

Understanding Variation

(Stephen Halliday)

“Variation there will always be, between people, in output, in service, in product. What is the variation trying to tell us?”

(Deming)

“Of all the issues that an Engineer has to resolve, dealing with variation is the most difficult.”

(T. Davies, Ford)

A key element in achieving Operational Excellence is to identify sources of variation that affect a process, product or service. Once identified the key sources can then be earmarked for attention.

The current focus on Six Sigma, as a methodology to achieve Operational Excellence, has at its roots a focus on variation.

“The objective in driving Six Sigma performance is to reduce or narrow variation to such a degree that six sigmas – or standard deviations – can be squeezed within the limits defined by the customer’s specifications.”

(Pande)

An important part of the Six Sigma model is the measurement phase. This produces the data that shows how much variation is present in the process. Once identified, the Six Sigma tools are then used to reduce this variation.

There are two basic sources of variation:

- Common Cause variation
- Special Cause variation

Common Cause variation is created by many factors, that are commonly part of the process, and are acting totally at random and independent of each other. Their origin can usually be traced to the key elements of the system in which the process operates. (Materials, Equipment, People, Environment, Methods). If only common causes of variation are present, the output of a process forms a distribution that is stable over time.

Special Cause variation is created by a non-random event leading to an unexpected change in the process output. The effects are intermittent and unpredictable. If Special Causes of variation are present, the process output is not stable over time and is not predictable. All processes must be brought into statistical control by first detecting and removing the Special Cause variation.

Dr. W. Edwards Deming introduced the terms Common Cause and Special Causes to business, although he assigns the first usage to W. Shewhart.

An understanding of the type of variation being observed is important if the correct course of action is to be taken.

“A fault in the interpretation of observations, seen everywhere, is to suppose that every event (defect, mistake, accident) is attributable to someone (usually the nearest at hand), or is related to some special event. The fact is that most troubles with service and production lie in the system.

We shall speak of faults of the system as common causes of trouble, and faults from fleeting events as special causes.”

(Deming)

Many involved in Six Sigma recognise the importance of this distinction.

“One of the most important things Deming taught me is that management must master the concept of common cause versus special cause variation.”

(Eckes)

Not everyone makes this distinction. It is interesting that Mikel Harry in his book “Six Sigma” does not use the terms in identifying sources of variation, implying by omission that distinguishing between Common Cause and Special Cause variation is unnecessary.

It is important to distinguish between the two types of variation because they require different approaches to deal with them.

“There are different improvement strategies depending on which type of variation is present (common cause or special cause), so it is important for a team to know the difference.”

(M.L. George)

“This type of variation (common cause) requires a long-term strategy to identify, understand and reduce it through on-going process management and improvement. Special causes of variation, inherently unnatural in origin, require quite different and immediate action.”

(G. Tennant)

If the type of variation is not identified then it is highly likely that the wrong tools will be used.

Although many advocates of the Six Sigma methodology state that different tools are required to deal with the two types of variation, few make any attempt to explain the difference. Hence the danger, and this is especially true for Six Sigma, is that Common Cause tools will be used to deal with a Special Cause.

“In analysing variation there are two kinds of mistakes we could make:

1. *We could mistake the cause of variation as being special in nature, when in fact it is random and caused by the system (common cause)*
2. *We could mistake the source of variation as being systemic in nature (common causes), when in fact it is special in nature (special cause) and can and should be identified and, if possible eliminated”*

(R. Aguayo)

There is no debate that the tools taught in Six Sigma can be used to significantly reduce Common Cause variation but what of Special Cause?

Some teaching ignores Special Cause and treats all variation the same – a serious mistake as mentioned by Aguayo. Others limit the appropriate tools to the “five whys” and a Cause and Effect diagram. Although useful, they have limited success in rapidly identifying the root cause of special variation.

The five whys suggest that by continually asking “why”, it is possible to move from a symptom towards root cause. If the situation is fully understood then the root cause itself may be identified. However, in many Special Cause situations, the answer to at least one “why?” is “don’t know”. At this point the Cause and Effect diagram is used.

It is not difficult in such situations to generate 10 to 20 ideas and may even reveal more than 100. With so many possible causes the most likely causes are chosen and tested. The process at this stage relies on the root cause being identified through experience and can result in much testing.

A more robust methodology for dealing with Special Cause variation is available. Such methodologies have been in existence long before Six Sigma appeared on the scene. These are often referred to as Special Cause Problem Solving or simply Problem Solving methodologies. Typical approaches to dealing with Special Causes are:

- Problem Analysis (Kepner Tregoe)
- Global 8D (Ford)
- R.I.S.E. (wdp consulting)

Their vocabulary may differ but their basic approach is similar. A key part of the methodology is to identify changes, a point recognised by George without any methodology to investigate the situation.

“To eliminate a special cause of variation, you need to investigate what is different or changed in the process – something that isn’t always evident.”

The model for Special Cause Problem Solving has similarities to the DMAIC model of Six Sigma, however as mentioned previously the tools differ.

Example: R.I.S.E.

Recognition – identify the situation (Define)

Investigate – gather facts, identify and verify root cause (Measure, Analyse)

Solution – identify and implement the best solution (Improve)

Evaluate – evaluate effectiveness and transfer knowledge (Control)

The tools used in Special Cause Problem Solving are Sub-dividing and stair-stepping, Problem Profile Analysis, Differences and Changes, Test Matrix, Selection Analysis and Planning and Problem Prevention.

Within these methodologies is a term that can cause confusion and that is the word “Problem”.

Problem: - a deviation from expectation with cause unknown.

This very definition of problem places this methodology in the Special Cause arena. Obviously, if the root cause of the Special Cause is known then the methodology is not required since all that is needed is to verify that the root cause has been found and identify solutions.

Unfortunately, Six Sigma itself is referred to as a problem solving methodology.

“The ‘problem-solving’ methods of Step 4 – Process Improvement and process Design / Redesign – are most powerful when driven by a wider focus and long-term perspective.”

(Pande)

As can be seen from the above quote, Six Sigma is a process improvement tool and not, in its purest form, a problem-solving methodology. That is, Six Sigma deals with Common Cause variation.

However, no process can be improved if Special Cause variation remains present. Thus, there is a need for an understanding of both Common Cause and Special Cause tools. Unfortunately, in many Six Sigma training courses, this latter issue is ignored.

Conclusion

Understanding variation is important if a process is to be improved. It is critical that the two sources of variation, Common Causes and Special Causes, are identified and handled using the appropriate tools. Six Sigma tools can be used to reduce Common Cause variation but not before the Special Cause Problem Solving methodology has been used to remove Special Cause sources of variation.

A final word from Deming:

“Confusion between common causes and special causes leads to frustration of everyone, and leads to greater variability and to higher costs, exactly contrary to what is needed.”

References

Peter S. Panda, Robert P. Neuman and Ronald R. Cavanagh, *The Six Sigma Way* (McGraw-Hill 2000)

Geoff. Tennant, *Six Sigma: SPC and TQM in Manufacturing and Services* (Gower 2000)

W. Edwards Deming, *Out of the Crisis* (Massachusetts Institute of Technology, Centre for Advanced Engineering Study 1986)

George Eckes, *The Six Sigma Revolution* (Wiley 2001)

Rafael Aguayo, *Dr Deming* (Fireside 1990)

Michael L. George, *Lean Six Sigma* (McGraw-Hill 2002)