

What Deming Saw

Abstract

What Deming Saw: The late W. Edwards Deming did not believe in zero defects – it was not economically viable he wrote. But he strongly promoted on-going business process improvement to continually reduce defect causing variation. There is one approach that Deming passed to Japanese industry which they successfully used to become the world renowned quality providers they are. But before Deming they were not. What Deming saw changed Japanese quality – and he made it available for everyone to use.

Keywords: quality management, control of variation, zero defects, process volatility

The late, famous American quality guru W Edwards Deming saw something worrying in the way businesses operated, in particular that so many suffered quality problems. Born October 14, 1900 and died December 20, 1993, he is credited with helping the Japanese industrial rebirth by starting the quality revolution in Japan. His books ‘Out of the Crisis’¹ and ‘The New Economics for Industry, Government, Education’² were written to explain his considered thoughts and experiences on why businesses failed to make quality products and how the causes of the problems could be corrected. He was passionate about the issue and explaining his insights became a lifetime’s work. For him variability was by far the single greatest source of business problems. He blamed nearly all business problems on company management that blindly created and unwittingly perpetuated variability in their business. He knew the causes of variability, he understood them, he knew what had to be done to correct them (his Fourteen Points for Management were created for this purpose) but he did not explain himself simply to managers in his books. This may have been intentional because Deming required people to seek understanding. He wanted people to make their own efforts to become enlightened, so they valued the knowledge.

Business Process Variation

Every business activity and task belongs to a business process. When all the activities in a process are completed there is a result, an output produced by the process. Figure 1 represents a multi-process business that makes a product. The configuration is a series arrangement, which puts the business at high risk, because a failure in any process fails the business. Deming said that process failures were caused by out-of-control variability.

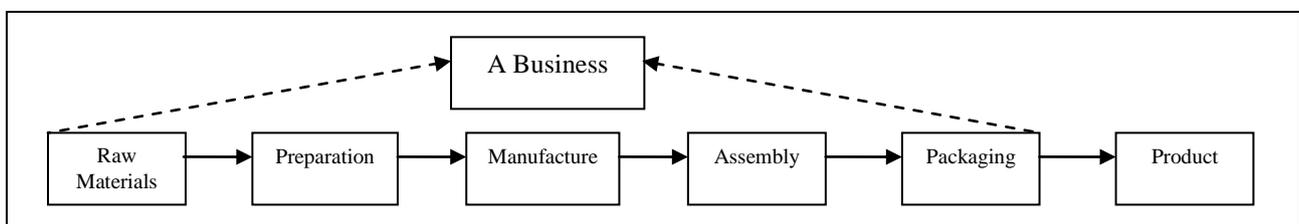


Figure 1 – A Series of Steps in a Production Process

Figure 2 expands the Manufacturing process step to show some of its processes. Though there is only space to show three of the sub-processes in the Manufacture step, there are more, and each of the other steps, Raw Materials, Preparation, Assembly, Packaging, also have numerous processes. In total there will be several dozen processes in the business. To get all of them right, so they all

¹ Deming, W. Edwards., ‘Out of the Crisis’, MIT Press, 2000

² Deming, W. Edwards., ‘The New Economics for Industry, Government, Education’, Second Edition,, MIT Press, 2004

deliver quality output that comes together to make a final marketable product, is an impossible challenge, unless variation is controlled.

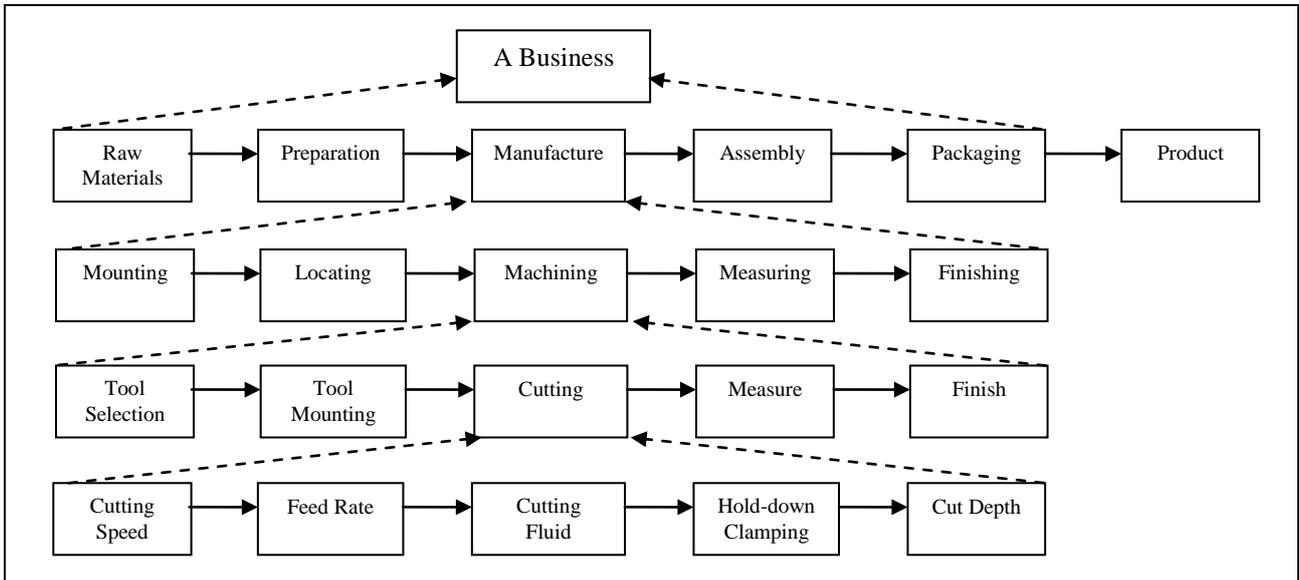


Figure 2 – There are Numerous Sub-Processes in Every Production Process

Figure 3 shows how businesses have processes that create a tangled web of interaction with suppliers, operations, management, purchasing, stores, finance, marketing, engineering, etc. Every step has dozens of process impacting it. In the end, there can be hundreds, even thousands, of steps involved in making a product, each with dozens of individual activities.

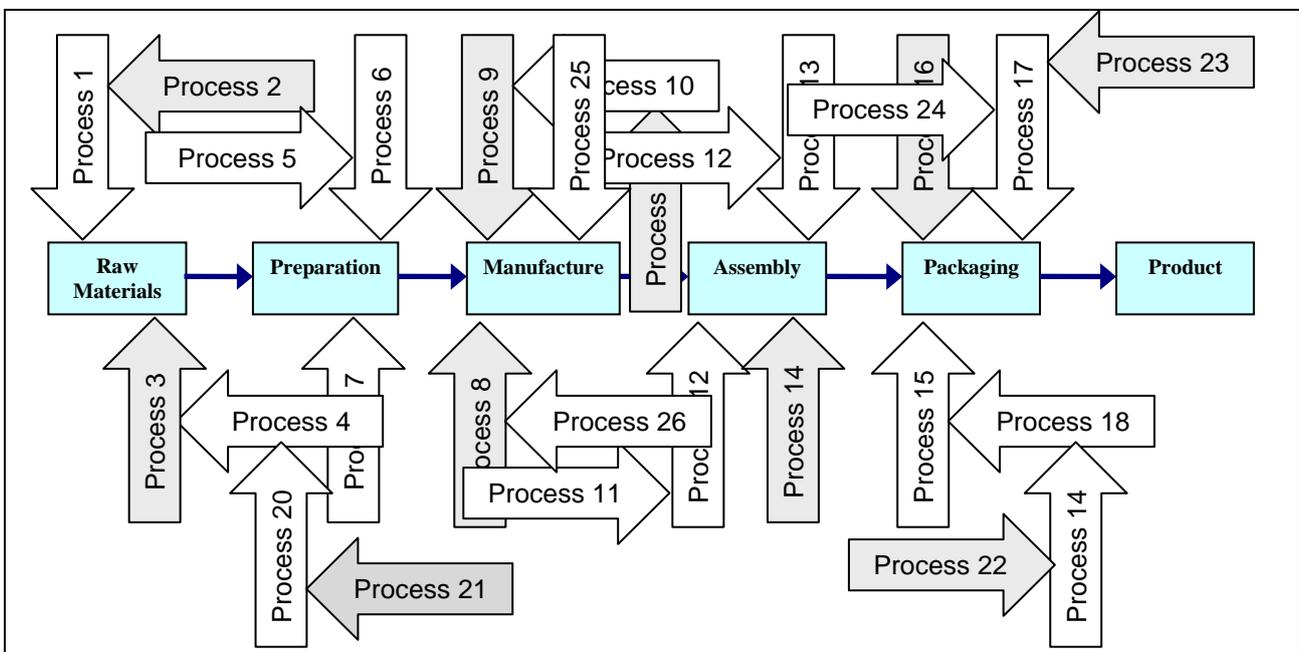


Figure 3 – Numerous Processes Interact across Every Process Chain

Imagine if you could see all the individual activities for every step in every process throughout the business. Depending on its size, and the complexity of its processes there are thousands, tens-of-thousands, maybe hundreds-of-thousands of opportunities for things to go wrong. Any error in a series configuration activity knocks-on and harms all those downstream of it. A poor maintenance

repair will cause a future production failure; an operator error that overloads a machine starts a breakdown that happens next month; the wrong material of construction choice by a designer means a dozen future production outages. This is the challenge Deming saw in running a business well – getting every individual process compliant, right-first-time, so the output is on-quality and the customer will be happy.

Figure 4 represents the spread of outputs from a process producing product that is normally distributed. Many real-world process outputs are normally distributed, but distributions can be skewed or multi-peaked. The extent of the spread reflects the process volatility. Volatility is produced by natural variation in a process and/or from external factors imposed on the process.

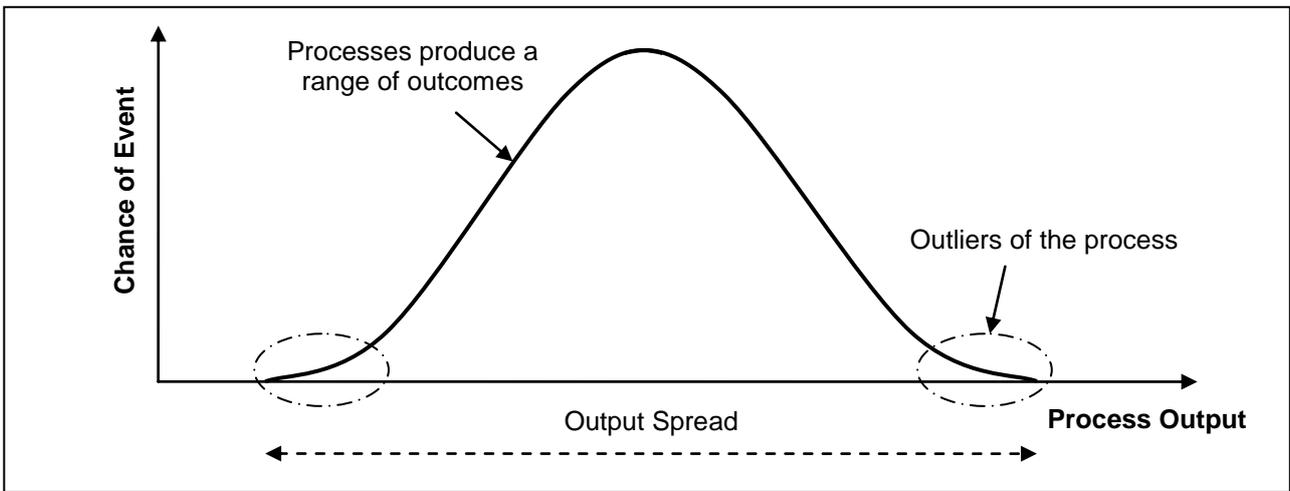


Figure 4 – Processes Produce a Range of Results

When the outputs of a process are examined they will either meet the specification or they will not. Those outputs that do not satisfy the acceptance criteria will be scrapped or reworked. If too many outputs are unacceptable the process is wasteful and uneconomic. Many of the outcomes shown in Figure 5 are outside of the required range. This process is a poor one for delivering its purpose because the majority of the output does not meet specification. Such a situation is unacceptable and the causes of the problems must be investigated to understand how to improve the process.

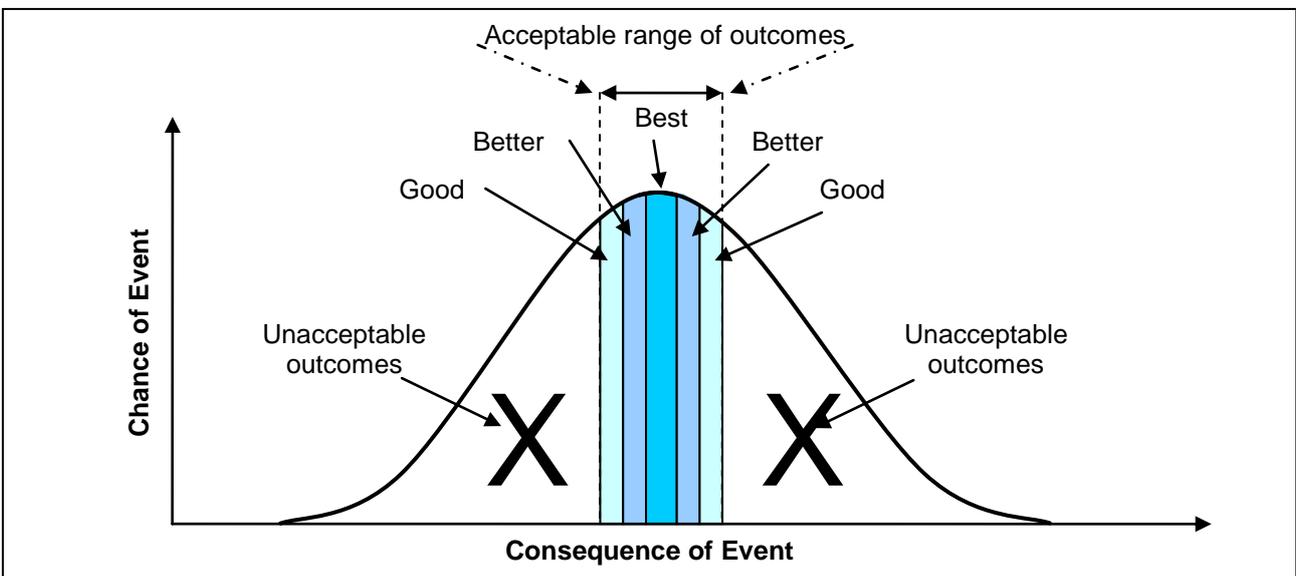


Figure 5 – Control the Chance of an Equipment Failure Event

A successful resolution of the problems will alter the output spread so that all products pass specification. The output spread will change from that of Figure 5 to the far less volatile distribution of Figure 6. Now the vast majority of output from the process is within specification.

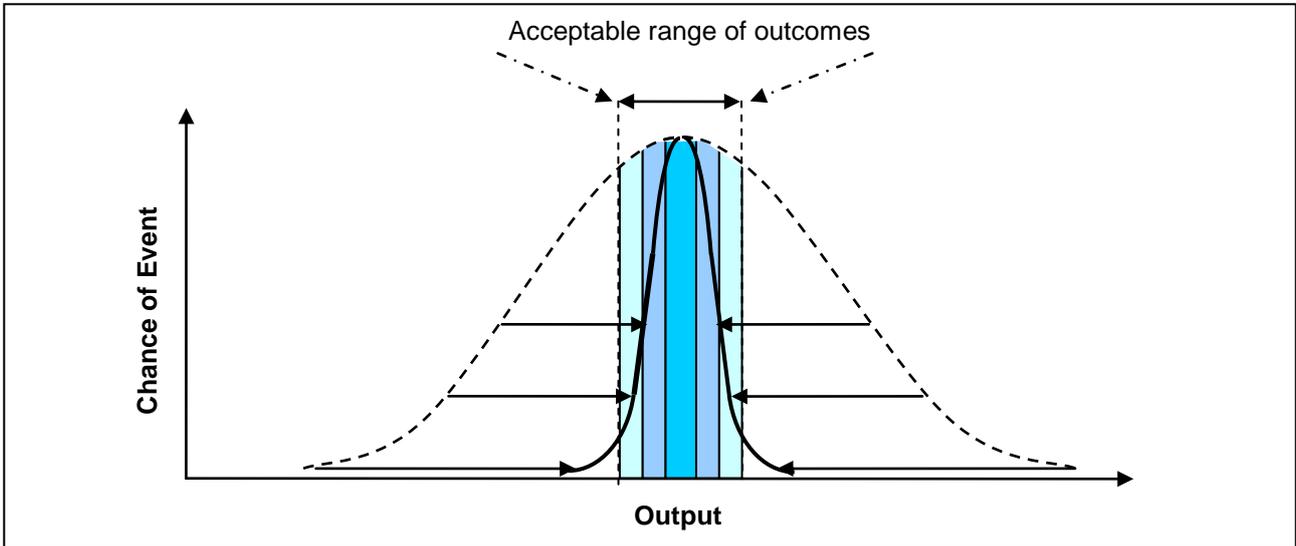


Figure 6 – The Effect of Removing Volatility from Processes

Each process has its own volatility and output variation. A business with poor process controls has thousands, maybe tens-of-thousands of chances to produce poor quality product. Figure 7 indicates that each process in a business has the chance of producing variable outcomes that feed into downstream processes. The outliers of a process are likely to cause problems. Any quality problems created travel through the business to eventually become a defect that has to be rejected. Once rejected, all the work, money and time spent on it is wasted; and customers get annoyed.

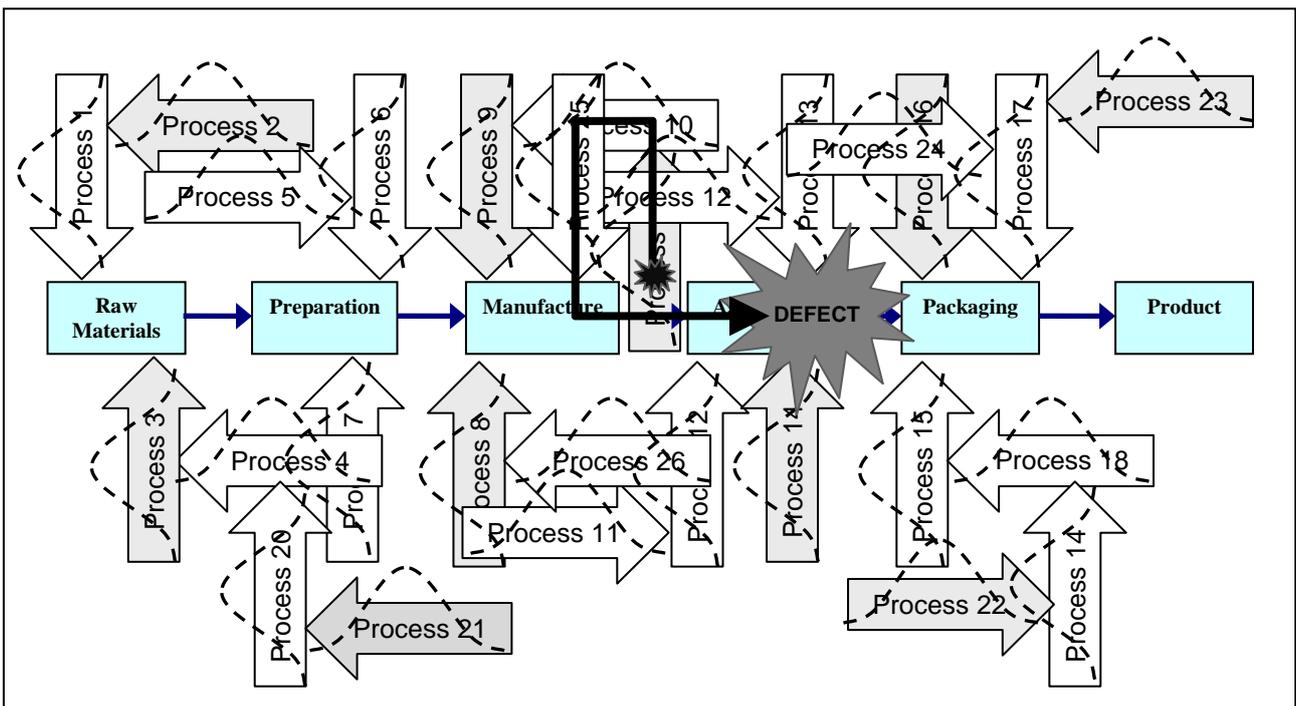


Figure 7 – Processes which Allow Wide Variation Produce many Defects

The Need and Purpose of Standardisation

Deming was concerned about the impacts of variability on business because he knew from his industrial experience that it caused great waste, inefficiency and loss. In the 1950's he taught industrial statistics to the Japanese. The Japanese managers, engineers and supervisors learned well and by the 1960s Japanese product quality was renown world-wide. The Japanese were gracious with their knowledge and willing told the world what they had learned. One factor in particular was identified as the most important one to start with. It was to standardise a process so that there was one way, and only one way, that it was done³.

Deming had taught them that output variation was either the natural result of using a particular process (called this common cause variation because it was inherent, common, to a process) or caused by factors external of the process changing its performance (known as special cause variation because they were identifiable as a particular problem special to a situation). The extent of the output spread was dependent on the amount of volatility permitted in a process. When many methods of work were allowed the final process output was widely varied. But when only one method was used the outputs were less variable. Figure 8 shows the difference in output distribution between using a standard method and permitting the use of many methods. Standardisation reduced variation.

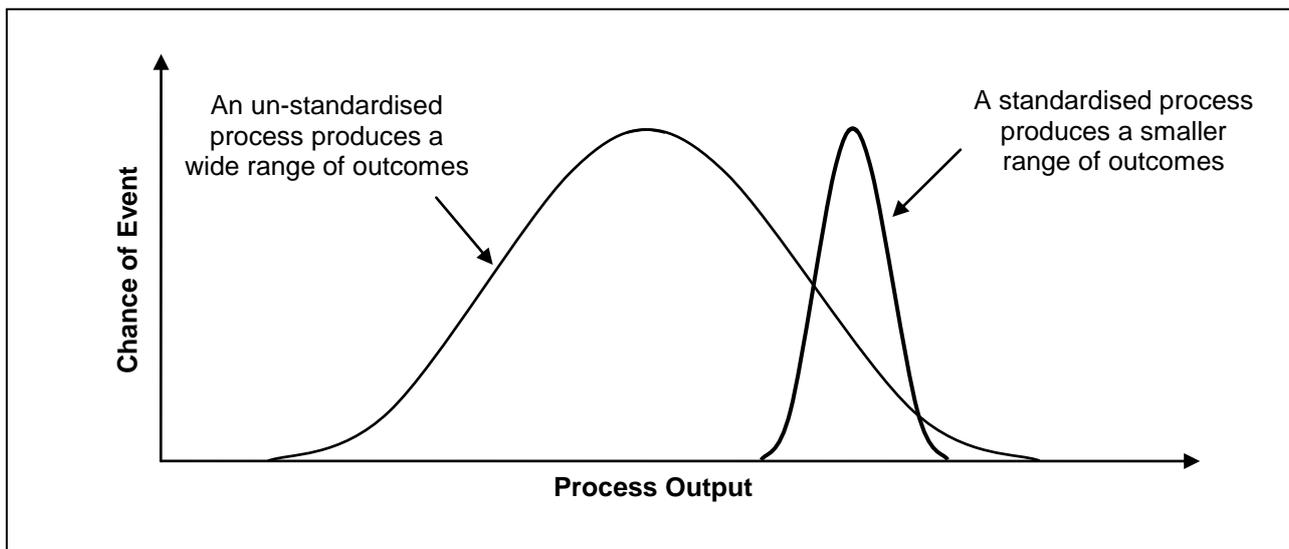


Figure 8 – The Effect of Applying Standardisation on Process Results

However, standardising a process did not guarantee that it was the best method for achieving requirements. In Figure 9 the standardised process produced fewer variations, but its output is not to specification. In such cases the Japanese repetitively applied the Deming Cycle (Plan-Do-Check-Act) to trail new methods and learn which produced better results. Through experimentation, testing and learning they continually improved the process until the outputs met the requirements.

The Japanese learnt that they could change their business processes to produce the results they wanted. It did not matter how much variation existed, because if it was due to the process, they changed and improved the process. If the variation was due to external special causes, they found and removed them. The approach used by the Japanese to build high-quality processes is shown in Figure 10.

³ Bodek, Norman., 'Kaikaku - the Power and Magic of Lean – A Study of Knowledge Transfer, PCS Press, 2004
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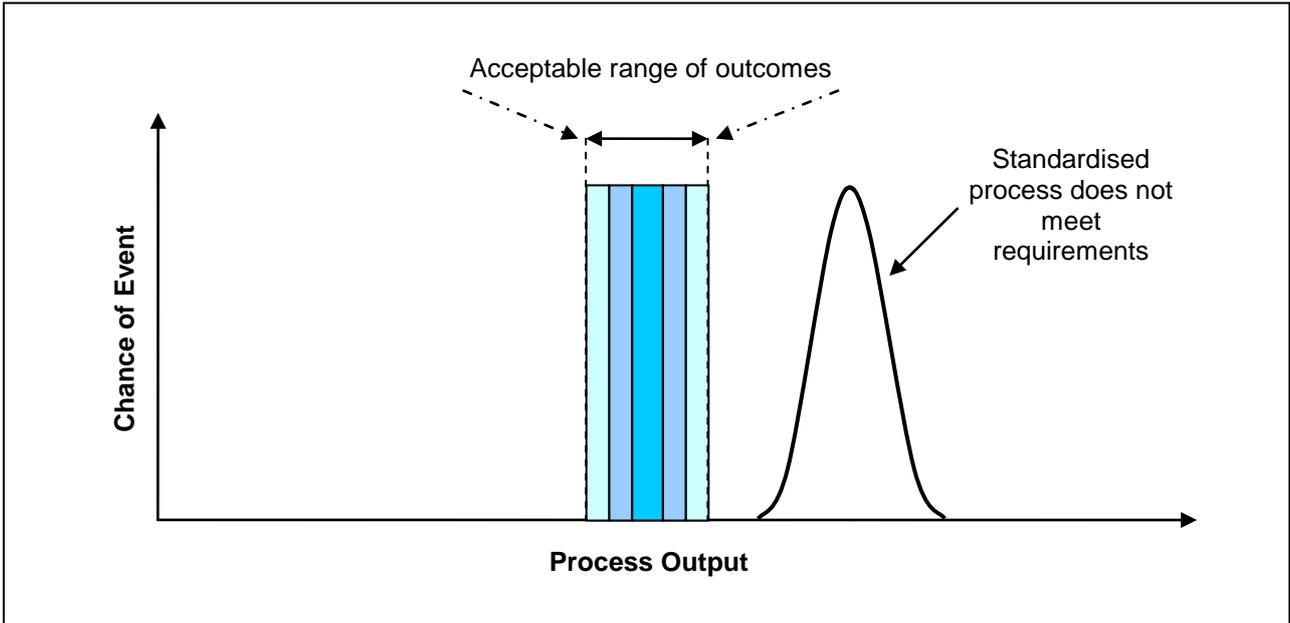


Figure 9 – Process Results do not Meet Specification

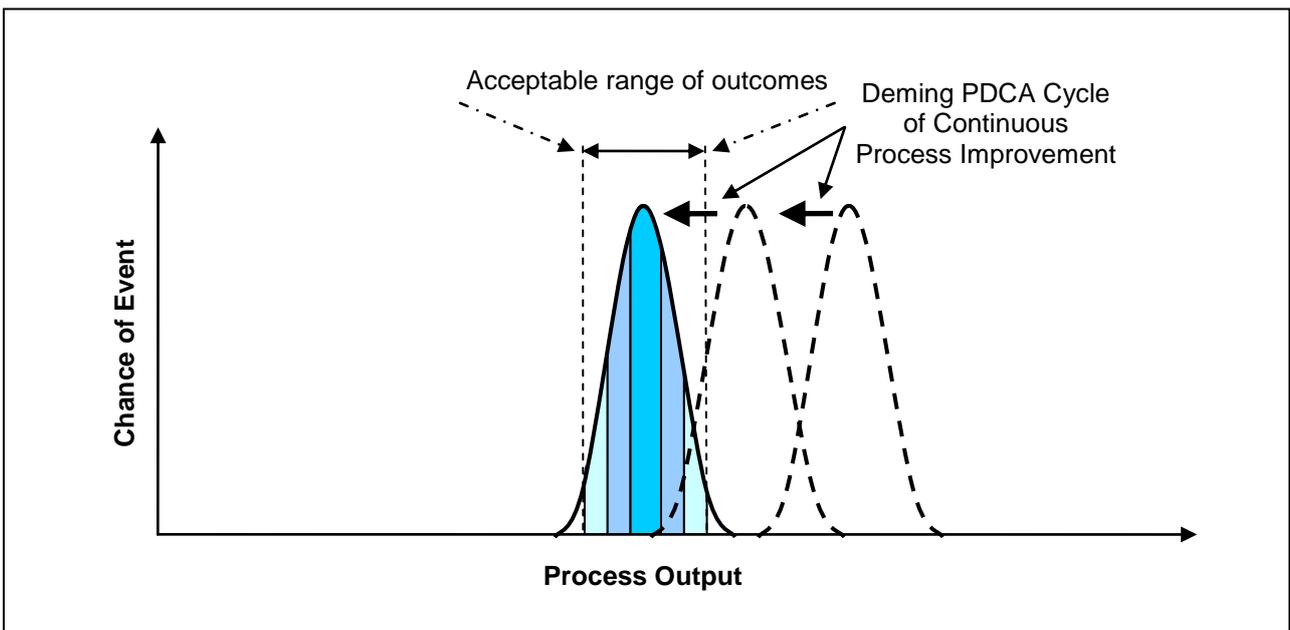


Figure 10 – Altering Process Performance to get Desired Results

You need to do the same in your business whenever a process cannot reliably produce the required performance. Figure 11 reflects what to do to create a process with excellent outcomes starting with any poorly performing process. First identify what is excellent performance. Then plot the outputs of your current process and see if they meet those requirements. If too many results are unacceptable, redesign the process and standardise on one way, and one way only, for work to be done. Then make the changes and run the new process. If the results are not to requirements, check if special causes are present that prevent compliance and remove them. If the process still does not meet requirements with all special causes removed, then you know the process is not capable of doing so. When only common cause problems prevent achievement of requirements, the process needs to be redesigned and changed to one that can deliver the necessary quality. You will know what changes to make from the learning made in trying to improve the process. This was the

method Japanese industry learnt from Deming and used to move their businesses to world-class performance.

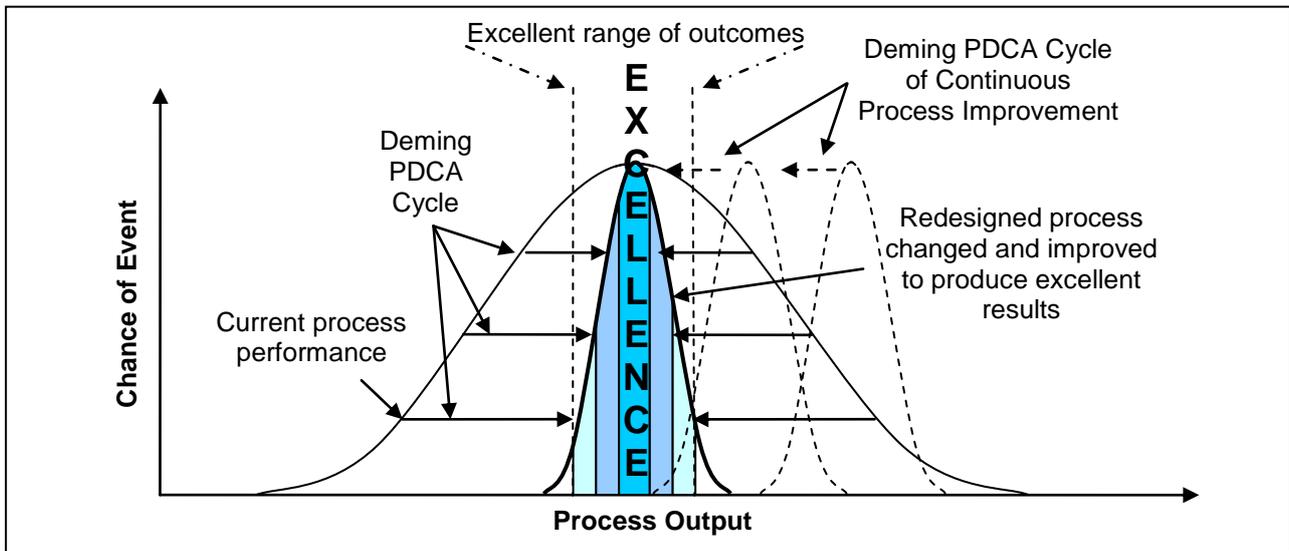


Figure 11 – Processes can be changed to Deliver Excellence

If a business process produces excessive errors, for example there is too much rework, it is necessary to investigate if it failed to meet the standard because of a process problem or because of a special cause problem. In his book ‘Out of the Crisis’ Deming provided an example of analysing the error rate per 5000 welds from eleven welders⁴. Deming calculated the process error limits and put the upper control limit at 19; implying the process error naturally lie between 0 and 19 errors per 5000 welds. Any results less than 19 errors per 5,000 welds were within the process variation and were normal results from the process. Nothing could be done about it because that was how the process was designed – it could make anything from 0 to 19 errors due to its natural volatility. Those results outside of the process limits were special-cause related and need to be corrected.

Figure 12 shows his analysis on a Shewhart control chart. Welder 6 is outside of the process. There are special causes affecting his performance. Deming never blamed people for poor performance, he knew that the vast majority of faults lay with the systems designed by management in which they worked (by his estimate 94% of quality problems were system caused). Deming suggested the investigation consider two issues. The first was to look at the work stream to see if it was exceptionally difficult material to weld or the welds were in difficult locations. If the job difficulty was the problem then no more needed to be done because the problem was not with the person and as soon as the job returned to normal the welder’s performance would too. The second factors to examine were such things as the condition of the equipment being used, the quality of his eyesight, and other handicaps, like problems at home or his health.

What Deming did with the control chart was to get the process to talk to us. He was trying to show us how to understand our businesses and their performance. Error in a process is a random event and the probability of errors forms a normal distribution. By showing error on a control chart and defining the 3-sigma limits of the normal distribution the data belongs to, you can immediately see if the error is likely caused by the system volatility or by something outside the system. If it was a system cause then the data falls within the natural normal distribution of errors produced by the system – it is inside the number of errors you would expect from running the process normally. If it is a system error it is no one’s fault – it is just how the system works due to its design. Only the

⁴ Deming, W Edwards., ‘Out of the Crisis’, MIT Press, 2000 edition, Pg 256

performance of Welder 6 was unexplainable, all the other welders have made no more errors than the system was designed to make.

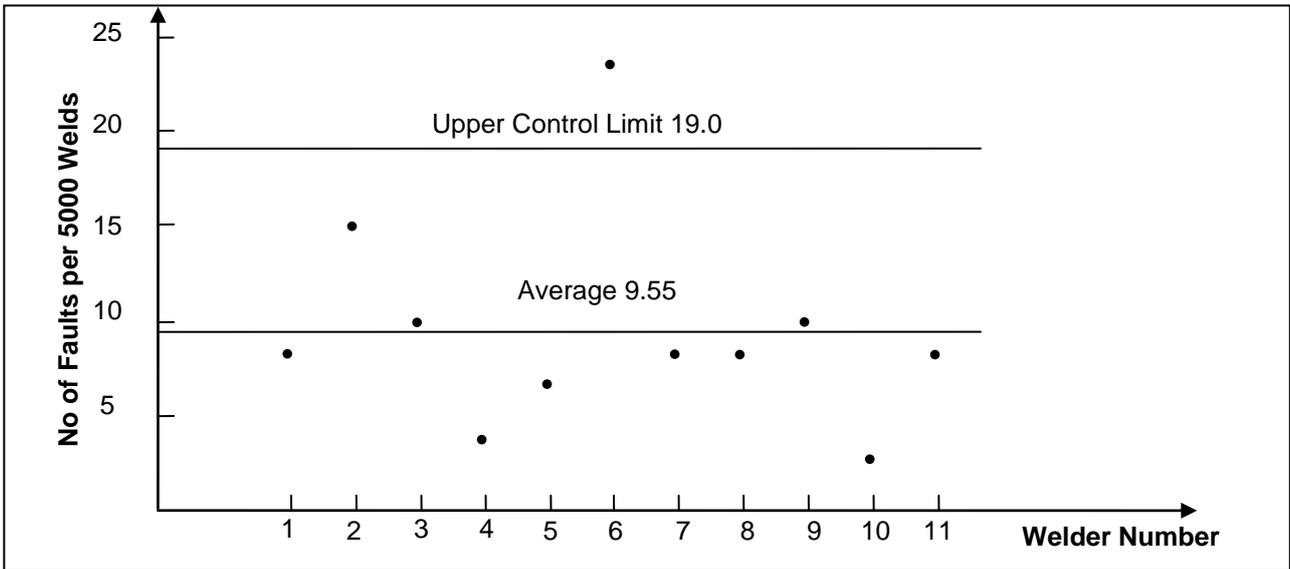


Figure 12 – Welding Process Control Chart

Figure 13 shows the measured welding results assuming the frequency of failures matched a normal distribution. It also shows the new distribution if the process was redesigned to produce an average of four faults per 5000 welds. To move from the current average of 9.55 faults per 5000 welds to an average of 4 would require an improved process with much less variation than the existing one. Deming said, “Overall improvement ... will depend entirely on changes in the system, such as equipment, materials, training.” He listed possible factors to consider, including getting the eyesight of all welders tested, reducing the variation in material quality, changing to material that was easier to weld, providing improved welding equipment, developing better welding techniques and retraining poor performers. To get fewer weld failures from the group of welders it would be necessary to change the design of the process to one with lower average number of faults.

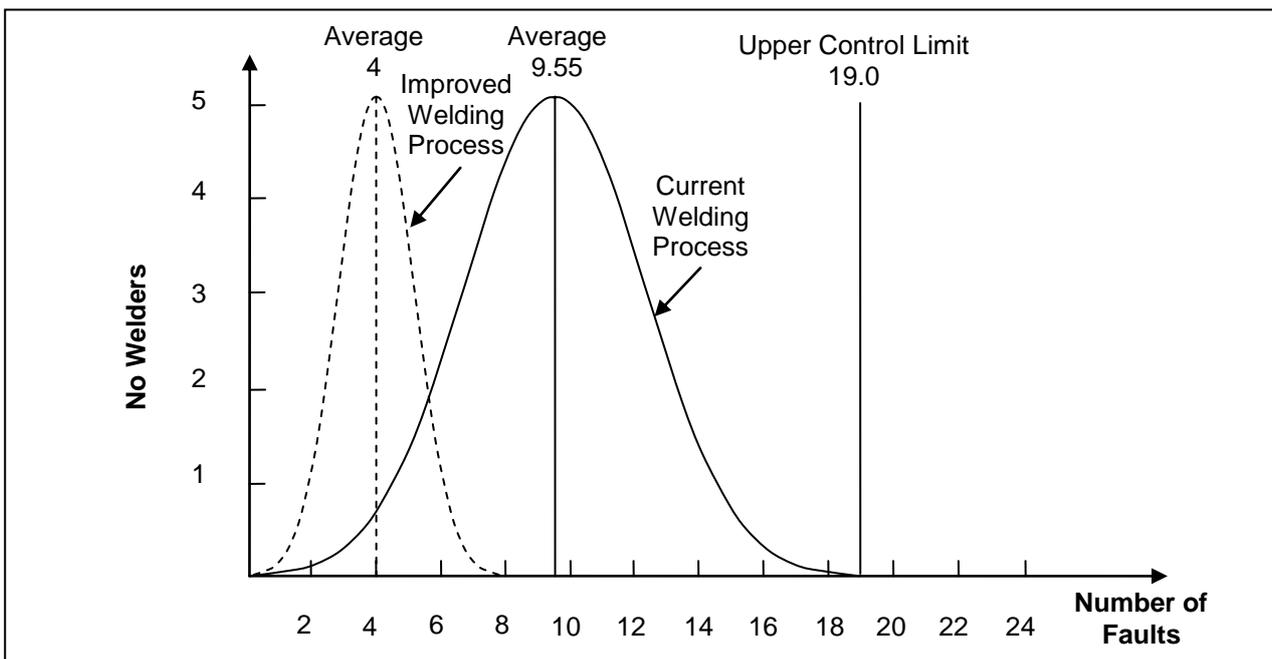


Figure 13 – Welding Fault Distribution

To have an operation where good results are natural and excellence abounds it is necessary to ensure variation in a process is controlled to within the limits that deliver excellence. It needs a standardised system of producing excellence to be developed and then followed. In a series process this means accuracy in every step, without which one cannot get excellent process outputs. World-class operations recognise the interconnectivity amongst processes and work hard to ensure everything is right at every stage in every process. This was Deming's purpose – to help businesses learn to control variation in their processes so the outcomes always produced top quality products that customers love. This too is our job – to help our business learn to control variation so its processes deliver excellence.

My best regards to you,

Mike Sondalini

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