolic equation or any other programming language routine to realize it. This characterizer will be inserted in between the output of the controller and the process itself. As a result, better performance will be achieved since the tuning may be tighter throughout the whole range with the same robustness.

Power spectral density (PSD)

When a variability parameter is found to be high compared to a quality specification target, it is necessary to find the root cause of this variability. Now cutting edge technology called power spectral density (PSD) can exhibit all the frequency content in the signal, along with the one that accounts for this variability. The PSD will perform a Fourier Transform on the time domain value collected by the software in order to break it down to individual frequencies that make up the whole signal. For each frequency, the software calculates the power or energy involved. Based on this information, the most hurting frequencies will be identified as the ones that have high power. Further analysis can be conducted to track down in the neighbourhood of this loop other loops that may have their PSD exhibit the same frequencies. Quite often, several loops are encountered at the same oscillation period with one of them as the root cause and propagating to others.

Real case example

Here below is a real case example of what has been made possible by the use of a performance monitoring software to audit and to assist on loop tuning and optimization of control loop and FDT/DTM (Field Device Tool/Device Type Manager) to troubleshoot field problems and quickly access field instruments 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 speciality 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 the debugging of the control loops, where the loops, areas or units operation are showing most direct impact on the finished product.

The first step was then to install and properly configure a 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 setpoint 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.

Some open loop tests were done on every machine's loops. These tests are essential for the identification of the process parameters of every loop, (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 Kp integral action Ki, derivative action Kd and filter time constant Tf 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.

Here are two 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-bottleneck-

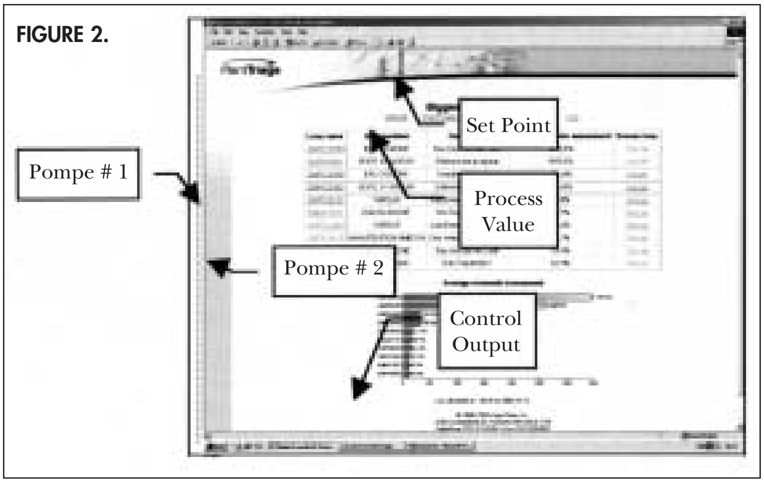


FIGURE 2.

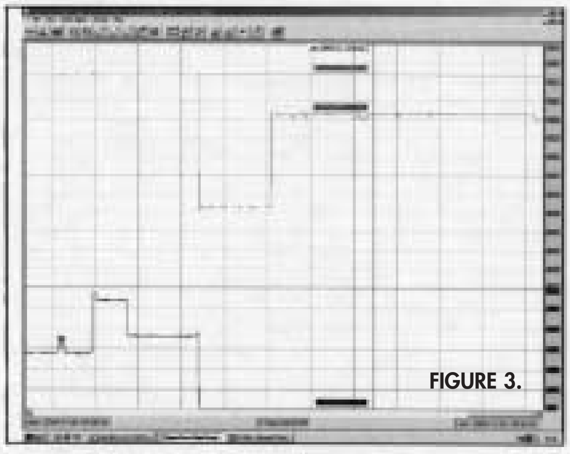


FIGURE 3.

ing done in 20 minutes:

Tuning of a pressure PIC loop on a fresh water distribution network based on the performance criterions;

Two days later, a performance report identifies this loop as similar to the one that performs less (Fig.2);

According to the Output at Limit Index, the output is at the limit 100% of the time 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);

Later on, a defective gasket was identified.

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 regroup eight heating units and one glycol exchanger with the same oscillation period;

According to the "oscillation strength index", the glycol exchanger temperature TIC loop is the cause of this oscillation;

Fig.4 shows the successive TIC and heating units tunings;

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

On the other hand, the new high technology field device communication was also very useful to cut down on troubleshooting and configuring time. This concept is called FDT/DTM technology which consists in providing a standard way to organize the interfacing of read-and-write information, start-and-stop of equipment between the engineering tool in place and the software components which support the field device. The standard interface is supplied by the Field Device Tool (FDT) and its goal is to decouple (Fig.5) the engineering interface from the software component which provides the engineer input. The Device Type Manager (DTM) will be used by the engineer to configure the intelligent field device.

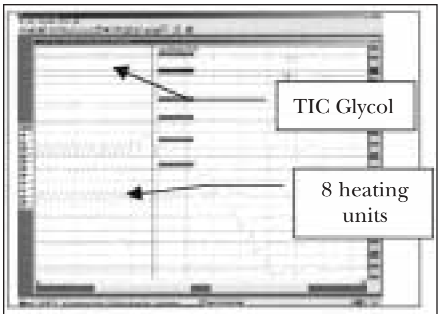
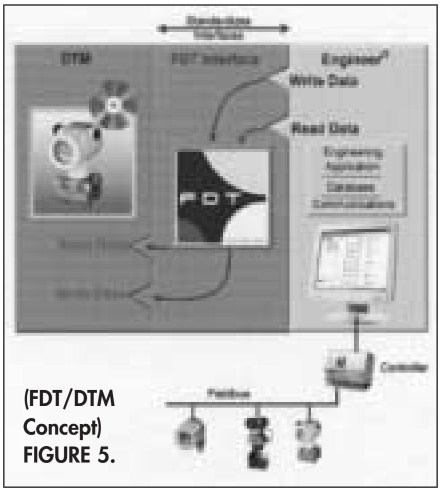


FIGURE 4.



(FDT/DTM Concept)
FIGURE 5.

The FDT concept is based on the DTM component which is delivered by the device manufacturer. The DTM is the software component required to configure and manage the field device. The DTM is loaded into the automation system libraries in a similar way to a printer driver being installed in an office environment. This component contains all graphical user dialogue, device configuration, diagnosis, and maintenance.

FDT is the component which helps solve the problem of engineering tool choice. This field device tool specifies an interface for data exchange between the engineering tool and the field devices software.

The engineering tool is responsible for the communications to field devices and the engineering database. The DTM, however, is responsible for providing the engineer interface (or, in other words, the Graphical User Interface (GUI)), providing access to the full device features and managing information transfer to the field device.

In conclusion, the start-up of the process performed with the assistance of a performance audit, diagnostic and control loop tuning software, as well as intelligent field device instrument and FDT software, leads to a fast progression of troubleshooting, instrument-configuring, tuning and optimization work. This, in turn, is based on the precise and meaningful performance report and a post-tunings analysis of the performances obtained.

These new technologies pay for themselves from start-up and remain available for the normal operation in order to operate the process at the least cost because resources can be directed where needed most, based on the automated data mining being done by the performance monitoring software. Once problems are pinpointed, modern tools are available to solve them.

This success story shows that new technologies is part of efficient, well-organised and most profitable process commissioning. Nowadays in the world wide market, these new technologies are becoming mandatory to stay competitive. **P&PC**

Performance Monitoring software:
PlantTriage by ExperTune, see: http://www.expertune.com/planttriage.html

FDT/DTM software :
FieldCare by Metso, distributed by Everest Automation http://www.metsoautomation.com/automation/home.nsf/FR?ReadForm&ATL=/Automation/FSprod.nsf/WebWID/WTB-030509-2256A-CDA8D

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