Measure. Decide. Act.

Applying Real-Time Feedback to Deliver Business Results

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Summary

The difference between good control and bad control is the difference between success and failure. Apply good feedback principles to your business, and you will see success in production rate, profitability, and career success.

- Measure the right things
- Decide what to do, based on the available information
- Act quickly, then start the cycle again.

These three steps describe a feedback control loop. This is exactly the same process that maintains the cruise control of your automobile, maintains the temperature in your office, and maintains the production rate at an oil refinery. The same process drives the business results of your company. This paper demonstrates how to apply feedback control to achieve business results.

Overview

The Basics of Feedback Control

Figure 1 shows the basic components of every feedback control loop.

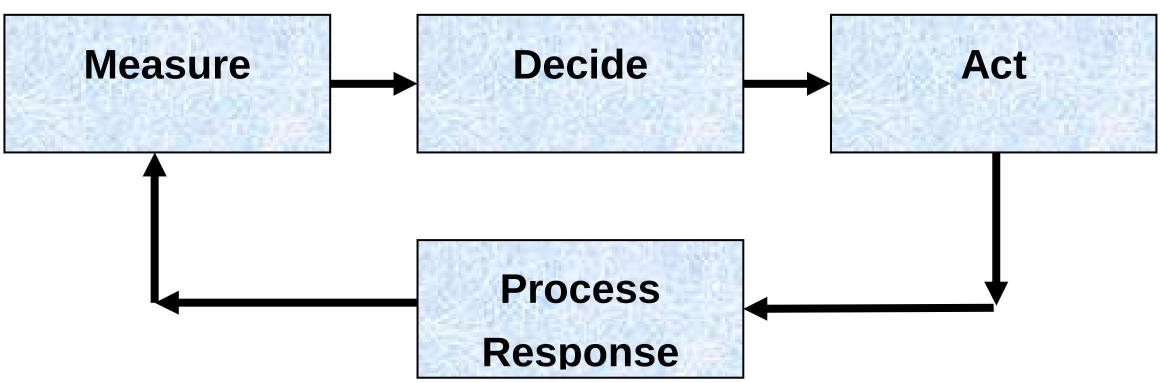


Figure 1. The Basic Components of Feedback Control

Every feedback control loop involves 3 simple steps:

- **Measure –** Measure the right things, accurately, and quickly.
- **Decide –** What to adjust, and by how much
- **Act –** Quickly act on the decision, before the process gets further out of control.

Principles of Measurement

If you want any chance of success, you have to start by measuring the right things. You can't control what you can't measure.

To control a business, key measures include sales, profit, productivity, and cash flow. In the sections below, we will discuss appropriate measures for control of single loops, unit operations, and entire businesses. The "right things" have a few common characteristics. They are:

- Measurable
- Meaningful
- Actionable

Principle 1

Measure the right things.

With modern computing power available, measurements are no longer limited to basic traditional measurements. Those who run the best operations know how to measure higher-level metrics, such as variability, oscillation, utilization, and opportunity gaps. These metrics will be discussed in more detail later..

Principle 2

Measure quickly & accurately.

Measurements must be quick and accurate. Measuring last month's production rate is not a big help for improving process throughput today. A delay in measurement will result in a 10X slow-down in the control of the process. In other words: if you make decisions to adjust unit operations based solely upon monthly measurement of results, it will take approximately 10 months to move the unit to its target state of operation.

Of course, if the measures are inaccurate, or noisy, then it will be harder to control the process. Imagine trying to hold your car at a steady speed if the speedometer is shaking plus or minus 10 miles per hour.

Principles of Decision

Make good control decisions by applying your process knowledge. In process control, the control loop is "tuned" for best response by applying knowledge of the process gain, deadtime, and time constant.

To make a good feedback control decision, you will need to decide:

Principle 3

Apply process & business knowledge

- What to adjust?
- In which direction?
- By how much?

This is not a trivial process. Too little correction, and you have no impact. Too much correction may result in harm to the control loop, the unit operation, or the business.

Principles of Action

Principle 4

Don't Hesitate.

All process control engineers know that the #1 enemy of good control is "dead time". The longer you hesitate, the worse the control. Imagine trying to drive your car by looking in the rear-view mirror!

Again, any hesitation will have a 10-fold impact on the overall response time of the control. Companies that get the best results know how to act quickly.

Follow the Principles

In the remainder of this white paper, we have highlighted references to the principles. You will see how these come back again and again.

Improving Control Loop Performance

The principles described above have come from years of experience with process control theory. The science and mathematics of single-loop process control are well-established, and we will not repeat them here. A number of reference materials are listed at the end of this paper if you wish to explore the fundamentals in more detail.

However, we will discuss some important measures of control loop performance that you probably have not considered. If you want you control loops to deliver peak performance, you need to think beyond the traditional PV, Setpoint, and Output. You will need to measure quickly and accurately, which usually means using real-time data, directly from your control system.

All of the measures described in this white paper are readily available in a Performance Supervision System, such as PlantTriage.

Measure

% Time in Normal Mode

% of Time in Normal Mode is one of the most important metrics you can establish for your control system. If the control loop is in MANUAL, it is not helping the process. The "normal" mode should be defined loop-by-loop, applying your process knowledge. For some loops, CASCADE is the normal mode, and AUTO and MANUAL are not normal.

In fact, %Time in Normal Mode is usually an indication of a hardware, configuration, or tuning problem.

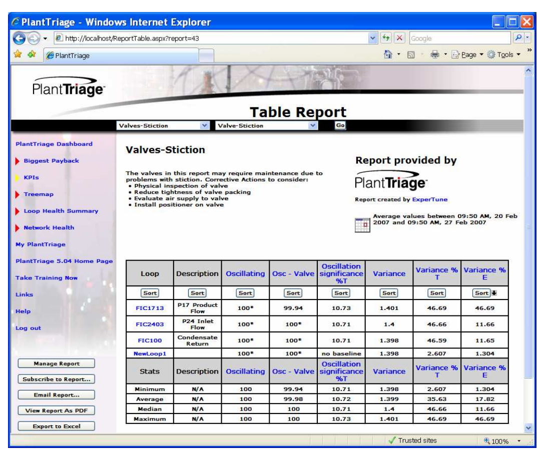
Most people are shocked to discover that 30% or more of their control loops are not in normal mode. What is the end result of loops not in normal?

- Underlying problems are left unresolved
- Greater safety risk
- Reduced production rate
- Sub-optimal quality

Service Factor

Going one step beyond "Time in Normal", we can look at the loop "Service Factor". This is the % of time that all components of the loop are in service. For example, this includes:

- Loop is in its normal mode
- Control Valve is not at limit
- Sensor is not at limit



Any time that the service factor is less than 100%, the process will suffer from the same effects as listed above for % Time in Normal. Again, use real-time data to measure quickly and accurately.

Hardware Problems

Most common sensor and valve problems can be measured quickly and accurately online, using real-time data from the control system.

If the hardware is not functioning properly, then the loop as a whole has no chance of working correctly. To ensure the success of the entire loop, you must measure the right things. A few examples include:

- Valve Stiction
- Sensor flat-lining
- Changes in sensor noise level

Tuning

The response of the closed-loop system is one of the right things to measure. In studies of data from thousands of process plants worldwide, ExperTune has noted:

- Typically, 30% of loop tuning is complete nonsense.
- 75% of control loops actually increase process variability

Using techniques such as Active Model Capture™, you can identify process models quickly and accurately, develop more process knowledge, and use this information to improve control system performance.

Decide

Prioritize

In a typical process plant, with 500 control loops, you are likely to find over 150 loops running in MANUAL, 150 with valve problems, 20-50 sensor or communications problems, and at least 100 loops that need tuning. Many loops will have multiple problems. How do you know where to start?

You need to start by applying process and business knowledge. 10% of the loops in your plant are significantly more important than the others. These are typically:

- Loops with a direct impact on product quality
- Loops directly associated with energy consumption
- Loops that limit throughput

Most process engineers and operators can develop this list very quickly, simply by looking through P&ID drawings or scrolling through the screens on the control system.

Take Action

When you measure the right things, you will have better information about what to repair. One study by the Gartner group found that “50% of maintenance efforts in process plants is not needed, and 10% is actually harmful". Use the measures described above to help focus on making the right repairs, for the right reasons.

Repair it now

Don't hesitate. Most control loop problems identified above can be addressed immediately, while the process is running. Here are a few examples:

- Adjust valve packing tension to reduce stiction effects.
- Use data from Active Model Capture to tune loops without additional testing.
- Repair valve actuator linkages to eliminate valve hysteresis
- Re-span instrument on DCS to ensure PV is not at limit.

Some repairs require downtime. Don't hesitate. Document the required repair, and add it to the downtime planning system immediately. You have measured the right things, quickly and accurately, then prioritized with process & business knowledge. You can speak with confidence about the required action.

Improving Unit Operation Performance

Get more directly-measurable results using real-time feedback of unit-level performance. Improving underlying control loops will have a positive impact on the performance of each unit operation. The unit will be more responsive to upsets, there will be reduced safety risk, quality and production rate may improve. But there are more gains to be had by managing the unit in real-time.

Measure

Unit performance metrics typically include:

- Production Rate
- Unit cost
- Energy cost
- Quality
- Material costs

And these are great measures of performance. If you measure these, you think you are measuring the right things. They are certainly measurable and meaningful. But are they actionable? Do you measure them quickly and accurately, in real-time?

In most cases, these measures are only determined off-line, after-the-fact. Last month's results are posted on the bulletin board in the hallway, and it is too late for direct action to solve any problems. In fact, it is possible to measure these quickly and accurately, on-line…if you make a few adjustments to these measures:

1. Unless you are switching between fuels, there is little need to accurately report the unit costs of energy. Focus instead on specific energy usage, such as BTUs per ton of product.
2. Similarly for raw materials, focus on rates of consumption and relative cost, rather than trying to integrate complex cost data based on the latest supply contracts or market price swings.
3. Look for ways to integrate on-line measures of quality, such as on-line analyzers or bringing lab quality data into the control system.
4. Monitor how closely the operator tracks to specification limits. Are they pushing the process closer to the spec limit, ensuring the best possible economic performance? Or do they shy away from the spec limit, to be "safe"?

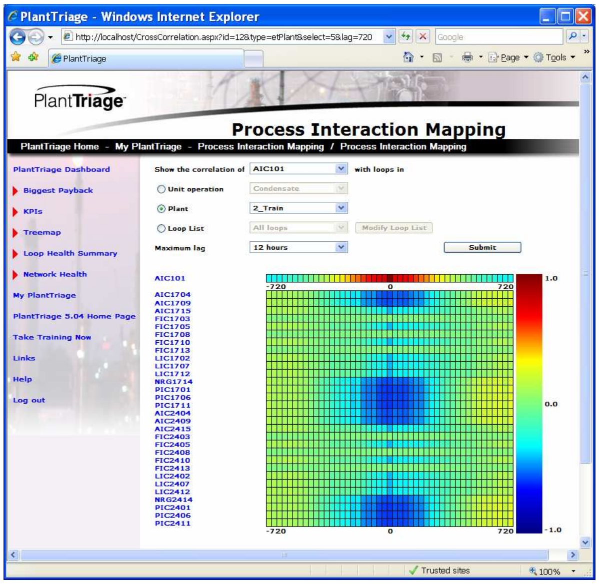
More Actionable Measures – Real-time

More than 50% of the upsets in a given process typically come from upstream. This may include:

- Changes in material supply
- Upsets in the upstream process
- Effect of recycle loops
- Effects of batch or cyclical operation
- Control strategy interactions
- Cycles and upsets in utility supply
    - Typically, 40% of a plant is oscillating, causing major inefficiencies.

If you don't have a way to measure these items, you have no hope of stabilizing and controlling the unit operation. **"You can't control what you don't measure."**

More of the right things to measure include:



- **Opportunity Gap** – Identifies opportunities to push closer to product specification limits.
- **Oscillation Detection** – Identify oscillations in the process. These are key sources of inefficiency, especially in energy-consuming loops. Sort by oscillation period to identify and eliminate the source of oscillation.
- **Process Interaction Mapping** – Increase process and business knowledge by understanding the source of interactions in your

process.

Decide

Where should you focus your resources? Apply your process and business knowledge to make these decisions. With the right measures in place, you can start with the following:

1. Assign an economic value to the real-time Opportunity Gap. This is very straightforward, can be done on-line, and shared directly with the operator.
2. Look at the interactions affecting your primary cost and quality metrics. Focus process engineering efforts on the most important interactions to improve overall process results.
3. Identify the source of oscillations for energy streams. Do this by sorting oscillations according to oscillation period. Then apply process knowledge to find the most upstream loop.

Take Action

Don't hesitate. You don't need monthly results to take action. Use today's real-time performance data:

1. Operators can start adjusting key setpoints using Opportunity Gap info today.
2. Process Engineers can uncover the root cause of interactions, and move upstream to the appropriate problem areas.
3. Find and eliminate the root cause of the oscillation. It is very common to uncover substantial savings by resolving oscillations that start far back in utility operations, such as boiler controls.

Take action today, and you will improve unit operations results before the month is over.

Improving Company Performance

You can apply these same principles toward improving the performance of the company. When you follow these same steps, you will see some direct results that impact the bottom-line.

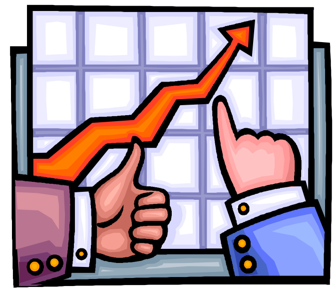
Measure

When it comes to your ability to impact the performance of the business, what are the right things to measure?

- Results from your day-to-day work
- Results from your projects

For instance, can you measure:

- Reduced energy utilization
- Increased throughput
- Improved quality



Here are a few guidelines:

1. Document baseline measurements before you begin.
2. Document the results of your work.
3. Measure and report results in economic terms, tied to the overall business results. Report your results quickly and accurately.
4. Use the real-time performance measures shown throughout this white paper. They are measurable, meaningful, and actionable. Best of all, they are directly tied to business results…something your manager can appreciate.
5. Involve operations management and plant managers. These people have a vested interest in the success of the unit operations and the business, and have direct impact on budget and career decisions.

Decide

Decide how you are going to spend your time. Steven Covey, author of *The 7 Habits of Highly Effective People* says, "The enemy of the best is the good". By this, he means that we need to prioritize our time to select only those activities that yield the **best results** on issues that are important to your company.

Take Action

One of the **best** ways to improve your results (and your career) is to demonstrate measurable, meaningful results, then report them quickly and accurately.

While this seems simple, most of us spend absolutely no time documenting results. You'll build credibility and support by communicating these results to management. This will also help to:

- Get you some immediate recognition through increased interdepartmental communication.
- Secure resources for future projects or activities with a proven track record.
- Document your contributions to support your career growth

Don't hesitate. Take action today. You can quickly and easily make improvements to control loops, unit operations, and your business by applying the methods discussed in this paper.

Contact ExperTune to estimate the economic benefits that your plant can achieve with PlantTriage™.

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About ExperTune

ExperTune has been improving process performance for over 20 years. With award-winning products, such as the PlantTriage® performance Supervision System, ExperTune has the technology and the expertise that you need to make improvements to your plant.

About the Author

George Buckbee is Director of 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

Term	Definition
DCS	Distributed Control System. A centralized process control system that typically provides data collection, operator interface, and control functions.
PV	Process Variable. The measured value that is fed to a control loop.
SCADA	Supervisory Control And Data Acquisition.