Performance Supervision

A two-part series by Michel Ruel, P. E.

(Editor's Note: Welcome to our new series of technical articles dealing with Performance Supervision and the optimization of industrial processes. In Part One the author asks the question, "What is process control?" and goes on to define performance and optimization. Be sure to look for Part Two in IPP&T's October issue, wherein Michel Ruel examines a new approach to Performance Supervision.)

Part One

Process Control

In most plants, more than 75% of assets are manufacturing assets. The majority of these assets are under process control. If they are not optimized, the assets are unproductive and inefficient. However, if process optimization is done, the assets are usually performing as they were designed to, or even better. Those assets represent millions of dollars. Thanks to process optimization, most plants have the potential to increase their profit by a few hundred to a few thousand dollars per shift.

Process control is used to:

- Maintain quality and reliability
- Improve efficiency and productivity
- Reduce costs
- Guaranty security and safety
- Respect environmental and other norms

For each loop, the optimization will meet one or more of these goals:

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

Process optimization consists of ensuring that all the equipment is performing at full potential, all the loops are tuned properly, all the control strategies are well designed, and all the operational procedures are optimal. After process optimization, it is essential to maintain the gains obtained; this will be done by doing performance monitoring and by using supervision software.

The benefits are evident to those who are familiar with process control and process optimization. Calculations vary from one process to another; also, precise records to quantify savings are not always available. This is not a valid reason to not use estimates to quantify production, reduction in raw material, reduction in energy, reduction in maintenance efforts, quality improvement, etc.

Complex processes are best controlled by simple control systems. Many academic researchers promote multivariable control systems. The reality is that most of these complex systems are turned off. We should move to multivariable systems only when simple techniques fail, even when they are properly tuned. A common mistake is to use advanced multivariable control with bad equipment.

Are Process Control Systems Used To Their Full Potential?

World markets have forced many factories to rationalize their operations. World overproduction has allowed customers to become very demanding regarding the quality of finished products, defining with precision the characteristics they desire. The good old days are gone when the only measure of success was quantity. Large-scale changes are happening.

Even if profitability is back, companies of the twenty-first century are fighting on a much larger scale than in the past. They must be more efficient than the competition; the difference will often be their profit margin.

Today, quality and production costs are so important that they mobilize efforts within the companies that succeeded in servicing the competitive market of the 90's. Many experts in the process control field confirm it: control systems contain unexploited possibilities.

In today's highly competitive worldwide market, it is becoming extremely important for management people to make sure that all resources are affected where they are the most needed. In such a way, all resources are generating value-added, process control equipment is maintained in an optimal state for best performance, and final product is produced at least cost. Performance monitoring and supervision is the only way to ensure that everyone is working toward the same goal.

Optimization of processes and control systems produces the largest gains for the investment. In fact, the principle is: "Use your existing equipment to its full potential".

Control loops in North American plants are divided as follows:

Typical control loop problems and performances	Percentage
Control valves of poor quality or in poor condition	30%
Poor controller tuning (unacceptable values)	30%
Poor controller tuning (accordingly to unit performance goal)	85 %
Poor loop design	15%
Controller in manual mode	30%
Control loop not performing accordingly to control objective	85%
Loops that perform better in automatic mode than in manual mode	25%

Even if 25% of loops perform better in automatic mode than in manual mode, they do not necessarily perform to their maximum capacity. In three out of four cases, the controller not only does not improve the performance of the finished product, it worsens the performance.

What Is Performance?

When a plant is performing well, all assets are used at their best potential, and the human and material resources are used where they are really needed and where they increase the bottom line.

Operation and production are optimal:

- Better yield, uniform production within tolerances
- Less production losses, energy costs reduced
- Productivity increased
- Less wear and tear on equipment
- Fewer production breakdowns
- Less time for start-ups, less time for grade changes
- Variability reduced

Maintenance and engineering are efficiently used:

- Efficient maintenance
- Repairs at the right time
- Quick troubleshooting
- Cycling removed

The figure below illustrates what has an impact on performance.

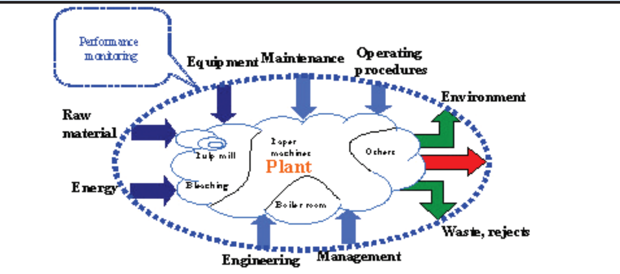

Figure 1. Performance monitoring and supervision for a typical paper mill

Optimization

Optimization consists of bringing out the best in the plant, the units, and the processes. It could include everything from Figure 1.

For example, in the drying section of a paper machine, optimizing performance consists of reducing variability in moisture content, reducing energy costs, reducing operation interventions, increasing yield, maintaining quality, etc.

Figure 2 illustrates a process before and after optimization. The dashed line represents the constraint for moisture content (paper). The customer will buy this product only if the moisture constant is below that limit. Since before 1000s the variations are large around the set point, the operation had to reduce the set point, hence drying too much to respect the constraint. Not only the amount of energy is higher but also the valve will wear out rapidly with all the useless movement. After optimization:

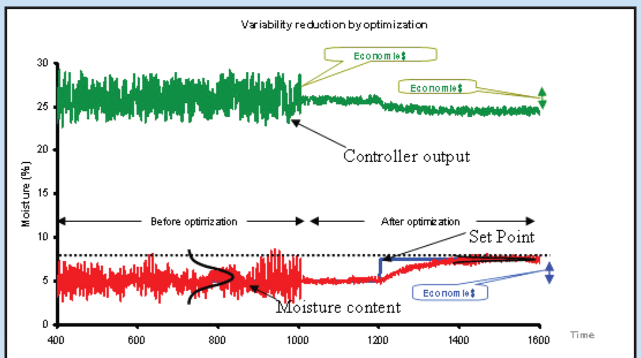

Figure 2. Paper drying process

- Valve movement has been reduced (so maintenance has been reduced)
- Variability in moisture content has been reduced
- Setpoint has been increased closer to the constraint
- Amount of energy is reduced (less drying)
- Fewer fibers are used since more water remains in the paper (this represents an economy)

This example illustrates the basics of process optimization, which consists of using your equipment at its best, modifying operation procedures to reduce costs and increasing profit.

After optimization has been done, expected results are:

- Variability reduced by 100%
- Quality increased by 30%
- Cycling removed
- Valve travel reduced by 500% (valve wear reduced 100%)
- Robustness and stability increased by 100 to 500%
- Stabilization time reduced by 30 to 300%
- Changes to variables reduced by 20 to 100%
- Performance increased by 100%
- Efficiency improved by 1 to 5 %
- Energy reduced by 1 to 5 %

How To Optimize? How To Maintain Performance?

After optimization has been done, it is essential to maintain that performance. If efforts are not concentrated to maintain the benefits, the performance will decline slowly (or gradually) because:

- Operation procedures change
- Raw material quality varies
- Equipment wears out
- Maintenance is done
- Process changes
- Personnel rotate

A good optimization plan requires a methodical approach. Traditional methods can be used, but modern tools with computers and software should be privileged. More important than the tools used is the approach: it needs to ensure that constant efforts are made. The performances of process control systems will decline if the system is not optimized regularly.

In most plants, the decline will result in a performance decrease of 50% per 6 months.

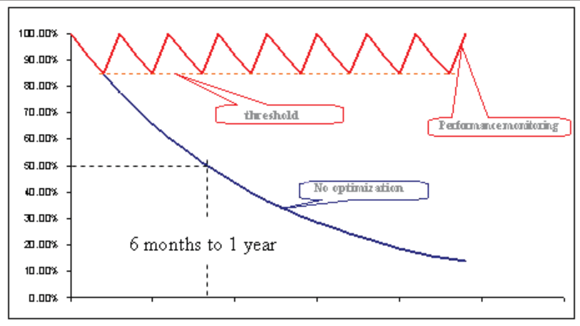

Figure 3. Performance decay

To keep the process running at its best, the performance is monitored (many performance indices are combined) and each time a threshold is reached, a warning is issued and tools are applied to determine the problems.

***Next Issue:** A new approach to maintenance; Differences between Asset Management and Performance Supervision; The cost of monitoring and supervising performance; The resources needed to supervise performance; The benefits of monitoring and supervising performance and the return on investment.*

References

Using Performance Monitoring and Optimization Tools For a Paper Machine Start-up, Lagace JG, Naud S, Ruel M, Paptac Conference 2005, Montreal, February 2005.

Instrument Engineers' Handbook Process Software and Digital Networks, 3rd Edition, edited by Bela G Liptak, CRC Press, Boca Raton Fl, 2002), 5.6 Plantwide Control Loop Optimization.

About the author:

Michel Ruel is a registered professional engineer, university lecturer, and author of several publications and books on instrumentation and control. Michel has 30 years 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.