SIX SIGMA SEEN AS A METHODOLOGY FOR TOTAL QUALITY MANAGEMENT

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Abstract *Six sigma programs are raging through corporations worldwide, with some corporations citing savings in the $US billions resulting from six sigma implementation. Six sigma has both proponents and detractors with some arguing that nothing new is involved and others identifying it as revolutionary. The view espoused herein argues for six sigma as a methodology within the larger framework of total quality management – a blend of old and new in the sense that the tools of six sigma are often familiar ones, but are applied with an eye that is more strategically focused than historic use of those tools ordinarily indicates.*

Keywords *Six sigma, Methodology, TQM, Business excellence*

Introduction

Six Sigma has been launched all the world over and many companies testify to its pivotal role in their success (Hutchins, 2000). Well-known examples of Six Sigma companies include Motorola, General Electric, AlliedSignal (now Honeywell), ABB, Lockheed Martin, Polaroid, Sony, Honda, American Express, Ford, Lear Corporation and Solectron.

Why Six Sigma? That is much like asking the question "why employee empowerment?" The answers of course are many and varied, but ultimately when business enterprises are involved there must be a well-founded business case made for such initiatives or approaches. In the case of employee empowerment the business case is one founded on the principle of providing – in as near to real time as possible – customer satisfaction, which should ultimately contribute to the bottom line financial results of the enterprise. Six Sigma is much the same in that many enterprises have been able to demonstrate that Six Sigma has generated substantial return on the investment made in its implementation (McClusky, 2000).

But what is Six Sigma? Is it really something new, or is it merely the familiar repackaged? This and other questions are being asked throughout the quality community – and that despite the fact that Six Sigma dates from the mid-to-late 1980s. Not surprisingly, the answer depends on the respondent as this is not simply a 2 + 2 = ? Instead, the answer seems to depend on the background in which one is steeped. Consider, for example, the following question distributed to selected members of the American Society for Quality in a 19 December 2000 on-line opinionnaire:

Which of the following statements best expresses your opinion of Six Sigma as a quality tool (pick one)?

- Six Sigma is a set of historically known and used statistical techniques, in a new package.

- Six Sigma is an effective application of statistical techniques, delivered in an innovative manner that has achieved acceptance, use and results by the management and associates of many organizations.
- Six Sigma is a fad.
- Six Sigma is not a technically rigorous approach.

Why are some companies able to achieve documented high levels of success that they attribute to application of a Six Sigma approach? In this paper we endeavour to explain our view of Six Sigma and, above all, to put Six Sigma in the larger context of total quality management (TQM). In essence, we provide our response to the above question from ASQ and justification thereof. The first option is consistent with the work of Breyfogle (1999), the second with that of Harry and Schroeder (2000), the third would appear to be naïve, and – we think – the last is an uninformed one. As will be seen, we embrace the second vision of Six Sigma and believe that the use of the word "tool" in the posing of the question is in itself revealing.

Six Sigma origins

The history of Six Sigma is a well-documented one and hence we note only briefly here that its origin as a quality improvement approach in the 1980s can be traced to the American electronic giant, Motorola where a goal of improving all products – goods as well as services – by an order of magnitude (e.g. a factor of ten) within five years was established. This provided an important focus on the improvement rate and, in particular, that simply "better" may not be sufficient, but that the critical consideration is that of becoming sufficiently better expeditiously. Six Sigma clearly focused resources at Motorola, including human effort, on reducing variation in *all* processes, that is to say manufacturing processes, administrative processes and *all other* processes. To set a clear measure on the improvement work, the program called Six Sigma was launched in 1987.

The reason for the name was that "sigma" is a statistical measure related to the capability of the process, that is, its ability to produce non-defective products/units/parts. In statistical jargon sigma is a measure of process variation referred to as the standard deviation and "six sigma" generally implies occurrence of defects at a rate of 3.4 defects per million opportunities (DPMO) for defects to arise. Note that this almost certainly implies more than 3.4 defective units per one million units, since typically any given unit is sufficiently complex so as to allow multiple opportunities for defects to occur.

It is generally possible to calibrate the "cost of quality" or – more accurately – the "cost of poor quality" (CPQ) with the sigma level at which processes perform. Six Sigma performance levels are generally considered to be world class with the CPQ being less than 1 per cent of sales. By contrast sigma levels of three, four, and five produce DPMO rates of 66,807, 6,210, and 233, and corresponding CPQ ranges of 25-40 percent, 15-25 per cent, and 5-15 percent. These numbers substantiate the importance of reducing process variation across all key primary and support processes in an organization as well as variation of that obtained from suppliers. Without significant divergence from our discussion this clearly illustrates sound reasoning behind reduction in the number of suppliers used by an organization that extends beyond negotiation/relationship issues into statistical ones. A straightforward example of process sigma level estimation is provided in the first chapter of Harry and Schroeder (2000).

Signs of significant success at Motorola quickly became apparent. In fact, from 1987 to 1997 Motorola achieved a fivefold growth in sales with profits climbing nearly 20 percent per year, cumulative savings at $US14 billion and stock price gains compounded to an annual rate of 21.3 percent. Motorola was also cited as the first winner of America's Malcolm Baldrige National Quality Award in 1988.

Soon other companies became interested in the program and successively more companies were able to demonstrate good results. As examples, AlliedSignal attained savings of $US2 billion during a five-year period while General Electric saved $US1 billion over a two year window. Indeed, "big dollar impact" is one of five key reasons cited by Hoerl (1998) for the success of Six Sigma. The other four reasons cited by Hoerl for Six Sigma success are ones that any quality advocate should embrace: continued top management support and enthusiasm, emphasis on a quantitative and disciplined approach to process improvement, value placed on understanding and satisfying customer needs, and the manner in which it combines right projects with the right people and tools.

One "small-scale" example from Sweden that should serve to encourage application in small and medium-sized enterprises can be found at the Solectron factory in Östersund, formerly Ericsson Network Core Products AB, where AXE switchboards are manufactured. In this company of approximately 1,000 employees, the year 2000 saw 14 people attending a seven month Black Belt (deep knowledge in Six Sigma philosophy and methods) education program on a half-time basis, 20 more people attending a two-day course on Six Sigma, and ten people in the top management group attending a one-day course on Six Sigma. Six Sigma applications at this factory saved about $US0.5 million during the first ten months of 2000 – about $500 per employee over the entire employee base, but closer to $10,000 per employee trained in Six Sigma methods. In the early stages of Six Sigma program implementation these

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figures indicate something on the order of simple cost recovery with return on investment promised for the near future, since many companies have reported savings on the order of $150,000 per Black Belt project with each Black Belt completing four to six such projects annually.

Is Six Sigma really something new?

While typically applied consistently within a company, the content of the Six Sigma approach varies from company to company, consultant to consultant, and author to author. Generally, however, Six Sigma programs do have some common features, among which are the following:

- It is a top-down, rather than bottom-up approach.
- It is a highly disciplined approach that typically includes four stages: measure, analyse, improve and control.
- It is a data-oriented approach, making sound and heavy use of various statistical decision tools.

It is our position that from a content perspective Six Sigma does not, in principle, contain anything new. Its focus on processes and variation is central to what is historically thought of as "quality control" and can be found in works by W. Edwards Deming and Walter A. Shewhart. Design of experiments and statistical process control, both of which are featured in Six Sigma programs, are not new – though their proactive use to improve processes and products is certainly laudable. Systematic application of quality tools such as Pareto diagrams and Ishikawa diagrams in Six Sigma is praiseworthy, but it is with good reason that these are counted among the so-called "old tools" of quality as these were developed by the late Kaoru Ishikawa of Japan during the 1950s.

So what is it, if anything, that is new about Six Sigma?

Reed (2000) contends that there is nothing at all new about Six Sigma and that it "has been around for many years, just called something else". She goes on to say that Six Sigma "could be called problem solving, team building, SPC, plan, act, do, check, whatever you want . . .".

Carnell and Lambert (2000) assert what we all know – that Six Sigma is no silver bullet and that like most change processes involving people it is difficult to institutionalise. The perspective offered by these two "in the trenches" Six Sigma professionals is that it is a tactical tool of great value in achieving operational excellence. Operational excellence is, of course, required for the overall attainment of business excellence – something that also requires customer-related, financial, and marketplace performance excellence (Edgeman, 2000).

We believe that the "new" of Six Sigma is its explicit linking of the tactical with the strategic. That is, what is new in Six Sigma is that efficient, often statistical, techniques are used in a systematic way to reduce variation and improve processes and there is a focus on results – including customer-related ones that lead to enhanced marketplace performance and hence improved bottom-line financial results.

The point is that Six Sigma is of great value in attainment of business excellence and measurement of that progress so that appropriately configured and deployed Six Sigma programs may be highly consistent with the results-orientation underlying various international quality awards, such as the European Quality Award, America's Malcolm Baldrige National Quality Award, the Canada Excellence Awards, and the Australian Quality Award. Mikel Harry[1], key developer and proponent of the Six Sigma program at Motorola, has defined Six Sigma as "a disciplined method of using extremely rigorous data gathering and statistical analysis to pinpoint sources of errors and ways of eliminating them". Well-known statistician and quality consultant Ron Snee (2000) has indicated that "Six Sigma should be a strategic approach that works across all processes, products, company functions and industries" and Bajaria (2000) reinforces this idea – a "nuts and bolts" point-counterpoint discussion of each of 14 key Six Sigma ideas.

In order to efficiently use statistical tools to base decisions on fact, substantial effort and resources are dedicated to education and training of staff members. Responsibility and authority are distributed in a structured way by using a "belt" system similar to that used in Korean karate, to identify experience and mastery of Six Sigma tools and application thereof.

Indeed, the terms "green belt", "black belt" and "master black belt" convey particular meanings within the Six Sigma vocabulary.

Here Six Sigma has actively contributed to the creation of a comprehensive infrastructure within the practising organization that includes clear routines for control and reporting. It is a non-trivial issue, however, as regards how to get more people – not only Black Belts and other formalised problem solvers – involved in conquering mental barriers and using statistical methods more routinely in daily work. For example, understanding of variation has been pointed out as an important aspect for successful implementation of a Six Sigma program and has been featured within the Deming management approach for several decades.

Six Sigma seen contextually

Six Sigma provides a structured means of pushing product and process improvement, but we do not see it as an alternative to TQM. It is important, instead, to position Six Sigma in a larger context. As illustrated in Figure 1, we regard TQM as a management system consisting of values, methodologies and tools that aims to improve customer satisfaction with a reduced amount of resources. TQM starts in most descriptions from values such as the six provided in Figure 1: focus on customers, focus on processes, base decisions on facts, let everybody be committed, improve continuously and top management commitment[2]. These values contribute to creation of organizational culture. To attain this, the values have to be supported, systematically and continuously, by suitable methodologies and tools.

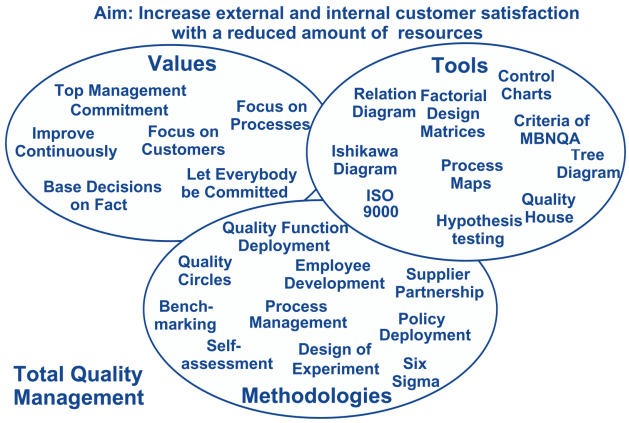
Of course, "everybody's commitment" cannot be obtained by simply proclaiming that "it is one of our deeply held organizational values". As is commonly said, the proof is in the pudding and organizational values reflect organizational practices so that "everybody's commitment" and other values can be made part of the organizational fabric through use of suitable methodologies in such a way that the values permeate the work being done, whether that work is performed by improvement groups or through goal deployment to individual goals. Robust and sturdy tools are also needed to support, systematize and facilitate the work. As examples, Ishikawa diagrams and Pareto diagrams are tools commonly used by improvement groups whereas deployment of goals might well be facilitated through use of matrix diagrams. These are reflective of approaches that may assist in embedding a value for fact-based decision-making in the organization's culture. An organizational value of focusing on processes can be obtained through use of Process Management, but within that methodology tools such as process maps and control charts are needed to map and control key organizational processes.

In building or transforming an organizational culture we must identify those values that we desire. We should then choose methodologies supporting those values and finally tools supporting those methodologies. Methodologies are not unambiguous but naturally some steps within a methodology may differ depending on the situation or organization. Of course, some methodologies may support several values and in general we need to employ multiple methodologies to support the various values. More or less random acquisition and employment of methodologies and tools that do not support organizational values should be avoided.

With this view it is obvious to us that Six Sigma is a methodology within TQM. The reason why this methodology has been so successful is that it is structured and systematic and uses several efficient tools. But it is also important to note that Six Sigma in fact supports all six values in Figure 1. Methodologies, supporting several values are important to the success of TQM. Six Sigma also illustrates that the management system is dynamic. New methodologies and new tools will appear and be developed and Six Sigma is an excellent example of this. But still Six Sigma is a methodology within – not an alternative to – TQM in much the same way as business process reengineering launched in the 1990s by Hammer and Champy (1993) is.

The main conclusion of this article related to application of Six Sigma methodology by an organisation is the following: Six Sigma is a methodology that might cut costs for your organisation;

Figure 1 — Total quality management



Note: Total Quality Management (TQM) can be seen as a continuously evolved management system, consisting of values, methodologies and er tools. The aim of the system is to increase external and internal custom , satisfaction with a reduced amount of resources. It is important to note that the techniques and tools in the figure are just examples and not a n complete list. In the same way the values may also vary a little betwee) different organisations and over time. (From Hellsten & Klefsjö, 2000.

however, think about how the Six Sigma methodology supports the values of your organization and how you choose the tools and, above all, do not forget the totality of TQM.

Suggestions for further reading

The idea of looking at TQM as a management system of values, methodologies and tools is further discussed by Hellsten and Klefsjö (2000). More about Six Sigma and its implementation can be read in, for example, Pande *et al.* (2000), Pyzdek (2000), Hahn *et al.* (2000) and Sanders and Hild (2000). The importance of knowledge about variation is discussed by Bergman and Kroslid (2000). Wiklund and Sandvik Wiklund (2000) discuss Six Sigma related to organisational learning.

Notes

1. Six Sigma is sometimes called "cowboy quality" in part because of the ranch and rodeo lifestyle of its main proponents Mikel Harry and Richard Schroeder.
2. The number of values varies between different sources. For example the European Quality Award is based on eight values and the Malcolm Baldrige National Quality Award is said to be based on 11 values. The six values in Figure 1 is the basis applied by Bergman and Klefsjö (1994).

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