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Six Sigma in the Southern Hemisphere

Bonzer or Bulldust?

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INTRODUCTION: EVOLUTION OF QUALITY MANAGEMENT AND SIX SIGMA

Various authors have charted the historical development of quality management from the age of craftsmen and artisans engaged in cottage industries and trades handed down throughout the generations (resulting in Western surnames such as 'Smith', 'Wright' or 'Cooper'), through the industrial revolution with its resulting mass production and inspection to the sophisticated management models of the later twentieth century and present day. These prevailing management models and approaches have themselves swung between highly mechanistic, structured, deterministic and mathematical techniques of traditional operational research (such as linear, nonlinear, goal or integer programming, method and work study, inventory control algorithms) and the softer, less mathematically prescriptive systems approaches associated with contemporary management science (incorporating approaches such as fuzzy logic, systems thinking, dynamic modelling or data mining).

The quality management (QM) field has gone through similar swings and roundabouts. From the hard, statistical thinking and techniques associated with certain prominent gurus such as Shewhart, Deming, Feigenbaum, Juran or Taguchi (including SPC, TQC, quality costing, experimental design, Taguchi's 'loss functions') at one end, through to the contextual, systems-oriented approaches of others such as Beckford (1998).

To illustrate the dichotomy, academic courses in quality are offered internationally out of both business schools and engineering schools. They effectively straddle the disciplines.

As figure 1 shows, Total Quality Management (TQM) emerged as a widely used term in the 1980s, and began to fall out of common use around 1994. There is considerable debate about what precisely became of TQM. It was variously reckoned to be replaced with Business Excellence (BE) and (Competitive) Continuous Improvement (CCI), to be still alive and well, and more recently to have been replaced by Six Sigma ("TQM on steroids"). Figure 1 charts the rise in use of the terms TQ, BE, CI and Six Sigma since 1990.

Prevailing theories of TQM have generally incorporated soft and hard elements, but as a general theme there is an over-arching emphasis on the need for management commitment and a solid understanding of organisational systems, coupled with the creation of a quality-conducive organisational culture supported by effective horizontal and

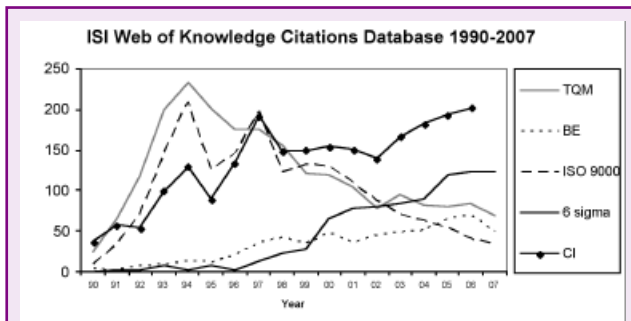


Figure 1 Citation frequency for common quality and improvement terms since 1990

vertical communication. Oakland (1999) originally referred to these as the ‘soft enablers’ of TQM. The ‘hard enablers’ included documented systems and procedures, the creation of interdisciplinary teams and the use by those teams of certain improvement tools and techniques to examine and question processes, and so bring about control and improvement (examples are SPC, the 7 old and new tools, experimental design, QFD, FMEA). Six Sigma represents a swing of the pendulum more towards the hard approach once again. It is a heavily tools-driven methodology, putting strong emphasis on the statistical and the mathematical tools. It does however, incorporate soft elements to some extent. It has recently been argued that Six Sigma facilitates an ‘organic’ approach to problem definition, but with a mechanistic approach to subsequent problem solution (Schroeder, Linderman, Liedtke & Choo, 2008).

There have been occurrences of the term Six Sigma in academic literature since the early 1990s. Although the search term sometimes appears within a context unrelated to improvement (since sigma is a commonly quoted statistical measurement), the first bona fide appearance in the journals and proceedings that comprise the ISI ‘web of knowledge’ database is that of (Fieler and Loverro 1991), who discuss Six Sigma manufacturing. Since then, the use of the term has increased to the present day as summarised in figure 1. Six Sigma is represented by the unbroken line in figure 1, shown alongside the other, common quality and improvement-related terms namely: TQM; Business Excellence (BE); ISO 9000; and Continuous Improvement (CI).

SIX SIGMA: EXTENT OF CURRENT USE

As is now largely common knowledge, Six Sigma was pioneered by Motorola in the 1980s, this process beginning

in 1982 when the CEO asked his corporate managers to cut quality costs by 50% in that year, and then continued making the same demand in subsequent years. By 1984, it had become clear further improvement would involve more and better analytical methods coupled with product design. The emphasis then focused on design quality and a number of advanced quality tools were employed which became Six Sigma (Hendericks and Kelbaugh 1998).

While the original emphasis was upon manufacturing processes, the Six Sigma approach soon spilled over into the support processes such as distribution, marketing and customer order processing (Smith 1993). Motorola eventually developed a Six Sigma curriculum and created practitioner qualifications. These early efforts led the company to winning the Malcolm Baldrige Award in 1988. Following the success of Motorola, the early proponents of Six Sigma included Texas Instruments, Allied Signal, Eastman Kodak, General Electric, Borg-Warner Automotive, GenCorp, Navistar International and Siebe plc.

Six Sigma has grown more ubiquitous over the past several years. The publication Industry Week in conjunction with the Manufacturing Performance Institute conducts an annual census of US manufacturers, to which over 600 manufacturers routinely respond. Figure 2 shows the data from 2003, 05, 06 and 07 in relation to the use of improvement methods and approaches. The data show that lean leads the way by a very clear margin, while all other methodologies are similarly enjoying a marked upswing from 2006 to 2007.

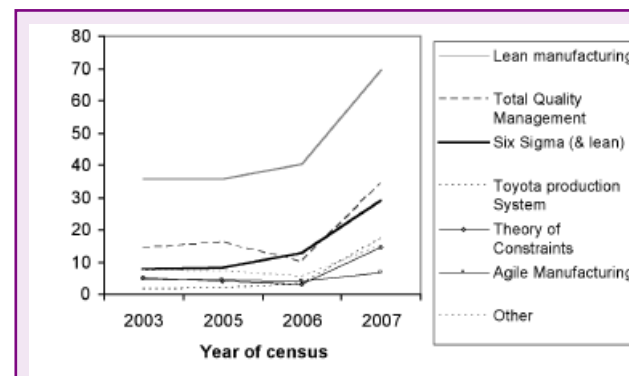


Figure 2 Change in use of improvement methods among US manufacturers over five years (2004 data missing). From data published by Industry Week.

A 2004 American Society for Quality (ASQ) survey of 600 CEOs in the manufacturing (180), service (220), healthcare (100) and education (100) sectors reported by Weiler (2004) revealed the pattern of awareness and use of certain quality techniques and practices summarised in figure 3. Six Sigma scored just under 50% in terms of awareness, and 15% in terms of use.

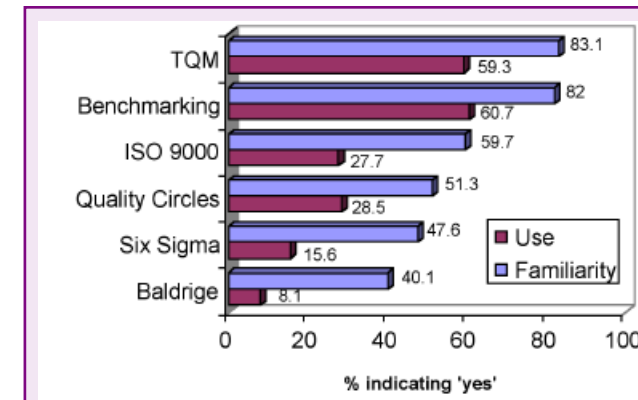


Figure 3 Awareness and use of quality techniques and practices (from Weiler, 2004)

A 2005 survey by ASQ confirmed that around 40% of US top executives were aware of Six Sigma (Okes 2006): figure 4 shows general awareness of various tools resulting from this study.



Figure 4 Top executive awareness of key improvement tools (Okes, 2006)

TOWARDS A CONCEPTUAL DEFINITION

Despite a sixteen year heritage and clear evidence of continued growth of the term, it is still being reported that there has been very little academic attention given to the phenomenon. In academic literature, there has been an identified lack of rigorous research examining the impact of Six Sigma on quality theory (e.g. Goffnet, 2004; Schroeder, Linderman et al. 2008; Zu, Fredendall & Douglas, 2008) or of study findings demonstrating effectiveness of Six Sigma interventions over the longer term or across a significant proportion of any industry sector, in terms of stock performance, shareholder wealth, or various operational performance measures. This research has previously been rigorously conducted done in relation to TQM and Business excellence, but Six Sigma is still at a relatively early stage of global interest. Academic attitudes towards it remains polarised, with, on one hand, proponents ‘overhyping’ Six Sigma, and on the other, detractors dismissing it as containing nothing that is new beyond the DMAIC cycle (Schroeder, Linderman et al. 2008).

According to (Kwak and Anbari 2006), Six Sigma has two major perspectives, or ‘lenses’ through which it can be viewed. Firstly, it originates from statistics and statisticians, and has a technical, probabilistic definition as given above. Secondly, it is viewed as a business strategy to improve business profitability, through improving the effectiveness and efficiency of all operations to meet or exceed customers’ needs and expectations (Antony and Banuelas 2001). Once described as “TQM on steroids”, (Anbari 2002) proposes that Six Sigma is more comprehensive than prior initiatives such as TQM and continuous improvement through having: more explicitly measured and reported financial results; additional and more advanced data analysis tools; greater use of project management tools; and a stronger customer focus. (Schroeder, Linderman et al. 2008) argue further that Six Sigma tools and techniques are similar to previous TQM approaches, but that Six Sigma provides an organisational structure not previously seen in TQM.

In response to the perceived need for definitive and unifying theory, (Schroeder, Linderman et al. 2008) have attempted to develop a single, unified, theoretical definition for Six Sigma that can underpin all subsequent research activity. This definition they have come up with is as follows:

“Six Sigma is an organized, parallel meso-structure to reduce variation in organizational processes by using improvement specialists, a structured method, and performance metrics with the aim of achieving strategic objectives.”

(Schroeder, Linderman et al. 2008)

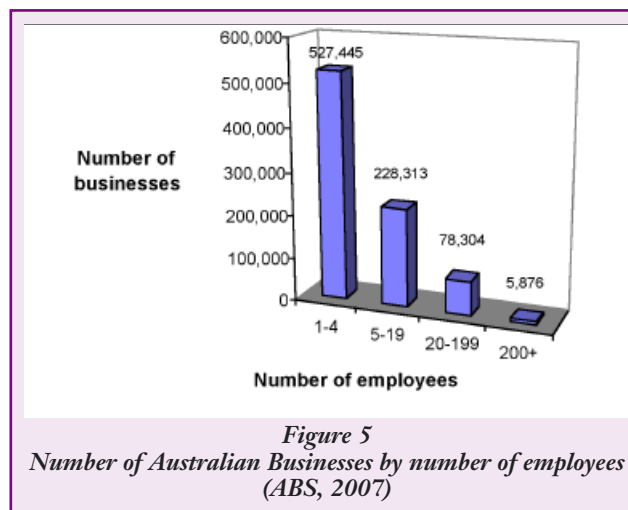
THE AUSTRALASIAN CONTEXT

In the marketing of Six Sigma courses, and in many of the conference presentations on the subject that I have attended over the past five years, it is frequently implied that since Six Sigma has resulted in multi million dollar savings or excellence awards for Motorola, G.E. and a number of other large, mature and highly-structured US-based firms, then it will, by some logical extension, also work for the majority of organisations in Australia and New Zealand. These early success stories have been so often repeated that they have come very close to being part of management mythology (definable as “a set of stories, traditions, or beliefs associated with a particular group or the history of an event, arising naturally or deliberately fostered”). This situation was previously seen in the Ford/Mazda billing process example that accompanied Business Process Reengineering (BPR). So is the assertion justified? Put another way: is Six Sigma bonzer or bulldust?

There are three main contexts for challenging or testing the assertion in the Southern hemisphere: Industry demographics, culture and quality maturity. These are examined in the following sections.

Demographic Context

In terms of demographics, firstly, figure 5 shows the size breakdown of Australian organisations, and table 1 gives a proportional comparison between Australia, New Zealand and the US (note that there are disparities between the size classifications owing to differences in the way in which national business demographic statistics are tabulated).



While the proportional distribution of Australian organisations is similar to that of the US up to the point of around 200 employees, clearly the US distribution has a much longer tail of very large organisations, as is summarised in table 2. This population of very large organisations provide a rich opportunity for the green belt / black belt / master black belt structure implicit within Six Sigma to be effectively utilised, and for Six Sigma to be maximally effective.

USA		Australia		New Zealand	
size	%	size	%	size	%
0-4	61.5	1-4	62.8	0-5	86
5-19	28	5-19	27.2	6-9	6.5
				10-49	6.4
20-99	8.7	20-199	9.3		
100-499	1.5			50-99	0.5
				100+	0.5
		200+	0.7		
500+	0.3				

Table 1
Proportion of businesses by number of employees: US, Aus and NZ (USCB, 2005; ABS, 2007; StatsNZ, 2007)

Number of employees	Number of firms
500 - 999	8,701
1,000 - 2,499	5,159
2,500 - 4,999	1,787
5,000 - 9,999	918
10,000 +	912

Table 2
US Organisation having over 500 employees (USCB, 2005)

As table 2 showed, the US have over 100,000 business that employ over 200 employees (including 17,500 with over 500 and over 900 firms with more 10,000 or more employees). This compares against 5,876 in Australia, and well under 1000 in New Zealand. According to Harry (1998), companies can achieve a 6% cost reduction each year when the ratio of black belts to employees is at its ideal value of one black belt for every 100 employees. It is reasonable to

infer that there is far less scope for black belts in Australia than in the US, and even less in New Zealand. For the predominant smaller, flatter organisations of Australasia, the hierarchical structure implicit within the Six Sigma belt methodology is unlikely to be appropriate. Very small organisations which are low on quality maturity will probably benefit most from having one or two green belt practitioners.

Research is being conducted, mainly in the UK, intended to demonstrate that Six Sigma translates into SMEs. It should be remembered, however, that the UK SME is defined as an organisation with 250 or fewer employees. SMEs in the Australasian context are very likely to be considerably smaller and considerably flatter in their structure than SMEs in the Northern hemisphere.

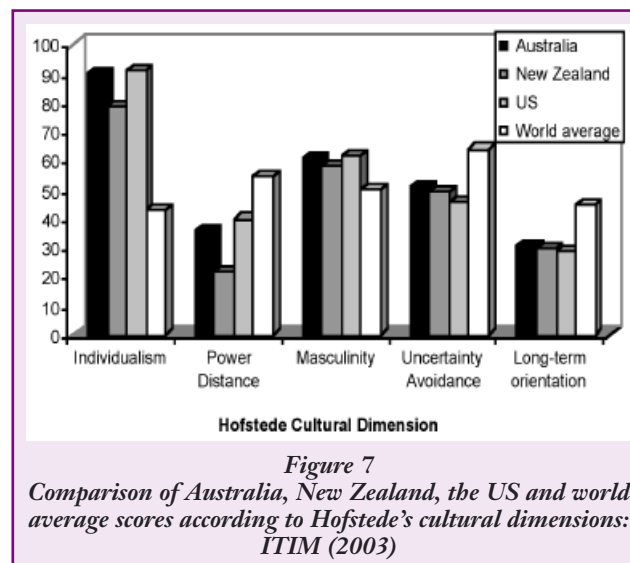
The potential danger to smaller organisation comes with investing significant amounts of budget in making employees very attractive to competitors. Investing in black belt training, for examples, carries the risk of losing the qualified employee very quickly, given the current interest in the method. Green belt training carries a lower risk and is likely to produce just as many benefits.

In terms of the sectoral constitution of the industry, as shown in figure 6, manufacturing accounts for 5.2% of Australia's overall industrial demographic, compared with 4.8% of the US, and so there are no marked differences in terms of the proportion of manufacturers.



Cultural context

National culture is often measured and compared using Geert Hofstede's cultural dimensions of Power Distance Index, Individualism, Masculinity, Uncertainty Avoidance, and Long term orientation. Without going into detail about these, as figure 7 shows, there is relatively little obvious difference between Australian and NZ cultural values and those of the US.



In their book the First XI, which was based upon extensive and rigorous research into the defining characteristics of the most successful Australian organisations, Hubbard, Samuel, Heap & Cocks (2002) summarise the aspects that typify 'winning' Australian organisations. They conclude inter alia the following three points: (1) winning is not about 'big, hairy audacious goals (BHAGs)'; (2) winning is not about a focus on profits; (3) successful organisations typically 'promote from within' (ibid p.226) rather than grafting expertise into the organisation. In these recommendations we can find some issues that relate to Six Sigma:

1. Six Sigma projects are judged on dollar value thereby placing the focus on profits;
2. The desire of an organisation to become six sigma capable could itself be seen as the classic example of a BHAG;
3. The practice of recruiting black belts into organisations in an attempt to 'get' Six Sigma clearly flies in the face of the advice to 'promote from within'. Certainly one has to consider the motivational effect on the existing employees

of an organisation, of expert black belts being recruited in from elsewhere to tackle or spearhead improvements on processes with which they are most familiar.

ORGANISATIONAL QUALITY MATURITY

Jack Welch (1992) discusses the firm's positioning in terms of its quality levels. He believes if a company is just short of attaining 100% compliance (the 'Wisdom' or 'certainty' stages of Crosby's Quality Management Maturity Grid; Crosby, 1980), then it needs a very sensitive approach to complete its objective. He believes that final few percent need to be placed under a 'magnifying glass.' Six Sigma is the 'Magnifying glass.' In other words, if your quality levels are below 3-sigma level, then it is cheaper to collect 'low hanging fruit' first using simple quality management principles.

It is in this respect that data are lacking to compare Australia with the US or other countries. Certainly one of the major differences observed in New Zealand is that NZ organisations exhibit generally low quality management maturity, with a few very notable exceptions, such as NZ aluminium smelters, winners of the 2008 NZ Business Excellence Award. This organisation has adopted Six Sigma effectively, and this has become part of their normal operating procedure. The majority of other organisations are somewhere between the 'inspection' and 'quality assurance' stages of maturity, whereby quality is a compliance-oriented activity and there exist no formalised, systemic mechanisms

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for questioning, improving on or learning from the processes. In such an environment Six Sigma cannot flourish and Six Sigma knowledge goes unused and unrecognised.

For an organisation low on the maturity scale, it will lack the mechanism and infrastructure to benefit from Six Sigma training for its employees. The knowledgeable employee merely returns to a situation where they are unable to put their learning into practice because of normal organisational barriers. The research is still to be carried out to reliably determine quality maturity levels in Australasia.

JUST HOW IMPERATIVE IS SIX SIGMA?

In *Out of the Crisis*, Deming (1986) argued that management should eliminate slogans, exhortation and targets for the work force asking for new levels of productivity. Six sigma - an approach based entirely upon such a performance target - does not refer to a methodology, but to a desired end-state hypothesised as resulting from the systemic application of long-standing quality tools in a structured manner. As a target it is not too dissimilar to Crosby's 'zero defects': near perfection and therefore virtually unachievable.

Toyota does not implement Six Sigma - they don't have Green Belts or Black Belts. They don't use measures like DPU, DPO, DPMO, Rolled Throughput, etc. They don't use DMAIC methodology, although they use simple seven step problem solving methodology more extensively. They keep things simple and use very few complex tools. For example asking "why?" five times is one of the most commonly used tool to find the root cause of the problem! Yet, they produce the highest quality cars with the fewest defects of any competing manufacturer in the world, and they have been doing this for decades. Organisations planning to implement Six Sigma are well advised to consider the following example extracted from Liker's (2005) book *The Toyota Way*.

"The CEO of a large automotive parts supplier wanted the Six Sigma program because of great success of GE and Jack Welch. He worked with a group of senior managers and executives to pick the right consultants to do the training and determine how many certified Six Sigma black belts were needed. The leadership team reasoned that recent college graduates with high grade point averages would be best suited to learn the complex statistical methods that are part of Six Sigma and decided to recruit bright young stars to become black belts. They recruited aggressively, offering a five-digit bonus and a brand-new car when they completed

the Six Sigma program and achieved the required dollar savings. Needless to say, they attracted some top-notch young recruits.

Unfortunately, these young recruits had little if any manufacturing experience and stepped into these rust-belt factories with the mission to "fix processes" when these factories had been operating for decades with a well-established culture. Word got out about the hefty incentives for the recruits, which caused some managers and engineers to wonder why they should help these "youngsters" successfully, complete a project when there wasn't any payoff for them. The employees with an affinity for lean claimed that the projects being turned in as Six Sigma projects were actually lean projects - cells, pull, etc.

In my view, by treating lean and Six Sigma as two tool kits and when setting up a situation in which different groups in the company go to war over whose tool kit is bigger and better, the company created a self-defeating improvement program. In this particular case, there was enough dissent over the large incentives for the Six Sigma recruits, as well as the awareness that experienced employees were actually helping them, that management ended up not giving out any of the cars. In the end, the company turned current employees into additional black belts. There still remained an uneasy tension between lean and Six Sigma, especially with internal lean zealots who viewed Six Sigma merely as tool kits. And the plant managers wondered what to do with the young black belts when they needed to move them into operational jobs, as their salaries were too high for the lower-level positions they were really suited for based on experience."

CONCLUSIONS

In the case of TQM, JIT, Lean and certain other interventions designed to bring about optimisation or improvement, the problem of failed attempts to implement them lies not with the programmes themselves but with the way the organisations use them. In the case of Six Sigma, the problem lies more with the programme itself. The Six Sigma method taken in its entirety (complete with belts, hierarchical rankings of expertise and associated implications for organisational structure), is not easily transferable to smaller, flatter organisations, such as those that typify the Australian and New Zealand demographic. Six Sigma also require a level of statistical knowledge and process analysis that is simply beyond what is necessary for an organisation at the early stages of its quality maturity. The following points of caution can be made for organisations seeking to engage with Six Sigma.

1. Quality Maturity: Low-hanging fruit first

Welch (1992) refers to the 'final few percent' of problems that need to be placed under a 'magnifying glass.' Six Sigma is the 'Magnifying glass.' Check Crosby's maturity grid. If you are in the 'wisdom' or 'certainty' stages, then Six Sigma is likely to work for your organisation. Otherwise, Six Sigma is not for you as your organisation is not yet ready for it. For these organisations, developing a systemic approach to problem, solving utilising teams armed with simple techniques the 7 tools, 5S and similar 'low hanging fruit' initiatives is likely to produce results and enhance maturity to the point where Six Sigma becomes viable.



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2. Beware high investment with uncertain return

The cost of training green belts and black belts can be high - well into the tens of thousands of dollars. The argument is always that this cost is immediately off set by the improvements which black belts achieve in the projects that are necessary for their certification. Can every organisation claim to have experienced these benefits from employees trained as black belts? Additionally, in countries with the populations of Australia and New Zealand, trained black belts are immediately valuable to employers on either side of the Tasman. There is a high risk of investing considerably only to very quickly lose your new champion.

3. Horses for courses: Australasian organisations are smaller than US ones

SMEs need to adopt Six Sigma according to the needs and availability of resources. For example they could implement Six Sigma with White and Yellow belt approach which is less costly, requires less overhead structure and can be implemented at their own pace. The potential savings per project with white and yellow belts is expected to be about \$25,000 (Antony, Kumar & Madu, 2005). When SMEs adapt Six Sigma this way, they are sometimes able to achieve faster and more impressive benefits than larger organisations due to their inherent agility.

4. There is a lack of accreditation in Six Sigma training

A fundamental irony about Six Sigma is that while it is a methodology with the primary aim of variability reduction, the worldwide provision of training is itself subject to variability. There is no single accreditation body governing the process of awarding yellow, green and black belts - and if the training has high variability, it is to be reasonably expected that the knowledge levels of trainers and recipients will be highly variable - and that the success with which Six Sigma is implemented in organisations will be highly variable.

The American Society for Quality (ASQ) offers certification to green and black belt level, which is available through AOQ. Other private organisations and consultancies will offer their own belt accreditation. There is, however, variability in the quality of training and grading, and the prospective trainee should be aware of the level to which the trainer him or herself is qualified in the techniques or approach that he/she is delivering, and of the degree to which the training is nationally or internationally valid.

To conclude, Six Sigma incorporates methods that are

tried and tested and appropriate to organisations of all sizes. It also contains a number of methods which are of no possible use to many organisations, or that require a level of analysis that is simply excessive (such as Taguchi methods and quality function deployment). Six sigma training still lacks accreditation and consistency, and there is likely to be considerable variability of knowledge between green belts, black belts etc. Organisations should attempt to develop their own experts, use what they find useful, and discard what is unlikely to be of practical benefit.

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