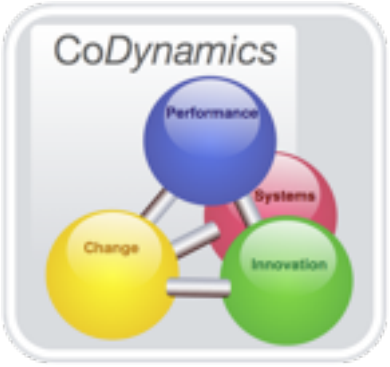

Fixes That Fly

Examining Contemporary Approaches to Improving Business Performance

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Introduction

Doing business was much simpler a century ago than it is today. The world has shrunk. Worldwide communication and travel are commonplace and have fuelled globalisation. The amount of interaction taking place within and between organisations has increased exponentially. Businesses no longer operate in isolation. They exist in a volatile mileu characterised by increasing regulation, strong competition, economic disarray, international influence and disruptive innovation. They are also subject to continuous pressure:

- to improve profitability and provide returns for shareholders
- to create market leading services and product lines
- to cope with rapid technological change
- to satisfy customer expectations of value which are steadily escalating
- to adjust to changes in the competitive landscape.

And as if that were not challenging enough, yesterday's winning formula is no guarantee of continued success:

- Competitive advantage can be quickly eroded by imitation
- Maturity in the marketplace can make an organisation vulnerable to disruptive innovation
- Pushing a strength to its limits can become destructive as exemplified by DEC or Polaroid
- Not spotting that the world has changed until it is too late opens the door to competitors

In response to these and other pressures, companies increasingly need to achieve breakthrough improvements in cycle time, service levels, costs, quality and almost any other performance criterion you can think of. But what actually happens? Most successful organisations evolve more or less successfully during relatively stable periods where incremental change is the order of the day. These periods are punctuated by upheavals in the business environment and the usual corporate response is to start one or more transformational change initiatives. But there is a fly in this ointment. It is generally recognised that most change initiatives fail to live up to the expectations which were established when their funding was approved. Current estimates indicate that 70% of change initiatives fail to deliver the promised results. This leads to a number of questions, but perhaps the most reasonable in the light of these dismal figures is "why embark on major change when the odds against succeeding are so high? Why not simply batten down the hatches and wait for the storm to pass?". The appropriate response depends on the circumstances. Change is needed for a number of reasons which include growth and improvement in times of stability, but in times of flux, the overriding imperative is to adapt to the changing environment in order to a) survive and b) exploit it. If an

organisation's environment has been disrupted, incremental change will not position it to exploit it's new context quickly enough. Slow adaptation to the new world, will see the laggards struggling as the faster moving competition secures and fences off the commercial resources necessary for future growth. Above all else, it is the organisations that adapt easily and quickly to changes in their environment, that survive and thrive.

So the challenge which management teams face is to optimise strategy, structure, working practices and culture during periods of stability, whilst being prepared to tear them down and reconstruct them quickly in order to survive and grow in a new world order. But why is it that well intentioned efforts to cope with increasing pressures and a volatile environment result in overly complicated and dysfunctional operations, low morale and customer dissatisfaction? Why have the various approaches, evangelised by the great and the good in the past: BPR ,TQM , JIT and EFQM and etc., been less than universally successful? In this paper we look at:

- why performance initiatives often do not deliver on their promises
- the conceptual elements of Lean, SIx Sigma and the Theory of Constraints and their positioning relative to each other
- ways to address the identified shortcomings

and we lay out a pragmatic approach to improving the performance of any organisation.

Why do performance initiatives Fail to Deliver?

With any significant undertaking there is potential for a lot of things to go wrong. John Smith in his book Troubled IT Projects[1] provides a good summary (Smith, 2001) and pointers for further reading. In this section however, we try to get away from the generalities of project failure and look at some of the factors which detract from the success of improvement initiatives.

Problem Areas Which Affect Improvement Initiatives

One possible explanation for the underperformance of improvement initiatives is the emphasis which Western management places on hierarchical organisation and the command and control management style which goes with it. Hierarchy promotes functional specialisation which results in only a few people in the organisation having the complete overview of how the organisation works. Individual functions end up competing with each other for resources and business units are optimised at the expense of the overall effectiveness of the larger organisation. Konosuke Matsushita (founder of Matsushita Electrical Industrial Co) commented the Western approach:

'Your firms are built on the Taylor Model; even worse, so are your heads. With your bosses doing the thinking while the workers wield the screwdrivers, you're convinced deep down that this is the correct way to run a business. For you, the essence of leadership is getting the ideas out of the heads of the bosses and into the hands of the labor. "We are beyond the Taylor Model; business, we know, is now so complex and difficult, the survival of firms so hazardous in an environment increasingly unpredictable, competitive, and fraught with danger, that their continued existence depends on the day-to-day mobilization of every ounce of intelligence. For us, the essence of effective leadership is precisely the art of mobilizing and pulling together the intellectual resources of all employees in the service of the firm. Only by drawing on the combined brainpower of all its employees can we succeed.

Looking at the success of Panasonic it seems like he was on to something. Schaffer and Thomson (Schaffer and Thomson, 1992) are equally gloomy:

"The performance improvement efforts of many companies have as much impact on operational and financial results as a ceremonial rain dance has on the weather. While some companies constantly improve measurable performance, in many others, managers continue to dance around the campfire — exuding faith and dissipating energy".

Their explanation for the apparent lack of impact is that although there is a large investment in improvement activities (benchmarking, assessing the voice of the customer, training, employee participation and the like), there is no linkage to business results. The improvement team is focussed on improving process not profit. This path typically requires a large up front investment coupled with faith that an improvement in the bottom

[1] Don't be put off by the title, the lessons in this book are universal.

line will result naturally from these preparatory activities. One anonymous vice president is quoted as describing his company's three year old total quality program thus:

" *We have accomplished 50% of our training goals, 50% of our employee participation goals and 5% of our results goals.*"

And this shouldn't be too surprising. The complexity of today's organisations means that there is an almost limitless array of things which could be improved. Most improvement methods do not address the question of what to focus on first. Peter Drucker was once moved to ask:

"Is this the best use of our resources? There is so much work to be done. Let's put our resources where the results are."[2]

Another potential source of difficulty is that performance improvement methods, of necessity are couched in general terms - the implementor is left to interpret and select the appropriate parts of the approach which are germane to the context in which he finds himself. The 'Total' in TQM becomes eroded by cherry picking those elements which are deemed to be most relevant. Guidelines such as Deming's 14 points or Juran's 10 steps are not detailed enough to pin down the essential organisational elements and requirements for a successful implementation. As a result, implementations suffer from real shortcomings in the way that they fail to address topics such as:

- management effectiveness
- policy formulation and deployment — much wasteful activity is driven by policies which are out of date or whose purpose is no longer relevant. An examination of the assumptions which led to a particular policy can be very informative.
- how managers are measured and rewarded
- the dissemination of, relevance of and workforce adherence to the organisation's values
- alignment of activities with the organisation's strategy.

Any of these can have a huge effect on an organisation's ability to meet it's goals and yet, in the headlong rush to make processes more efficient, they are often ignored or passed over and as a result, after the work has been done and processes have been optimised, bottom line results are not vastly improved.

Another unhelpful characteristic of improvement methods is the shrouding of improvement initiatives in mystique:

- transplanting Japanese terminology into a western setting can be less than helpful, creating unnecessary barriers to understanding. It is far more effective we suggest, to reduce the level of obfuscation and simplify the language. This can only increase the level of understanding of those people who will be expected to live with the

[2] Admittedly Drucker was talking about Government, but the principle can apply to any organisation.

results and make it easier for them to contribute. As a result, staff enthusiasm will be markedly higher and the (often justified) level of suspicion diminished.

- Similarly, the use of the Six Sigma belt hierarchy with its elitist connotations can get in the way of team working. At Lockheed Martin the belt system fell into such disrepute after a number of projects foundered that no one describes themselves as a black belt any more, opting for the anonymity of titles such as program manager in order to maintain some semblance of credibility.

Staying with the subject of expertise and mystique, responsibility for performance improvement is often put in the hands of process mapping experts. Why? The people who understand how a process really works (or doesn't) and so have the knowledge to improve it, are operations staff, the people who carry out the organisations bread and butter activities. Quite often, these people are not consulted or are consulted superficially or for some other reason, their voice is simply not heard. The consultants do their best and try to roll out theoretically ideal solutions, but processes are contextual and the ideal rarely works in practice as well as it does in the manual. When the new solutions do not deliver the promised results in full, when the consultants have left the building, the organisation slowly reverts back to at least some of the earlier ways of working. If challenged, people will rationalise their behaviour, saying "we didn't believe in it at the time, but we had no choice other than to go along with what the consultants were saying" or "we tried to explain that it wouldn't work but nobody listened".

It seems logical that quality programmes are only likely to have a significant affect on business results where the organisation's overriding problem is one of poor quality. Some large companies including Lockheed Martin, IBM, Continental Airlines and even Motorola, despite its well publicised early successes with SIx SIgma have failed to recognise this fact and have wasted money as a result. So while it is possible and desirable to eliminate waste and variation from business processes, in many organisations, all too often, once the dust has settled, although efficiencies in diverse areas can be pointed to, the important parameters, by which the organisation is measured (mostly financial) appear not to have been greatly affected. The problem becomes even more pronounced once the one-off savings (usually from inventory reduction) have been harvested. This lack of improved key results happens despite the fact that millions have been spent to improve them. The underlying problems remain unresolved and this leads to frustration, lack of cooperation, cynicism and resistance which in turn makes it harder for new projects to succeed. There is more than one possible explanation for this state of results inertia. The most likely being a failure to consider the correlation between the financials of an organisation and the way that its processes combine to produce goods and services.

In order to really make a difference, the performance of the organisation as a whole must be considered so that improvement activities can be targeted to where they will have most impact rather than pursuing local optimisations across the board which is the approach used in many organisations. As Figure 1 illustrates, if the organisation's output is created by interlinked and interdependent processes 1 to 6, only improvements in

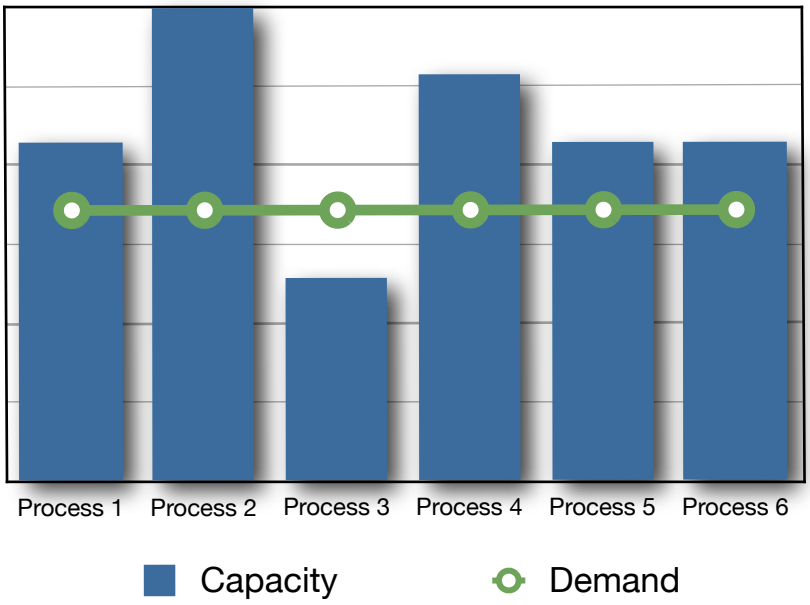

Figure 1. Effect of Process Capacity

process 3 will result in customer demand being met. Improvements in the other processes may result in some savings but they will not affect the ability of the organisation to satisfy demand and this could mean the difference between winning new business or having to turn it away. Not only that, improving process 1 or 2 but not 3 could result in the accumulation of additional WIP, tying up funds and generally worsening the cash position.

Another possible explanation for unimpressive results lies in the realm of unintended consequences. Any change to a system introduced without the benefit of an understanding of how the whole system works, bears the risk that it might inadvertently introduce new unanticipated problems, the resolution of which add to the cost of the original change and eat into the promised benefits. Coupled to this is a propensity to focus solely on cost savings and local efficiencies. In this paper, we suggest that In order to affect bottom line results dramatically, attention should be turned to increasing organisational throughput which can be taken as a synonym for the creation of wealth.

The Importance of Throughput

Big rewards come from maximising throughput. What does this technical sounding term mean? In a commercial setting, throughput is "*the rate at which the organisation generates money through sales*"(Goldratt, 2004). In the public sector, this translates to transactions with someone outside of your department who is in the role of the customer. This could be a member of the public or another department - we believe that only transactions with the public should qualify. Throughput is only real when a sale occurs or formal acceptance of a deliverable or service by someone in the role of customer takes place. This is not the same measure as the rate of production. Creating stockpiles of finished goods does not count as throughput. It should be clear that making improvements in areas which are not directly related to a customer (in the loosest sense) transaction, will not dramatically affect the results by which an organisation is measured.

Throughput drives growth, which in theory should have no upper limit. You create a killer product which is aligned with customer needs and everyone wants[3]. The number of

[3] or you have a monopoly or you are the Government

customer transactions disappears into the stratosphere (or at least the troposphere) with no end in sight. Success! In practice there are always limits. These may be found in the finite capacity of the supporting environment (the carrying capacity) or in limits to the rate of growth which can be achieved. Growth tends to follow an S shaped rather than an exponential trajectory. The levelling out at the top of the curve is caused by some inherent limiting force slowing the rate of growth. The origin of the limiting force may be external to the organisation, market indifference to your product perhaps, or it may be an internal problem causing a failure to produce sufficient output to satisfy demand at the rate that the market wants it.

Senge describes the phenomenon with his 'Limits to Growth' archetype (Senge, 2006). He established that it is far more effective to weaken and if possible, remove the limiting force than it is to strive ever harder to push through it in an attempt to return the growth curve to its earlier trajectory. For example, you diet to lose weight and you are at first successful in shedding a few pounds. Then you plateau. What happened? Having registered the lower food intake, your body lowered it's metabolic rate to maintain fat stores in anticipation of a period of famine (the limiting force). Eating even less will result in a further lowering of your metabolic rate to compensate. Take this to extremes and you may damage your health. Alternatively, maintaining your food intake while taking steps to increase your metabolic rate through regular aerobic exercise or swimming is much more likely to have the desired effect. The key to good results here is understanding the system which is at work. How many organisations trying to improve their performance, persist with the diet while not exercising? In business, limits to growth occurs frequently and sometimes its effect can be catastrophic:

- The collapse of People Express caused by a steep increase in customers combined with much slower growth in personnel
- The lemming like exodus of AOL subscribers after an intense marketing campaign increased the number of subscribers to a point where the infrastructure was overwhelmed
- Productivity in many companies falling as growth brings with it an increased bureaucratic burden

Senge goes on to point out that having cleared one limit, and returned the growth curve to its exponential shape, it is only a matter of time before the next limiting force asserts itself.

So, having attained an understanding of the system which is producing sub-optimal results, how to go about maximising throughput? As you might expect, our attention turns to the business process.

A process is simply a way of describing the way that work is carried out. It is a set of activities designed to produce an output by using resources to transform one or more inputs. For the process to have any point, the output should be of value to the customer

and for management purposes it should be measurable. It is generally acknowledged that organisations have three types of process:

1. Those that are core to the organisation and create its outputs
2. those that support the core processes; and
3. those that are concerned with the management of the organisation.

It should be obvious that category 1 processes, which are usually few in number have a direct affect on throughput and this is where attention should be focussed. By homing in on core processes, the practitioner should be able to:

- Establish the linkage between the organisation's strategic goals and what it produces
- Develop a view of the organisation based on the perspectives of customers, suppliers and the competition
- Quantify the flows and accumulations of cash, material, people and information; and
- identify where internal boundaries are causing difficulty.

This doesn't mean that processes in categories 2 and 3, should be ignored but with these, the emphasis changes to ensuring that they don't disrupt the category 1 processes, that they aren't absorbing too much cost and they don't become an end in their own right. It is surprising how quickly bureaucracy can spring up and alarming to see how hard it can be to eradicate it once established.

Three Contemporary Improvement Techniques

Improving the efficiency and effectiveness of business processes is at the heart of most approaches to improving organisational performance. In this section, we pause to summarise and compare the use of three approaches, two of which (Lean and Six Sigma) are currently in vogue and Goldratt's Theory of Constraints which is not so popular. We start with a brief description of each of the three disciplines[4], compare and contrast them from a functional perspective and then continue the comparison with a simple worked example of Throughput Accounting.

Lean

Lean is derived from lean manufacturing which itself has origins in the Toyota Production System. It is not so much an implementation method, or a collection of tools but more of an organisation wide philosophy which is based on the dual concepts of Build to Order and end to end value streams which integrate marketing, sales, design and production. In combination, these two ideas set the organisation up to maximise the delivery of customer value which should be the foundation on which all Lean activities take place. In the Lean operation, employees are engaged and equipped to modify or eliminate any activity which doesn't contribute to the creation of customer value. Decision making is pushed down to those people who are closest to the work and there is an opportunity in doing this to eliminate a lot of unproductive overhead in the form of reporting and inspection.

Activities that don't add value are referred to as waste. Their elimination is a key element of Lean. Examples of waste (Bicheno, 2004) include:

- Mistakes requiring rework
- Producing items no one really wants
- Unnecessary process steps such as capturing the same data more than once , requiring too many authorisations, or processes that are responsible for poor quality.
- Unnecessary motion when carrying on a task often caused by a non ergonomic work environment
- Movement of employees and goods for no good reason
- People or machines being forced to wait because upstream activities haven't delivered in time
- Goods or services that don't meet the needs of the customer

[4] It is not intended that we describe these three in great detail. Our aim here, is to examine how to improve the success rate of performance initiatives. There are a large number of books available which will go into the detail of each method. Some are mentioned in the bibliography.

- Overproduction - making too much, too early or ‘just in case’
- Holding unnecessary inventory which ties up money, space and hides process problems
- The waste of untapped human potential
- The waste of inappropriate systems imposing bad working practices because processes were automated before the waste was taken out and not afterwards (a syndrome often observed with ERP system implementations)
- Wasted energy
- Waste of materials arising from scrap, sitting idle or ordering more than is needed
- Poor use of space
- Unnecessarily hazardous environments leading to accidents
- Waste arising from unclear communication
- Failure to provide a good customer experience leading to a loss of repeat business.

The Identification of waste also supports target costing where an ideal product cost based on the assumption that all waste in the production process has been eliminated is calculated. As the name implies, this ideal becomes the target which the organisation strives to achieve. As costs reduce, the organisation may choose to take increased margins or add customer value by reducing prices.

Lean takes a horizontal business process view of the creation of products and the delivery of service. It seeks to optimise and synchronise flow so that output is (ideally) created at the rate of customer demand. Variation is kept to a minimum by building flexibility and mistake-proofing into the process. Operations are highly visible with management information on display at the point where the work is being carried out. This helps keep surprises to a minimum as schedule and actuals are tracked at each step in the process.

Implementing Lean requires cultural changes away from the usual Western approach to management. The after the fact, ‘inspect and fix’ mindset is discarded in favour of preventing errors and mistakes before they happen. Continuous improvement and problem solving becomes everyones responsibility and is not limited to management or groups of troubleshooters. Where possible, Lean adopts a ‘small is best’ approach, avoiding the false economies of scale resulting from big ticket procurements, preferring a policy of buying many small items and maximising asset use. Organisation units are also kept small and people are expected to work flexibly across a range of jobs. The small and frequent delivery of goods is preferred to large shipments and small offices located close to customers are preferred to central monoliths.

The establishment of value networks where the entire supply chain is tuned and synchronised to the beat of customer demand becomes a logical step in pursuit of

customer satisfaction. The Toyota ecosystem is a prime example. All of this requires operating with a high degree of trust between managers and workers and also between companies. Trust is a prerequisite for de-layering, streamlining and the elimination of bureaucracy. It encourages suppliers to collaborate and invest in servicing your business. Most of all, trust encourages creativity and innovation in the workforce.

In their book lean Thinking, Womack and Jones (Womack and Jones, 2003, pp. 16-28) summarized Lean in five principles:

1. For each product or service, ***identify value*** as defined by the customer (not what is convenient for the producer). This may be the ultimate customer or an intermediate company or even a receiving business process. However, all activity must be based on what the real customer or end user wants to buy. The focus of Lean is to equip the organisation with a set of processes that tuned for the creation of value. Activities that do not contribute to customer value are candidates for elimination or modification as they can be regarded as waste. Lean companies will often organise around product lines to maximise value creation. However, this can lead to problems if product lines are not truly independent as it leads to competition for the organisation's resources.

2. For each product and service, design *a **value stream**,* the entire sequence of steps, including those in the supply chain which are necessary and sufficient to deliver that product or service. Womack and Jones (Womack and Jones, 2003) define a value stream as:

   "The set of all specific actions required to bring a specific product through the three critical management tasks of any business: problem solving, information management and physical transformation."

   In defining the value stream, the value adding (VA) and non value adding (NVA) steps in an operation are identified and this starts the process of exposing waste. Not all waste can be eliminated. Some activities such as complying with government regulations are categorised as non value-adding but necessary (NVAN) and cannot be discarded. Buildings maintenance, or payroll activities for example don't contribute value directly to the end customer, but they are necessary for the smooth running of the business. Where NVA activities can't be eliminated, efforts are made to minimise their impact on value adding activities.

3. Make value ***flow***. Once the VA and NVA activities are understood, improvement efforts are directed towards achieving flow. Typically, this means reducing the scope for interruptions and delay by reducing batch and queue sizes as far as possible, minimising transportation and reducing the number of buffers. The Lean view is that buffers tend to hide process inefficiencies and tie up cash in inventory and are to be avoided. The result is that value creation flows easily and quickly across the organisation and in some cases the supply chain to the customer.

4. Let the customer ***pull*** product or service from the producer. In the Lean enterprise, inventory is seen as waste. Making what the customer wants, exactly when they want it means the elimination of stockpiles of work in progress, finished goods and other inventory.
5. ***Pursue Perfection*** The preceding principles are used to create a virtuous circle of continuous improvement, continually trying to reduce NVA activity, improve flow and meet customer needs. Increasing the flow rate always exposes more waste and the harder the *pull* the more impediments to flow can be found.

Note: Historically, the focus of Lean Implementations has been on waste reduction, which is subject to the laws of diminishing returns. Latterly, however, the realisation that creating customer value is at least as important is gaining prominence.

To be effective, Lean thinking has to be embedded in the company culture and adopted by everyone from the senior management team to the most junior of employees. The transition to flow thinking changes peoples perception of their role and its contribution to customer value. It is not unusual as the organisation tries to achieve more and more without a corresponding increase in resources, that people start to feel squeezed. Much of Lean marketing emphasises cost savings through head-count reduction and there may indeed be job losses. The situation can lead to industrial relations problems if other productive jobs are not found for those who have been displaced. Lean in the public sector is even more problematic with challenges such as the absence of a profit motive, a lack of competition and civil service rules that tend to limit the flexibility and appetite for risk in the workforce. These problems are less evident in Japan where the employee/ employer relationship is far more harmonious and collaborative.

Lean aims for simplicity of operation and systems yet a full implementation of Lean is neither quick nor easy. Toyota, the Lean exemplar, took 20 years to get it right in a supportive cultural environment and although it is possible today to learn from the experience of others, the difficulties to be overcome are significant and many. In particular, persuading a workforce to embark on a Lean journey where the last stop may be their removal or reassignment isn't easy.

Six Sigma

Six Sigma originated in Motorola in the 1980s where credit for a huge leap in quality and productivity was ascribed to its use. General Electric, Allied Signal and others subsequently took up Six Sigma with similar tales of success.

The fundamental idea of Six Sigma is that by focussing on the reduction of variation in products and the processes required to deliver them, customer value, internal efficiency and ultimately, business performance are improved. By measuring the defects in a process and understanding the causes of fluctuation, you can begin to predict and control process performance and find ways to eliminate errors taking you towards a quality level of zero defects. Six Sigma can be thought of in a number of ways:

- as a statistical definition of how far a process deviates from perfection
- as a target of 3.4 defects per million opportunities (DPMO) or virtually perfect performance. DPMOs can be thought of as a measure of the organisation's overall performance as experienced by the customer.
- as a business strategy focussed on the reduction of cost through the reduction of variability in products and processes
- As a well defined quality method.

The Six SIgma method is in truth a development of a number of earlier techniques, not least statistical process control which was pioneered in the 1920s by Shewhart and developed by W. Edwards Deming who famously introduced it to Japanese industry after the second world war. It might be thought of as a simpler version of TQM. Six Sigma revolves around the use of statistical tools and data combined with a rigid and structured methodology the standard version of which is known by the acronym DMAIC. Using DMAIC, practitioners build up their understanding of processes; identify the factors that cause waste, errors and rework and implement solutions to correct them. Over time the quality of processes improves and it is assumed that bottom line performance automatically follows.

Six Sigma is based on a few key concepts:

A Focus on Data and Numbers

There is a basic assumption that numbers can represent the features and characteristics of a process. A deeper understanding of data can be used to produce improvements and graphical representation can be used to deliver new insights and perspectives. This is an approach which naturally appeals to people with a left brained orientation. While there is nothing wrong with such an approach, we suggest that it is important that healthy scepticism and common sense are applied liberally to interpretations of what the data is telling you.

Defects and Variation

The critical to quality elements (CTQs), of a process, product or service, those which contribute most to customer satisfaction are surfaced and become the main points of focus for the reduction of variation which naturally leads to an improvement in quality. In particular, the cost of rework, scrap, delays, missed opportunities, customer defection and poor quality are eliminated.

Customer Satisfaction

Six Sigma emphasises listening to the voice of the customer. This is achieved through understanding the customer's critical to quality expectations, i.e. the characteristics that matter most (similar in concept to Kano's performance and excitement factors). Once the CTQs are understood, the boundaries of acceptability, known as the upper and lower specification limits (USL and LSL) are quantified and then used to determine how well the

organisation is meeting those expectations. The difference between USL and LSL is often referred to as the 'voice of the customer'.

Process Capability

The aim of six sigma is to reduce the standard deviation of the variation in key processes to the point that 6 standard deviations can fit between the USL and LSL, or to put it another way:

Process capability C_P = (USL - LSL) / 6σ

The higher C_P is, the smaller the process variation.

There are two other limits which are also used, referred to as the upper and lower control limits (UCL and LCL). These are the voice of the process and represent the inherent limits of the process. For a process to be considered capable of meeting customer expectations, the control limits must fit within or align with the specification limits.

The DMAIC method is based on Deming's Plan - Do - Check - Act cycle and has five stages :

Define	By focussing on customers, determining what their problems are, what is important to them, how well their needs are being met and identifying the processes which contribute to that state, the goals for improvement are identified and improvement projects are shaped.
Measure	Attention moves to measuring process performance. Relevant product or service characteristics are identified, process maps drawn, measurement systems evaluated and designed and current performance levels are established.
Analyse	Data is collected and analysed to gain insight into the process and how it performs. Root causes of performance problems are drawn out through statistical analysis and hypothesis testing. A performance baseline is established
Improve	Solutions are developed and changes are made. Results are seen through further measurement and the process is refined to eliminate defects until it is seen to be operating consistently within acceptable limits I.e. a state of statistical control has been achieved.
Control	Once the process is performing at a desired and predictable level, it is monitored to ensure that no unexpected deviations occur and performance is sustained. Steps such as changing the reward system and updating the quality system are taken to institutionalise improvements.

Pyzdek claims that the typical American company operates at 4 sigma which equates to 6210 failures per million opportunities (Pyzdek, 2003). The cost of dealing with this level of errors (the Cost of Poor Quality in Six Sigma parlance) can be as high as 25 - 40% of revenue. General Electric estimated that difference between 3 and 4 Sigma was costing

them in excess of $8 billion per year. Table 1 illustrates what the difference in Sigma levels might mean in practice.

Sigma Level	DPMO*	Area	Spelling	Time	Distance
1	697,672	Floor space of a factory	170 misspelled words per page	31.75 years per century	From here to the moon
2	308,537	Floor space of a large supermarket	25 misspelled words per page	4.5 years per century	1.5 times around the world
3	66,807	Floor space of a small store	1.5 misspelled word per page	3.5 months per century	Dublin to Moscow
4	6,210	Floor space of a living room	1 misspelled word per chapter	2.5 days per century	40 minutes of UK motorway driving (50 miles)
5	233	Size of the bottom of a telephone	1 misspelled word in the Encyclopedia Britannica	30 minutes per century	A walk to the local store
6	3.4	Size of an average diamond	1 misspelled word in a town library	6 seconds per century.	4 steps.

Table 1. Sigma Level Illustration

* By Convention, these figures contain an allowance for a drift of 1.5 sigma over time.

As with Lean, implementing SIx SIgma successfully should be viewed as an all or nothing commitment. History tells us that piecemeal implementations are not successful. It requires strong commitment from the highest levels of management to the most junior levels. However, in practice, organisations tend to expect the most improvement as quickly as possible for the least investment and herein lies a source of conflict. It is not unusual for it to take a year before the first positive results start to materialise and up to two years before a 10 fold improvement in DPMOs, a reduction from say 58000 to 5800 is achieved. It can take 5 years and major investment to attain Six Sigma levels of performance with continuing effort and investment to sustain that level of performance. In other words, it is not a journey for the faint hearted, the cash constrained or those in a hurry.

Design for Six Sigma

Finally, we cannot conclude this section without mentioning Design for Six Sigma which has tremendous potential for value creation. When the goal of development is a new or at

least a radically redesigned process, product or service, Design for SIx SIgma aims to produce a design with Six Sigma levels of quality incorporated. As with DMAIC projects, DFSS relies on the use of statistical techniques and the voice of the customer but its strength is that taking a proactive approach to eliminating variation is ultimately far less expensive and delivers higher levels of customer satisfaction than undertaking a 5 year programme to eradicate variation and waste after product launch.

The Theory of Constraints

During my career, I have visited the offices of many senior managers and directors. Usually, these are nicely furnished, and typically, they all have a bookcase containing an array of business volumes. Given the opportunity, I always make a point of examining the contents of the bookcase as they provide an indication of the interests, history and sometimes the biases of their owner. I have always been struck by the fact that some books appear time and time again. One that appears more often than most is The Goal by Eliyahu Goldratt and Jeff Cox.(Goldratt and Cox, 2004). This book is notable because it was one of the first books to try and get a serious concept over using the format and style of a novel. An approach which was fresh and engaging when the book was first published in 1984. The trials and tribulations of the main character, Alex Rogo “a harried plant manager working ever more desperately to try and improve performance” are used to illustrate the concepts, principles and measurements which combine to form the theory of constraints.

The Theory of Constraints (ToC) sees organisations as systems and takes a holistic view of organisational performance. The ‘system in focus‘ could be the entire business or it might be some subdivision of it, but the idea of the organisation as an open system, one that operates within and interacts with its macro-environment is a strong metaphor. So let’s start by asking this, ‘in this context, what do we mean by the term constraint?’ As you might expect, constraints are limits. They restrict what we can do in a particular set of circumstances. A constraint is like the pinch point in an hour glass. It determines the rate at which the organisation moves towards its objective. Goldratt’s thesis is that constraints are points of leverage which when manipulated will result in performance changes which are out of proportion to the effort used.

Goldratt describes organisations as ‘chains of action’ where a chain is only as strong as it’s weakest link. Strengthening the weakest link improves the strength of the entire chain. Conversely, strengthening the other links has no effect on overall strength. There can only be one weakest link in each independent chain and so looking at the organisation as a whole, where the number of independent chains is probably small (think of them as core processes), there are likely to be very few constraints which matter. On the other hand, maximising local efficiencies in each part of the organisation without thought to the effect on flow rate is unlikely to have a corresponding effect on results. By strengthening links other than the weakest, all you are doing is creating additional capacity which, because of the limiting effect of the constraint, will never be called upon. The secret to achieving major increases in throughput therefore is the identification of

constraints and the elimination of their root causes. As might be expected, there are a number of constraints which occur regularly. One such is policies which are inappropriate or out of date yet still in force . Another problem area frequently encountered, is the rate at which work flows across organisational boundaries. Others might be related to resource availability (people, cash or materials) or capacity, competence or market demand. There is no shortage of possibilities.

One unintuitive consequence of the focus on these leverage points is that the performance of some parts of the end to end system (the stronger links in the chain) will be subordinated to the bottleneck. As with Lean, the ideal is to match the rate of flow to customer demand and by definition, it is the system constraint that sets the rate of flow. It follows therefore that performance improvements away from the bottleneck amount to a waste of effort and resources. Parts of the organisation will be expected to operate at less than full capacity. The only part of the system that ever operates at full capacity is the capacity constrained resource (CCR) and it is the function of the non constrained elements to feed the CCR at a rate which keeps it 100% utilised for as long as customer demand requires maximum throughput, even though they are under utilised in so doing. This can be problematic when considering the way that rewards systems usually work. Persuading departmental managers to ‘under perform’ when their bonuses depend on exceeding targets laid down at the beginning of the year can be a tricky proposition.

So how to go about maximising throughput? Prior to doing anything it is vital that the system under consideration is understood in terms of its boundaries and its purpose (the goal). It is also helpful to understand where the constraint ought to be. With those prerequisites in place, Goldratt defined five focussing steps which have stood the test of time:

1. Identify	Find the constraint which is limiting performance. It may be internal (capacity or skills shortages) or external (inadequate market demand or availability of materials). Finding it may be as simple as identifying where there are backlogs and queues. If the constraint can be broken without too much effort or resources, do it and start again. Otherwise proceed to step 2.
2. Exploit	Optimise with what you have got. Eliminate all waste at the constraint and inspect WIP as it reaches the constraint. Measure the constraint’s output. Can throughput be increased by living with the constraint, but doing things differently? For instance, if the constraint is not enough people with specialist knowledge in a particular area, can training more people to a basic level of knowledge, free up the specialists to deal with the more difficult questions which they alone are equipped to deal with?

3. Subordinate This step ensures optimisation of the entire system rather than its component parts. Subordination changes the organisation's policies, rules,norms, behaviours and measures to support the constraint. The organisation's processes are changed so that non-constraints are relegated to the role of feeding the constraint, but only at the speed necessary to ensure that the constraint is not starved of work and where required, operates at full capacity. In other words, local productivity is sacrificed.

As a result, most processes will have spare capacity. This can be hard to accept as the implication is one of waste and as we have said, it can be very difficult to persuade departmental managers that they have to slow down when their pay and bonus structure encourages over-performance.

4. Elevate By this point, the organisation should be performing as well as it possibly can short of taking ambitious action to remove the constraint by increasing capacity. This could mean for instance, acquiring more or better equipment or people or enhancing a product. Elevation means that significant investment is made in order to improve performance. Naturally, This will require consideration of all available options and being clear about the implications of eliminating the constraint, especially understanding the amount of performance improvement which can be expected before the effects of the next constraint makes itself felt.

5. Start Again Working on the basis that there will always be a constraint, whether internal or external to the organisation, at this point, the new performance levels resulting from the previous steps are baselined and then the cycle starts again, with the next constraint and its effects being identified and dealt with.

It is worth emphasising two crucial things to get right in the above steps:

1. Correctly identifying the current constraint to be sure that when action is taken it will make a difference; and
2. Understanding where the next constraint is. It would be unfortunate if a lot of money was spent breaking the immediate constraint yet the return on investment remained limited because the next constraint in line was prevented the anticipated step change in performance.

The chances of success are also affected by the availability, selection and use of the right tools. Goldratt offers a number of tools to help with constraint management. These take the form of five interrelated logical thinking trees which address three questions:

- What to change?
- What to change to?

- How to change?

The thinking tools are best used in the order shown to establish a complete picture, but once this has been achieved, it is to be expected that the complete set will be updated on an as needs basis. The tools are:

The Current Reality Tree	Designed to trace a cause and effect chain, the CRT is a network which has the indications of poor performance at it's head and links backwards to root causes. CRTs often reveal that several undesirable effects have their origins in a single root cause.
The Evaporating Cloud	Root causes often exist because powerful influences keep them in place. A proposal for change leads to conflict. The EC is a 5 element tree that expresses the conflict surfacing hidden assumptions and supporting the search for a win - win resolution.
The Future Reality Tree	Similar to a CRT, when conflict resolutions are found, the FRT verifies the cause and effect chain of a likely solution. FRTs have a feature known as the negative branch which identifies possible new undesirable effects.
The Prerequisite Tree	The PRT identifies the conditions necessary for a successful implementation and the sequence in which they must be met. It identifies intermediate objectives and forms the skeleton of an implementation plan.
The Transition Tree	The TT adds detail and ownership of actions to the PRT. In essence it becomes the high level implementation plan.

The ToC tools don't address performance issues in the way that SIx Sigma uses statistical tools and they don't explicitly address some of the dynamic aspects of poor performance. For a detailed exposition of the use of the logical thinking tool set, see (Dettmer, 2007).

Throughput thinking is not limited to addressing problems of transformational change, it is used in day to day decision making, especially when choices between competing claims for resources have to be assessed. There are three basic measures:

Throughput	The rate at which the organisation makes money through sales or the rate at which customer transactions are completed. In a commercial setting, Throughput = Sales Revenue - Totally Variable Cost. Overhead is not included in the throughput calculation.
Operating Expense	All of the money that the organisation spends in order to create throughput from inventory. A combination of fixed and variable costs which ignores the distinction between direct and indirect costs. OE is the cost of all expenses except the cost of raw materials. It includes the the cost of rent, maintenance, taxes, utilities and payroll. In order to be profitable, the company must generate enough throughput to pay for the all operating expense.
Inventory **(aka investment)**	All of the money that is spent on the things that the organisation intends to turn into throughput. Investment includes fixed assets such as equipment, facilities and buildings as well as the cost of materials excluding any adjustment for value add on work in progress.

In order of importance, Goldratt prioritises increasing throughput (T), followed by reducing inventory(I) and finally, reducing operating expense (OE). Increasing T equates to growth and wealth creation. The capacity to improve it is potentially without limit (but not in practice, pages 7,8) whereas you can only reduce I or OE by so much. It is even acceptable for I and OE to increase as long as T increases proportionately. It is noteworthy that in times of crisis, businesses usually tackle the three indicators in reverse order cutting people first, then inventory before attempting to improve throughput.

The three basic measures can be (and for GAAP[5] reporting reasons, must be) converted into other more mainstream measures. For example:

- Net Profit = T - OE
- ROI then becomes Net Profit / I or (T-OE) / I
- Cash Flow = T - OE plus or minus the change in Inventory
- Productivity is T / OE or the ratio of money generated to money spent.
- Inventory (or Investment) turns are T / I.

However, their power lies in using them to evaluate the effect of decisions on the organisation's goal. When making decisions then, managers can ask throughput related questions such as:

[5] or other regulatory body

- Will the constraint be better used
- Will total sales revenue increase
- Will delivery to customers be faster
- Will scrap or rework be reduced
- Will warranty or replacement costs be reduced
- Will we be able to allocate people to other chargeable activities

as a result of this decision?

It is also possible to say that if less raw material or purchased parts will be needed, fewer materials will be kept on hand, WIP will reduce or fewer facilities or equipment will be needed to do the same work, then Inventory will go down. Alternatively, if overheads go down or payments to vendors decrease then OE will go down.

Comparing and Contrasting

Having summarised the three approaches, some comparison and positioning is called for. Positioning the three approaches is not straightforward. They all lay claim to enterprise-wide status and in general, they have similar objectives and there is consequently overlap between them; for example, all three emphasise the voice of the customer as being the yardstick by which success is measured. It is possible however to make the following broad brush positioning statements:

- There is general agreement that the health of a company depends on its ability to meet the needs of its customers. Lean and ToC are built on the foundation of providing customer value as perceived by the customer. Six SIgma is also highly committed to responding to the voice of the customer.
- With its focus on the value stream, Lean not only seeks to optimise flow and eliminate waste across the entire organisation, its proponents assert that it can be implemented across the entire supply chain shifting the basis of competition from inter-company to inter-supply chain which is exactly what Toyota has achieved.
- Despite its enterprise-wide applicability, many of the precepts of Lean, waste elimination, 5S (housekeeping), standard work, visible management, A3 reporting for example, can be applied at the local level. Many of them seem to be little more than good practice and so perhaps management should be asking why they aren't being applied in the first place.
- The DMAIC structure, around which Six Sigma is built makes it suitable for project based implementations. However, in order to avoid some of the failings referred to in section 2, understanding where to apply it for maximum effect is crucial.
- ToC is the technique which tells you where to focus attention for the best results; the leverage points which are limiting performance. To do this effectively requires that organisational goals are widely understood and that processes are stable.

- With ToC, external volatility and internal variability are assumed to occur despite our best efforts. As throughput is affected by both, the organisation must be prepared to accommodate both rather than attempt to eliminate them completely.
- With its focus on waste elimination, Lean can eliminate much of the noise from a process. Six Sigma provides a problem solving sequence supported by the use of statistical tools and is well suited to isolating the fundamental causes of chronic performance problems. The complementary nature of these two methods has led to attempts to integrate the two methods, creating Lean SIx Sigma.
- There is a limit to how far tuning and cost savings can be taken before it becomes counterproductive. The pursuit of perfection can prove to be very expensive. It is more rewarding to target growth while keeping waste under control.

To help with comparison, Table 2 uses a High/Medium/Low scale to indicate the importance of different aspects of the three methods and the notes which follow, present a (somewhat subjective) view of the way the approaches overlap and differ.

	Lean	ToC	Six Sigma
A whole system approach [1]	H	H	M
Assumes Continuous Improvement	H	H	H
Objective is higher profits [2]	M	H	M
Quality is essential to success [3]	H	M	H
Small production batches [4]	H	M	L
Flow oriented [5]	H	H	M
Pull Oriented [6]	H	H	L
Liberates hidden capacity [7]	H	M	H
Minimise Inventory [8]	H	M	M
Workforce participation is essential [9]	H	M	H
Value is defined by the customer	H	H	H
The value stream extends beyond the production process	H	H	M
Continued pursuit of waste and variability reduction [10]	H	M	H
Relevance of constraints [11]	M	H	L
Approach to variability [12]	M	L	H

Safety net [13]	L	H	M
Use of Takt Time [14]	H	NA	L
Reliance on data and statistical tools [15]	M	L	H

Table 2. Differences and Similarities between the three approaches.

Table 2 Notes:

1. All three approaches look at the whole system. ToC focusses on the constraint once it has been identified. The management of efficiency and utilisation at non constraints takes a back seat to maximising those same measures at the constraint. Lean identifies the Value Stream for the purposes of waste elimination and optimising flow. Six Sigma aims to reduce variance but emphasises the need to select the right projects in order to maximise impact,
2. ToC focusses on increasing profits by increasing throughput to meet market demand. The other two approaches aim to increase profits through increasing customer value, but efforts often become diverted into cost reduction and optimising flow through waste elimination and minimising variability.
3. Quality underpins all three approaches although six sigma emphasises it more. ToC assumes that an acceptable level of quality is present. If it is not, then insufficient quality quickly becomes the system constraint which must be dealt with in the usual way using the five steps.[6] Unlike Lean and SIx Sigma, ToC does not prescribe the use of specific tools and techniques to address quality problems.
4. All three approaches recognise the unattractiveness of large batch and queue operations. One of Lean's aims is to achieve single piece flow. Within ToC, the effectiveness of small batch sizes is recognised, but the use of time buffers to protect against starvation of the capacity constrained resource (CCR) is preferred to striving to reduce batch sizes to one. SIx Sigma has little to say on the subject
5. Six Sigma tends to see flow as a means of reducing inventory and releasing cash, whereas Lean aims for single piece flow from end to end to improve flexibility and reactiveness. ToC aims to minimise set ups at the CCR whilst allowing the non-constrained stages which have the benefit of having more time, more latitude. If the CCR is not fully loaded because of demand patterns, then it too is treated more flexibly.
6. Letting customer demand dictate the rate at which work and materials flow through the system is a goal for Lean and for ToC. However, with ToC, the system constraint determines the rate of flow, whereas with Lean, the production process

6 There are many examples where products do not have the highest level of quality but are commercially successful cf. Microsoft Software

is regularly retuned to match demand. There are tactics such as preferring discounts for regular orders to discounts for quantity which can be employed to smooth out peaks and troughs in flow.

7. Lean and Six Sigma liberate spare capacity throughout the organisation. However the effects of this additional capacity might never be felt. By focussing on the constraint, ToC increases capacity at the point where doing so will result in greater throughput.
8. Using a combination of takt time (see point 14) and single piece flow, the ideal in Lean is to have no idle inventory. In practice this is hard to achieve and so Lean focusses on cutting inventory, work in progress and stocks of finished goods to the bare minimum. However, the benefits of doing so tend to be one off savings. Once these have been claimed, the cost of finding further savings increases rapidly, but the benefits tend to tail off. ToC on the other hand aims to maximise throughput at the CCR and uses inventory as a means of achieving this as well as to allow for things going wrong and to maintain flexibility. Inventory takes the form of time buffers in front of key positions, especially the CCR. WIP is planned to arrive at the constraint some time before it's scheduled start time. The buffer then is the time difference between arrival and the start of processing. On the same principle, a shipping buffer is often used so that finished goods are ready for shipment some time before the customer ship date. All of this serves to maintain flexibility while allowing for a minimal amount of physical inventory in the system.
9. All three approaches require workforce participation. However, Lean and Six Sigma have become associated with cost reduction and doing more with less. In Japan, with its tradition of a job for life, this tends not to be contentious because the prosperity of employee and the company are strongly linked. In the West, labour relations influenced by a generally low sense of company loyalty are not conducive to the never ending search for greater efficiency and cost reduction. The ToC focus on growth and expansion means that resources are much less likely to feel squeezed by demands for ever increasing efficiency and head count reductions. The impact on industrial relations is correspondingly better.
10. All three techniques support the idea of ongoing improvement. With Lean and Six Sigma, there is no end to the elimination of waste and variability. With ToC, the emphasis lies in the pursuit of increased throughput. Lean and ToC cite the workforce as being the source of improvement.
11. Six Sigma does not differentiate between constraints and non-constraints although it does acknowledge that maximising impact through project selection is important. WIth Lean, as long as flow is occurring at the rate of customer demand, constraints are not considered to be particularly important With Lean and Six Sigma, all improvements are celebrated as being equally valuable whereas the removal of constraints is ToC's raison d'etre. With ToC, time saved at a non

constraint has no immediate value — for example, saving a person/hour at a non constraint will not improve sales revenue and the costs of employing the affected person will remain unchanged.

12. Six Sigma and Lean seek to eliminate variability, which is an internal issue but do not specifically address external uncertainty whereas ToC assumes that variation and external uncertainty are always present, even in a stable system and require planning and the use of buffers (see 8. for a note on the use of buffers) to protect against all forms of variability.
13. A system where everything is always working requires the ability to move workers around, equipment that is always available, standardisation of work and extensive mistake proofing. These pre-requisites are virtually impossible to create yet Lean, viewing idle capacity as waste strives to achieve this ideal state. There is no concept of a safety net or contingency, the analogy being one of a finely tuned machine where any problem can have significant knock on effects. ToC's starting premise is that nothing works perfectly and ensures that allowances are made for the inevitable appearance of Murphy's Law. Within ToC, there is an expectation that much of the system will not be operating at full capacity and spare time is used for maintenance, learning and similar support activities. Six SIgma has little to say on safety nets.
14. Takt time or the ratio of available production time to the rate of customer demand is used in Lean to determine how many resources to apply to meeting the day's production plan. ToC does not do this, as the rate of production is set by the capacity constrained resource. Note, in practice, the ToC view is that it is not usual to treat the workforce as a variable resource, they are a fixed cost. Six SIgma is silent on takt time.
15. Statistical process control is at the heart of Six Sigma which makes it ideally suited to the analysis of intractable problems where historical data is available. Lean and ToC do not put any emphasis on the use of statistics to address performance problems. There is a school of thought however that says that variation should be prevented (the Lean approach) instead of analysed and fixed after the event.

The table shows that there is a lot of overlap and similarity behind the three approaches, but we position them as follows:

- There is no conflict between the use of ToC and the tools which Lean and Six Sigma provide. However, in most organisations, there are so many possible areas for improvement that the finite resources available can not possibly address them all in a sensible timeframe. ToC provides the means to identify the opportunities which are likely to pay off most. By finding the system constraint, something which the other techniques have overlooked, it tells you where to focus your improvement efforts for maximum effect and provides a rationale for making the day to day decisions which must be made about the optimum use of resources.

Lean and Six SIgma tools are undoubtedly effective when used properly but they are far more useful when they are focused on the factors which are limiting progress towards the organisation's goals.

- Lean, with its focus on value streams, waste reduction, flow and pull reflects its manufacturing roots although it has been applied in a wide variety of sectors with varying degrees of success. It is as much as anything, an 'all or nothing' management philosophy. Elements of Lean, waste elimination, visual management, error proofing , etc., can of course be applied at the local (departmental) level, but a piecemeal approach to implementation has often proved to be ineffective.
- By contrast, Six Sigma is first and foremost a problem solving tool operating at the most granular level of detail. Its data driven approach, combined with emphasis on the use of statistics to reduce variation make it ideal for problem solving at the process or the work unit level. However, its contribution to business success is highly dependent on the right projects being chosen.
- There is a real danger that achieving Lean status or Six SIgma can become a goal in itself and when this happens, the extravagant up front investment referred to earlier can take hold. The focus moves from improvement to ideology. In contrast, the Theory of Constraints asks a deceptively simple question: "what is limiting our ability to achieve our stated objectives?" and it is clear from that question that of the three approaches, ToC is most closely aligned with business strategy implementation. Its main aim is to take the organisation towards it's goals by focussing on the small number of issues which are currently hindering performance and of the three techniques, it is also most likely to take you into the softer areas (page 4) which Lean and Six SIgma tend not to address. However, ToC doesn't provide a comprehensive set of tools and procedures for exploiting or elevating a constraint once it has been identified; rather it relies on managers to decide on the action to take.

A final note on Lean: historically, much emphasis has been placed on cost reduction and making working practices more effective. These are after all, the obvious things to target. More recently, possibly due to a lack of results, attention has been turning to the creation of customer value which is the other side of the Lean coin. Realisation that the point of efficiencies is to support the creation of value has at last started to crystallise.

Perhaps the most telling comparison is that of how each approach affects financial results.

Financial Implications

In the introductory remarks, we identified that it is entirely possible to carry out a good deal of improvement without having a corresponding effect on financial results. Further on, we suggest that high returns result from finding and breaking the constraint. It is worthwhile illustrating the throughput vs cost control comparison with an example. The following is gleaned from Dettmer (Dettmer, 2003):

A company with £50 million pa. in sales revenue pays £20 million for raw materials and other variable expenses, has fixed costs of £20 million and maintains £7 million in WIP and Finished goods. The operation usually runs at 70% capacity.

From these figures we calculate that Net Profit = (£50m - £20m) - £20m = £10m (Figure 2)

Note: The legend for the columns used in this example are:

R = Sales Revenue

T =Throughput (sales revenue - variable costs)

VC = Variable Cost

OE = Operating Expense (fixed costs and labour costs combined)

I = Inventory (WIP and finished goods)

NP = Net profit

The scale of the Y axis is in £million

In the next year, using Lean techniques[7] [8] and being naturally optimistic, let's say that:

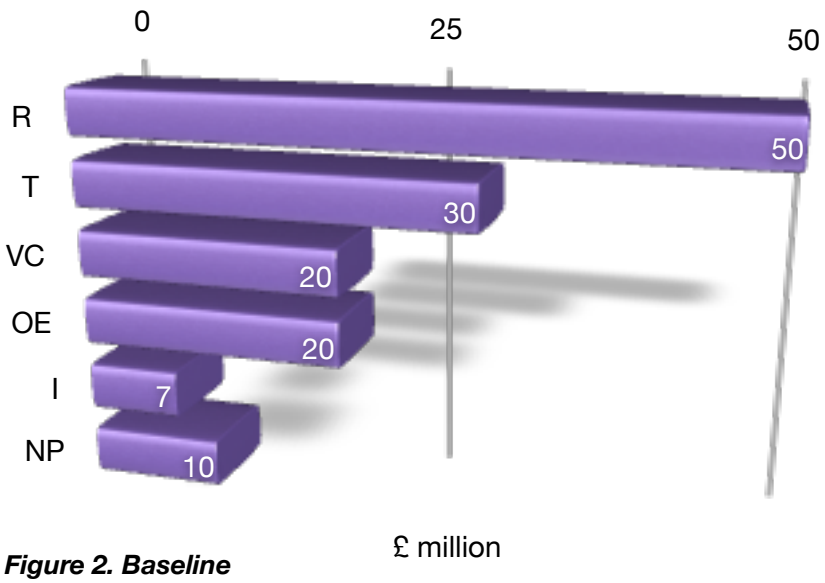

Figure 2. Baseline

- £5 million is saved by reducing scrap and rework and
- The workforce operates more efficiently approaching 100% utilisation.
- £5 million in waste is eliminated from fixed expenses.
- WIP and Finished goods drops to £1 million.

This amounts to £10 million in cost savings and a £6 million saving in the amount tied up in WIP and finished goods. Fantastic results: net profit has doubled to £20 million. Lean works (Figure 3).

However, there is a problem: in year 2: where will the next round of savings come from? Waste elimination in year 1 was effective and so there may only be a few percent remaining to be trimmed. What about the third year? What happens when churn in the

7 the principles and results are similar using SIx Sigma

8 This example assumes the emphasis is on efficiencies and cost saving.

workforce starts to increase because of the now relentless work pressure? Costs start to rise again as staff dissatisfaction and other balancing forces start to make themselves felt. There is a hard limit to how much you can save. Cross that line and the organisation becomes less effective, even damaged.

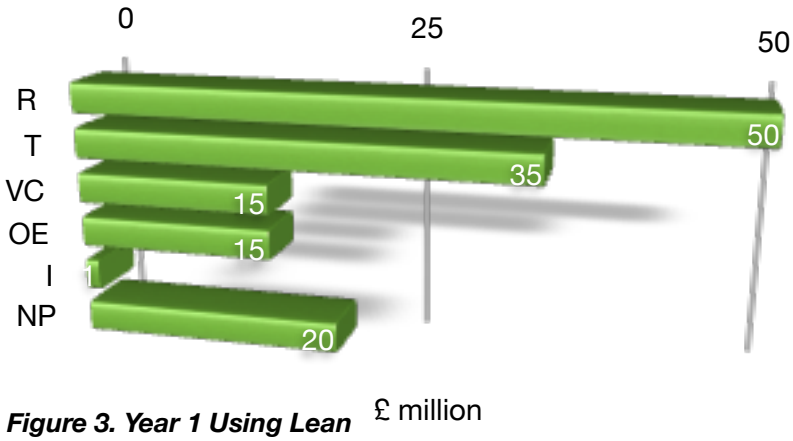

Figure 3. Year 1 Using Lean

Now lets contrast that with the throughput approach. If the £50 million revenue came from 100 customers, what would happen if you invested in reaching 200 additional customers?

- Revenues in year 2 would increase to £150 million
- Even without eliminating any waste, variable costs correspondingly increase to £60 million
- Assume for arguments sake that OE increases by £10 million because you need 50% more employees and
- You move to a shift system instead of buying more equipment and
- Your £7 million in WIP and finished goods climbs proportionately to £21 million

Taking all that into account, Net Profit climbs to:

(£150m - £60m) - £30 million = **£60 million**

- which is an improvement in net profit of £50 million compared to the baseline. Even if the calculation is out by 30%, the improvement after one year is still much more than would have been achieved by only chasing cost reduction. In addition, the 30% spare capacity will have been preserved, avoiding the potential industrial relations problems referred to above. Note the difference in scale on the Y axis. From year two onwards, the gap between the two approaches can only increase. Demand will of course eventually tail off because of market forces, but only after a further period of significant growth. Commercially, the potential is impressive.

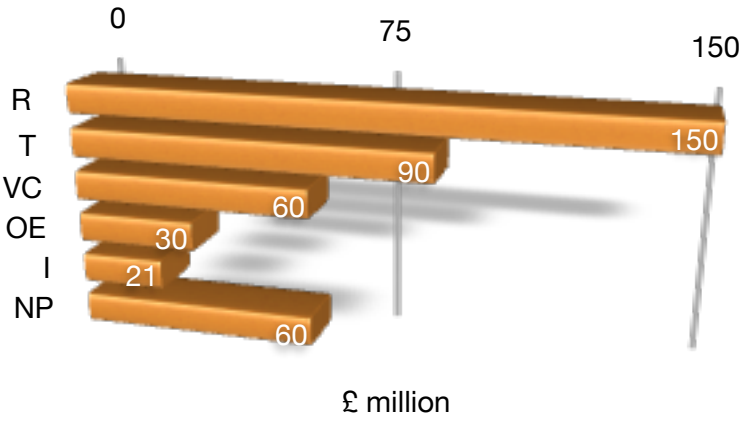

Figure 4. Year 1 Using ToC

The point being made in this admittedly contrived example is not 'throughput good, efficiencies bad' rather that greater rewards result from dealing with the constraint and

seeking growth (or doing more, in the public sector) than from attempting to do the same old thing for less money and with fewer people. It should always be kept in mind that the constraint will sometimes be external to the organisation (demand uncertainty) and sometimes internal (process variability), limiting the organisation's ability to satisfy demand. There is no reason why a judicious approach to controlling costs and delivering value efficiently cannot be combined with ToC. However, some words of caution are necessary:

Firstly, any competitive advantage resulting from cost reduction tends to be temporary as the competition will usually catch up. If cost cutting is passed on to the customer base in the form of price reductions, a downward spiral of competing on price resulting in lower margins, is likely to ensue.

Also, the Lean and Six Sigma approaches emphasise the pursuit of perfection but perfectionism may not always be a good a thing or indeed even possible. Figure 5 illustrates that as long as processes are operating in a state of statistical control, the closer you get to perfect quality, the more the cost of further improvement escalates, quickly becoming prohibitive.

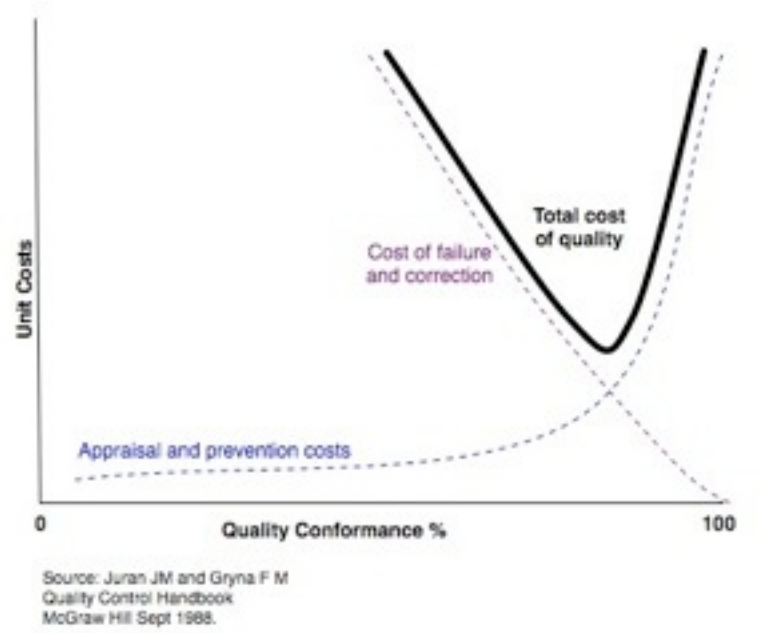

Figure 5. The Cost of Perfect Quality

In a nutshell, improving quality beyond a certain point (this applies to process, product and service quality) is not only subject to the law of diminishing returns, if taken too far, it can be commercially detrimental. The organisation loses its ability to react to changing circumstances and weather market downturns and even more dangerously, cutting costs often results in a reduction in customer satisfaction which is the opposite of the reason for undertaking any improvement initiative.

Increasing The Chances of Success

For most organisations and situations, large scale initiatives are simply not necessary. An approach of pushing back constraints and placing responsibility for improved results in the hands of local management can be extremely effective and is far more likely to consistently improve bottom line results than a policy of investing heavily in order to pursue untargeted and increasingly elusive cost savings.

However, regardless of the efficacy of bottom up, grass roots led performance initiatives, we cannot ignore the fact that organisations buy into enterprise wide approaches so let us examine the question of which one to adopt. The acceptability of a particular approach is an important consideration because it will affect the speed and enthusiasm of take up. The cultural make up of the organisation should influence the choice of method. In an engineering environment for example, Six Sigma is more likely to be viewed favourably by staff because of its focus on numbers and the use of statistical tools which will lend credibility to the case for change whereas the staff in an advertising agency might be less enthusiastic.[9] ToC is more likely to find favour in a sales oriented organisation where throughput is a motivator. However, keeping the goal of creating wealth and/or growth in mind, in the end, the decision is likely to based on a perceived need and it's urgency:

- If the problem requires the design of a new product or service, then to ensure that the most commercial combination of features and functions is built into the product then use Outcome Driven Innovation (described below). To ensure a robust product design use DFSS and if you have intractable product problems, Triz[10] will help to solve them.
- If the overriding need is to reduce variation and create a more uniform output or if process variation is too high, then Six Sigma is the most appropriate choice. It will also help reduce waste, throughput time and inventory to some degree.
- If the requirement is to eliminate waste and create a responsive flow system, then Lean is the better choice. Lean will also lead to a reduction in variation over time; however,
- If your primary aim is to increase throughput quickly and your processes are in statistical control, then the Theory of Constraints is the strongest choice. Over time, its use will result in inventory reduction, growth and improved decision making.

If in doubt, ToC is likely to deliver results more quickly than Lean or SIx Sigma. Use ToC to tell you where to focus your efforts and then consider a light, localised implementation of Lean or Six Sigma techniques to get waste and variance out of the system. However, a challenge is in order. If there is waste or variance in the system and it is having a noticeable and continued impact on performance, **what has your management team**

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[9] With apologies for the outrageous generalisation.

[10] Triz is not described in this paper. ODI is reviewed in 'Tuning in to the Voice of the Customer' below.

been doing? Surely, ensuring the smooth and efficient flow of work through the organisation is what they are they for. Put another way, before embarking on an expensive and potentially ineffective initiative, consider whether or not the management team has become a constraint and deal with that question first. Addressing this surprisingly common phenomenon can be as simple as reframing objectives, refocussing, training, changing the reward system or team building. It would be unusual if these techniques don't take the organisation closer to meeting its objectives.

Before we suggest a more pragmatic way of improving the organisation's performance, we first touch on two key elements of performance management. The first is a technique for improving understanding of what is happening inside the organisation and leads to clear identification of constraints and the second looks briefly at how to maximise the commercial potential of your service or product offering by listening to the voice of the customer systematically.

Finding the Constraint

In the book 'The Goal', finding the constraint was relatively straightforward. The setting was a manufacturing operation and you could tell where the constraint was by the piles of WIP queued up in front of it. Organisational performance problems are rarely that straightforward to unravel, not because the organisations themselves are particularly complicated; complex and dysfunctional behavior can emerge from very simple systems. What makes diagnosis difficult is dynamic complexity, which emerges from the organisation's structure, feedback loops, accumulations, time delays decision making processes and behaviours. These element paint a picture of how the organisation functions and how that manifestation changes over time. When a change happens in one part of the system, it's effects are sooner or later felt elsewhere and because of the intricacies of interconnection, they are often counterintuitive. Dynamic complexity exists because:

- Nothing remains constant. Over time, patterns and cycles in the flows of material and information, in stock accumulations, in time delays and the behaviour of actors emerge. if a variable appears to be unchanging, it is highly likely that the wrong scale is being used. when looked at over a longer time horizon it will be seen to vary.
- Everything is interconnected and our actions feed back on themselves, changing the situation which we are trying to deal with.
- The component parts of a system interact with each other, sometimes in unpredictable ways with many variables changing at once which complicates decision making. Small random perturbations are often amplified and shaped by feedback loops.
- Cause and effects are often separated in time and space, not proportional to each other and not easily tied together. This may encourage a misguided focus on recent symptoms with the result that the underlying cause is often overlooked.

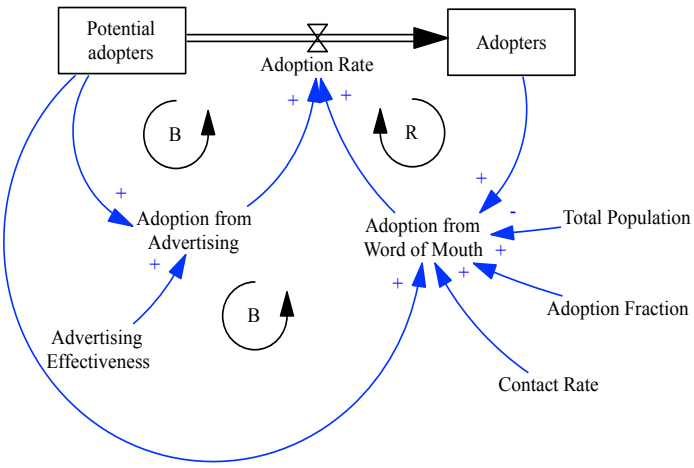
- The rate of change is not linear, with different events occurring in different timescales — the stock market can rise steadily for years and then crash in a very short period. Fish stocks, seemingly stable for years can disappear quickly and (seemingly) inexplicably as has happened in the English Channel and Canada's Grand Banks.
- Reinforcing and balancing feedback loops which connect different parts of the organisation continually change the game. Delays in feedback loops create instability and diminish our ability to discern cause and effect and maintain control over operations.
- Time delays between the start of an initiative and results appearing can result in things getting worse before they get better. Patience is often lost, new initiatives are started, change fatigue sets in and ultimately high leverage policies are subverted before they have a chance to show results.
- Organisations learn and adapt to changing circumstances, sometimes well, sometimes poorly. This adaptation can lead to the selection and proliferation of specific types of organisational life form. This in turn determines the nature of decisions which are made by default.
- History determines today's status and choices: things that happened before can't be undone (you can't unboil an egg) and may limit the options for future action.
- The complexity of the business environment exceeds our understanding with the result that seemingly obvious solutions to problems sometimes fail or they generate unintended consequences, making the situation worse.

Contrast this built in complexity with the process maps beloved of consultants. It would seem that the process map is at best a linear idealised view of the way that work should get done and at worse, a completely unrealistic representation of what actually happens. In any event, it is a poor diagnostic tool.

To deal with the added complication which dynamic complexity introduces to organisational problem solving, our approach includes the use of System Dynamics (SD) modelling. Developed at MIT by Professor Jay Forrester in the 1960s, SD is essentially a powerful tool for modelling and simulating the behaviour of urban, social and ecological systems over time. It helps to explain the circular, interlocking, non linear and often time-delayed relationships which occur between it's component parts and also between the system and its macro-environment.

Being focussed primarily on the behaviour of business systems, we rely on SD for the modeling of structure, systems and human behaviour and simulation to test hypotheses about organisational performance over time. Without simulation, conceptual models and the likely effects of new policies (or indeed the removal of old ones) can only be tested and improved by relying on feedback from the real world. This can be very slow in coming and mistakes can be extremely expensive. There are a number of tools specifically designed to support the development of SD models, the most popular being Powersim,

IThink and Vensim[11]. All are graphically based, using a set of drawing tools to describe the structure in a map which is then populated with equations and data. Figure 6 shows a model fragment developed in Vensim illustrating the influences on the rate of adoption of



Mathematical Model

d(Potential Adopters/dt = -Adoption Rate

d(Adopters)/dt = Adoption Rate

Adoption Rate = Adoption From Advertising + Adoption From Word of Mouth

*Adoption From Advertising = Advertising Effectivectiveness * Potential Adopters*

*Adoption From Word of Mouth - Contact Rate * Adoption Fraction * Potential Adopters * Adopters / Total Population*

Figure 6. Model fragment describing the rate of take up of a new product

a new product. The effect of influences such as competitor actions, available wealth and the life expectancy of predecessor products are omitted.

Models are built up using a facilitated group process where participants are drawn from across the affected area (it is always the problem which is modelled not the organisation). The developed model represents the sum of the mental models and shared knowledge of the participants. Its complexity is likely to exceed the capacity of the group to understand all of its implications and this makes simulation, a capability provided by the tool, the most thorough and effective way to test theories and to play different ‘what if?’ scenarios in a safe environment. The learning that occurs while developing the model is extremely important. Where a process crosses departmental boundaries, SD models can be used to generate a shared understanding of what happens end to end and help to quantify the effect of possible changes on individual areas. Model building surfaces conflicts as different points of view are aired. Being cross functional, the group is well positioned to explore the alternative solutions. Models are often very successful in highlighting ‘things

11 We prefer iThink as it emphasises thinking and the communication of ideas over the sometimes more sophisticated modeling capabilities of other tools

we didn't know we didn't know'[12] causing new questions to be asked. When this happens, value is added in abundance as new levels of insight and understanding are reached. It is not an unusual conclusion from these sessions that the performance measurement system in place has some serious shortcomings or that policies are not having the intended effect either because of interactions between different policies or because they have become out of date. By developing an understanding of how decisions made in one place affect other parts of the organisation, it becomes possible to address inter-departmental barriers in an informed way surfacing and dealing with conflicts — an anti-venom for silo behaviours at last?

It is absolutely vital that in order for the model to be taken seriously and used in decision making, that it is seen to reflect the participants view of the world and not that of the modeller. Because it represents a joint cross functional understanding, the model helps participants to converge on an agreed course of action. When complete, the model becomes a powerful communications tool and central to the effort to persuade the workforce that a course of action is a) necessary and b) likely to succeed. It becomes particularly powerful in this regard when it can be demonstrated that feedback provided by all and sundry has been considered and where appropriate, incorporated. Using SD, a large range of scenarios can be tested without risk, to identify sensitivities, thresholds and regions of robustness. It is often very helpful when disseminating the insights generated by the modelling activity throughout the organisation, to package the model as a management simulation come dashboard and give people the opportunity to pull different levers and observe the effects. It should be clearly understood however that models do not remove the need to exercise judgement, what they do is make the decision making process more informed. By modelling the 'before' and 'after' (and sometimes intermediate stages), SD models can be particularly helpful when designing the transition from today's state to some future state; a useful example being modelling the effects of the integration activity which follows a merger or acquisition or for testing the effects of new technologies on an existing business operation.

With their ability to model stocks, flows, structures and relationships, SD models and tools are well suited to capturing and demonstrating the effects of dynamic complexity in an organisation. They are as a result, ideal for pinpointing constraints, both current and those whose effects have not yet been felt. Using simulation, it is easy to test the results of the removal of constraints safely. If integrated into the decision making process, they improve the quality of decisions by making managers better informed about what they are considering changing and simulating the changes in advance of implementation. They are an important tool in creating a ground swell of support for the selected course of action.

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12 was Donald Rumsfeld an unwitting SD practitioner?

Tuning In To The Voice Of The Customer

Lean, Six Sigma and ToC all place heavy emphasis on the importance of listening to the voice of the customer — and quite right too it seems to be an obvious thing to do…. but lets take a closer look to see what the implications are.

It should be clear by now that the attractiveness of products or services to the marketplace can act as a constraint on commercial performance, yet similar to the failure rate of change initiatives referred to at the beginning, it has been estimated that during the last 20 years, over 50% of product and service initiatives in the US have failed at an estimated cost of $100 billion. Sometimes failures have been spectacular: New Coke for example flopped after huge expenditures: $4 million on market research alone. It is our contention that the underlying cause of these difficulties is a failure to truly grasp what customers want and herein lies a pointer to the reason why products and services flop even though the portents seem favourable.

The difficulty is that asking the customer what he or she wants is fraught with problems because they answer you with imprecise language and insufficient understanding to do the question justice. Such responses will not lead to the creation of breakthrough products and services. As Henry Ford put it,

“ If I had asked my customers what they wanted, they would have said a faster horse”.

Successful innovation whether it is in products, services or the processes used to create them, requires an understanding of the criteria which customers use to judge the value of the product or service which they are getting. Anthony Ulwick, CEO of Strategyn, invented the term Outcome Driven Innovation (Ulwick, 2005) to describe the process of achieving that understanding. Outcome Driven Innovation is underpinned by three fundamental principles:

1. Customers buy products and services to get jobs done
2. Customers use from 50 up to 150 performance measures to judge how well a product/service helps them get a job done
3. These measures are the key to the systematic and predictable creation of breakthrough products and services

So what is wrong with the requirements gathering process? Firstly, there isn’t a standard definition. Requirements can be described in terms of needs, wants, solutions, benefits, ideas, outcomes, use cases and other specifications and often these terms are used interchangeably. So the first thing that would help is a commonly understood language and vocabulary that companies and interviewees could use to describe what the customer wants.

Secondly, although customers are often willing to share their thoughts, they are not aware of the information that a company needs to turn that information into a valuable product or service. Usually the interviewer is equally in the dark and so the customer explains their needs in language which, while meaningful to them is imprecise and ambiguous — and

then it gets worse, their questionable and ambiguous information is interpreted and enhanced by marketing and/or product development.

Thirdly, companies invest considerable energy and resources conducting one on one interviews, focus groups, company visits, ethnographic or anthropological research, to collect information, but because the right information isn't being gathered, the results are somewhat hit and miss, which leads to the question 'what information should be collected?'. Ulwick suggests three main categories of information:

- What jobs are customers trying to get done that this product or service will help with?
- What outcomes are customers seeking — how do they measure the successful execution of the job?
- What constraints are preventing customers adopting or using a particular product or service or successfully completing a job?

It is worth elaborating a little on the concept of a job. There is always a primary job, but there are often anciliary jobs as well. Taking the ipod as an example: despite being more expensive than competing products, the ipod has come to dominate its market niche by providing complementary products and services which meet the needs of users beyond that of storing and playing music. In any given scenario, there are likely to be three types of jobs that customers are trying to get done:

- Functional :- which define the tasks which people want to accomplish
- Personal :- which are about achieving a feeling about oneself
- Social :- which address how people want to be perceived by others.

As an example, take the case of a German 4x4 car: functional jobs may include providing comfortable, reliable transport for up to 7 people and to have a large amount of boot space. They may include travelling over rough ground without damage (although this use seems to be rare in practice, at least in the UK). The personal job may have something to do with protecting the family, because these cars are viewed as being safer for passengers in an accident and the social job may include affecting the perceptions your neighbors hold about you. All three categories contribute to the customer's perception of value. Interestingly, with environmental concerns increasingly affecting public perceptions, (in the UK at least), these cars have become a symbol representing the motor industries' contribution to global warming and attracting the disparaging epithet 'Chelsea tractor'. For a while it became socially acceptable for people to let their tyres down or vandalise gas guzzling 4x4s in cities. People's perceptions changed and as a result, the social jobs that these cars addressed altered, leading to a dramatic slowdown

in sales. Some manufacturers have taken a long time to respond to this attitudinal change and it is only recently that more fuel efficient 4x4s have started to be seen in the UK.[13]

Having identified the jobs, that a product or service will fulfil, you can then start to flesh out what it means to complete those jobs well by identifying the 50 - 150 performance measures which the customer will apply. Once captured, these statements of value can be applied not only to your products but also to the competition's and that comparison may led directly to competitive advantage as you satisfy the criteria that are high value and not served well by competitive products. It becomes possible to identify under-served jobs, new market segments and new product/service development opportunities. Personalisation becomes possible: producing variants of products to meet the variations in need which may be experienced in different market segments or indeed by individual customers.

How is all this relevant to the topic of organisational performance? Well, obviously, the closer your product or service is to meeting the needs of customers, the higher the demand for it will be and the greater the throughput requirement. If the identification of the customer's 50-150 value criteria, is done systematically then it can start the process of eliminating variability and waste at the point of opportunity identification and be the basis of effective value creation all the way through to the point where the customer uses the product or service. Looking at the other side of the coin, if lack of customer demand for a product or service has become the primary constraint on throughput, then the CoDynamics outcome driven innovation service may well hold the key to breaking it.

13 Interestingly, Toyota were ahead of the market with a hybrid version of their 4x4 but it was seen as overpriced and less commodious compared to it's competitors (personal and functional jobs not addressed) and as a result take up has not been stellar.

A Pragmatic Approach

We suggest that there is an alternative philosophy for addressing performance problems requiring both a top down approach to working out where the leverage points are and a bottom up approach to implementation. It avoids the big implementation, keeping initiatives small and local and making all improvement initiatives results driven. To be effective, the approach relies on a well defined strategy which has been cascaded throughout the organisation a systemic understanding of how the organisation works and an organisation design that supports the strategy. Armed with these, the results you are seeking can be quantified— reduced lead time, reduced costs increased inventory turns, improved customer satisfaction, lower product development time — whatever; and then you will be in a position to

- Ensure that all improvement initiatives are aligned with corporate and business unit strategies.
- Make managers accountable for the elimination of waste and variance in the fulfillment of those strategies as part of their day to day responsibilities but ensuring that efficiency seeking is not taken to excess.
- Focus on your throughput processes, find the performance bottleneck and deal with that, applying the five focussing steps and eliminating all waste and variation at the constraint. People will rally round in support of a growth agenda. Always put the constraint at the centre of ongoing improvement activities.
- Use modelling and simulation to find the best solution, minimise unexpected consequences and generate support.
- Remove waste and variation from support and management processes, ensure that they don't impact throughput processes but don't waste resources fine tuning them.
- If you are addressing a product or service related problem, then approach it systematically. We use Outcome Driven Innovation to define what the product/service should do, DFSS to introduce rigour into the product creation process and Triz for creative problem solving.
- If cost cutting is necessary, don't apply percentage reductions across the board. Target cost reductions in line with the organisation's strategic goals, projected marketplace trends and the activities which create value. Targeted cost reductions will not necessarily diminish efficiencies and are less likely to weaken the organisation.
- Use operational managers, not people in staff positions or external consultants to design and run initiatives i.e. people who know how the operation works rather than experts in a method. Use consultants to fill temporary expertise gaps such as large group facilitation or modelling.

- Surface conflicts and build commitment to change through joint diagnosis of problems.
- Use a systematic approach to identify the elements which drive customer value and pinpoint those which are falling short of expectations . We recommend the use of Outcome Driven Innovation techniques to do this.
- Only introduce the innovations in process and methods which are necessary to achieve the targeted results.
- Use empirical testing to determine what works and discard what doesn't.
- Start an improvement in one area, demonstrate the results and then roll it out into the larger organisation where it is appropriate to do so.. Build up a portfolio of improvement activities in this way.
- Energise the process by publicising the achievement of short term goals.
- Institutionalise improvements through formal policies, systems and structures. Be prepared to modify or discard existing policies if they are shown to be ineffectual.

In this way, investment is matched with results and each successful performance enhancement can be rolled out to appropriate parts of the organisation, safe in the knowledge that it works. This approach can in time grow into a full scale enterprise-wide performance initiative, if that is what is needed, without requiring a large initial investment of time and resources and it is far less likely to encounter resistance than a big bang methodology roll out. It also has the advantage that the improvements which are most urgently needed can be addressed first. It doesn't seek to change behaviours in an attempt to equip people to be effective in a brave new world by converting their attitudes and/or values (a time consuming and frankly an almost impossible task), it puts them in a situation where the push for results drives out the behaviours that are needed. Naturally, such an approach requires handling with sensitivity, requiring a collaborative mindset but handled well it can galvanise the workforce into action and as a result, resistance will be minimised and much less time and energy wasted.

Conclusion

At the beginning of this paper, we pointed out that the success rate of enterprise wide improvement initiatives is surprisingly low. We have suggested a number of causes:

- The major up front investment of time and resources in preparatory activities required by some approaches; coupled with
- A lack of focus on bottom line results; and
- A tendency to hand responsibility for improvement to quality or process specialists (or worse, consultants) who can be more focused on doing things as per the instruction manual than on doing the right things.
- A tendency to attempt to improve all or any processes without consideration of how they contribute to the customer value.
- Some areas which are crucial to performance such as capturing the voice the customer are not well defined and consequently not done well.
- An emphasis on efficiencies and cost savings rather than growth

In exploring the use of Lean, Six Sigma and the Theory of Constraints, considerable overlap was identified, but there are sufficient differences to help you decide which is best suited to your situation. The important thing is not to get caught up in methodology fundamentalism. Each technique has something to offer. Our preferred approach is to use ToC to tell us where to focus attention and then use the tools best suited to dealing with that situation. To make sure that we have developed a deep understanding of the problem area, we take a systems approach, using modelling and simulation in combination with large group techniques to develop a joint understanding of structures, behaviours and relationships. This helps create buy in to definitions of the problem and the preferred solution among interested parties, easing the problems of resistance to change.

A keystone in all of this is the effectiveness of the management team. Bad situations arise when managers do not act in the best interests of the organisation, whether knowingly or unknowingly. Neither Lean or Six Sigma address this sensitive area directly, which may go some way to explaining the high failure rate of improvement initiatives. A good starting point to building a cohesive, effective management team and a prerequisite for all improvements, is to get them aligned around the organisation's strategy and the goals and success factors which stem from that strategy.

Finally, it is vital when addressing organisational performance, that operational managers are held to account for results collectively and individually. In general, they know where the problems are and what to do about them. They just need to be allowed to deal with them and in doing so demonstrate leadership, without which, no initiative is going to succeed.

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