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***Wysowl Pty Ltd***
***Newsletter Number 24***
***May 2008***

# *THE CURSE OF OVER-CONTROL*

**It remains common for both manual control methods and instrumentation designed to either control or reduce variation (or both) to actually increase this process variation. Before we attempt to use instrumentation to reduce or control variation, we would be wise to ensure our control systems are not injecting it.**

Over-control is very common. In 23 years as a consultant I have never visited a manufacturing site where over-control was not present. Unfortunately, the problem is as widely misunderstood as it is common. In nearly every case, the managers and technical people of the sites visited were unaware that over-control was present. When the likelihood that the issue existed was pointed out, most of these people found the conclusion difficult to believe, at least initially.

Over-control is defined as reacting to random "noise' in the data, causing adjustments to be made when a better plan was to leave the process alone. Under-control occurs when a "signal" in the data is treated as random and ignored when action is necessary. Both harbour the potential for quality, productivity and financial losses.

Shewhart identified over-control as a significant issue in the 1920's. [1,2] Reacting to individual data or results is a guaranteed recipe for increased variation. Nevertheless, this is what many, instruments and people in manufacturing do. If sales fell (randomly) last week, or if inventory levels rose, the production schedule is likely to be automatically adjusted. If the data are stable, this is an error. The sales manager may move to introduce a promotion to lift sales based on one or two data values, quite possibly in error. A drop in monthly profits may lead to a cost cutting exercise in an attempt to guarantee the following month's result. Such short-term cost cutting sometimes does more damage than good. In manufacturing, it is altogether too common to find that over-control is increasing variation in parts or materials, and that the harder the operators and control engineers try to hit target, the worse matters become.

It is important to note that the most diligent operators, biologists, chemists, engineers and managers are the very people who are more likely to introduce over-control. The problem is seldom the people. It is their education and training.

The mental models and approaches used in many factories are very different to those developed by Shewhart. Where knowledge of variation is inadequate, over-control is common. Variation increases, as does the reject rate, costs rise and customer satisfaction decreases. Those companies which adopt the approaches developed by Shewhart can expect to create progress. Those which remain unaware of Shewhart's approach often remain trapped in a cycle of over-control. [3,4]

One of the most damaging practices is that of adjusting a process based on its specification limits. Where the random variation is more variable than that allowed by the specifications, adjustments based on specifications will always lead to over-control. When the variation in the process is less than that allowed by the specifications, it is likely that the process will be allowed to drift around between the specifications, increasing variation and costs. Other options exist. A control chart with projected limits is a far superior tool for process control than specifications, but those not trained in its use will remain trapped in the old "go, no-go" mindset so often created by specifications. [5]

**A TRAINING EXAMPLE**
A mine site was experiencing difficulty with its electronic truck despatch system that allocates trucks to varying machines digging the blasted rock. The digging machines vary in size, speed and capacity. Trucks haul ore to the crusher and waste is sent to a series of waste dumps. The truck cycle time varies significantly, depending on the dump site and the size and speed of the digging unit. Delays caused by imperfect scheduling of the trucks cause productivity losses. A series of observations revealed that on two separate shifts, new operators were under training. It was further observed that the procedures used on these shifts were quite different. The first shift preferred to leave the computer based despatch system on automatic and to intervene on rare occasions only. The second shift tended to dedicate some trucks to certain digging machines, and to allow the remainder of the vehicles to run on semi-automatic. The two new operators were receiving very different training. Over the years, the process of worker training worker in succession had taken its toll on the skill level and approaches used by the different shifts. The processes had become so different that the data from the varying shifts were no longer comparable.

Where operational definitions, clear written instructions and effective, uniform supervision across all shifts are absent, this form of over-control will take over. In some companies, the quarterly reviews use this approach because the last quarter's results are used as the basis for planning for the coming quarter.

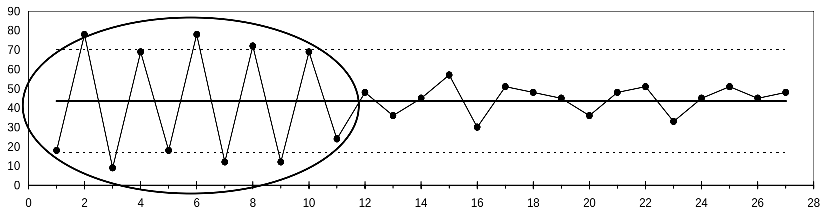
As absurd as this type of over-control appears, it is all too common. Most readers will recall being encouraged to start any action, plan or policy with a statement of the current situation. A superior approach is to start every action, plan or policy with an aim. Starting with the current reality tends to limit thinking and shorten horizons.

**PROCESS CONTROL EXAMPLES**
A very common form of over-control occurs when an operator, technical person or instrument adjusts the process by an amount that is equal and opposite to what is thought to be a change in the process when in fact the variation noted was random.

**Example from Fabric Dyeing.** At Figure 1 is a chart that shows a period of over-control of the colour of dyed fabric. A sample is taken after a few bolts of cloth and tested for colour. The process is adjusted to bring the colour back onto target for the next bolt. The process engineers and operators were unaware of the degree of natural, random variation in the process, and often made unnecessary adjustments, resulting in over-control. Sometimes, severe over-control is characterised by a saw-tooth pattern. This pattern is circled at Figure 1.

The colour test results were plotted onto a control chart. If the variation noted was random, it was ignored and no changes were made to the process. The over-control disappeared and both yield and productivity increased. In cases such as this, it will be necessary to train people so they are better able to differentiate between random (noise) and non-random (signal) variation.

**Figure 1**
**Over-control of Fabric Dyeing (Ranges chart Omitted)**




As technology advances and automatic process control equipment becomes less expensive, it becomes more common. However, it is still customary for these instruments to either under or over-control the process. Over-control is more frequent. Control engineers not possessed of a working knowledge of Shewhart's methods are at a disadvantage, and are more likely to program instruments such that over-control occurs.

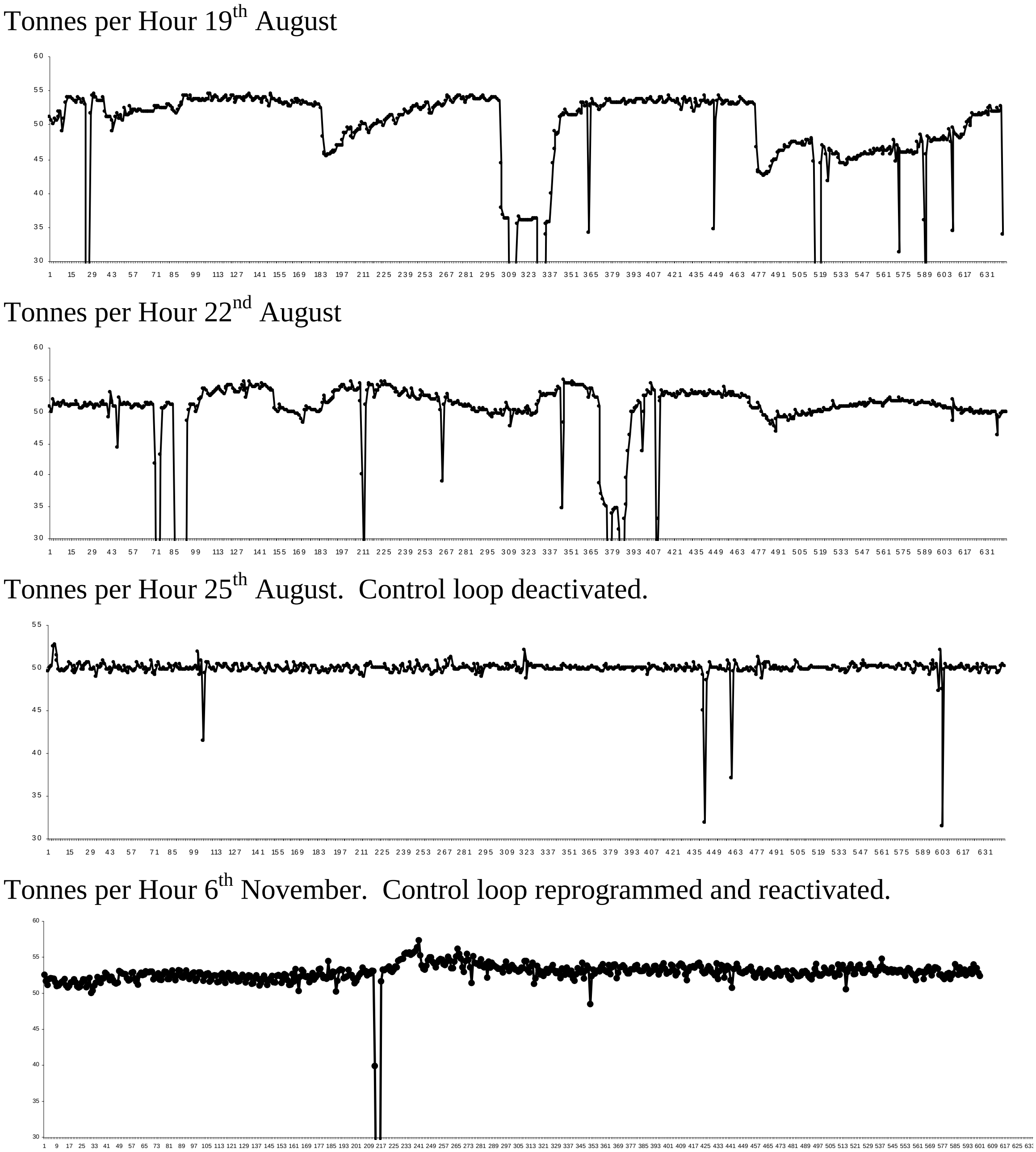
Even in financial areas, inventory and stock control and production scheduling, over-control is widespread. Examine the data over time. If the process appears to exhibit the characteristic of feast followed by famine, one should suspect that over-control is present.

Often, the worst example of over-control in manufacturing is found not in the factory itself, but in production planning and scheduling. For mature products, sales figures are often reasonably stable. In such cases, the schedulers can often afford to manufacture to the average sales figure and allow inventory to soak up the variation, which in the majority of cases is its primary purpose. If the schedulers react to individual data, in most cases they will only make matters worse, by oscillating the load on the factory or making regular last-minute schedule changes. This can drive inefficiencies into the factory and increase costs.

One way to understand the situation is to plot the actual market consumption of the product and to compare this with the incoming factory orders to the same time scale. Where the factory orders show significantly more variation than consumption, it is wise to suspect over-control and to commence an investigation. The practice where distribution centres work with minimum and maximum stock levels regularly leads to wild oscillations in factory orders, particularly when a large distribution centre feeds several smaller distribution centres.

**Example from Cement Milling.** In this case the control system was over-controlling the process, producing an erratic pattern, as noted in Figure 2. Once the Operations Manager, Mr. Geoff Ward, turned off the controller and had the process controlled manually, the process stabilised immediately. When the controller was reprogrammed so that it ignored random variation, it was reactivated, also noted in Figure 2.

**Figure 2**
**Over-control of a cement Mill**

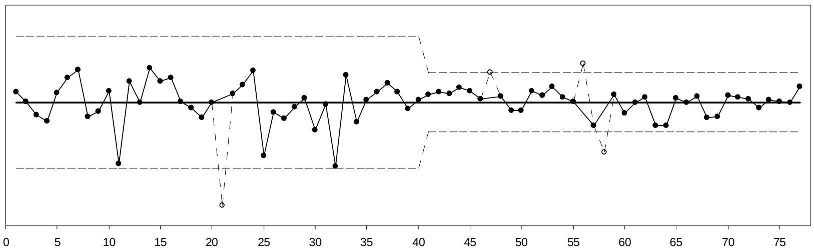



Over-control can be very difficult to detect. The classic oscillation pattern noted in Figure 1 is not always present. Where over-control is suspected, but not obvious from the data, a trial to expose it can be conducted. Electronic over-control is so common as to be endemic amongst process control instruments. Eliminating over-control can produce rapid quality and productivity benefits. It is unwise to trust automatic process controllers. They should be tested to ensure that they are not increasing variation and costs.

**Pharmaceutical Industry Example.** In Figure 3 are the results of a trial to test the automatic process controllers in the fermentation event of a pharmaceutical plant. The variable plotted is potency. [5]

To conduct this trial the automatic process controllers had a significant dead band created so the controller would only react in the event of a large change in the process. Essentially, the controller was not used during the trial. Variation dropped immediately. Some special causes were found and eliminated, after which time the process entered a stable state.

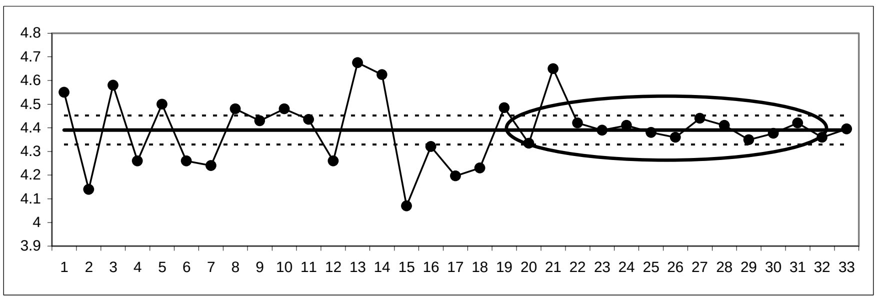
**Figure 3**
**Over-control in a Pharmaceutical Plant**




In the book, *Six Sigma in the Pharmaceutical Industry*[5], Dr. Nunnally cites another common example this type of over-control. When the use of drug substance potency stability data is used to determine the amount of material needed for formulation, over-control is common. When the drug substance potency data is stable; that is, in a state of statistical control and neither increasing nor decreasing over time, adjustment from the last target is neither desirable nor necessary. If the drug substance potency is not changing over time, such adjustment only leads to increased variation in the formulation outcomes. Each formulation should be done using the original value, provided the data are stable. It is common for chemists and biologists to adjust based on the latest outcome. In this way, unnecessary reaction to analytical variability is directly increasing the variability in formulation.

Similar examples abound. The chart in Figure 4 comes from a factory producing concrete roofing tiles. The operator and the plant engineer made regular adjustments to the process, thinking that they were either making essential adjustments or "fine tuning" the process. In fact, they were introducing massive over-control; making matters worse. The process engineer and production manager had requested millions of dollars in capital to replace old equipment. They were sure that the installation of new equipment was the only way to significantly reduce the variation in the process. During the period when the last 12 points in the chart were produced, a steady state trial was conducted which revealed the true process variability. There was no need to spend capital on the process.

**Figure 4**
**Over-control Eliminated in a Concrete Tile Plant**




Another common example can be found in automatically controlled continuous process. It is not uncommon for such continuous processes to have their variability increased by unnecessary calibration of automatic control equipment. In one cement plant the controller was doing an excellent job of holding the chemical composition of a blend of raw materials on its set points. The issue was in the calibration process. Once per shift, a physical sample was taken. The analytical result was automatically used to calibrate the controller as if the laboratory result were perfect; as if it were free from sampling or analytical error. This approach doubled the variance of the chemistry of the raw materials. A superior approach is to plot the laboratory results as a control chart. For as long the data remain stable and on target, no calibration is necessary. When a statistically significant signal is recorded, a recalibration process can be introduced once the initial signal has been confirmed.

## SERVICE ELEMENTS OF MANUFACTURING

A common feature of service elements, and in particular those in mature markets, is that processes are mostly stable and robust. Usually, sales data for mature products are good examples of this inherit robustness, which is both good and bad. It is good in as much as when managers first run control charts with their data, the analysis is simple because service elements tend towards stability. The process is easy to "see". However, the down side is that quite often the inherent robustness means that significant or profound change is necessary to bring about any worthwhile improvement. Tinkering or fine tuning seldom has much impact.

The evidence of this is to plot some historical data as control charts. Separate out those processes that appear to be reasonably stable. Some common examples are:

1. Sales, of mature products.
2. Customer service levels for mature products.
3. Costs.
4. Response time.
5. Safety data

On the stable charts, mark those instances where some sort of corrective action has been taken in an attempt to improve matters. The data, or the voice of the process, is trying to say that whatever actions were taken failed to improve the outcomes. The variation is random. Another impact that chasing random points about can have is to preclude improvement. Two possibilities are:

1. **Erroneous causal relationships**. If the process is stable, a low point will nearly always be followed by a high point, which also explains how chasing points up and down so often leads to erroneous causal relationships.
2. **De-focussing managers**. Imagine a factory has twenty targets and key performance indicators. Imagine also that all twenty are at least reasonably stable. Any given weekly or monthly report will indicate that about half of these metrics are above average, and about half are below average. On any given month it is likely that one or two will be quite high (assuming that higher is better), and a couple are likely be low enough to be problematic. Under these circumstances, most managers will focus on seemingly bad results, despite the fact that they are random. The following month's report is likely to indicate that these results to have improved, but another one or two variables have missed their targets, and that corrective action is necessary. The most common outcome of this kind of erroneous thinking is that new priorities are established each reporting period. In turn, this leads to unproductive fire fighting which is little more than chasing random points up and down.

These problems are common in manufacturing, but are most obvious where the process is robust and mature. The most likely places to find robust processes will be the service elements. The more robust a process is, the more fundamental any change for improvement is likely to be. However, the practice of chasing weekly or monthly variances from budget or target prevents managers, supervisors and technical people from bringing a strong focus to one or two key areas until they create a breakthrough. For so long as managers and technical people find themselves chasing variances, any problem that will take longer than a month or two to be resolved is unlikely to be successfully addressed.

**One Point Summary:**

1. *Stabilise first* is the first principle. In manufacturing this means we must stop injecting unnecessary variation by over-controlling processes.
2. Eliminating over-control is an early imperative in attempts to reduce variation and improve productivity. This requires of managers and technical people an understanding of Shewhart's methods.
3. Over-control exists in scheduling, sales and marketing, customer service and all other areas. To focus on the factory alone is a mistake.
4. A process should ***never*** be adjusted based on specifications. Control charts should be used for this purpose.

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