Low Cost, High-Return
Process Control Improvements
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Summary
Process control improvements can make significant financial gains for your company. In fact, it is estimated that optimizing the control system can deliver between 2% and 6% of total operating cost\[1\]. This paper focuses on proven low-cost methods to increase profitability. Some of these methods are incredibly simple, and can be implemented in less than a day. As you try them out, be sure to document the benefits, and share them with your management.

Overview

How Control Systems Deliver Results
The control system acts as the nervous system for the plant. It provides sensing, analysis, and control of the physical process. The control system sits directly between the operator and the process...almost all of the operators’ information comes from the control system, and all of the operators’ commands are carried out by the control system. When a control system is at peak performance, process variability is reduced, efficiency is maximized, energy costs are minimized, and production rates can be increased.

Finding Low-Cost, High-Return Improvements
Most process plants are full of inefficiencies and losses. The process, the control system, the instrumentation, and the infrastructure are all less than perfect. For example, a typical process plant will have as many as 30% of control loops running in MANUAL. Many of those loops are in MANUAL because of an underlying problem with the instrument, the control valve, or the controller. A loop in MANUAL is only one symptom.

In this paper, we’ll show you how to spot many other symptoms. More importantly, we’ll show you how to apply some simple, low-cost fixes that will drive up profits.
**Improvement #1 – Compressed Air Leaks**

**The Problem**

Compressed air, which is used to actuate control valves, is actually one of the most expensive utilities in your plant! You are using expensive electricity to (inefficiently) compress air, and then transport it all over the plant through leaky tubes. Compressed air leaks not only cost money directly, but these losses can be large enough to require more or larger compressors.

**Low Cost Way to Find and Fix It**

The next time you have a shutdown, take a spray-bottle full of soapy water, and a wrench. Walk through the plant, and listen for the telltale hiss of leaky air lines. Spray some soapy water on the air tubing connections to see which one is leaking. Then tighten with the wrench.

**Expected Return**

Just how expensive is compressed air? If you know your plant's cost per kilowatt-hour, you can estimate the cost per year for 1 standard cubic foot per minute (SCFM) of air: 0.25 hp/SCFM x 0.745 kW/hp x 24 hr/day x 365 day/year x cost/kWh. [1]

At a typical industrial rate of $0.06/kWh, this is roughly $98/year for each SCFM. And this doesn't count the capital, depreciation, and maintenance costs for the compressor, dryer, and distribution system. So that begs the question: How much is leaking? According to the U.S. Department of Energy, it can be as much as 20 to 30% of compressor capacity! They estimate the air leaking from a 1/16-inch leak can be over 5 SCFM. Fix one of these leaks, and you have saved $500. Not bad!

**Estimated Cost/Effort:**

(100 loops / 12 loops/hr) = 8.5 hours, 8.5 hrs * $60/hr = $510 labor cost

**Savings Estimate per 100 Loops:**

100 Loops x 10% Loops leaking x $500/leak = $5,000 / year

**Improvement #2 – Eliminate Derivative Action**

**The Problem**

The PID controller is a very capable tool that is often misapplied. Most control loops do not require derivative action. If derivative is applied too broadly in your plant, it will cause process upsets, variability increases, valve wear, and excessive compressed air consumption.

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Figure 1 shows an example of excessive valve travel due to derivative action.

Figure 1. Excessive Valve Travel Caused by Derivative

Derivative action should only be applied to loops when:

- There is little or no noise
- Fast-responding control is critical
- P-I alone is not good enough
- There is some (small) filtering of the PV.

**Low Cost Way to Find and Fix It**

You can easily find candidates to remove. You are looking for loops that have excessive valve travel, and some derivative action. Valve travel is the total amount of valve movement, up and down, totalized over a one-day period. Figure 2 shows a report that
automatically discovers these candidates. The simple solution is to remove derivative action on these loops.

Figure 2. PlantTriage Report Identifies Loops with Excessive Derivative

**Expected Return**

There are several sources of savings when you remove derivative. This includes:

1. Reduced use of compressed air. See the article in Reference [1] to calculate the savings.
2. Reduced maintenance cost. Valves with excessive derivative will wear out positioners, actuators, and seals. Eliminate the excessive action and you will save on valve repairs and replacements.

**Cost Estimate:**

With PlantTriage, cost is less than 1 hour per 100 loops, to find and fix the problem.

1 hour * $60/hour = $60

**Savings Estimate per 100 Loops:**

Air: 100 Loops x 5% Loops eliminate derivative x $500/loop = $2,500 / year

Eliminate at least One Valve Repair per Year = $2,000/year
Improvement #3 – Add a Filter

The Problem

Some instrument signals are noisy. Due to the inherent characteristics of the sensor, or its application, or its position in the process, some instrument signals are noisy. Even if you don’t have derivative action, this signal noise will be amplified by the Proportional action of the controller, inducing more process upsets. Furthermore, excessive noise makes it difficult for operators to see what is happening.

Low Cost Way to Find and Fix It

Look for loops with a high Noise Band. If the random noise makes up a significant part of the signal, then you have an opportunity to improve. Figure 3 show an example Process Variable (red) with a high noise band, even though the control output (blue) is not moving at all.

You can identify these loops manually, by scanning through each loop, or use PlantTriage to identify the issues automatically.

Figure 3. Excessive Noise Band

Choose a filter for the loop based upon the dominant process dynamics. Too large a filter will hide the real process behavior, and too small a filter will result in no improvement. The filter should be at least 3X the sampling time, and no more than 1/3 of the process dead time. PlantTriage contains tools to develop a model of the process dynamics and recommend an appropriate filter.

Expected Return

Excessive Noise Band often results in quality upsets and poor decision-making. This is especially true on a modern DCS, where PV’s are displayed as rapidly-changing numbers on a screen. It can be difficult to estimate the actual value. From typical customer case studies, we can estimate the value at between $1,000 and $10,000 per affected loop.

Estimated Cost/Effort:

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Less Than 1 Hour per loop x 100 loops x 2% Loops x $60/hr = $120 / year

**Savings Estimate per 100 Loops:**

100 Loops x 2% Loops High Noise x $5500/year average value = $11,000 / year

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**Improvement #4 – Stop Cycling Energy Loops**

**The Problem**

When energy-consuming control loops are cycling, they are inefficient. Imagine how inefficient your car would be if the engine speed were constantly cycling up and down. The same thing happens in your plant. As many as 40% of all control loops in process plants are typically cycling. A cycle in one control loop often forces cycles in other loops. The oscillation spreads throughout the plant.

![Process Variable Trend](image)

**Figure 4. A Cycling Loop**

**Low-Cost Solution**

Start by looking at key energy loops (Temperatures, fuel flows, Excess O2 Monitors) that are cycling. When a loop cycles, it does so at a specific period. In the loop shown in Figure 4, the dominant cycle has a period of 6 minutes. 80% to 90% of cycles are not caused by the loop in question, but by some other loop. We refer to this is Oscillating Due to a Load disturbance. The key to solving the cycling problem is this: The root cause of the problem is cycling at the same period. So you are looking for other loops that cycle every 6 minutes.

In the old days, this was accomplished by slowly and methodically putting loops in MANUAL, until the cycle goes away. While this was effective, it often took weeks to find the root cause. Modern tools allow you to get a list of all loops that cycle at a given period, as shown in Figure 5. It also indicates whether the source of the cycle is Oscillating-Load, Oscillating-Tuning, or Oscillating-Valve. This greatly reduces the time needed to solve the problem.
Figure 5. Loops That Cycle at 6 Minutes per Cycle

Most valve-induced oscillations can be resolved by simple adjustments to the valve, positioner, or air supply.

**Expected Return**

The savings for these efforts can be quite remarkable. Energy cost reductions of up to 2% are typical. A conservative estimate is 0.5% of energy budget.

**Estimated Cost/Effort:**

With modern tools: 6 hours to solve x $60/hour = $360.

**Savings Estimate: (Assume $3 Million Budget)**

0.5% of Energy Budget = $15,000 / year

**Improvement #5 – Stop Wasting Pump Energy**

**The Problem**

A typical plant will have 5% to 10% of control valves oversized. Whether this happened due to design errors, changes in the process, or other unknown reason, these valves and the pumps that supply them are major energy-wasters. The pressure-drop across the valve is wasting pump energy.
Low-Cost Solution

First, identify oversized control valves by looking for those that are rarely open more than about 20%. Figure 6 shows an automated report that lists oversized control valves.

![Image of an automated report listing oversized control valves]

Figure 6. An Automated Report of Oversized Valves

Some energy-saving methods for handling this problem include:

1. Reduce the pump speed.
2. Replace the pump impeller with a smaller impeller.
3. Use a smaller pump motor.

In most cases, you can get the equipment you need from the storeroom.

Expected Return

Of course, the savings depends on the size of the pump in question. But it can be dramatic. The expected returns below are based on saving 20 Horsepower with a 100-HP pump. With 100 control loops, you will typically find 3 to 6 over-sized valves.

Estimated Cost/Effort:

With modern tools: 3 pumps * (8 hours/pump parts x $60/hour + $500 parts) = $2940.

Savings Estimate: (Assume $3 Million Budget)

Depending on your energy costs, each horsepower costs between $600 and $1200 per year. For a 20HP savings:

20 HP x $600/HP-Year x 3 Pumps = $36,000 / year
Summary of Results

Using the five methods shown above, a typical plant can achieve significant savings. The table below summarizes the costs and benefits of these methods.

<table>
<thead>
<tr>
<th>Process Improvement</th>
<th>Cost Per 100 Loops</th>
<th>Savings per 100 Control Loops</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Air Leaks</td>
<td>$510</td>
<td>$5,000/year</td>
</tr>
<tr>
<td>2. Eliminate Derivative</td>
<td>$60</td>
<td>$4,500/year</td>
</tr>
<tr>
<td>3. Apply Filters</td>
<td>$120</td>
<td>$11,000/year</td>
</tr>
<tr>
<td>4. Cycling Energy Loops</td>
<td>$360</td>
<td>$15,000/year</td>
</tr>
<tr>
<td>5. Pump Energy</td>
<td>$2940</td>
<td>$36,000/year</td>
</tr>
<tr>
<td>Total per 100 Control Loops</td>
<td>$3,990</td>
<td>$71,500/year</td>
</tr>
</tbody>
</table>

Of course, the full extent of the benefits depends on your starting point, and how much focus is put on control system improvement. This paper has used very conservative numbers in estimating the value.

Conclusions

There are simple, effective, low-cost techniques that can deliver bottom-line savings. A conservative estimate is that you can save over $70,000 per 100 control loops…that’s over $700 per control loop in savings. When combined with other PlantTriage tools and techniques, the total value can be much larger – from 2% to 6% of total operating costs.

Recommendations

1. Get Started Today. These are simple, easy, and effective techniques.
2. Use Modern Tools. Consider the use of PlantTriage Control Loop Monitoring tools to speed up your results.
3. Continuously Monitor. More of these opportunities will appear over time, as plant operating conditions change.
4. Document the Value. Your management would like to know how you have helped the business.
About ExperTune

About the Author

George Buckbee is V.P. of Marketing and Product Development at ExperTune. George has over 20 years of practical experience improving process performance in a wide array of process industries, George holds a B.S. in Chemical Engineering from Washington University, and an M.S. in Chemical Engineering from the University of California.

About PlantTriage®

PlantTriage is a Plant-Wide Performance Supervision System that optimizes your entire process control system, including instrumentation, controllers, and control valves. Using advanced techniques, such as Active Model Capture Technology, PlantTriage can identify, diagnose, and prioritize improvements to your process.

Glossary

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
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<tbody>
<tr>
<td>DCS</td>
<td>Distributed Control System. A centralized process control system that typically provides data collection, operator interface, and control functions.</td>
</tr>
<tr>
<td>KPI</td>
<td>Key Performance Indicator. A metric that can be used to monitor overall performance.</td>
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<tr>
<td>OPC</td>
<td>OLE for Process Control. An industry standard communications protocol, allowing</td>
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<tr>
<td>OPCHDA</td>
<td>OPC Historical Data Access. An enhancement to the OPC protocol that allows data to be pulled directly from standard data historians.</td>
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<tr>
<td>ROI</td>
<td>Return on Investment. Measured as the amount of time needed to fully recoup an investment.</td>
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</table>
References

