WHY SIX- SIGMA IMPLEMENTATION FAILS

How Six Sigma implementation focuses management attention away from core business matters

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ABSTRACT

In the late nineteen eighty's, Six Sigma replaced Total Quality Management (TQM) as the go-to management fad. And, as Lean Six Sigma, it remains a major force in today's business world.

This paper aims to understand Six Sigma, what is it, what is its technical background, how is it implemented and whether it has been successful in achieving its stated aim of enabling organisations to drastically improve their bottom line and improve their market position.

We look at the origins of Six Sigma, to understand the basic messages that make it more attractive to management than TQM, how it is implemented and why it is now out of fashion.

We look at the experience of four organisations that have gone for full scale implementation of Six Sigma across their organisation, and the long-term effects of these programs. Did they achieve the growth they expected, or did it focus management attention away from core business matters?

Six Sigma is an extremely vague concept. Don Wheeler described Six Sigma as *"a blend of tortured computations and incompatible, highly questionable assumptions having a hypnotic effect, often resulting in a suspension of critical thinking".*

Six Sigma captured the imagination of CEOs around the world. It offered high levels of net profitability by reducing *"errors",* no management transformation or culture change was required. When quality improvement projects are said to result in real savings, expanded sales opportunities, or documented improvements in customer satisfaction, upper management pays attention. It required little upper management involvement in day to day activities of Six Sigma project teams. All that was needed was a commitment to the resources needed to train personnel. In other words, set up a separate quality function using the Training Budget as a resource!

After twenty-five years of Six Sigma, there is no evidence of any lasting success. Only an endless parade of hollow promises, followed by failure after failure. Claims that companies saved billions and billions of dollars, year after year, are unsubstantiated.

Six Sigma was a classic management fashion; Abrahamson says, *"promoted by highly regarded companies like Motorola and GE, as a result, it spread widely. The Six Sigma rigor of generating metrics with baseless success measures and the implementation of specialized statistical tools that measures things for no reason except to measure things, using principles, techniques, and concepts that create reports that no one wanted, needed, understood, or read; and financially driven projects, squashed ingenuity and stifled innovation."*

Evidence from four leading organisation suggests that Six Sigma was implemented, in part at least under the influence of investors interested in return on equity, return on invested capital and stock price, who saw Six Sigma as a Badge of Approval and Respectability, adding a patina of scientific management to the hum-drum financialised projects of cost-cutting, head count reduction, outsourcing. It also camouflaged these projects as quality initiatives.

If anything, Six Sigma focusses on efficiency. But, a better place to start is by asking the question, ***"Is this going to be effective in delivering the service to the customer?"*** Evidence from some of the example organisations suggests that the need for Six Sigma Projects to demonstrate a positive RoI (RoNA) to be approved, by others, stifled innovation and inventive engineering, with negative consequences for their overall performance and the consequential loss of benefit to the organisation.

INTRODUCTION

In the late nineteen eighty's Six Sigma replaced TQM as the go-to management fad. And, as Lean Six Sigma, it remains a major force in today's business world.

This paper aims to understand Six Sigma, what is it, what is its technical background, how is it implemented and whether it has been successful in achieving its stated aim of enabling organisations to drastically improve their bottom line and improve their market position.

We look at the origins of Six Sigma, to understand the basic messages that make it more attractive to management than TQM, how it is implemented and why it is now out of fashion.

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WHAT IS SIX SIGMA?

Six Sigma is a method that is claimed to provide organizations with the tools to improve the capability of their business processes. It is a project-oriented approach for removing defects, and eliminating waste from products, processes, and transactions. Organisations seek to reduce defects and achieve Six Sigma quality; defined as 3.4 defects per million opportunities (DPMO).

Six Sigma is claimed to be about improving profitability. According to Mikel Harry [(1)], companies implement it with the goal of improving their margins. In the "Themes of Six Sigma" he says it allows organisations to drastically improve their bottom line by minimising waste, errors, and resources. It is claimed to drastically improve financial results, in other words, better profitability.

This is achieved by improving quality, defined as the value entitlement of both customer and provider, in every aspect of their business relationship.

Basic message is - Reduce Cost of Quality [(i)] (CoQ) – increase profit.

ORIGINS OF SIX SIGMA

Because of the term Six Sigma, it is generally thought that this methodology is based on the statistical methods of Shewhart [(2)] and the quality improvement ideas of Deming, later used by Japanese companies under the practice generally known as TQM. Later incorporated in the Toyota Production System (TPS). This sounds plausible but is not the case. The work of F. W. Taylor under the heading **Scientific Management** permeates virtually all current management thinking, including Six Sigma, see ***APPENDIX 2***.

All the evidence suggests that Six Sigma originated in Motorola, who were being battered by Japanese competition in the 1980s. Motorola already were a respected manufacturing firm and had stringent quality measures. However, their analysis had revealed that they were lagging way behind the Japanese and to be competitive they had to improve their quality goals by a 1,000% in five years.

(i) But quality is not a cost, it is an enabler / productivity moves up as quality improves.

An initial goal of a 10:1 quality improvement was set out.

Motorola management summoned their top engineers and told them to combine all the best quality management practices known till that time and make an aggregated methodology which would be the base of Motorola's competitive quality improvement program.

Bill Smith, an engineer, developed an internal methodology in 1985 that became known as Six Sigma. This was said to be based on ideas imported from Japanese companies generally known as TQM, and CEO Bob Galvin made it a company-wide initiative.

By reference to misunderstandings of the statistical work of Shewhart and Deming, they defined Six Sigma quality as a target that the organization should seek to achieve just 3.4 defects per million steps, insisting that 99.99966% of its products or services are without flaws.

Harry's, "Themes of Six Sigma" states that, "By 1993, Motorola had developed and implemented Six Sigma to the point at which it became a hard science at the process level and a management art at the business level. Prior to this, the pursuit of quality was more a philosophy than it was an art or a science."[i]

"Originally Six Sigma was developed by Motorola to achieve Six Sigma levels of quality. This was further developed by Allied Signal and GE into projects managed by Black Belts in a cost-reduction program—every project needs a clear ROI. In other words, the program went from a leadership philosophy [i.e. built-in improvement] to a bunch of one-off projects to cut costs [i.e., bolt-on quality][(ii).]

WHY IS SIX SIGMA ATTRACTIVE TO MANAGERS

Following the earlier success of Deming and TQM, Six Sigma and subsequent fashions – Lean, Lean Six Sigma and Agile – seem to be based on the same basic aim of improvement in process and delivering change.

TQM achieved only moderate success for a variety of reasons. Probably the most significant factor was the widely held idea, held by many TQM consultants, that it required managers to transform themselves and the culture of their organisations.

Frequently there was no real effective integration of the quality system with business goals, and too often insufficient effort was devoted to widespread utilization of the technical tools of variation reduction.

Some general reasons that are cited for the lack of conspicuous success of TQM include:

a) lack of high-level management commitment and involvement.
b) general, as opposed to specific, business-results-oriented objectives; and
c) too much emphasis on widespread training as opposed to focused technical education.

(ii) quality cannot be added on or inspected in; it has to be designed into the process from the start. In other words; ***Prevention not Inspection****.*

Another reason for the erratic success of TQM is that many managers and executives regarded it as just another "programme" to improve quality. During the 1950s and 1960s, programmes such as Zero Defects and Value Engineering were widely deployed, but they had little real impact on quality and productivity improvement.

Another generally held belief is that achieving registration to ISO-9000 is sufficient to achieve a quality organisation!

Generally, Six Sigma has been far more successful than TQM was. There are several reasons for this:

1. Firstly, the message that no management transformation or culture change is required. As we saw earlier, the simple message is that each sigma increase produces a 10% net income improvement. When quality improvement projects are said to result in real savings, expanded sales opportunities, or documented improvements in customer satisfaction, upper management pays attention.

2. Management support is required overall, but the day to day activities of project teams requires little involvement. Business leaders are more likely to be fully supportive, to commit the resources needed to train personnel, and to make Six Sigma positions full-time, using these positions as steppingstones to higher positions of responsibility in the organization. In other words, set up a separate quality function using the Training Budget as a resource!

In the early development of Six Sigma, a table (table 1) was used that purported to show a 10% net income improvement link between sigma level of errors and net profitability. This was said to show the benefits of reaching higher sigma levels through reduction in waste, errors, rework and claims. However, there is little evidence to back up this assertion.

Table 1 **Claimed benefits of reaching higher sigma levels**

SIGMA LEVEL	DMPO	Cost of Quality
2	308,537 (non-competitive)	N/A
3	66,810	25 – 40% of sales
4	6,210 (industry average)	15 – 25% of sales
5	233	5 – 15% of sales
6	3.4 (world class)	<1% of sales

Source: S.N. Teli, Dr.V.S. Majali, Dr. U. M. Bhushi, Sanjay, 2012, *Automotive Product Development Process (APDP) Strategy by Integrating Six Sigma to Reduce the Cost of Quality.* Journal of Mechanical and Civil Engineering Volume 4, Issue 3, Table VIII

This was said to show the benefits of reaching higher sigma levels. A cost-benefit analysis claimed to show that improving GE from three or four sigma to six would save the group between $7 billion and $10 billion annually, or the equivalent of 10 to 15% of annual revenue (3). Other claims included:

"GE saved $12 billion over five years and added $1 to its earnings per share."

"Six Sigma reportedly saved Motorola $15 billion over the last 11 years."

None of these claims can be substantiated.

Six Sigma is attractive to stockholders, top executives, members of the board of directors, and business analysts who guide investors because they typically are interested in return on equity, return on invested capital, stock price, dividends, earnings, earnings per share of stock, growth in operating income, which Six Sigma is said to augment.

Six Sigma became a Badge of Approval and Respectability for organisations. It added a patina of scientific management to the hum-drum financialised projects of cost-cutting, head count reduction, outsourcing, down-sizing, to name a few.

Six Sigma captured the imagination of CEOs around the world. There have been many claims of its successes, yet these have at least partially been attributed to the Hawthorne Effect, which implies that if enough money is thrown into any methodology, at least some short-term results can reasonably be expected.

> ***Note:*** *Shewhart Control Charts are based on the economic choice of +/- three standard deviations as a reference for whether variation is from a common cause or a special cause. This is little understood in Six Sigma projects.*

IMPLEMENTING SIX SIGMA

Six Sigma is project-based problem-solving methodology [(iii)]. Implementation strategies can vary significantly between organizations, depending on their distinct culture and strategic business goals.

Projects are based on strategic business objectives. In this approach, defining the key set of critical business processes and the metrics that drive them is the first step towards successful project development. Linking those processes together to form an integrated view of the business then follows. Projects that focus on the key business metrics and strategic objectives, as well as the interfaces among critical business processes, are claimed to be more likely to have significant value to the company. The only risks here are that the projects may be very large, and still may focus only on some narrow aspect of the business.

A one-off Six Sigma program or initiative does not usually create an infrastructure that leads to bottom-line benefits through projects tied to the strategic goals of the organization. Therefore, it may not capture the buy-in necessary to reap a large return on the investment in training.

Six Sigma crucially depends on executive-level support and management buy-in. This can help lead to the application of statistical tools and other Six Sigma methodologies across organizational boundaries.

A project-based approach relies heavily on a sound project selection process. Projects should be selected that meet the goals of an organization’s business strategy. Initially, companies might have projects that are too large or perhaps are not chosen because of their strategic impact to the bottom line.

(iii) if you pick an inappropriate problem to solve, the solution (if any) will not improve the organisation.

The Belt System

One key feature of Companies involved in a Six Sigma effort is the use of specially trained individuals, called Green Belts (GBs), Black Belts (BBs), Master Black Belts (MBBs) and Champions. Each of these "Belts" have specific roles in the general structure of process improvement.

BBs typically have a minimum of 4 weeks of specialized training, sometimes spread over a 4-month period and usually combined with concurrent work on a Six Sigma project. They lead teams that are focused on projects with both quality and business (economic) impact for the organization. In most organizations, BBs train GBs and work on other functions such as new project identification.

MBBs are often engaged in training both BBs and other MBBs. They often write and develop training materials, are heavily involved in project definition and selection, and work closely with business leaders called Champions.

The job of Champions is to ensure that the right projects are being identified and worked on, that teams are making good progress, and that the resources required for successful project completion are in place. Champions are project sponsors. MBBs also work closely with other members of the business leadership team. It is claimed that it is more effective to have BB and MBB positions which are full-time posts. GBs typically have less training, often 1 or 2 weeks, and either assist on major project teams or lead teams engaged in smaller, more highly specific projects.

Deployment of Six Sigma

Most companies implement a top-down strategy, said to be successful because of senior management support. Regardless of the deployment strategy employed, there are three features of every Six Sigma, (Lean, Six Sigma, or Agile) project implementation:

- Top management; visible support.
- Use of an expensively trained cadre of elite practitioners – "Belts" who implement the projects; and
- Projects must demonstrate a positive RoI before they are approved.

Six Sigma deployment is a project-oriented approach. Six Sigma projects are typically 4–6 months in duration and are selected for their potential impact on the business.

GE started the trend to use HR to drive Six Sigma. If the members of the organization realize that the best people are becoming BBs and Champions, they will take the Six Sigma programme more seriously and want to be involved. Supporting infrastructure means financial systems integration with project activity so that the benefits of completed projects can be accurately assessed, a system of defining and selecting projects can be developed, and that consistency and excellence of training can be maintained.

A project should represent a potential breakthrough in the sense that it could result in a major improvement in the product or service. Project impact should be evaluated in terms of its financial benefit to the business, as measured and evaluated by the finance or accounting unit. Obviously, projects with high potential impact are most desirable. This financial systems integration is standard practice in Six Sigma. The value opportunity of projects must be clearly identified, and projects must be well aligned with corporate business objectives at all levels.

OUT OF FASHION

After twenty-five years of Six Sigma, there is no evidence of any lasting success. Only an endless parade of hollow promises, followed by failure after failure. Proponents claim that Six Sigma has saved corporations and companies like Motorola and General Electric, billions and billions of dollars, year after year, and that Champions, Experts and Black Belts can train and lead your people into performing continuous improvements on your company's processes and products, that will lead to endless prosperity.

Don Wheeler [(4)] described Six Sigma as a "blend of tortured computations and incompatible, highly questionable assumptions having a hypnotic effect, often resulting in a suspension of critical thinking". Shewhart Control Charts are based on the economic choice of three sigma as a reference for whether variation is from a common cause or a special cause. This is little understood in Six Sigma projects.

Six Sigma was a classic management fashion, Abrahamson [(5)] says, "…and GE was its leading model, a high-performing company touted by consultants eager to help other firms implement the system." As a result, it spread widely. These things run their course, and it has run its course. And as with all fashions, once Six Sigma was picked up by the masses, fashionable companies lost interest and moved on to the next big thing. These things have a life cycle: They get popular and then people start looking for something else. It did not help that Six Sigma has no owner, accreditor, or even a commonly agreed upon body of knowledge. Six Sigma is defunct, but this is not the case of Lean Six Sigma and Agile.

Its decline was also a symptom of a broader change in the corporate world, where innovation became more valued than efficiency, and technical precision was no longer a differentiator. Silicon Valley's culture of "move fast and break things" meant business leaders were less concerned with reliability and more focused on game-changing discoveries. An obsession with efficiency can come at the expense of invention.

The Six Sigma rigor of generating metrics with baseless success measures and the implementation of specialized statistical tools that measures things for no reason except to measure things, using principles, techniques, and concepts that create reports that no one wants, needs, understands, or reads; and processes, which prolong projects, squash ingenuity, and stifle innovation, with full buy-in and support of management- doesn't work!

While GE's management was hitting the limits of Six Sigma inside the company, outside it the system was spreading far and wide. It quickly became unmoored from its manufacturing origins and was sold as an instant fix for companies and careers mired in mediocrity.

THE EFFECT OF SIX SIGMA ON ORGANISATIONS

Motorola

Motorola already were a respected manufacturing firm and had stringent quality measures. However, analysis had revealed that they were lagging way behind the Japanese and to be competitive they had to improve their quality goals by a 1,000% in five years. Thus, an ambitious goal of a 10:1 quality improvement came into picture.

Motorola established Six Sigma as both an objective for the corporation and as a focal point for process and product quality improvement efforts. The Six Sigma concept was said to be tremendously successful at Motorola.

It has been claimed that they reduced defects on semiconductor devices by 94% between 1987 and 1993. As developed at Motorola, Six Sigma, is at its core a system for eliminating defects in manufacturing.

In May 1990, Motorola created the Six Sigma Research Institute to research and develop the theoretical framework and supporting tools necessary to accelerate the achievement of Six-Sigma quality, partnering with IBM, DEC, Kodak, Texas Instruments and Asea Brown Boveri.

Motorola Before Six Sigma- Innovation, Profits, Success, and Awards!

Prior to Six Sigma, Motorola was a multinational telecommunications leader in the innovation of mobile radio receivers, two-way radios, colour television, guided missile design, military, space and government communications, produced the first handheld mobile phone is 1973, developer of the cellular telephone and microprocessors that spurred the computing revolution in 1984 for companies such as Apple and Hewlett Packard. Motorola developed the first mobile radio receivers and two-way radios, including Neil Armstrong's radio that communicated his famous words from the moon. The 1986 Annual Report states, "It was a year that illustrated our continuing process of renewal- in terms of leadership and renewed commitment to quality, sales increased 8 percent, earnings rose to $194M, up from $72M in 1985." Motorola was doing just fine before Six Sigma, winning the first Baldrige Quality Award in 1988.

Motorola After Six Sigma- Stagnation, Incompetence, Losses, Spinoffs, and Disaster!

After a top to bottom implementation of Six Sigma in 1993, Motorola became a very different company. Six Sigma squashed innovation and creativity prompting many of their best engineers to leave the company. Motorola was over three years late in their development of digital cell-phone technology. Just ten years after winning the first Malcolm Baldrige Quality Award, quality slipped dramatically, and profits tumbled 33%. In 1998, Motorola lost a $500M contract with PrimeCo because equipment would shut down leaving customers unable to make calls.

Motorola lost billions of dollars on the Iridium satellite telephone network, in part due to poor quality of the equipment, prompting CEO Chris Galvin to terminate over 60,000 workers and turn to outsourcing. Motorola continued to lose $4.3 billion between 2007 and 2009, prompting a division of businesses and spinoffs. Today, Motorola is just a shell of its former self.

Six Sigma permeated every level of Motorola and camouflaged many of the technical problems with Motorola products.

General Electric

GE adopted Six Sigma from Motorola in 1995, and under Welch it became corporate religion. The company invested more than $1 billion in training thousands of employees, and the system was adopted by every GE business unit. Tools designed to streamline the making of widgets were adopted for every company process, from accounting to customer service to hiring.

Fealty to the doctrine of Six Sigma became paramount. No one could be promoted to management without at least green belt training, and candidates could be rejected if their faith wavered.

To drive home its importance, Welch determined that 40% of employees' bonuses would be tied to Six Sigma, and that stock options would be reserved only for managers in black belt training [(iv)]. By 2001, GE boasted that some 80,000 employees had received Six Sigma training and completed 500,000 Six Sigma projects since the system was adopted.

It seemed to produce results. In the five years to 2001, GE's annual profit increased by 66%, to $13.6 billion. The spotlight turned to Welch, and the countless profiles and articles that trumpeted his management savvy inevitably discussed the central role of Six Sigma.

According to Hopper and Hopper [(6);] *"Six Sigma at GE was a major and long-lasting public relations campaign to enhance the reputation of CEO Jack Welch and drive up its share price. Credentialism ruled, those members of staff who taught or applied Six Sigma were awarded a fancy Belt. People who knew nothing about a Division would descend on it, allegedly to enhance performance, but in fact to engage in financial cosmetics. …. this was enhanced by the sound of institutional investors encouraging them to work backwards from a projected rate of return on capital."* Six Sigma was the pre-eminent management credential.

Welch's successor, Jeff Immelt, continued to preach the gospel of Six Sigma, but without the same missionary zeal of its early days. Managers began to complain about employees lost to Six Sigma training, particularly for functions like sales, where there was little obvious benefit, according to one long-time GE manager who asked to remain anonymous. *'A growing number of Six Sigma projects launched by employees, essential for securing the all-important green belt, were no longer fixing major flaws in the company but instead focused on marginal, or even trivial, improvements.'* [(v).]

"Originally Six Sigma was derived from [Total] Quality Management (TQM) by Motorola to achieve Six Sigma levels of quality, and then through Allied Signal and GE it morphed to projects by Black Belts based on statistics to become a cost-reduction program—every project needs a clear ROI. In other words, *we went from a leadership philosophy* [i.e., built-in improvement] *to a bunch of one-off projects to cut costs* [i.e., bolt-on quality].

(iv) Employee divisive?

(v) A case of award chasing to gain personal reward.

GE Before Six Sigma

Twenty years ago, no company was flying higher than General Electric. In early 2000, GE passed Microsoft to become the world's most valuable company. The sprawling conglomerate, which sold everything from jet engines to mortgages to advertising on *Seinfeld*, was directed by a dynamic CEO, Jack Welch, and his unwavering faith in the power of Six Sigma.

GE After Six Sigma

While GE hummed along for years under Immelt, its earnings were propped up by its financial services business, which under Welch had become the company's single-largest segment. That over-reliance proved ruinous during the financial crisis of 2008, almost crippling the company.

After the financial crisis, Wall Street's frustrations with GE's complex organizational structure boiled over and Immelt responded by launching a new program dubbed, simply, "Simplification." At a corporate level, it meant streamlining the business around a few core industries.

3M

3M had traditionally revolved around collaboration, individual initiative, tolerance for mistakes and the absence of pressure for short-term results. These cultural traits fostered an environment of entrepreneurialism and original thought – factors crucial to 3M's success.

In 2001, low profitability, caused by the demise of several "cash cows", prompted a change in senior leadership; 3M brought in Jim McNerney, a former vice president of General Electric (GE), as its new CEO. With McNerney came Six Sigma, which he introduced as soon as he took the helm of the firm, streamlining work processes, eliminating 10% of the workforce, and earning praise (initially) from Wall Street, as operating margins grew from 17% in 2001 to 23% by 2005.

McNerney forced Design for Six Sigma (DFSS) into 3M's Research and Development department. Top scientists, researchers, and engineers, stifled by rigors imposed by Six Sigma, left the company in droves and revenue from new products dropped quickly from 33% of total revenue down to roughly 20%. Six Sigma temporarily improved 3M's performance, but when its success waned, tensions about its implementation resurfaced. Six Sigma's strict process and lack of freedom caused significant roadblocks and killed innovation. While it is not uncommon for new CEOs to introduce strategies from former environments, Six Sigma clashed with 3M's existing culture of serendipitous discovery and tolerance for mistakes. But the efficiency gains came at a price. Scientists and engineers griped that McNerney, an MBA, did not understand the creative process. Six Sigma rules choked those working in the labs. It's really tough to schedule invention.

Seeing the pending disaster caused by Six Sigma, McNerney left in 2005, replaced by George Buckley, who removed Six Sigma, which restored 3M's R&D morale and innovative spirit saving 3M from the fate of Motorola and GE.

Buckley worked to preserve the benefits of Six Sigma's cost-cutting and efficiency-improvement efforts while simultaneously re-stimulating the creative and innovative juices at 3M. His solution was in part to exempt a lot of the research process from the more formal Six Sigma forms and reports.

According to Buckley, *"Invention is by its very nature a disorderly process. You can't put a Six Sigma process into that area and say, well, I'm getting behind on invention, so I'm going to schedule myself for three good ideas on Wednesday and two on Friday. That's not how creativity works."*

Why is that important? Because as 3M's older products grow outmoded or become commodities, it must replace them (see above). The company, as a result, had in place a long-term goal to generate 30% of revenue from new products introduced in the past five years. By 2005, when McNerney left to run Boeing, the percentage was down to 21%, and much of the new-product revenue had come from a single category, optical films.

3M Before Six Sigma

3M was a globally recognized company and leader in diverse technological innovation of products with a trademark of "Innovative technology for a changing world."

3M After Six Sigma

Employees were frustrated [7], [8]. They were vocal about their concerns over how metrics seemed to matter more than performance. Many believed Six Sigma was getting in the way of real invention – and that its principles were applied even in situations where they made no apparent business sense.

Buckley remained CEO at 3M until he retired in 2012 and restored the company's innovative lustre. By 2010, in fact, in a Booz & Company survey of the world's most innovative firms, 3M was the third-most cited company, just behind Apple and Google.

BOEING

In 1957, Boeing started the age of jet travel with the intercontinental B707. It was the plane that changed the way we fly.

The medium range Boeing 727 entered service 1964.

The short-range Boeing 737 entered service 1968. It had (by today's standards) tiny little engines, which easily cleared the ground beneath the wings. This gave low ground separation, allowing ground staff working in small domestic airports to service and prepare the aircraft easily, in light of the constrains and limitations of those airports in the 1960s. Passengers boarded and disembarked the 737 using airstairs, rather than airbridges.

The 737 has been continually developed over the last 50 years. The Classic Boeing 737s, the -300, -400 and -500, were introduced in the early 1980s, and the New Generation -600, -700, -800 and -900 followed in 1996. In its five-decade history, airlines have cumulatively ordered more than 10,000 of the planes; effectively, Boeing's "cash cow". Other long-range and medium-range replacement aircraft were developed in this time frame.

Lean Engineering

In the early 90s, Boeing — facing a deregulated commercial airline industry — realized it needed to become more efficient in order to offer its customers airplanes at cost effectiveness and improved quality.

Company executives travelled to Japan, where they studied concepts that would become known as Lean — just-in-time delivery, error-free production, and continuous flow.

The implementation of Lean tactics across Boeing was not merely a cost-cutting strategy, but a philosophy of growth and improvement. That required a seismic cultural shift away from the old ways of designing and manufacturing products, executing business processes — and of managing and developing people.

Boeing's mid-90s shift to Lean had reaped tangible dividends.: the 737 program shaved its flow time [(vi)] by 30 percent, reduced its crane moves by 39 percent, lowered its inventory levels by 42 percent, and reduced its needed floor space by 216,000 square feet.

When regular Boeing customer United Airlines bought the more technologically advanced Airbus A320, this prompted Boeing to update the 737 Classic variants into the more efficient, longer New Generation variants. The *737 Next Generation* (737NG) variants commenced production in 1996.

In an all-out bid to reach his declared goal of 67% market share, Ron Woodard, the President of Boeing's Commercial Airplane Group, discounted planes deeply, apparently believing predictions that they could shave 25% off costs by the time of their delivery.

Instead, it was Boeing that was buried by the onslaught of orders. The company was forced to shut down its 737 and 747 lines for 25 days in October 1997. That's when Boeing's numbers crashed: Just months after the McDonnell deal closed, it reported a $178 million annual loss.

McDonnell Douglas Merger

In 1997, Boeing acquired McDonnell Douglas, the St. Louis competitor whose historic caution and conservatism had allowed Boeing to all but blow it out of the jetliner business.

In the mid-90s, McDonnell's flailing commercial jet business had one new plane on the books, a rehash of the aged DC-10. The MD-11 was one of those airplanes that was classically ill-timed. It was produced by a dying company that had lost touch with its customers. In the end, 200 MD-11's were produced, by the time production was cancelled in 2001.

(vi) TAKT time

Financial Engineering

Prior to the merger, McDonnell Douglas's stock price had risen fourfold as they focussed on cost-cutting, headcount, and out-sourcing, but many analysts feared that this came at the cost of the company's future competitiveness. This continued with MD-11 production at Long Beach, CA.; in trying to outsource everything but design, final assembly, and flight testing and sales; the MD-11 suffered production and performance problems.

One odd feature of the stock swap, that was part of the merger, was that two ex-McDonnell Douglas executives ended up with the largest shareholding in the merged organisation. These executives occupied surprisingly powerful positions in the combined company. One became CEO and another was elevated to chief financial officer. It appeared as if McDonnell Douglas had organised a reverse take-over of Boeing with Boeing's money!!

One of the most successful engineering cultures of all time was quickly giving way to the McDonnell mind-set. People at Boeing always understood that they were an engineering-driven company, not a financially [(vii)] driven company. They are no longer honouring that as their central mission and have just become another company. It was not just technical knowledge that was lost, it was a recipe for disempowering engineers.

The merged company became focussed on the trendy accounting metric "return on net assets" (RoNA), which was called "residual income" at GE. It claims to be a quantification of how efficiently a company is using its factories, warehouses, office buildings, storefronts, and other elements of its physical plant. In reality, all you had to do to make RoNA go up instantaneously, no matter what, was to sell off your assets indiscriminately, and outsource whatever functions they used to serve to other strategic points along the supply chain.

That's what happened but on an exponentially more ruinous scale in mortgage lending and pharmaceutical sales and at General Electric, which over the past decade has spent more than $50 billion buying back its own stock even as its staggering insurance business losses threaten to bankrupt the company.

Boeing ploughed $16 billion into dividends and share repurchases.

Between 2013 and 2019, Boeing would spend more than $43 billion buying its own stock, and an additional $17.4 billion on dividends.

Six Sigma

In 2005, Boeing turned to an outsider, without a traditional aviation background, to repair its reputation after a series of high-profile ethics scandals. James McNerney, a Harvard MBA, had spent almost two decades in management at General Electric and as CEO of 3M (yes, that McNerney!). With him came Six Sigma; he was following a tried-and-tested route of cutting, downsizing, outsourcing, and separation of management from day-to-day action.

Meanwhile, R&D spending went down, head count was pared from 230,000 to 185,000. By 2003 Airbus sold more A320 variants than Boeing sold B737 variants.

(vii) Product drives profit; profit is a lagging indicator, not a primary one.

To a large extent much of this has been disguised by the rapid growth in global air traffic passenger demand from 2000 to the present. Annual growth of more than 7% per annum was recorded in that period. Annual production of A320 variants and B737 variants increased from 200 in 2000 to 600 in 2019. By September 2018, there were 7,251 A320 family aircraft in service versus 6,757 737NGs.

Two decades on, perhaps the most lasting consequence of the change in culture has been in Boeing's approach to aircraft building. Cutting costs and diversifying revenue ought to have served as an ideal way to subsidize the expensive process of plane development. Instead, with engineers now disempowered and management far away in Chicago, the actual building of new planes in Seattle all but stalled. Boeing announced the development plans for a new plane in 2003. The 787 Dreamliner was intended to replace both the B757 and B767, it used advanced composites to achieve weight reduction and greater fuel efficiency.

The board ultimately approved a development budget of $7 billion for the 787, but, even then managers would require subcontractors to foot the majority of costs. As a result, the 787-development programme was seriously com-promised. Made worse by shifting to a new production facility at Charlotte, NC.

Its maiden flight in 2011 was three years behind schedule, tens of billions over budget, and was grounded 14 months after its first flight. The whole 787 project had been ludicrously understaffed from the outset; Boeing deliberately subcontracted the components without designing them. No one thought it was a good idea to slash research and development spending, lay off half the engineers, or subcontract whole chunks of a plane without designing it first.

In the end, the Dreamliner cost no less than $30 billion, and probably closer to $50 billion. By 2015, Boeing was said to be losing $25m on each 787 sold.

737

That approach was applied to upgrading the 737, Boeing's 'Cash Cow' which had become the victim of its own success.

Boeing started to consider an all-new aircraft to replace the 737, using technology derived from 787, but the plan was held back while 737NG's continued to sell well. By 2010, Boeing was said to be ready to proceed with an all-new aircraft optimised for the 150 to 220 seat market. By this point, there were only two suppliers of short to medium range, 100+ passenger airplanes – the biggest volume sector – Boeing 737 / Airbus 320. That year, Airbus, launched the Airbus A320neo family to improve fuel burn and operating efficiency with new engines: the CFM International LEAP and Pratt & Whitney PW1000G, helping to maintain its A320 product line's position as the world's most advanced and fuel-efficient single-aisle aircraft family. By June 2011 Airbus had orders for 1,700 of the new A320neo.

This caused a considerable panic in Boeing. CEO Jim McNerney committed to a new airplane using these new engines. But rather than replacing 737NGs with the new technically advanced plane, they opted instead to keep costs down by tinkering and adjusting the NG models to fit still more passengers. The version to be called the 737MAX was the alternative, cheaper solution.

737MAX variants would have a 78" diameter nacelle to incorporate CFM/PW Engines. To maintain minimum 17" ground clearance, the engines pylons were re-engineered to configure the engines forward and upward. This offered two additional advantages:

Firstly, the 737 was always intended to be a regional airliner that could serve small, domestic airports, without sophisticated facilities. The 737s short undercarriage allowed baggage handlers to load luggage without requiring much ground support equipment and enabled them to climb into the cargo hold to load, organise, and retrieve the bags. The plane could be refuelled and serviced using smaller domestic airport trucks and bowsers. Passengers could board and disembark the 737 using on-board airstairs, rather than airbridges.

Boeing's two largest customers, Southwest and Ryanair have standardised on one variant 737-800 and tend to use smaller domestic airfields, they could see an advantage in using the same short undercarriage.

Second, like the 737NG, 737MAX retained a six-screen LCD glass cockpit flight display system with modern avionics but designed to retain crew familiarity with previous 737 generations. The airlines went for it because the new engines promised higher efficiency and—so it seemed—pilots would find it very simple to move from the NG to the MAX, with little, or no, flight simulator hours required.

Southwest was always the biggest user of 737s and had a lot of input about the projected modifications to the NG. To appease any concerns, they had about conversion training, Boeing were said to have offered them a rebate of $1 million for every MAX it bought, if the FAA required level-D simulator training [(9)] for their pilots. Simulator training for Southwest's 9,000 pilots would have been a pain, but hardly ruinous. It turned out to be unnecessary because the FAA never identified any differences in 737MAX that would have required simulator training, although they should have!!

However, what should have been ~~a~~ major concerns [(viii)] were ignored in the rush to compete with Airbus. The re-engineering pylons created a shift in the plane's centre of gravity - pronounced enough to raise early concerns when scale models were tested in a wind tunnel. The model kept dragging its tail down and causing its nose to pitch up. So, the engineers devised a software fix called MCAS (Manoeuvring Characteristic Augmentation System), which pushed the nose down whenever an [(ix)] angle-of-attack (AOA) sensor detected a stall, regardless of the speed.

(viii) a simple and important step in any major development is for senior management to take time out, and ask the question: "What are we really doing here and what are the consequences for our customers of what we are doing?"

(ix) on the 737 there are two A0A sensors, however there is no *'voting system'* if both sensors do not agree, and no indicator for the pilot that there is *'disagreement'* between the instruments.

The MCAS System

There were two critical traits of the MCAS system which should have been major concerns:

Firstly, only one AoA, was programmed to trigger MCAS. Any program coded to take data from both sensors would have had to account for the possibility the sensors might disagree with each other and devise a contingency for reconciling the mixed signals. Whatever that contingency, it would have involved some kind of cockpit alert, which would in turn have required additional training - but no one wanted to risk that. So, the system was programmed to turn the nose down at the feedback of a single sensor. Since AoA failures are common, triggering the MCAS anti-stall after take-off below 400 feet, could jeopardise the aircraft.

Secondly, MCAS was programmed to nose- dive again five seconds later, and again five seconds after that, over and over again.

Together these traits would challenge even the most highly skilled of pilots. It has been reported that a Boeing technical pilot emailed the FAA and asked that the reference to the software be deleted from the pilot manual. This was accepted. Result, no more than a handful of people in the world knew MCAS existed before the plane entered service in 2017. [(10)] [(11)]

Boeing Before Six Sigma

For about 80 years, Boeing basically functioned as an association of engineers. Its executives held patents, designed wings, spoke the language of engineering and safety as a mother tongue. Finance was not a primary language. Even Boeing's bean counters did not act the part. As late as the mid-90s, the company's chief financial officer had minimal contact with Wall Street and answered colleagues' requests for basic financial data with a curt "Tell them not to worry."

Boeing After Six Sigma

The emphasis of the business was going to switch away from engineering and toward supply-chain management. In a clash of corporate cultures, where Boeing's engineers and McDonnell Douglas's bean-counters went head-to-head, the smaller company won out [(12), (13)]. The result was a move away from expensive, ground-breaking engineering and toward what some called a more cut-throat culture, devoted to keeping costs down and favouring upgrading older models at the expense of wholesale innovation. The 737MAX catastrophe was a direct result of this new culture.

WHAT DOES THE EVIDENCE TELL US?

CASH COWS

The BCG (x) model states that the cash generated from cash cows must invariably be routed to R&D expenses and question marks in the matrix. In simple words, the only reason for cash cows to exist is to allow for the birth of future cash cows.

THE INNOVATOR'S DILLEMMA

Is your cash cow a dinosaur already? Why do innovative incumbents invariably get stuck at this dilemma even though it is a scenario which has played out countless times throughout history? Why do companies that beat all and sundry to become world leaders come undone by smaller upstarts? Why do they become blind to the shockingly obvious?

Incumbents are invariably loath to get started on the next technology S-curve because from the peak of the existing S-curve (fig 1), the just-forming new S-curve looks decidedly unattractive.

Evidence from Boeing and 3M suggests that the need for Six Sigma Projects to demonstrate a positive RoI (RoNA) to be approved, stifled innovation and inventive engineering.

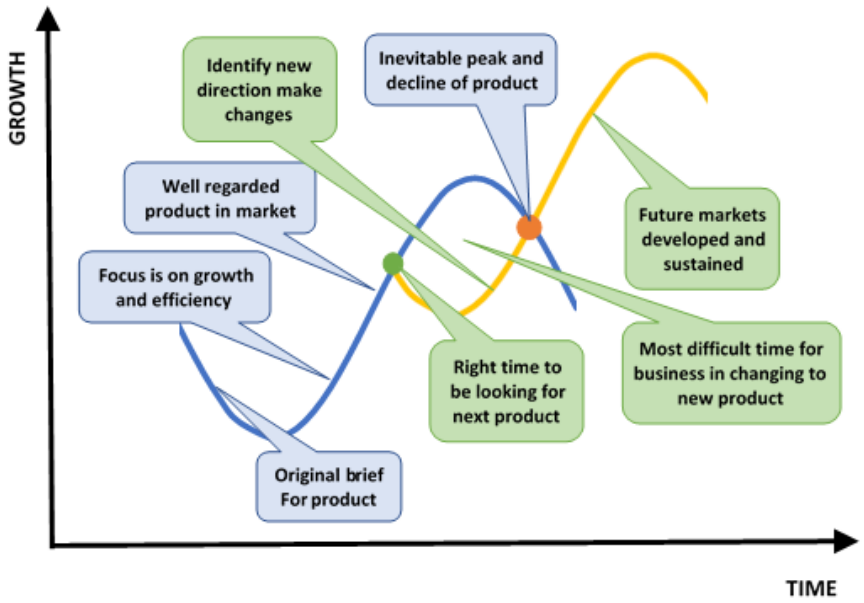

Fig 1 typical growth and decline in a product life cycle (S-curve) and the time investment needs to be made in bringing new products to the market.

(x) Boston Consulting Group – Matrix for market share growth

THE BIG PROJECT MENTALITY

All top managements are susceptible to the lure of the big project that will increase profits, for example Iridium at Motorola and GE Capital. Despite the risks, it looks more attractive than the boring steady growth from internal improvement (Fig 2).

RISK TAKING

All managements are susceptible to down-playing low probability but potentially, catastrophic risks.

Organisations tend not to respond to warnings that estimate the risk of some disaster at a seemingly low figure like 0.1% per year, even when the predictable costs of ignoring such probabilities are massive.

Opting to keep costs down by tinkering and adjusting the B737NG airframe, in a rushed response to the A320neo, rather than continuing the developing an advanced engineering replacement, Boeing ignored the early warnings about the technical risks of the 737MAX development.

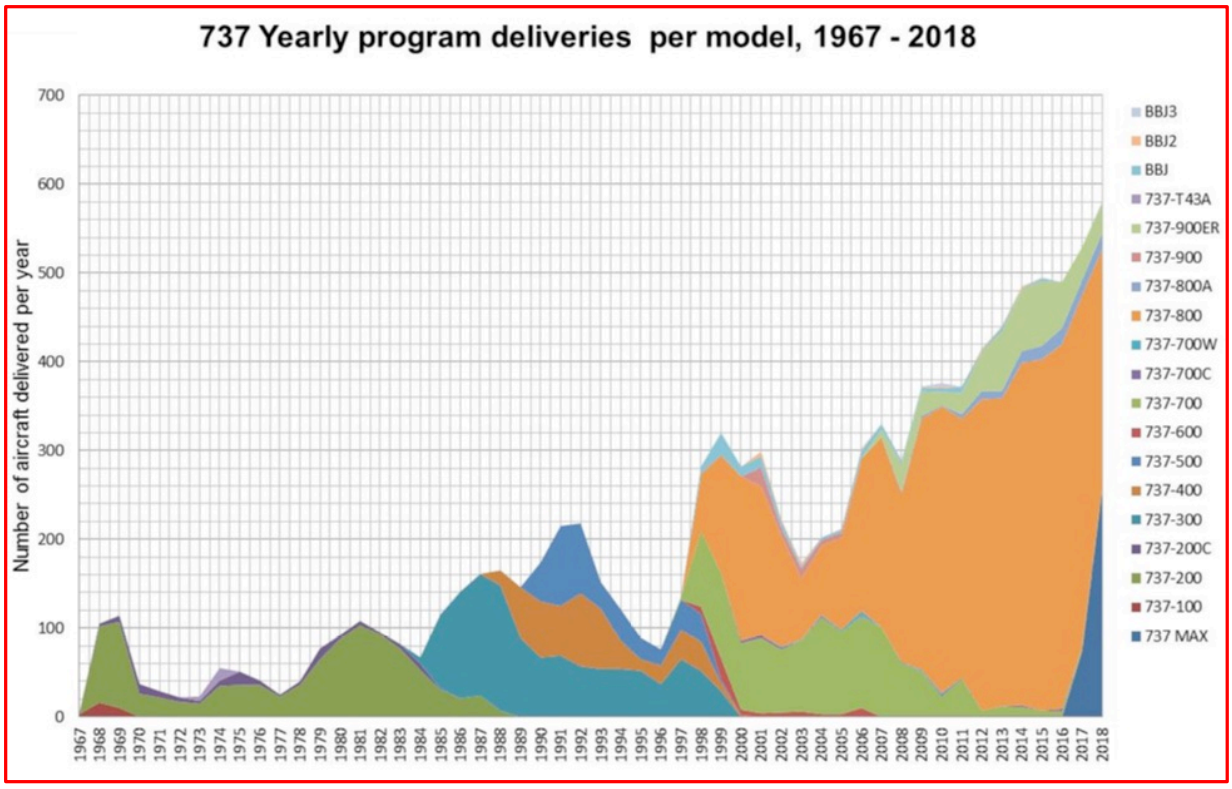

Fig 2 Boeing 737 Yearly program Deliveries between 1967 and 2018.

https://en.wikipedia.org/wiki/Boeing_737

WHAT FOLLOWED SIX SIGMA?

Quality Fads

Over the decades there have been numerous quality improvement fads; Zero Defects, Quality Circles, Motorola Six Sigma, Business Process Re-engineering, Raytheon Six Sigma, GE Six Sigma, Honeywell Six Sigma, Design for Six Sigma (DFSS), Lean, Lean Six Sigma, among many other mutations and combinations.

Regardless of the name, and what each professes, these fads essentially make the same claims and have similar life cycles.

The distinction between Six Sigma and lean has blurred. The term "lean Six Sigma" is being used more and more often because process improvement is said to require aspects of both approaches to attain positive results.

Six Sigma focuses on reducing process variation and enhancing process control, whereas lean drives out waste (non-value-added processes and procedures) and promotes work standardization and flow.

Lean Six Sigma claims to be a fact-based, data-driven philosophy of improvement that values defect prevention over defect detection. It is said to drive customer satisfaction and bottom-line results by reducing variation, waste, and cycle time, while promoting the use of work standardization and flow, thereby creating a competitive advantage. It applies anywhere variation and waste exist, and every employee should be involved.

There exist expensive Lean Six Sigma Black Belt training courses.

Integrating lean and Six Sigma

Lean and Six Sigma are both claimed to provide customers with the best possible quality, cost, delivery, and a newer attribute, nimbleness. There is a great deal of overlap between the two disciplines; however, they each approach their common purpose from slightly different angles:

- Lean focuses on five Management Principles:
    1 Identifying Value
    2 Mapping the Value Stream
    3 Creating Flow
    4 Establishing Pull
    5 Seeking Constant Improvement [xi]

(xi) continual is preferred as continuous implies never stopping or slowing (reviewing) which is not possible.

• Lean achieves its goals by using less technical tools such as kaizen, workplace organization, and visual controls, whereas Six Sigma tends to use statistical data analysis, design of experiments, and hypothesis testing.

Often implementations begin with the lean approach, making the workplace as efficient and effective as possible, reducing waste, and using value stream maps to improve understanding and throughput. If process problems remain, more technical Six Sigma statistical tools may then be applied.

Agile

Agile began life in 2001 [(14)], when 17 software developers, frustrated at the frequent failure of large IT initiatives, met to seek a more proactive and interactive way of developing software that would on completion be more closely integrated to customer need by working closely with customers during the development phase. They argued a need to move from traditional (waterfall) to collaborative sequential (short burst) writing methodologies. And the addressing of culture and values in organisations [(xii)].

The key idea was to develop applications alongside the people who use them, in short spurts for rapid delivery. The ambition was and remains largely sound. It's simply and erroneously been hijacked as a universal solution to the digitisation of services.

Agile's step from a methodology for software development to an enterprise wide project management tool was precipitated in an article by Rigby, Sutherland, and Takeuchi [(15)].

Agile is showing large-scale failure rates for IT solution-based improvement (digitisation) as anything between 50 and 80% of the code written never gets used (but gets paid for) and in order to control Agile large amounts of command and control management are inappropriately and unnecessarily applied. By which a new and basically sensible approach to IT deployment is hijacked into old style Taylorism management.

In digitising services, the solution on offer is by design necessarily bounded packages that are perceived by management to be the whole range of solutions to all customer problems.

The packages need to be contractually controllable and chargeable chunks of service. So, they produce Blue Square / Green Triangle / Red Round thing problem solutions for delivery. But the root-cause-problem is that most customers turn up with say Orange Oval type problems. As such, the service provider cannot solve the problem of the customer and that results in large amounts of failure demand and associated cost backing up in the organisation and frustration for the Customer.

(xii) The overarching problems of *culture* and *value* being discussed were really about wider systemic problems in organisations dubbed as Dilbertesque. Basically, Command and Control management with its roots in the methodologies expounded by F. W. Taylor.

The real issue is that those commissioning the digital solutions do not know what is going on at the customer interface. Indeed, anything about that interface is not built into the reporting model. As such the service delivery indicators only report metrics associated with matters unrelated to the customer / consumer / patient / passenger etc.

Hence, the underlying problem stems from Managers in the Service Company not visiting the true GEMBA, i.e. what is happening at the customer interface. The performance indicators they see are based on, time to answer the phone [in a call centre], the number of pre-packaged interventions delivered, the 'first time fix' metrics, which may not fix the actual customer problem at all, and say deployment time. But these indicators do not report on the effectiveness of the intervention from the customers perspective.

See also Seddon *et al.* (16)

Toyota Production System is not Six Sigma or Lean

Many Six Sigma proponents erroneously claim that the Toyota Production System (TPS) is Six Sigma or Six Sigma Lean, which is totally false! Harvard Business School professors, Steven Spear and H. Kent Bowen (17), studied Toyota for four years finding little similarity between the rigid tools and practices of Six Sigma and Six Sigma Lean, and the continuous, creative, flexible, and adaptive flow of TPS, which has never actually been written down and grew out of 50 years of the workings of the company.

Toyota sets up its operations as experiments, teaches workers the scientific method (xiii), how production lines are constructed and how people learn to improve. Every activity along the way has built-in tests to identify and correct problems immediately, making TPS flexible and adaptive to any circumstance. Best practice, 5S, and Kaizen events, among many other, Six Sigma and Lean practices and tools play no part in the TPS.

(xiii) This is not Taylorism, but the true scientific method based on PDSA as developed by Shewhart and later expounded and augmented by Deming in Japan in the 1950s. This method is used extensively by many Japanese companies for enhanced and sustained improvement.

CONCLUSION

Six Sigma is an extremely vague concept. Don Wheeler [4] described Six Sigma as *"a blend of tortured computations and incompatible, highly questionable assumptions having a hypnotic effect, often resulting in a suspension of critical thinking".*

Six Sigma captured the imagination of CEOs around the world. It offered high levels of net profitability by reducing "errors", no management transformation or culture change was required. When quality improvement projects are said to result in real savings, expanded sales opportunities, or documented improvements in customer satisfaction, upper management pays attention. It required little upper management involvement in day to day activities of Six Sigma project teams. All that was needed was a commitment to the resources needed to train personnel. In other words, set up a separate quality function using the Training Budget as a resource!

After twenty-five years of Six Sigma, there is no evidence of any lasting success. Only an endless parade of hollow promises, followed by failure after failure. Claims that companies saved billions and billions of dollars, year after year, are unsubstantiated.

Six Sigma was a classic management fashion, Abrahamson [5] says, *"promoted by highly regarded companies like Motorola and GE, as a result, it spread widely. The Six Sigma rigor of generating metrics with baseless success measures and the implementation of specialized statistical tools that measures things for no reason except to measure things, using principles, techniques, and concepts that create reports that no one wanted, needed, understood, or read; and financially driven projects, squashed ingenuity and stifled innovation."*

WHAT DOES THE EVIDENCE TELL US?

Evidence from four leading organisation suggests that Six Sigma was implemented, in part at least under the influence of investors interested in return on equity, return on invested capital and stock price, who saw Six Sigma as a Badge of Approval and Respectability, adding a patina of scientific management to the hum-drum financialised projects of cost-cutting, head count reduction, and outsourcing. It also camouflaged these projects as quality initiatives.

If anything, Six Sigma focusses on efficiency. But, a better place to start is by asking the question, ***"Is this going to be effective in delivering the service to the customer?"*** Evidence from some of the example organisations suggests that the need for Six Sigma Projects to demonstrate a positive RoI (RoNA) to be approved, by others, stifled innovation and inventive engineering, with negative consequences for their overall performance and the consequential loss of benefit to the organisation.

WHAT COULD ONE DO INSTEAD?

In the following three appendices, we set out to answer this question. Firstly, by comparing Six Sigma with other methodologies, then setting out our view on the purpose and role of management, including systems design for delivery, and lastly, looking at what motivates people.

APPENDIX 1

ON THE COMPARASON OF SIX SIGMA PROGRAMMES WITH OTHER METHODOLOGIES

In their paper, Cory *etal* [18], examine in detail the relationship between Six-Sigma, Lean, and SPC at a level of commonality between the application of the tool sets in each approach. They also raise the question as to whether *"…Six-Sigma will remain a strong brand and more popular than its predecessors".*

The 'success' of Six Sigma is unmistakable, it has become a strong brand, many courses have been sold, many "Belts" have been trained and many corporations have spent large sums in pursuit of results. However, we contend that Six Sigma could never address the fundamental purpose of the organisation, it is fundamentally a set of tools deployed in small isolated projects. Not a philosophy. As a result, the promised results of a 10% net income improvement (pp 3) have not been empirically demonstrated, and it is now out of fashion and the brand has faded.

Within the TPS, a tool is only called upon when it is needed for a specific analysis. Tools do not dominate, only the elimination of impediments to waste in all its forms. Unlike Six-Sigma, the TPS focuses on both improvement and the teaching of improvement across the organisation. The TPS is a culture, a way of life within Toyota.

It is this approach that was missed by so many of the Western managers who visited Toyota to study their methods over the years.

In the 1950s, Deming and Juran showed the Japanese that it was not the tools that mattered, they were only a means to an end, a way of examining the problem in detail; what was important was *'Surfacing of the Problem'* making it visible. Then the confirmation that the problem under examination was the root cause problem. Only then did the *'Current Local Problem Champion'* (see Shook) work on the problem, with other people affected by the problem (both up-stream and down-stream) within the organisation.

Toyota also added a vital dimension; quality is everyone's responsibility and that it must start with those leading the organisation. It could be argued that with Toyota they were building on and developing ideas that had been in the minds of successive generations of the Toyoda family since the beginning of the 20th century, but not so with the then emerging Sony Corporation and others.

Deming's *Chain Reaction* and his diagram of *Production Viewed As A System* [19] remain core elements of the TPS. And set it aside from the Six-Sigma approach.

The elements and approach taken within the TPS are covered in detail in two books, *Managing to Learn*, Shook [20]; and *Understanding A3 Thinking*, Durward, Sobek & Smalley [21] , both take a slightly different approach to the explanation. Both books are recommended for a greater insight to the practical application of the TPS and A3 thinking. Both authors were long term Toyota employees.

As Cory *etal* describe, tools can be easily packaged. Training courses can be constructed and delivered in the use of the tools. But as Shook and Durward *etal* set out, only a common culture and pursuit of a common objective focused on the customer, will result in a strong and robust organisation capable of absorbing variety. A primary requisite for survival.

Moreover, these approaches are not limited to manufacturing organisations. They are equally applicable, if not more so, within the Service Sector.

APPENDIX 2

WHAT WE BELIEVE

AIM

The first duty of a sound business is to create a customer, sustain and grow intelligently. A long-term view enables improvement and innovation; profit is an outcome from doing these things right.

Managing to provide customers with ever-better quality, faster, for less requires a plan to support daily work and continual improvement and a system for involving everyone in the development and implementation of the Plan. It features top-down and bottom-up [(xiv)] communications.

CUSTOMERS

The Customer is the most important element of the product or service delivery. The customer determines what is value throughout their total experience of product/service. Only the customer can define quality. Central to this is the total customer experience. Each customer contact with the product or service, or with a member of the organisation makes up the total customer experience.

Identifying, listening to, and understanding the wants and needs of customers and users at every stage in total customer experience is a critical process.

If you look after the customers, they will look after the profit [(xv)].

VALUE FLOW

Everything is Working Together to deliver value to the total customer experience. A model of the whole organisation can be useful to show how the parts of the system work together. All these parts, especially the people, need to work together for the business to serve its customers effectively. When you have a basic model, that is simple and comprehensive, make sure everyone follows it consistently. Cooperation, (not competition), is required between the parts of the system.

All activities that directly relate to making goods or providing services should be the key focus of management attention. Management exist to provide the necessary support to the daily work. Everything flows from quality. Quality is not an incidental or support issue, but the central issue for management. Improving quality reduces cost; do both in order to provide ever-increasing value to customers.

(xiv) the Japanese understood the message from TWI (Deming and Juran), that, as the ***Quality*** of the process improves, counterintuitively, ***Productivity*** also moves upwards, and ***Operational Costs*** fall.

(xv) although in many companies' great emphasis is put on *Managing the Numbers*, profit is a lagging indicator and can only be the result of a customer transaction.

MEASURE

Data does not necessarily provide information that leads to knowledge and understanding. It is important to collect the right data about how the organisation is achieving the goal of providing ever-better value to customers.

Use evidence, facts and numbers to learn and understand what is happening and what has happened. They act to balance normal human emotional and intuitive responses.

Sound organisations understand what the things they measure are telling them about how they are performing against their purpose. The causes of trends and variation are identified in order to ensure they are understood.

Is this "noise"? Or is it a "signal" for action? What about seasonal patterns? What constitutes a valid trend in the data?

ALWAYS A BETTER WAY

Customers and competition impose constant pressures to change, which means sound organisations have to continually improve their products and services, as well as making constant improvements to the way they do things to improve value in the total customer experience.

Improvement and learning are directed not only at better products, but also toward being more responsive, adaptive, and effective — giving additional marketplace and performance advantages.

Doing things better involves a planned approach to continual improvement and innovation.

PEOPLE

Organisations are the people working to achieve its purpose. The people inside an organisation are the source of its strength; provided that they are respected, trusted and supported.

In a sound workplace, people are given and accept control of their own processes. They are naturally self-motivated to do the best they can, and they get true satisfaction from their contribution.

Enabling everyone in the business to flourish and enjoy their work will serve customers and so sustain the business.

If you look after your people, your people will look after your customers and your customers will provide your profit.

A POINT ABOUT EFFICIENCY

In many organisations, managers talk about being Efficient. Claiming that a new initiative will bring efficiencies of scale, operations, or simply ways of working. In all of this, organisations are looking at their own operations and rearranging the way those operations work for internal gains. What all these claims really focus on is doing the wrong thing better. And indeed, one can simply be 100% efficient at doing completely the wrong thing.

The place to start when designing a system, or changing one, is with asking "how will what we are proposing affect the customer?" and, better still, asking the question, not how efficient will this be, but "is this going to be effective in delivering the service to the customer?" i.e. what does the customer actually need to solve their problem?

Once an organisation looks at the things it does by asking the question, "is this effective?", the whole process of purpose and delivery allied to customer actual need changes. The organization can then only move in an improvement direction to the benefit of both customer and organisation. The question drives it all.

Managers need to manage the flow of solutions, and not disassociated numbers and nebulous data, for the actual customer need. And whilst it may seem counterintuitive, operational costs go down as the delivery becomes more effective. Basically, solving customer needs reduces *Failure Demand*, a major cause of increased costs and frustration in a business.

Dr Deming's principles are focused on:

thinking together,
learning together,
working together and
improving together.

He insisted that the four components of the system of profound knowledge cannot be separated because they all interact with each other.

APPENDIX 3

BASIC PHILOSOPHY [of SM / 6σ / lean / Agile]

Scientific Management **(after F W TAYLOR)** assumes there is one best way of doing a job, and so set out to find and institutionalize this one best way. Employees are assumed to function most effectively when made to follow strictly this one best method and are not expected to make any valuable contribution to how a job is to be done. Thus, employees are treated as robots who do not and cannot make any contribution to the way their job is structured and executed.

So, the underlying belief is that scientific management provides the basis for separating management from the execution of work. 'The rationalisation of work has the effect of transferring functions of planning, allocation and co-ordination to managers, whilst reinforcing the managerial monopoly of decision-making, motivation and control'. Hales [(22)] (1993).

This leads to disenfranchised workers because more senior people within the organisation are the ones who think, workers are told what to do and how to do it, without thought.

In Scientific Management, the principle of line-staff organization introduces flexibility into hierarchical lines of authority while trying to preserve a unified command structure. The cadre of "belts" in Six Sigma constitute elite staff groups who are able to control the project methodology.

Hopper and Hopper say that as Taylorism has morphed into neo-Taylorism in the last 50 years, the so-called staff experts in neo-Taylorism have five attributes,

1. They are scientifically taught to measure,
2. Credentialism – a multiplication of paper qualifications ("multicolour belts"),
3. A top-down method of working, (Champion→MBB→BB→GB),
4. Unclear responsibility / authority, and
5. Basic problem-solving expertise that could be transferred to any situation.

Scientific Managers sought to rule by measuring. There is one quantitative approach that seems to give an insight to every part of the organisation – the accounts! So, every Six Sigma project must have a financial rationale - a defined RoI in advance.

However, if the business focuses on the money side alone, at the expense of actual customer need, then the cost of doing business will rise exorbitantly.

What the above misses is that people are motivated by three things: ***Autonomy, Purpose*** *and* ***Mastery***. Provide these in the work environment and your employees will be motivated problem solvers. See also - M. Csikszentmihalyi [(23)] and D. Pink [(24)].

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(18) Cory R. A. Hallam, Justin Muesel, William Flannery, *Analysis of the Toyota Production System and the Genesis of Six Sigma Programs: An Imperative for Understanding Failures in Technology Management Culture Transformation in Traditional Manufacturing Companies.* The University of Texas at San Antonio, USA. ISBN: 978-1-890843-21-0. Reproduced by IEEE 2010.

(19) Deming, W. Edwards, Out Of The Crisis. The MIT Press, Cambridge, MA, London.2nd. Ed. 2002. ISBN: 0-262-54115-7

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(21) Durward K, Sobek Il, Smalley Art; *Understanding A3 Thinking*, CRC Press, Taylor & Francis Group NY. ISBN: 978-1-56327-360-5-HC.

(22) Hales, C. *Managing Through Organization: The Management Process, Forms of Organization and the Work of Managers (Organizational Behaviour & Management),* (1993), Thomson Learning. ISBN: 978-0-4150-1003-0.

(23) Csikszentmihalyi M. *Flow, Rider, London*. ISBN: 978-0-71265-759-4

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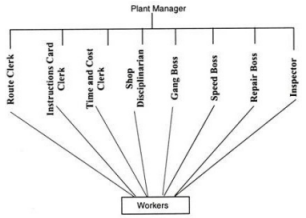
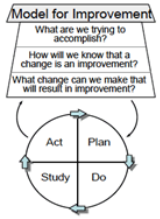
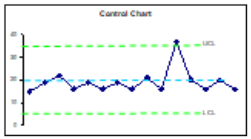
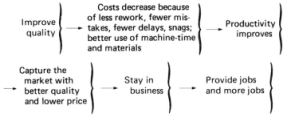
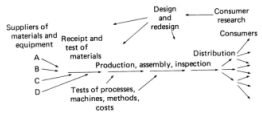
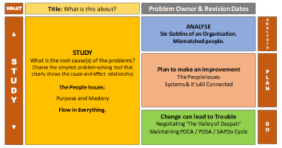
A SHORT CHRONOLOGY OF THE EMERGENCE OF IDEAS FOR MANAGING THE ORGANISATION – EVOLVING UNDERSTANDING of IMPROVEMENT

(Profit is not a dirty word – it is essential for survival, but not at the expense of the customer – **Critically, the concept of a CUSTOMER/CONSUMER focus, only appears in Shewhart, Deming and Toyota methodologies**)

TAYLORISIM	Walter A SHEWHART	W Edwards DEMING	Lean / Six Sigma	TOYOTA	AGILE
Scientific Management	**The Economic Control of Manufactured Product**	**System of Profound Knowledge and The Chain Reaction**	**Quality Circles and 6σ**	**A3 Thinking and Learning to Learn**	**IT Origins**
Fundamental principles: But these were not realised due to the conflicting requirements of the many management functions put in place to control the Workers. (i) Science, not the rule of the thumb. (ii) Harmony not discord. (iii) Co-operation, not individualism. (iv) Maximum production, in place of restricted production. (v) Development of each person to the greatest of his capabilities. (vi) A more equal division of responsibility between management and workers. (vii) Mental revolution on the part of management and workers. **Outline structure:** (1) Determination of a fair day's task for each worker through scientific methods (including the best way of doing a job). (2) Scientific selection and training of workers. (3) Standardisation of raw materials, tools and working conditions. (4) Functional foremanship. (5) Differential piece-rate system of wage-payment. **Heavy Top Down Management:**  But with conflicting objectives built into the system. Also, no feedback loop for improvement. Disenfranchised workers as more senior people within the organisation were those who thought that workers just needed to be told what to do, how to do it, and when to do it. And that workers were motivated by reward alone. People worked in an environment where output was rewarded over quality. See 5 above.	**The Shewhart or PDSA Cycle:** The PLAN, DO, STUDY, ACT cycle as a model for improvement.  **PDCA is The Scientific Method** & PDCA / PDSA / SAPDo are all the same process. **The Control Chart:** To differentiate between ASIGNABLE and COMMON causes of VARIATION.  To reduce common cause sources of variation to improve QUALITY for CUSTOMER satisfaction and to reduces COSTS. Quality of a product means the continual improvement of the process so the consumer may depend on the uniformity of a product and purchase it at low cost. From 1938 influenced the work of Deming and these methods were a foundation of TWI which started in the USA around 1940. (Training Within Industry)	**SOPK** System of Profound Knowledge, Appreciation for a ***SYSTEM***, knowledge of ***VARIATION***, theory of ***KNOWLEDGE***, and ***PSYCHOLOGY***. **PDCA is The Scientific Method** (see also later work by Drucker, Kohn, Joiner, Csikszentmihalyi and Pink on Psychology, motivation, autonomy, purpose and mastery) **Deming's Chain Reaction & production viewed as a System**   **Deming's 7 Deadly Diseases:** **1** Lack of constancy of purpose **2** Emphasis on short-term profits **3** Evaluation of performance, merit rating, or annual review. **4** Mobility of management **5** Management by use only of visible figures **6** Excessive medical costs **7** Excessive costs of liability **Deming's 14 Points:** 1. Create constancy of purpose for improving products and services. 2. Adopt the new philosophy. 3. Cease dependence on inspection to achieve quality. 4. End the practice of awarding business on price alone; instead, minimize total cost by working with a single supplier. 5. Improve constantly and forever every process for planning, production and service. 6. Institute training on the job. 7. Adopt and institute leadership. 8. Drive out fear. 9. Break down barriers between staff areas. 10. Eliminate slogans, exhortations and targets for the workforce. 11. Eliminate numerical quotas for the workforce and numerical goals for management. 12. Remove barriers that rob people of pride of workmanship and eliminate the annual rating or merit system. **Analytic as opposed to Enumerative analysis:** Most problems in business are Analytic in nature. But only Enumerative analysis is taught at school and in tertiary education, and hence is quite erroneously widely used in Business.	**Six Sigma doctrine asserts**: Continuous efforts to achieve stable and predictable process results (e.g. by reducing process variation) are of vital importance to business success. Manufacturing and business processes have characteristics that can be defined, measured, analysed, improved, and controlled. Achieving sustained quality improvement requires commitment from the entire organization, particularly from top-level management. **Claimed features that set Six Sigma apart from previous quality-improvement initiatives are said to include:** A clear focus on achieving measurable and quantifiable financial returns from any Six Sigma project. An increased emphasis on strong and passionate management leadership and support. A clear commitment to making decisions on the basis of verifiable data and statistical methods, rather than assumptions and guesswork. (from Wikipedia) **DMAIC** and **DMADV** methodologies. **Six Sigma** focuses on reducing process variation and enhancing process control, whereas **lean** drives out waste (non-value-added processes and procedures) and promotes work standardization and flow. **Has many critics:** Juran, Crosby and others due to ***lack of originality***, over-reliance on ***Statistical Tools*** and the relevance of coloured belts for practitioners. Does not address the management and contributions to learning within the whole organisation as an essential connected whole. Claims origin from Toyota, but mainly Womack & Jones All ended badly for companies using 6σ in focusing on things that were not useful to managing the business as a whole, with outcomes that were negative. (see Deming's SOPK for a holistic approach) ***Does not address the end Customer.***	An **A3** form of improvement cycle based on  **PDCA - The proper Scientific Method; i.e. Scientific Thinking rather than Scientific management.** The A3 is used as a communication tool for garnering knowledge and as a means of communicating ideas. The objective is for the author to become the Local Current Expert on the perceived problem, describing the perceived problem and the Root Cause Analysis that has been undertaken during investigation. The Toyota model bestows authority to where it is needed. I.E. ***Pull Authority***. By this method the organisation has many employees working on the daily matters any business needs to deal with, and not just *Managers*. This also delivers training in problem solving throughout the entire workforce. **Toyota Way of Thinking:** Recognise obstacles early and understand them. Problem solving. Improve the process. Work together on a common objective. **The Toyota Five Questions:** 1. What is the target condition? (the desired state) 2. what is the actual condition now? 3. What problems or conditions are currently preventing you from reaching the target condition? And which one are you focussing on now? 4. What is your next step? (start of next PDCA cycle). 5. When can we go and see what we have learned from that cycle? The Japanese realised: That ***Productivity*** moves upwards as the ***Quality*** of the process improves. Basis of Toyota Production System / Job Instruction System which is not Command and Control as practiced by Western Management  Durward K. Sobek II. & Smalley, Art; *Understanding A3 Thinking*; CRC Press, Taylor & Francis Group NY. ISBN: 978-1-56327-360-5 HC. See Chapter 2	Agile began in 2001, constructed by 17 software developers frustrated at the frequent failure of large IT initiatives. They argued a need to move from traditional to sequential writing methodologies. The key idea was to develop applications alongside the people who use them, in short spurts for rapid delivery. The ambition was and remains largely sound. It's simply been hijacked as a universal solution to the digitisation of services. Http://agilemanifesto.org/ Agile's step from a methodology for software development to an enterprise wide project management tool was precipitated in an article entitled ***Embracing Agile*** Rigby D, Sutherland J, Takeuchi H, May 2016 USA HBR. Agile is showing large-scale failure rates for IT solution-based improvement (digitisation) as anything between 50 and 80% of the code written never gets used (but gets paid for) and in order to control Agile large amounts of command and control management are erroneously needed. In digitising services, the solution on offer is by design necessarily bounded packages that are perceived by management to be the whole range of solutions to all customer problems. The packages need to be contractually controllable and chargeable chunks of service. So, they produce Blue Square / Green Triangle / Red Round thing problem solutions for delivery. But the root-cause-problem is that most customers turn up with say Orange Oval type problems. As such the service provider cannot solve the problem of the customer and that results in large amounts of failure demand and associated cost backing up in the organisation and frustration in the Customer. The real issue is that those commissioning the digital solutions do not know what is going on at the customer interface. And the service delivery indicators only report time and use, not effectiveness. **No one in the delivery organisation visits the GEMBA!** See also Seddon etal ***Beyond Command and Control*** 2019

Claimed and known origins and extent of use by others.

Circa 1890s – 1920s Book 1911	Circa 1924 – SPC / met Deming 1948	Circa 1950 in Japan – influenced Toyota, Ohno, Taguchi	Claims 1913/1930 but really 1990 / 96	Circa 1950 from Deming etal to date	Circa 2001 to date

Note that *Newer* is not a sign of better in either structure, implementation, control or benefit.