

BEST PRACTICES FOR MANAGING CONTROL LOOP PERFORMANCE - ROADMAP TO SUCCESS

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Abstract- It is generally accepted that PID loop health has a direct impact on the plant's bottom line: it reduces variability, improves quality and throughput, and decreases energy costs and raw material usage. This has been well proven and documented in many articles. An earlier paper (Patwardhan and Ruel, 2008) outlined criteria for determining what can be considered as excellent, good, fair, or poor controller performance. That paper also dealt with roles and responsibilities of key players needed to work toward control performance best practices. This paper completes that earlier discussion by outlining a work process to support the effort.

INTRODUCTION

Although PID controllers are reliable workhorses in the process industry, they are often underrated. Since the 1980's, computer control has evolved and the control algorithms used by control engineers have been increasingly complex. However, PID controllers still handle over 90% of the control loops in operating plants. Table 1 shows the savings that can be realized by achieving best-practice in several different process control categories (Brisk, 2004). The savings are expressed as a percentage of production costs.

Process control categories	Savings in production costs
Final control device performance and basic loop tuning	1.5%
Unit operations control	0.8%
Advanced control	1.4%
On-line optimization	0.5%

Table 1. Savings in production costs associated with different process control categories (Brisk, 2004)

Certainly the actual benefits will vary from industry to industry but in every case the benefits are significant and will undoubtedly impact the bottom line. Reported benefits are most often based on very specific case studies where a problem was identified, perhaps a faulty steam valve for example, and then corrected thereby resulting in savings. Unfortunately, there is no guarantee that the conditions in the case studies will be reproduced elsewhere. For that reason we feel it is better to have a systematic approach to performance improvement rather than attempting to 'cherry pick' individual control problems.

The rest of this paper outlines one such systematic approach.

CAPTURE THE BENEFITS WITH A WELL DEFINED WORK FLOW

This section provides a detailed explanation of the work flow shown in Figure 1. Responsibility for managing control performance is distributed among the production, maintenance, engineering and process control departments. One of the key enablers of this process is the online control performance monitoring software.

The Role of Online Performance Monitoring:

The first step in improving control performance is to isolate and quantify the problem. The previous paper outlined a set of metrics that should be used to quantify and diagnose feedback control performance.

These metrics include:

- % time in service
- % time in saturation
- Oscillation index
- Variability
- Integral of absolute error
- Stiction
- Settling time
- Operator activity

We are unlikely to want to review these assessments manually since that may mean perusing hundreds or thousands of performance reports daily. It is critical that the tool chosen is capable of highlighting those controllers which require immediate attention.

Table 2 proposes guidelines regarding the key metrics for any PID application. These metrics are used at the overall application level but they are

related to the individual level. Variability is calculated based on design performance or desired variability. Model performance is calculated based on benchmarked model performance.

Effective utilization is based on (worst case):

- % time in service
- % time in saturation
- Operator activity

Variability is based on (one):

- Variability
- Integral of absolute error

Stability is based on (worst case):

- Oscillation index
- Stiction
- Settling time (should not change unless the process model changes)

Targets	Effective utilization	Variability	Stability
Daily	>50%	<150%	<40%
Weekly	>80%	<125%	<30%
Monthly	>90%	<125%	<20%
Quarterly	>90%	<110%	<20%
Yearly	>95%	<110%	<10%

Table 2. Recommended targets for performance metrics as a function of time (targets are expressed in terms of normalized values)

These targets take into account that there will be short-term variations in the different performance metrics because of operating point changes or disturbances. It is essential that the team that owns the PID application agrees upon these targets.

Each time one of the three characteristics is outside the expected bounds, a flag is raised in a report and personnel should be notified. That way, the workflow is automated and actions and decisions are taken based on rational performance measurements.

This is the point where many of us are guilty of thinking “now we have a list of poor controllers, lets go fix them!” Unfortunately we soon find out that 30% or more of our controllers have significant problems. That means our software will identify hundreds of controllers for immediate action and few plants have the resources or desire to fix everything.

One approach is to initially focus on specific problems and drive their numbers down. For example you could first focus on loops that have poor utilization. Next you could focus on loops that demonstrate significant stability problems through severe oscillation and valve problems. Finally you could focus on those loops with more subtle

performance problems. This makes the task less daunting but you will still have a large number of issues to manage. At this point it is time to introduce a work flow process.

One possible work flow process for managing control performance is shown in Figure 1. The first step in this process is performed by the control performance monitoring software shown in the upper left corner of the schematic. This software has the job of analyzing control performance and periodically identifying a loop as ‘Requires Attention’. This is the first of several states or ‘dispositions’ used to designate progress through the process. The remaining dispositions will be described later.

Once a loop has been given the disposition ‘Requires Attention’ by the control performance monitoring (“CPM”) software, responsibility for follow-up is passed to the production department.

What to do when a controller “Requires Attention” - The Role of the Production Maintenance Coordinator

When configuring priorities in control performance monitoring software, production, engineering and maintenance are involved, but, priorities and economic weighing vary depending on which angle it is looked at. In an ideal world the CPM software would not only identify and diagnose problems, it would also prioritize them based on their impact on the business. Unfortunately the technology has not developed to that point and we still require a person with knowledge of the process to prioritize control problems.

One approach is to have knowledgeable individuals go through the entire list of controllers and weight them according to their importance to the overall process. Unfortunately this exercise is extremely time consuming and somewhat arbitrary. The authors have personally experienced numerous examples where seemingly unimportant controllers were responsible for costly control problems. For example, on a paper machine, overall efficiency was reduced by a poorly tuned level controller in a condensate tank.

A more meaningful approach is to ask the area Production Maintenance Coordinator to periodically scan the list of the ‘Requires Attention’ loops and choose an appropriate follow-up plan. His role is shown with the dashed outline boxes in Figure 1. The Coordinator quickly scans the reports and sets the disposition to one of the following:

- False Positive – this means the coordinator doubts the assessment based on his practical knowledge and experience.
- Assess Problem – this means the coordinator wants to review issue in detail or he feels he can correct the problem himself.

- Work Order Pending – this means the coordinator agrees that there is a problem and he has issued a maintenance work order.
- Capital Engineering Request Pending – this means the coordinator feels engineering design work is required to fix the problem or else he feels the problem will soon be addressed by a planned capital project.
- Deferred – this means that the coordinator agrees there is a problem but feels it is not worth

working on at this time. A control issue may also be deferred by the Engineering or Maintenance departments due to budget constraints.

This work should be done every week and should require less than one hour even for a large plant. At this point follow-up responsibility is passed to one of the remaining departments unless he chooses to set the disposition to “Assess Problem” pending a more detailed review of the problem.

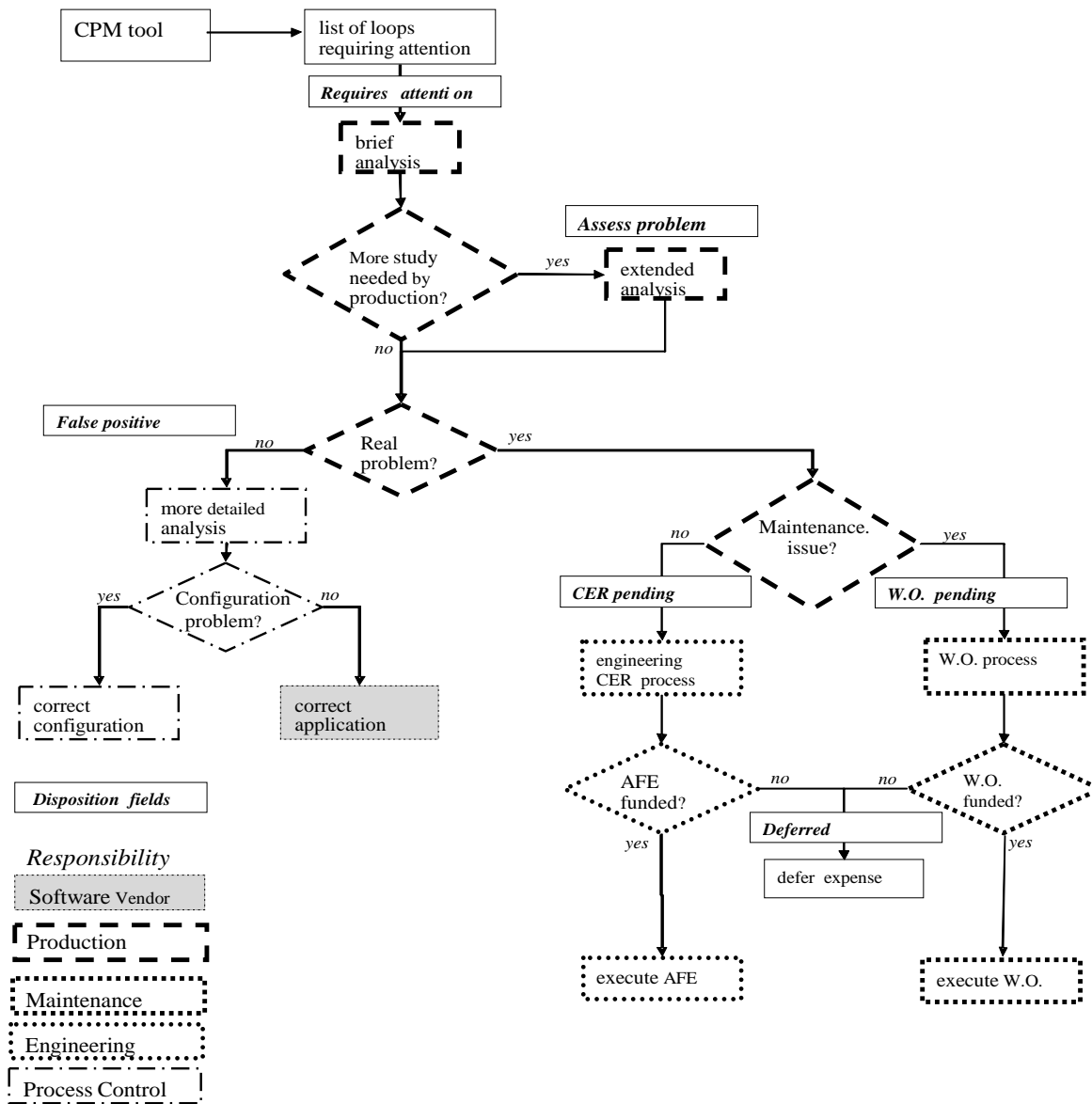


Figure 1. Assessment, diagnostic, and remediation of a typical PID application

Disposition Follow-up Roles and Responsibilities

There must be a single person accountable for each disposition in each production area for this process to work.

1) False Positive

Typically the Process Control group will be responsible for any loops labeled as ‘False Positive’. Their job is to review and correct configuration mistakes. False positives due to bugs or limitations to the software are reported to the software vendor’s customer support group to be addressed.

2) Maintenance Work Order Pending

Typically the area maintenance supervisor is responsible for insuring that loops in this category are followed-up on promptly. A rough outline of the procedure followed is shown in Figure 2 below. A technician is assigned to perform a more detailed assessment of controller performance, preferably with the controller in use. He then takes the appropriate action to correct the problem.

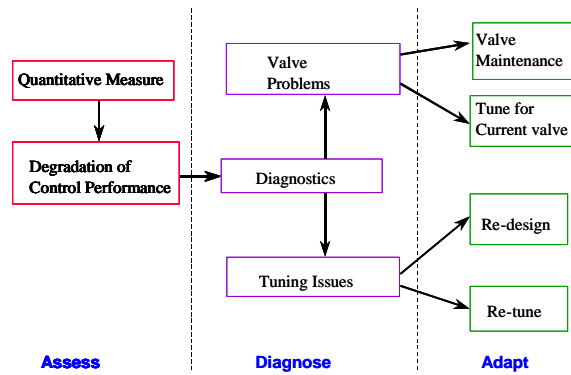


Figure 2. Assessment, diagnostic, and remediation of a typical PID application

The technician should be trained to go through a standard series of tests and not spend an excessive amount of time troubleshooting the problem. He should contact the area process control engineer to assist him if the problem turns out to be more complex or appears to be the result of a flaw in the control strategy.

The area maintenance supervisor completes the task by closing the work order and changing the disposition of the control problem to 'Resolved' after verifying that the problem is not in CPM lists anymore.

3) Capital Engineering Request Pending

Responsibility for follow-up is passed to the Engineering Department. This disposition is reserved for those issues that either require capital funding and significant redesign work or will be impacted by a planned capital project.

4) Deferred

The responsibility for "Deferred" loops remains with Production Management. Regrettably, no business has unlimited resources and it is generally the responsibility of the production manager to decide which activities to fund and which activities to defer so that he can stay within his budgetary constraints. This is generally true even though the actual maintenance and engineering budgets are controlled by those respective departments. In most plants the majority of the maintenance and engineering projects are prioritized based on guidance from the operating departments.

The Production Department should review the list of 'Deferred' control problems quarterly. This list can and should be used along with other information to drive the next maintenance and capital budget.

CONCLUSIONS

A past paper by Patwardhan and Ruel established a framework for monitoring control performance. This paper has built off that foundation and addresses the question of how to manage control performance once you have decided to monitor it. The work process described here is just one of many possible solutions. Many other processes will succeed if they are developed with the following considerations:

- The work flow must be flexible, well defined and as simple as possible.
- There must be a single individual accountable for each stage of the process recognizing that in most cases it will be a different individual for each area of the plant. Any work flow process will fail if there is uncertainty around follow-up responsibility.
- There must be accountability. We all have more work to do than there are hours in a day. This process will fail if it is not monitored regularly by senior and mid-level managers.
- And finally, a well designed Control Performance Management Work Flow will change how you do your work currently but it must not add additional work. If implemented correctly, it will begin to pay dividends in terms of process performance, process reliability and individual productivity.

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