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HAVING IT ALL

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There is no trade off between quality and quantity. The laws of statistics dictate that only operations that successfully reduce variation and improve quality will achieve high output and low work in progress. The good news is that we can have it all.

It is ironic that to this day we find people engaged in a quality versus quantity debate. Some folk are concerned that the production of improved quality will result in slower production, and higher unit costs. However, when the approach to improved quality based on reducing variation is successfully used, it almost certainly leads to higher throughput volume capacity, lower work in progress and cycle time, reduced unit costs and improved customer service levels.

Many companies are directing a lot of effort into scrap and rework levels, work in progress, cycle time, inventory, adherence to schedule, throughput volume and time in queue. Whilst there is nothing wrong with wanting to improve these characteristics, most are suffering the frustration of seeing one such measure improve after much work, only to note that other measures worsen. The problem is widespread, on both sides of the Pacific.

THE FIRST PRINCIPLE
The first relationship we need to understand is called "Little's Law", and it can be expressed in the formula:

Throughput Volume = Work In Progress/ Cycle Time

Bear in mind that this law, whilst surprisingly effective, is not as exact a law as $E=mc^2$. It can't be because every factory is unique, with its own constraints, limitations and capabilities. Nonetheless, the relationship expressed in Little's Law is remarkably robust and useful in the long term.

THE PROBLEM
The major problem is that many people can be found trying to isolate and improve scrap or rework, throughput volume, work in progress or cycle time as separate issues. Inventory is another aspect people struggle with, and it is closely associated with these facets.

Any approach that attempts to isolate and improve any one of these characteristics is probably doomed. If the business is in poor shape to begin with, it might be possible to make some initial advances. But very soon, we note that attempts to reduce work in progress usually result in a lowering of throughput volume or perhaps late deliveries or stock out situations; or that when we tried to increase throughput volume that all we achieved was a glut of work in progress.

A brief look at the formula shows why. These characteristics are interconnected; inexorably enmeshed. To understand and improve one of them, it will be necessary to understand the relationships that exist between all of them.

Recently, a lot of the literature claims that the answer lies in reducing cycle time. Themes such as Time Based Manufacturing are the latest craze. Again, the formula shows why. If work in progress is held constant and cycle time is reduced, throughput volume must increase. Great. Alternatively, if cycle time is reduced but there is no need to increase throughput volume, work in progress can be reduced.

Another way to express cycle time is residence time, or the length of time the material or components reside in the process. Clearly, if this is reduced, work is flowing through the process faster. Also, Little's Law seems to indicate that if we can significantly reduce cycle time, we get a lot of control over throughput volume and work in progress, and this is correct (within the physical limitations of each operation).

Sadly, a common outcome from this revelation is that corporations put in place lowered targets for cycle time. In many cases, the people in the factory have few ideas on **how** to reduce cycle time without simply driving machines harder. When this is done, the most common outcomes are a rise in scrap and rework, down time and other process disturbances, which increase delivery delays and degrade quality, sometimes to the point where the customer rejects the product.

Cases abound in both Australia and the USA where the new target value for cycle time (or work in progress or throughput volume or inventory) have been plugged into computer models such as MRP 2 **before** the process has been improved to this level. The disaster that follows is entirely predictable. So, the attempts by many well-meaning people often result in a financial disaster. There is a better way.

THE SECOND PRINCIPLE

If you are familiar with the Dice Experiment, this principle will come as no surprise. The lessons from the experiment are that both cycle time and work in progress are a function of variation in volume, or if you prefer, variation in flow rate through the process. This is a fundamental principle of operations research.

Unlike this simple experiment, factories have physical constraints and limitations. For instance, there will be a limit on the amount of work in progress that can be held at any given workstation. In any event, when variation is successfully reduced, throughput volume capacity increases.

Little's Law gives us a way out, regardless of whether our problems are throughput volume, work in progress or cycle time. Reduced variation in the flow of materials always lowers both cycle time and work in progress for any given throughput volume. Alternately, reduced variation will increase throughput volume capacity if cycle time falls and work in progress is held steady. This in turn provides an opportunity to reduce unit costs.

In particular, variation in the inputs to a process, or in the first few events, has the greatest impact on cycle time, work in progress and throughput volume. And yet it is most common to find our most talented people clustered around the transformational event in the process or that part of the process that does the core work the process was created to do. Usually, they are too late in the process.

Knowing that reduced cycle time will provide a competitive advantage is one thing. Knowing what to do to reduce cycle time without pushing the process past breaking point is another. In this case we are talking about reducing variation in volume, as opposed to reducing variation in product characteristics (or quality). So, how do we do that?

TWO PROVEN APPROACHES

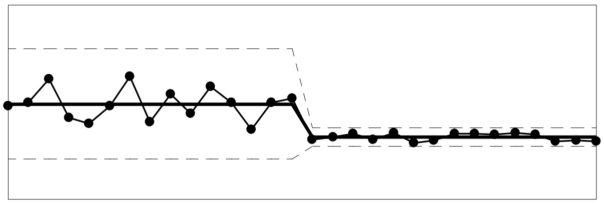
You might think that reducing variation is imperative. Maybe you can also convince a few executives, but this is not enough. Somehow it is necessary to create an approach that disentangles the middle managers and technical folk from the knot of day-to-day issues so they can focus on reducing variation. After studying many approaches, only two have been seen to enjoy a predictably high level of success.

However, let us commence with an approach that, by itself, does not work. Sadly, it is also very common. It is a training based approach where mass training is conducted and a plea is made by senior executives at the end of each course for folks sally forth and do battle with variation.

There is nothing intrinsically wrong with large-scale training. It can be invaluable in creating: common understandings; a shared experience; a common language and providing new skills. But by itself, it seldom brings about significant change. Something more is needed.

Approach one - Making reduced variation the AIM of the operation. Here, senior executives make reducing variation the number one business imperative. Everything else is, at least temporarily, subordinate. This is what Geoff Ward did at Sola Optical Australia. His managers and team leaders were left in no doubt that conquering variation took precedence over all else. This is one of those things that is easy to say, but much more difficult to do. It severely tests the courage of whosoever issues the instruction.

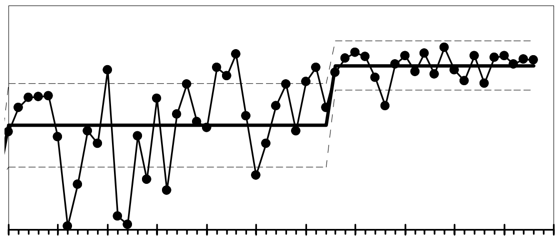
FIGURE 1
SOLA OPTICAL AUSTRALIA
STEADY STATE OPERATION - CYCLE TIME



Because Geoff Ward never wavered, his people stayed focused on reducing variation. The approach worked. Cycle time fell, (see Figure 1) as did work in progress. Throughput volume capacity rose. Yields increased and costs fell. Geoff Ward had taken the business through a metamorphosis; and a profitable one at that.

Another example of this approach comes from a cement plant. The plant manager created a full time team of six people and gave them the job of conquering variation. Within a couple of months, quality had improved and volume output nearly doubled, as noted in Figure 2.

FIGURE 2
OUTPUT FROM A CEMENT PLANT

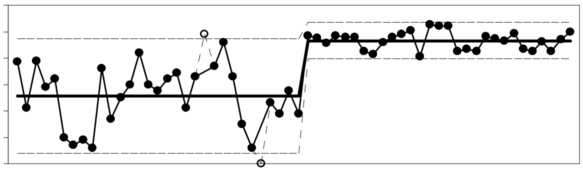


Approach two - Steady State Trial. This approach has been most successful in continuous and semi-continuous processes, although it has been applied successfully in all types of manufacturing operations. A plant trial that has as its aim the holding of every conceivable variable constant for any given product is conducted. Raw materials, machine set-ups, operating procedures, temperatures, pressures, flow rates and all other variables are kept as constant as possible for any given product.

This approach has been spectacularly successful when the process under examination was unstable to begin with. Sometimes, the trial never ceases.

FIGURE 3
LEINSTER NICKEL OPERATIONS
Recovery of nickel from ore

Before.....Dec '95 After......Jun '96



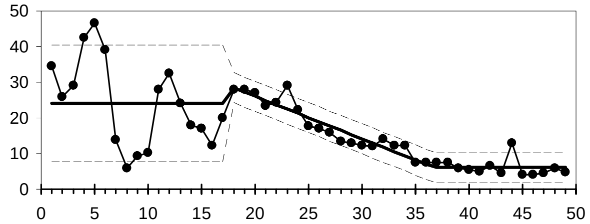
Once low levels of variation are achieved, the technical folk find that isolating and understanding causal relationships is much simplified, and further improvements flow. A key characteristic of this approach is that because it is a formal plant trial, complete with deadlines, a strong focus on the job at hand is achieved. This is the type of approach used by Peter Smith at Leinster Nickel Operations. (See Figure 3.) Again, cycle time fell and throughput volume rose. Recoveries improved and unit costs fell. Peter Smith took a struggling operation and transformed it.

ICI had a similar experience with a major petrochemical process. A steady state trial (see Figure 4) resulted in better quality and higher output. Again, the financial improvement was measured in the many millions of dollars.

QUALITY and QUANTITY

Chief amongst causes of variability in volume are quality and reliability problems. The latter are obvious. If breakdowns and other disturbances occur, variability in cycle time is inevitable. Product quality also heavily impacts variability in volume. If people and machines must struggle to obtain a satisfactory result, variation in work rates and therefore throughput volume is almost inevitable.

FIGURE 4
YIELD LOSS DURING STEADY STATE TRIAL - PETROCHEMICAL PLANT



Rework, scrap and poor changeovers/set-up have a similar effect. Quite apart from the obvious cost of poor quality, we suffer also an increase in variation in volume. This additional cost almost never appears in cost of quality analyses, and yet it is nearly always significant.

Interestingly, the first successful applications of this approach I saw was in Metropolitan Permanent Building Society before it became Metway Bank. Howard Manning led several projects that significantly reduced cycle time for aspects such as production of monthly accounts and loan application turnaround time. It works just as well in service as it does in manufacturing.
So we note that poor quality and reliability are chief amongst the causes of variation in volume and therefore of high work in progress, low throughput volumes and higher unit costs. Little's Law is more than a good idea. It is a law. Understanding this law and the effect of variation can lead to large scale cost reduction and impressive increases in productivity.

Improved quality, reduced scrap and rework, lower work in progress and inventories, higher throughput volume, lower unit costs and enhanced customer service levels. We can have it all, if only we know how to reduce variability.

References:

1. *Factory Physics,* W. Hopp & M. Spearman, McGraw-Hill, 1996
2. *Metamorphosis,* J. McConnell, Wysowl Pty Ltd, 1997