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## **Alarm Reduction Using Exaplog** **“A Case Study”**

### **Introduction**

Information bombards operators today at an ever-increasing rate. This growing barrage of information is driven by additional measurements in the field and by inclusion of business data on the plant floor. Control systems only exasperate the problem if data is not properly filtered and tuned.

At best, unorganized, unfiltered data can become useless. At worst, it can lead to confusion and operational mistakes. The job of the control engineer must now reach beyond traditional control to include data management on the plant floor.

In recent project involving GFS Computing and a major chemical company, the alarm management of a large plant was redefined to reduce drastically the number of nuisance alarms. The CS3000 system in the plant controlled over 10,000 I/O points. Before initiation of the project, the system was generating over 50,000 alarms per day. It was more than the operators could handle. As a result, audible alarming had been disabled in the plant.

GFS used 6-Sigma methodology and several analysis tools, including Exaplog, to cut the alarming rate by 98%. This has resolved several production and safety issues. In addition, operator errors have been reduced, as have production losses.

### **The Background**

#### **Plant**

The plant involved in the project is a large chemical batch plant. In late 2000, a legacy DCS system was replaced with a Yokogawa CS3000 system. The replacement was made on an in-kind basis. Functional requirements were not reviewed and revised. Code from the old system was simply translated and restructured to fit the Yokogawa system.

The CS3000 system was completed and simulated testing was run for 9 months. During this testing period, the system was debugged and some improvements were added. Operator training was also conducted during this time.



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### **6-Sigma**

6-Sigma is the relentless quest for perfection through disciplined use of fact-based, data-driven decision-making. It is a statistically based methodology developed by Motorola which emphasizes setting extremely high objectives, collecting data, and analyzing results to a fine degree. The goal is to reduce defects in products and services.

The Greek letter *sigma* is sometimes used to denote variation from a standard. The philosophy behind 6-Sigma is that if you measure how many defects are in a process, you can figure out how to eliminate them systematically and get as close to perfection as possible. For a company to achieve 6-Sigma, it must produce no more than 3.4 defects per one million opportunities.

Proponents claim 6-Sigma's benefits include up to 50% process cost reduction through such improvements as reduced cycle-time and less waster of materials; better understanding of customer requirements which leads to increased customer satisfaction; and more reliable products and services. It is true that 6-Sigma can be costly to implement and that a company may wait several years before beginning to see bottom-line results. Texas Instruments, Scientific-Atlantic, General Electric, and Allied Signal are a few of the companies that practice 6-Sigma.

There are four major steps to the 6-Sigma methodology: Measure, Analyze, Improve, and Control. These steps are performed sequentially and the entire process is pursued repeatedly.

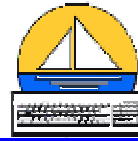
### **Exaplog**

GFS used the Exaplog package from Yokogawa as its measurement tool and as one of the analysis tools. Exaplog gathers data from the CS3000 system through the historical message file and feeds the data to an event database. GFS developed filters to sort through the alarms and extract the alarms of interest. The sorted data was then displayed as a timeline trend and as a pie chart.

The package contains the following analysis tools:

Event Balance Trend – EBT displays a timeline trend of “process requests” and “operator responses”.

3W Filter – This allows filters to be built which limit the data displayed to that from problem areas.



## **The Problem**

When the previous system was decommissioned in late 2000, all audible alarms had been disabled because too many were being generated for the operators' to handle them efficiently. The new CS3000 system had been designed and built to be a duplicate of the legacy system. As a result, the number of alarms had only increased.

When the CS3000 system was installed, alarms reached a maximum of 50,000 per day for the entire plant. They were divided between three operator consoles, and the audible alarms on all three consoles were disabled.

Without audible alarms, operators were missing critical alarms. And when the high volume of alarms was combined with the scrolling nature of the CS3000 alarm display, alarms were rolling off the bottom of the display in 10 minutes or less. Failures to recognize these alarms led to lost production, increased safety hazards, and increased production cost.

Decreasing the number of alarms proved to be a difficult challenge due to the sheer volume. With so many alarms, determining cause-and-effect without using a methodical approach to the problem would be a hit-and-miss proposition.

## **The Approach**

The project was justified by estimating both tangible results (e.g., reduced cost, increased production, and increased productivity) and intangible results (e.g., increased safety in both human and environmental terms). The 6-Sigma methodology was chosen as the overall approach to attack the problem.

After determining the initial rate of alarm generation, an overall goal of 10 alarms/hour/console was set. This amounts to a 98% decrease in the number of alarms generated.

Using the 6-Sigma methodology, the project was split into the following four steps:

### **Measure**

Once approved, the first step in the project was to determine accurately the extent of the problem. Exaplog was used to make that measurement. After a baseline was established, GFS used the filtering function of Exaplog to identify the top 20 alarms (ranked by number of occurrences per day) and to send them to the analysis step.



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Minitab was also used to track the overall progress. Periodically throughout the project, unfiltered data would be imported and a distribution would be generated. The overall mean and standard deviation would be determined in order to monitor progress.

### **Analyze**

Once identified, the filtered data for the top 20 alarms was imported into Minitab. Minitab is a statistical analysis tool employed extensively in the 6-Sigma methodology. GFS used Minitab to generate a Pareto chart. This chart listed the selected alarms in order of frequency. Each of the top 20 was analyzed and assigned to one of the following groups for determination of cause:

- *Process Engineering* – This group handled things such as resetting process alarm limits and selecting different instruments.
- *Maintenance* – This group handled things such as repair and rescaling of instruments.
- *Control Engineering* – This group handled things such as revising control strategies to eliminate alarms.

Once the top 20 alarms were assigned to a working group for resolution, they were eliminated from the database and the analysis was re-run to identify the next 20 most frequent alarms.

### **Improve**

During the Improve step, each group worked to resolve the alarms assigned to them. The fixes fell into the following categories:

- *Elimination of Nuisance Operator Guide Messages* – Some of the alarms were guide messages to the operator referencing the progress of the batch. Control Engineers worked with Operations to reduce the number of Operator Guide messages per batch. In some cases the messages that had required an operator response were automated and the operator was removed from the process.
- *Re-ranging Instruments* – Instruments riding along the upper part of the measurement range caused many alarms. They would continually bounce in and out of the IOP alarm. Process Control Engineers worked with Maintenance to resize the instrument.
- *Re-evaluating Alarms* – Process Engineers evaluated alarms to determine if the alarms were critical to the operation of the plant. These reviews resulted in reprioritization of the alarms. As the alarm priorities were reduced, many became inaudible. This process forced the group to rethink the alarming strategy that ultimately leads to more efficient alarming.



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As alarms were eliminated, the resolution was recorded and GFS executed further analysis. If other alarms further down the frequency list fit the same pattern as the resolved alarm, they were also fixed.

### **Control**

During the process the Measure, Analyze and Improve steps were repeated until alarms in a given area were reduced to the point where audible alarms could be enabled. Once alarms were audible again, Exaplog was used to audit them periodically to confirm that the alarm rate remained consistent. Any deviation from the new baseline is investigated even if the deviation is in the positive direction (i.e. fewer alarms than normal).

After all areas of the plant have their audible alarms enabled the process begins again, starting at the Measure step. The goal of this pass through the process changes from getting the audible alarms enabled, which occurred at the rate of 30 alarms/hour/console to further reducing the number of alarms to 10/hour/console. As this second wave of alarm-reduction commences, the other functions of the Exaplog tool will be used, such as the Event Balance Trends (EBTs).

### **Results**

Initial results from the alarm-reduction effort have been quite impressive. A partial list of the accomplishments follows:

- Two of the four operator stations, which together cover one-half the areas of the plant, now have audible alarms. Audible alarms for the areas covered by one console were enabled when the total number of alarms for the console dropped below 30 per hour for that console. Work continues on the other consoles.
- Operator mistakes have decreased in these areas. This is documented as part of the production process. Anytime plant production is stopped, a log entry is made and the root cause is identified. One documented even included stopping a take of hazardous material from overflowing. This observation would not have been made in time had the audible alarms not been enabled.
- One example of increase productivity centers on a level switch in a production vessel at the end of the process train. If that level goes high, there is very little time before the plant starts to plug up and you've got production downtime. In addition to production stoppage, there is a maintenance issue for cleaning equipment out if it backs up. Response to this alarm is now much faster because operators are not chasing lower priority alarms.
- Operating issues around several pieces of equipment were resolved once the audible alarms were enabled. These issues had been around for many years, even prior to the system replacement, but were not identified and resolved until there was a systematic analysis of the process.



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### **Conclusions**

By reducing the number of alarms and enabling the audible alarming function of the CS3000 system, GFS Computing and the customer were able to restore audible alarming on one-half the operator consoles. This enabling of the alarms has led to tangible, measurable improvements in productivity, safety, and cost-reduction.

The 6-Sigma methodology allowed engineers working on the project to focus on the largest problems first. The methodology also provided a means for measuring results and setting goals for improvement. The Yokogawa Exaplog tool was used synergistically with 6-Sigma to identify problem areas and to interface with other statistical tools used on the project. The Exaplog package is also used to monitor the current state of the process to ensure that previous problems do not resurface.

While great strides have been made, additional improvement is still to be made. Now that most of the low-hanging fruit has been harvested, advanced 6-Sigma techniques can be employed to realize this additional improvement. Once again, the unused features of the Exaplog package will be invaluable in achieving this additional improvement in the rate of alarming.

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