PERFORMANCE AND OPTIMIZATION -- AN ECONOMIC POINT OF VIEW

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This is the first in a series of articles that will present numbers and examples to help convince management of the process control opportunities available to improve the bottom line. This article will describe the basics and will also explain why process control can affect plant performance. Subsequent articles will cover maintenance, process optimization, performance supervision…

PART 1

Why Do We Use Process Control? What Are the Goals?

Manufacturers are constantly seeking ways to improve production processes, to constantly improve the quality and reliability of the products that they produce and to optimally utilize plant assets. One method of achieving process improvements is through the better use of process control in their plants.

Process control is used to maintain a process within its boundaries; most systems use feedback from the process then send appropriate signals to final element like valves and motors. In most plants, more than 75% of plant assets are employed in manufacturing. The majority of these assets are under process control -- *If not optimized, these assets are not fully productive, are inefficient and are not being used to their full potential.*

However if process optimization is done, these assets will usually perform as designed or even better. Thus, through optimization most plants have the potential to increase profit by hundreds to thousands of dollars per shift -- *Usually a minimal investment can produce impressive results.*

Before we discuss optimization let's quickly review why process control systems are employed:

- Maintain quality and reliability
- Improve efficiency and productivity
- Reduce costs
- Ensure security and safety
- Respect environmental requirements and other regulatory requirements

Optimization can be used to improve the performance of each process control loop by maximizing the loop-tuning process. Via optimization each process control loop can be configured to:

- Quickly follow a set-point change without overshoot
- Move at the same speed as another loop on a set-point change
- Quickly reject a load change or a disturbance
- Reduce interaction with other loops

Process optimization ensures that all plant equipment is performing at full potential, all loops are tuned properly, all control strategies are well designed and all operational procedures are optimum. After process optimization, performance monitoring and supervisory software can be used to ensure that processing improvements that have been achieved are maintained.

These benefits are evident to those who are familiar with process control and process optimization. Since calculations vary from process to process and precise records may not be available it can be difficult to quantify savings. This however is not a valid reason not to quantify reduction in raw material, energy, maintenance, product and quality improvements, etc.

Complex processes are best controlled by simple control systems. Many academic researchers promote multi-variable control systems. The reality is that most of these complex systems are turned off! One should only move to multi-variable systems when properly tuned simple control techniques fail. Another common mistake is using advanced multi-variable control with equipment which is not in working order!

What Is Performance?

If a plant is performing well, then all assets are used at their best potential. Human and material resources are used where they are really needed and where they increase bottom line financial performance.

Operations and production are optimum resulting in …

- Better yields
- Uniform production within tolerances
- Less production losses
- Energy costs reductions
- Productivity increases
- Less equipment wear and tear
- Less production breakdowns
- Less time for start-ups
- Less time for grade changes
- Reduced variability

Maintenance and engineering are more efficiently used:

- Efficient maintenance (less useless repairs, detect inefficient equipment needing attention)
- Repair at the right time (predictive and proactive maintenance)
- Quicker troubleshooting
- Cycling removed to reduce equipment wear and stress on the process

The figure below illustrates what has an impact on performance.

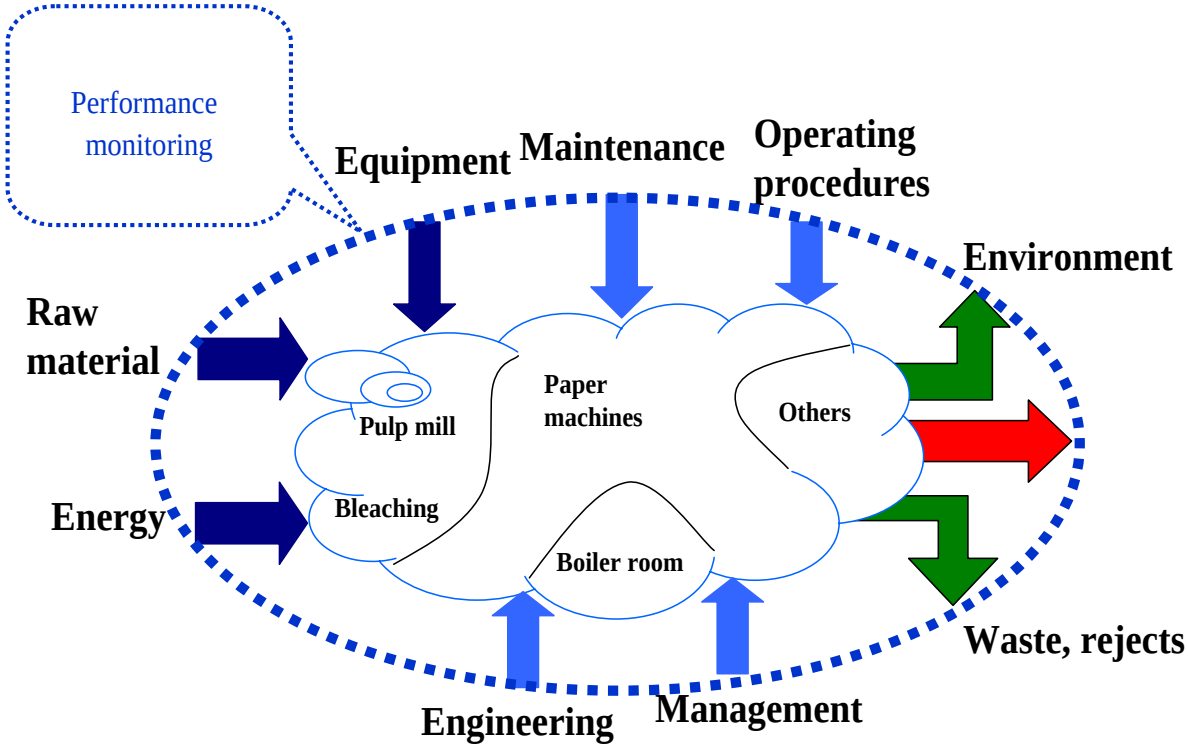

Figure. 1 Performance Monitoring and Supervision for a Typical Paper Mill

What are the Differences Between Asset Management and Performance Supervision?

Asset management software directly reads data from equipment: valves, transmitters, variable speed drives, rotating monitors, etc. The software displays alarms and computes statistics based on simple thresholds selected, for example: if a valve actuator needs extra strength to move the valve. If a valve can not follow an incoming signal, its positioner will report an alarm. With this asset management system, equipment is monitored.

One drawback of this system is that only digital equipment connected to a computer via a digital communication link can be monitored. Also, to troubleshoot a unit, it requires time to analyze all the data. On the other hand, it does provide quick access to equipment to diagnose, configure, re-range, and monitor conditions.

Performance monitoring and supervision software is used to analyze incoming (process variables, transmitter signals, measurements, generated set points, states) and outgoing signals (controller outputs, set points) to determine if expected performance is reached. All signals are read from the control system (Distributed Control Systems, Programmable Logic Controllers, Quality Control Systems, etc.) via digital communications. The system detects oscillations, equipment not behaving as benchmarked, process control problems, process problems, operational problems, etc.

For example, if a pump is not functioning well, the pressure loop starts to oscillate …

Asset management software will not report it since the transmitter and the valve are working properly. Performance monitoring software will report: "Oscillation on PIC-101 coming from the process". If a valve has restriction (restriction occurs when an actuator is not strong enough to overcome static friction) problem, asset management software will report a valve problem such : "Valve FIC-102 unable to follow command".

Performance supervision software will report "Oscillation on FIC-102 coming from the valve". In this case, the personnel will use asset management to interrogate the positioner in lieu of using a hand-held device to communicate with the positioner. Troubleshooting time is greatly reduced and basic diagnostics lead to quick results.

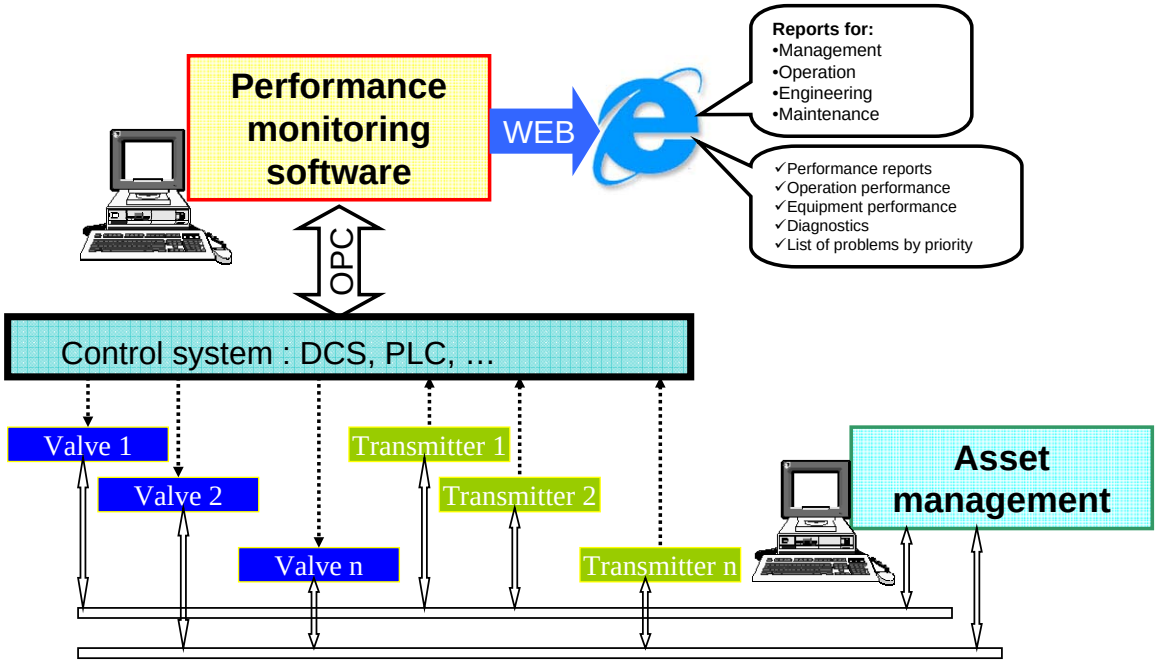

Figure. 2 Asset Management and Performance Supervision

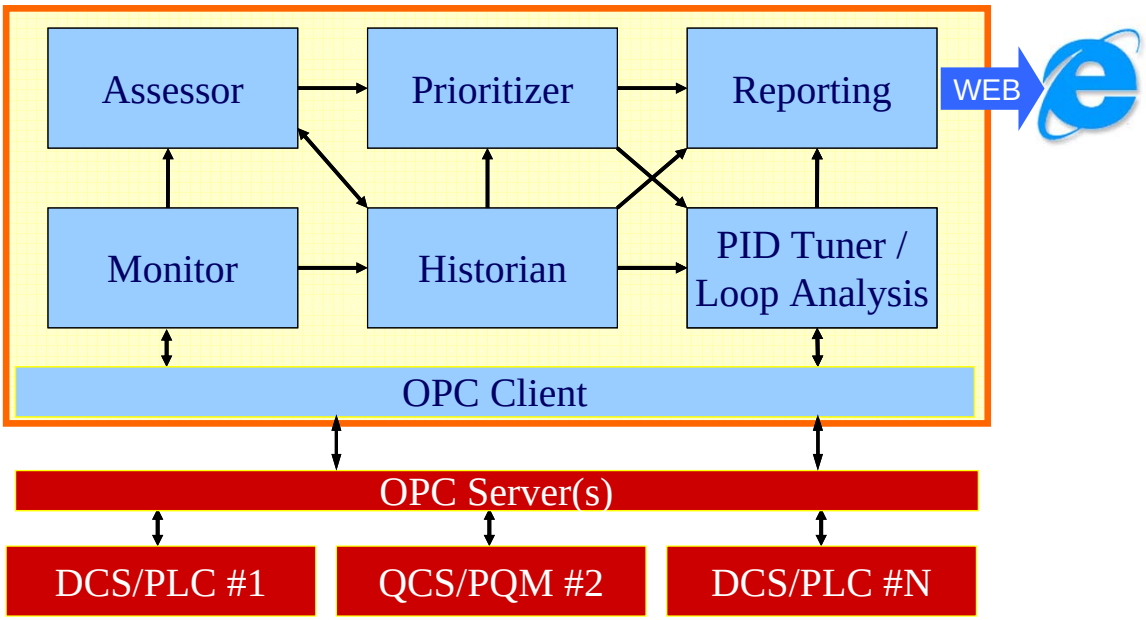

Figure. 3 Performance Supervision Software

	Asset Management	Performance Supervision
Monitor	Equipment	Operation, process, process control, performance
Communications	If conventional instruments (4-20mA), requires an additional network, ex Hart If digital equipment, communication via control network, ex Profibus, Foundation Fieldbus, …	OPC with process control systems
Manpower	Personnel has to analyze the data and diagnose problems	All diagnostics and analysis done in the background by the program
Reports for	Control personnel Maintenance personnel	Management personnel Operations personnel Production personnel Control personnel Maintenance personnel
Results	Equipment performance	Plant, unit, sector performance Operation performance Process performance Process control performance Equipment performance
Cost	Network deployment + 50$/loop	~100$/loop large systems (>500 loops) ~400$/loop small system (<100 loops)

North American Paper Mill Situation Survey

Top Control has frequently helped managers justify projects: process optimization, asset management implementation, performance supervision installation. Often, getting numbers has not been easy; risk analysis and approximations have been used instead. It has been suggested that some customers use common numbers or simple statistics.

To obtain realistic numbers, TOP Controls recently conducted a survey of some 87 North America paper mills (See details below) … And, while only ten survey questionnaires were completed (about an 11% sampling), we are confident that almost anyone in the paper industry will identify with the findings. Thus, the results of this survey can be used to help evaluate the return on investment for mill optimization and performance supervision.

Survey Sample:

Mills by Location

Origin	Number
Quebec	5
Ontario	2
New-Brunswick	1
Nova-Scotia	1
United States	1

Mills by Type

Mill Type	Number
Newsprint	3
Added-Value Paper	3
Tissue	2
Cardboard	1
Pulp Only	1

The questionnaire covered a number of areas. The table on the following page represents the consolidated results. Minimum and maximum values where excluded to prevent distortions and to arrive at realistic values.

The values obtained were presented to some mills for validation. The number of planned and unplanned shutdowns and the average durations allow us to estimate the costs, essentially in terms of production losses. The valves maintenance costs (pieces and manpower) allow us to estimate the costs attributed to bad maintenance. The efficiency and the estimated gains allow us to evaluate the possible production increases … Finally, the fuel and chemical products costs allow us to estimate the cost reductions that could be possible with the optimization of the systems.

	Minimum	Average (without extremes)	Maximum	
Unplanned shutdowns	**3.0**	**7.4**	**120.0**	per year, per sector
Average duration	**1.0**	**4.1**	**8.0**	hours
Reduction of the duration if optimization is used	**1%**	**34%**	**50%**	
Planned shutdows	**4.0**	**10.3**	**12.0**	per year, per sector
Average duration	**8.0**	**9.7**	**15.0**	hours
% of useless work done	**5%**	**16%**	**75%**	
Yield improvement if problems are identified	**2%**	**14%**	**30%**	
Number of valves repaired	**5.0**	**17.9**	**48.0**	per year, per sector
Reparation time	**6.0**	**11.3**	**25.0**	man-hours per valve
Reparation costs	**$ 500**	**$ 2,286**	**$ 5,000**	per valve
% of valves withdrawed uselessly	**5%**	**35%**	**75%**	per year, per sector
Major problems	**1.5**	**15.9**	**48.0**	per year, per sector
Troubleshooting time	**4.0**	**35.1**	**80.0**	man-hours
Estimated troubleshooting time if performance monitoring system	**1.0**	**6.8**	**30.0**	man-hours
Average efficiency (% time of sellable production)	**75%**	**84%**	**90%**	
Improvement expected if planned optimization	**1%**	**2%**	**10%**	
Number of sectors in the plant	**1.0**	**5.3**	**10.0**	
Number of technicians instrumentation/control	**4.0**	**12.8**	**24.0**	
Number of process/control/DCS engineers	**1.0**	**2.0**	**4.0**	
Number of employees dedicated to performance monitoring	**0.0**	**0.3**	**2.0**	
Electricity costs	**8.0**	**52.2**	**113.8**	
Fuel costs	**3.0**	**28.4**	**75.0**	
Chemical products costs	**3.5**	**12.8**	**20.0**	
Loop tuning software used in the plant		**80%**		answered yes
Performance monitoring software used in the plant		**40%**		answered yes

** A sector corresponds to a paper machine, a TMP line, etc.*

It is interesting to note that the estimated percentages of improvement are definitively higher for the mills using performance monitoring software. The benefits attributed to optimization are also higher for the mills having personnel dedicated to this task … Finally, it is disappointing to note that on average, the personnel dedicated to performance monitoring was 0.3 employee.

Based on these results, we will evaluate the return-on-investment in “Performance and Optimization -- An Economic Point of View Part 2” which will appear in the September Management Division newsletter edition.

Questions or comments pertaining to this article are welcome, and can be forwarded by e-mail to:

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About the Author

Michel is a registered professional engineer, university lecturer, and author of several publications and books on instrumentation and control. Michel has 30years of plant experience, including with these companies: Monsanto Chemicals, Domtar Paper, Dow Corning and Shell Oil. He is experienced in solving unusual process control problems and he is also a pioneer in the implementation of fuzzy logic in process control.
Michel is a fellow member of ISA.

TOP Control Inc. specializes in the optimization of continuous and batch processes … And, offers services in optimization, troubleshooting, start-up assistance, implementation of control strategies, training and consulting

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