If the question “What is your supply chain?” were asked of 100 business leaders, the replies would vary from the expected “raw materials inward to goods outward” to the more forward thinking organization that would describe an extended chain from the “suppliers’ supplier to the customer’s customer.” However, all of the answers would describe a similar and recognizable set of business processes.

Ask the same group of people the question “What is Six Sigma?” and answers could vary from “Is it a classically trained boy band?” to a more informed “Something complicated and probably expensive, invented in Japan, that we might use to improve our business” through to any master black belts present, who will give a complete and informed description. In layman’s terms, the knowledgeable response would normally describe a set of statistically valid measurements of business processes, first introduced by Motorola, which provide the opportunity to systematically improve business processes by eliminating defects and reducing variation.

Much academic study has been undertaken to show the complex algebra that goes towards designing a Six Sigma Supply Chain (SSSC), but the majority of companies have been unable to get anywhere close to implementing it as they have not had the capability or spare resource to measure their supply chain in enough detail, or define what excellence would be for them. Six Sigma has the ultimate goal of achieving 3.4 defects per million objects (DPMO) — which is another way of saying you have to get to six Standard Deviations from the ‘mean’ or ‘perfect’ before you have a problem. It requires constant monitoring, analysis and refinement to ensure that this target is met. It is not enough to be able to claim that on one occasion a company delivered On Time In Full (OTIF) or manufactured a complete process run with minimal defects. To claim to be Six Sigma this has to recur consistently — it is the process, much more than the product, that is being measured.

The five steps making up Six Sigma are known as DMAIC — Discover, Measure, Analyse, Improve and Control. Increasingly, an ‘R’ is being added for Realize — although many would contend that focusing on any financial gains that result from putting Six Sigma into practice is counter productive and that these gains are merely a by-product of a good process improvement programme and should be expected. A number of global manufacturing companies, including GE, Honeywell and Toyota, have refined Six Sigma over the years for their own use, but the fundamental principles survive intact.

Measuring the Supply Chain
The introduction of RFID (Radio Frequency Identification) and its increasingly rapid uptake by global industry has given companies the ability to measure their supply chain performance somewhat more easily. More importantly, the information received via RFID is real time, and it has demonstrated that the majority of companies are not even achieving One Sigma! As a result, there is still some considerable way to go in the design of the true SSSC in the real world — however easy it may appear in theoretical studies undertaken in university environments.

Shai Verma, RFID practice leader for IBM Canada, and Venkat Krishnamurthy, Chief Technology Officer at OATSystems, an RFID software company and a partner of IBM, made a presentation at RFID Journal LIVE! Canada. The focus was on how RFID could be used as a tool to measure supply chain efficiency.

Using RFID data supplied by one retailer to one of OAT’s customers, Verma and Krishnamurthy found that the retailer’s ability to comply with a promotional plan was 0.5 Sigma. Even getting to Four Sigma would have resulted in a 20% increase in sales.

The supply chain, as any professional recognizes, is a complex succession of dependent business processes. Six Sigma devotees would declare that it is a prerequisite that each of these processes meet Six Sigma requirements to achieve the optimum benefit, resulting in the Holy Grail of an SSSC — where OTIF orders are consistently being delivered to the customer — and eventually realizing the financial benefits of introducing the Six Sigma methodology. This is a costly exercise both in terms of training staff to the various required standards of the Six Sigma disciplines and the potential pain points that must be addressed to change the business to work to Six Sigma principles.

Varying supply lead times from the wide number of different suppliers and business processes (both internal and external) are, perhaps, the principal determining factors in influencing the performance of the supply chain. As the number of business partners and suppliers increase in number, so too is the likelihood of one or more being below par — and thus the possibility of a breakdown in the overall ability to deliver to the customer’s expectations.

A supply chain is only as strong as its weakest link. If the customer believes that it cannot rely on the supplier then they may go elsewhere. If the supplier suspects that their service falls below acceptable standards then they may overcompensate by holding additional stock, overstating demand or expected delivery dates to give buffer time, or using unnecessarily expensive logistics to receive raw materials or deliver finished goods. All of these factors lead to a level of predictability in the supply chain but are costly and inefficient and can be ‘leaned’ out. Applying Six Sigma principles to the individual process areas provides quantitative evidence enabling management to improve
towards a lesser number of defects and, ultimately, to eliminate the majority.

The process of manufacturing contains many of the elements involved throughout the extended supply chain. In many cases, the manufacturing process lies at the heart of the supply chain, regardless of whether this is outsourced or in-house. The Six Sigma methodology was developed to prevent defects occurring during production and, thus, it is reasonable to arrive at the conclusion that Six Sigma tools and techniques could have application throughout the wider supply chain. Any breakdown in the making of an item is analogous to the failure of a particular element of the supply chain network, however small.

This requires review and potentially the redesign of processes to achieve lead time compression and OTIF order fulfilment and Six Sigma takes a statistical approach to this through all of the five DMAIC stages, but most particularly during the “Analyse” phase. If we were to take a relatively simple supply chain with a supplier of raw materials, a raw materials inward process, internal handling and outbound logistics, then using the statistical capabilities afforded by Six Sigma it is possible to afford supply chain managers the ability to determine, for example, the optimum number of pallets that will be produced in any one day and thus the number of vehicles that will be needed in each manufacturing location to deliver those pallets to the customer.

There are, of course, many different elements to supply chains, but this is a logical course of events that could be broadened to cover the extended supply chain. However, it must be remembered that for each additional element more variables are introduced that require analysis and which, exponentially, increase the likelihood of a reduced capability to achieve the SSSC aim of minimal defects.

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Six Sigma Application in the Supply Chain

Six Sigma, with its champions, master black belts, black belts and green belts, is geared to cascade its concepts throughout an organization, and this approach is equally applicable in the supply chain environment. Roles and responsibilities are defined; top down and bottom up change processes are developed to enable the business area to respond more effectively, and there are detailed statistics readily available to justify decisions. However, one of the potential weaknesses of an SSSC lies in its very reliance on detailed statistical outcomes. Strict adherence can occur and help a company to understand the state of the industry in which the business operates, the current state of the economy (recession, inflation etc.) or the company’s position at any given moment. There is, therefore, the classic divergence of theory and practice, where theory assumes a perfect world and practice tells the seasoned professional that in certain circumstances it is better to take another approach.

Readers who are familiar with the work of the Supply Chain Council, its SCOR methodology and Lean practices, will be aware that there are many similarities with Six Sigma. By judicious application approaches of SCOR can be applied to the quantitative tools contained within Six Sigma and Lean to derive a synergistic benefit far greater than if one approach alone is selected and applied, wholeheartedly, across an entire supply chain.

Furthermore, unless a company has total control over its suppliers, their suppliers, its customers and their customers, any company wishing to introduce an SSSC can only do so internally — thus it cannot impose Six Sigma practices across every tier and echelon in the extended supply chain. This means that the business can only, in reality, get its own house in order and effectively manage its supply chain from raw materials inwards to finished goods outwards. The benefits it obtains as a consequence may be sufficient to encourage companies in the extended supply chain to adopt similar business processes, at the least, thus gradually improving the integrated whole.

It is realistic to define an SSSC as one that has been designed to deliver finished products to the customer within the time specified as the delivery date with as few defects as possible — at the lowest cost achievable. Thus, the SCOR defined metric of Perfect Order Fulfilment (On Time, In Full, Perfect Quality, Correct Documentation) could be defined as the Six Sigma success metric.

It has been argued (specifically in the IEEE Transactions of Automation Science of 2004 by Garg, Narahari and Viswantham) that there are two sets of design problems that are most common in proposing an SSSC: generic design problems including • allocation of process means • allocation of process variances • allocation of customer windows and concrete design problems, including • due date setting • choice of customers • inventory allocation • capacity planning • vendor selection • logistics providers • choice of logistic methods.

Because these problems can arise at any level of the design of the SSSC, each sub-process must be addressed individually in the design strategy. By concentrating on each sub-process and applying Six Sigma statistical and mathematical formulae to each element it should be possible to achieve optimum delivery to meet the 3.4 DPMO standard.

Moving Closer to Six Sigma?

Possibly the most important question that arises from all of the above would be whether or not Six Sigma tools and techniques have a place outside the manufacturing environment and in the wider context of the design of the supply chain as a whole? The answer to this has to be a categorical yes; with the caveat that they are used judiciously and that they are not suitable for use across the extended supply chain — as there is unlikely to be sufficient

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to the mathematical principles can mean, in theory, that there is a weak link in the chain. Mathematics is a precise science; economics and the theory of supply and demand are not, and it could be argued that combining the two could be mutually exclusive and result in confusion.

One of the disadvantages of Six Sigma is that it lacks a fundamental methodology for recognizing and leveraging competitive advantage in terms of strategic or operational opportunities that may arise. Furthermore, its mathematical basis and structure do not allow for the “human factor,” thus it can miss the high priority prospects in favour of the “quick wins.”

Six Sigma has in-built tools that speak to the “Voice of the Customer” and the “Voice of the Process,” but nothing that recognizes the openings that of these three practices, the advantages of Six Sigma itself become apparent as its rigour and structure complement the other practices and negate the potential disadvantages it has when it is used in isolation.

Six Sigma is statistically analytical in its approach, so applying it everywhere across the supply chain is not realistic. However, by combining with SCOR, specific areas to focus on can be determined together with the metrics to measure the success of the exercise. Additionally, Lean practices can also be applied in areas where Six Sigma’s overly statistical approach is not appropriate. The combined application of the three, through experienced practitioners, means that the right technique is selected at the right time. This selective application of the techniques means that the qualitative

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control to ensure continuous and contiguous practices.

Companies that wish to move towards an SSSC should determine what their success criteria are (lowering inventory or improving pick accuracy being two obvious and easily measured examples) and put checks in place to ensure that they have ascertained the correct metrics for measuring success. If the right metrics are in place then it is possible to examine performance, then change the process and measure it again.

Using a combination of methodologies may be more practical than using a standalone Six Sigma approach. For example, the SCOR competitive advantage analysis can be utilized to determine where focus should be placed in an organization. Six Sigma can then be applied to that specific area. This reduces the cost of the exercise as well as producing measurable benefits as the part of the supply chain that is under scrutiny is readily identifiable.

Embracing the philosophy of Six Sigma, or continual process improvement, is not easy. It requires a constant re-examination of what a company is doing wrong, then correcting it. However, the results can be transformational; after Motorola embraced Six Sigma manufacturing, the company said that it saved $16 billion per year! Given that the majority of supply chain processes are only at 0.5 Sigma today, the savings for large companies could be even greater for companies that adopt the Six Sigma approach in their supply chain.

The following methodology combination is recommended to achieve optimal results: Six Sigma is primarily applicable to processes that are quantitatively measured — and within the organization’s control — and thus should not be used in isolation in the design of the supply chain. Other methods that are designed for the extended supply chain, such as Lean and SCOR, should be used in conjunction with Six Sigma to widen the area of focus outside of the organization.

Use SCOR’s “Analyse” approaches to define the primary areas of focus, the metrics that should be used to define success and the level at which success will be achieved via their Competitive Advantage Matrix. Use SCOR or Lean to improve areas that are Qualitative and thus not appropriate for statistical analysis.

When using Six Sigma, aim to reach the optimal level for the organization, rather than the six sigma ideal. Use the following calculation to decide when that optimal level has been reached:

\[
\text{Benefit} = \text{Value} - \text{Cost}
\]

And once the cost of implementing Six Sigma is greater than the additional value gained (when the law of diminishing returns kicks in) then the optimal level is reached and it is an appropriate time to move onto the next improvement area.

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