

LEAN SIX SIGMA AND INNOVATION CAN SYNERGISTICALLY FIT WITHIN PRODUCT DEVELOPMENT

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Abstract

In a June, 2007 *Business Week* article the author outlined the issues 3M faced when integrating the disciplined Six Sigma methods and tools into their innovation-oriented culture. This paper suggests the Lean Six Sigma and innovation are linked as part of an evolutionary journey and that DMAIC and Design for Lean Six Sigma are key first steps for enabling effective, efficient and predictable delivery of innovative products first to the marketplace.

Introduction

A June 11, 2007 *Business Week* article outlined the struggles within 3M, a company admired for its innovation, balancing that innovation with Lean Six Sigma[1]. In late 2000, James McNerney a highly regarded General Electric executive, joined 3M as its new CEO. Borrowing from General Electric's past, Mr. McNerney implemented Six Sigma programs which included DMAIC (Define, Measure, Analyze, Improve and Control) problem solving and Design for Six Sigma aimed improving product development. During Mr. McNerney's tenure, 3M saw impressive profitability improvements with operating margins going from 17% to 23% in 2005. Six Sigma unquestionably had an impact on those results. However, behind the scenes there was a growing concern that Six Sigma had taken a negative toll on innovation by trying to systematize the creative process. In mid-2005 Mr. McNerney left 3M to become CEO of Boeing, newly appointed (and current) CEO George Buckley had the challenge of dealing with the culture clash between 3M's innovation heritage and Six Sigma philosophy. CEO Buckley was quoted "Perhaps one of the mistakes that we made as a company-it's a danger of Six Sigma-is that when you value sameness more than you value creativity, I think you potentially undermine the heart and soul of a company like 3M." [2] By the end of 2007, 3M had given back the Six Sigma decision making authority to researchers and they had largely abandoned Six Sigma. [3]

The *Business Week* article is often held up as an example that innovation and Six Sigma cannot easily coexist. That discipline and the "drive for sameness" can limit creativity and innovation. Some people also use 3M's steady decline in Boston Consulting Group's Innovative Company list from number 1 in 2004 to

number 22 in 2008 as further evidence of the negative impact Six Sigma had on Innovation. Though I cannot speak specifically to 3M's situation, I believe that there is a positive and even synergistic relationship that can exist between innovation and Six Sigma.

Evolutionary Versus Revolutionary

I use the term "evolutionary" within this context to communicate the longer term, systematic deployment and migration from the basic Lean Six Sigma DMAIC problem solving to higher level innovation. Table 1 illustrates this evolutionary process. The first step in this evolution is the deployment of Lean Six Sigma DMAIC problem solving techniques. This step integrates the methods, tools and principles of Lean and Six Sigma within the context of the disciplined, phase gated DMAIC process. In general, Lean's focus is to reduce waste and increase overall process speed by identifying and eliminating non-value added process steps that cause delays. Six Sigma's focus is on improving performance on the critical to customer items and identifying and eliminating process variability. Together Lean and Six Sigma create a synergistic relationship which drives true productivity; the product of efficiency (Lean) and effectiveness (Six Sigma).

Table 1: Lean Six Sigma Evolution to Innovation

	DMAIC	Process DfLSS	Product DfLSS	Innovation
Goal	•Problem solving •Eliminate waste	Process right the first time	Product right the first time	Product people will come to want
Common Methods (include those to left)	•SPC •FMEA •Cause & Effect •Value stream mapping •Kaizen •Little's Law	•Voice of the Customer •QFD •Pugh Analysis •KANO •Monte Carlo	•Conjoint Analysis •Design of Experiments •Robust Design •Expected Value Analysis	•Theory of Innovative Problem Solving (TRIZ)
Outcome	Free up resources to develop new products, offerings and services		Create efficient, effective and predictable delivery engine	Systematic and repeatable innovations

Integrating both Lean and Six Sigma methods and tools within the phase-gated structured problem solving process, DMAIC enables teams to attack significant problems within an organization, eliminating unnecessary waste and process defects that often require rework and redirect valuable resources to non-value added tasks. The deployment of DMAIC is a common Lean Six Sigma

starting point as the methods, tools and techniques can quickly be implemented and resources brought to bear on an organization's "low hanging" process improvement opportunities. As projects are completed, productivity improvements and savings result improving the organization's overall financial performance.

As organizations continue with their DMAIC deployment they often find that (a) projects within an organization become more difficult to define, (b) there are great opportunities and productivity gains in projects that cross functional and organizational boundaries and (c) their Master Black Belts, Black Belts and Green Belts increasingly run into situations where a process is so broken that it cannot be fixed or there is no process documented at all. When trained belts run into this last situation, they often find that the DMAIC roadmap and tool set do not adequately meet their needs. In these cases the intent is to completely redesign the process from scratch and/or design the process right the first time. For this a new roadmap, Process Design for Lean Six Sigma (Process DfLSS), and an incremental set of methods and tools are applied. This is the second step in the innovation evolution. Though they share several of the DMAIC-based methods and tools, the incremental methods added focus on acquiring and translating the Voice of the Customer (VOC). These include conjoint analysis, Quality Functional Deployment (QFD) and the Kano model to name a few. By understanding the true voice of the customer, there is a higher probability that the newly developed process will be "right the first time" and not require future DMAIC improvements.

By attacking and eliminating business process waste with both DMAIC and Process DfLSS, organizations can focus on customer value added activities and resources and process capability are freed up to develop and deliver new products, offerings and services. Even in the most efficient organizations, there are significant opportunities to eliminate waste. Process Cycle Time (or PCE) is defined as customer value added time (the time associated with activities that add value and customers are willing to pay for) divided by the total process or lead time. iSixSigma.com, a leading on-line Six Sigma website, indicates that world class Process Cycle Time performance is 25% or that only 75% of even world class processes have embedded waste. Even with world class product delivery capability, there is still a significant portion of a product delivery professional's time that adds no customer value. Therefore, even research, development and other product delivery organizations should have an ongoing set of DMAIC and Process DfLSS projects aimed at eliminating wasteful steps and freeing up resources to increase overall product delivery productivity.

If only 25% of a product delivery professional's time is truly customer value added, Product Design for Lean Six Sigma (Product DfLSS) is intended to optimize that portion of their activities. One of the ultimate goals of Process DfLSS is to enable the "product delivery engine" capability by delivering products efficiently (fast time to market with little waste), effectively (products tied to the Voice of the Customer) and predictably (delivering what and when it was promised). Again, Process DfLSS includes many of the tools used in DMAIC. However, greater emphasis in Process DfLSS is placed on capturing and translating the Voice of the Customer into actionable requirements (with such tools as Quality Functional Deployment or QFD), modeling (Design of Experiments) and design optimization (Robust Design and expected value analysis). Though one may view the Process DfLSS as being a very disciplined approach, there are still several innovation tools and techniques that are typically used. These include brainstorming, Pugh Analysis and other methods for generating ideas (e.g. six thinking hats, random words, etc.)

Process DfLSS as the third step of this Lean Six Sigma evolution ensures that the product deliver engine is fully functional. The commercial success and the customers' perceived value of an innovation typically can be related to a company's ability to bring that innovation to the market. The first to market with an innovation will typically achieve premium margins, significant market share and be perceived as an innovative company by their customers. Conversely, late market entries fight for market share, often have lower margins and have less of the overall product life revenue available for them to capture. Therefore, being innovative organization is often not enough. Organizations also need an efficient, effective and predictable product delivery capability to fully capture the financial and other benefits associated with those innovations. A classic example is Xerox Corporation never fully capitalizing on their Palo Alto Research Center's (PARC) computer innovations such as mouse and graphical user interface in the 1970's. Without the "product deliver engine" to deliver innovations to the market place, organizations cannot easily capture the benefits of their innovation.

The last step in the evolution is innovation. For many, this step includes elements such as the Theory of Innovative Problem Solving (or TRIZ) and other methods and tools to help drive systematic innovation. For many companies, this is the desired state: the ability to regularly and repeatedly deliver innovations, both continuous improvement and disruptive innovations, to the market. It is difficult to believe that this innovation desired state can be pervasive throughout an organization and sustainable over time without freeing up time to innovate (eliminating non-value added time so they can

innovate) and having the product delivery engine to drive those innovations to market.

Creative Tension: Innovation and Execution

When examining the roles of innovation and disciplined product delivery execution one might imagine a degree of “creative tension” between what some may feel are two diametrically opposed items. This tension could be viewed as competing diverging and converging thought processes. Innovation can be considered a diverging thought process as one generates numerous new ideas, options and possibilities. Conversely, execution in this context is a converging thought process where options are systematically narrowed as one strives to a defined desired state. To be successful, one needs both in the right balance at the right time to deliver innovative products quickly to market that meet customers’ wants, expectations and requirements.

Figure 1 illustrates a common, phase gated product delivery cycle ranging from research to product launch. Each of the phases have documented product performance and market driven exit criteria that must be met to move through the phase and the product’s development. To this process delivery process there are two added axis: innovation (on the left going from low to high) and execution discipline (on the right going from low to high).

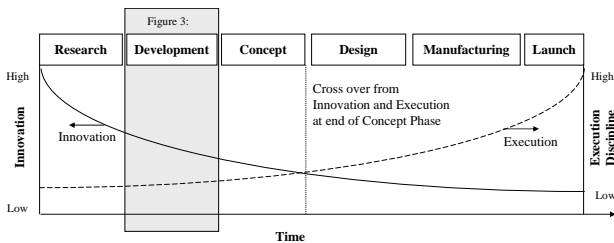


Figure 1: Product Delivery Process with Innovation

Looking at the solid innovation curve first, as one would expect the earlier research and development phases have a high degree on innovation. Here inbound marketing is gathering and translating Voice of the Customer, research is identifying technology options and various platform architectures are being evaluated. Through the development phase the Voice of the Customer converges with various technologies, design option and other key elements into a final product at the end of the Concept phase. At this point, the goal is to design and deliver that product concept to the market place as quick as possible. As teams move through the remaining product delivery phases, there is less and less overall innovation and the innovation that exists is focused on understanding specific design relationships and resolving design and

other issues. This steady decline in innovation continues until the product is successfully launched.

Looking at the execution discipline axis at the right, one finds just the opposite relationship. During the research and development phases, there are relatively low levels of process discipline. The markets and product platforms are described in broad terms and the focus is generating many potential options and solutions. As one enters the Concept phase a greater degree of discipline is applied as the product begins to take shape. The product and technology options are narrowed and demonstrated within the final design architecture. A higher degree of specificity is also given to such design elements as failure modes, critical parameters, latitudes and manufacturability within the specific configuration to demonstrate the design team is ready to move forward with the Design Phase. As mentioned above, after the Concept Phase, it is a race to market with execution discipline taking precedence and innovation, though important, is selectively applied.

Timing is also an important factor. Too much execution discipline too early in the product delivery process can negatively impact creativity. As a result, key Critical to Customer characteristics may be missed or innovative product features or technology solutions may not be considered. On the other hand, too much innovation at the later phases of the product development process can also have a negative impact as well. Trying to innovate (e.g. adding new features, etc.) late in the product delivery process extends time to market, drives resource requirements up and diverts the design team’s attention away from getting to market as quick as they can. Therefore, the logical “cross over” point for innovation and execution discipline is at the end of the Concept Phase. Here, the market and business case is defined, product specifications are set against the Voice of the Customer and the individual technology selections are made and shown that they can work together in an integrated fashion. Innovation and its associated methods has successfully gotten the research and design teams to point, now it is time for execution discipline to take center stage to ensure efficient, effective and predictable product delivery.

Though both the innovation line and execution discipline line are drawn as a smooth curve, in reality the line represents somewhat of an average. Figure 2 illustrates that even within a phase, there can be an ebb and flow of both innovation and execution discipline. For example in the middle of the phase, one can be faced with a problem that requires brainstorming potential solutions and Pugh Analysis techniques to select the best option. Both of these methods would raise the level of innovation. However, at the end of that same phase, design teams are

working to systematically generate the parts, process and

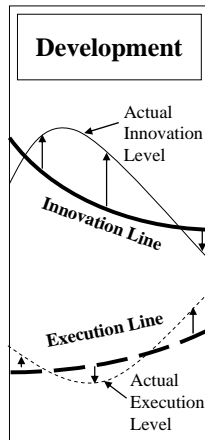


Figure 2: Variation within a Delivery Phase

functional performance responses to the phase gate exit criteria, thus decreasing innovation and increasing the level of execution. The challenge for product design teams and their management is to be aware of the desired level of innovation and execution for the phase they are in and to be always vigilant to ensure they maintain the right balance.

Do Not Underestimate the Impact of Culture

It is not enough just to have great Lean Six Sigma and Innovation processes. From the *Business Week* article, it seemed pretty clear from the comments from past and current 3M employees that there were some cultural barriers that prevented an effective Six Sigma deployment. It is often corporate culture and embedded group norms that are the biggest barriers change initiatives face.

As a member of Xerox Corporation’s Senior Lean Six Sigma staff responsible I had responsibility for developing and deploying Design for Lean Six Sigma to the product development community. Several years into our successful deployment I sat down and captured the lessons learned from our unconventional program. As I examined those lessons learned, a majority of them were around cultural transformation and overcoming organizational road blocks and very few with DfLSS methods and tools. These cultural issues included training leadership first, taking time up front to assess an organization’s capacity for change and giving people only the amount of content and discipline that they are process capable to accept. [4] In many cases the product development organizations’ behaviors and group norms have been cultivated with years of rewording, recognizing and promoting the wrong behaviors. This embedded culture, with both good and bad elements, can be a

powerful barrier to implementing new ideas, processes or capabilities even though they are the right thing to do. The power that the stated and unstated group norms can have on an individual can be significant. Therefore you need to take the time, make the effort and proactively deal with the cultural aspects of the deployment of Lean Six Sigma, Innovation process or almost any new initiative.

Two tools I found that helped deal with the cultural issues were (a) stakeholder analysis and the seven levers of change. In George Ecke’s book *Making Six Sigma Last*, he deals with overcoming Six Sigma resistance by using several methods, one of them being a stakeholder analysis. The stakeholder analysis is set up as a table with key stakeholders and organizational opinion leaders (not always managers) down the left column and levels of acceptance from “Strongly against having Six Sigma happen” to “Makes Six Sigma happen.”[5] An example of a stakeholder analysis chart can be found in Table 2. Within this table you take a stakeholder, assess where they currently are on the continuum and where they need to be for the initiative to be successful. After understanding the resulting gap that needs to be closed actions are developed, assigned and tracked over time to ensure that the individual is moving in the desired direction. Hopefully by influencing key opinion leaders, one can help knock down barriers and help drive cultural change.

Table 2: Stakeholder Analysis Example [5]

Key Stakeholder	Strongly Against Having Six Sigma Happen	Moderately Against Having Six Sigma Happen	Lets Six Sigma Happen	Helps Six Sigma Happen	Make Six Sigma Happen	
Vice President of Sale and Marketing		O	—————	X		
Vice President of Manufacturing			O	—————	X	
Executive Management			O	—————	X	
Human Resources Management				O	—————	X
Finance Management		O	—————	X		
Vice President of Quality				X	—————	O

In *Creating Contagious Commitment*, Dr, Andrea Shapiro discusses cultural transformation efforts necessary to reach the “tipping point” in gaining an organization’s commitment to a new initiative. Her model includes seven levers of change that influence creating that tipping point. These include (1) contacts between advocate and apathetics, (2) mass exposure, (3)

hiring advocates, (4) removing resisters, (5) walking the talk (6) ensuring reward and recognition supports the change and (7) making sure that the infrastructure is in place to support change.[6] Used in combination, all of these levers can influence an organization's commitment (both good and bad). It is also important to note that each organization and situation is different. As a result, there are no "set positions" for these seven levers to ensure success. In Xerox's Design for Lean Six Sigma deployment, we were conscience of these levers and took specific actions aimed at each of these levers to help move our design community to the desired tipping point.

These two methods with other culture-oriented activities took a significant portion of the time it took to deploy our Design for Lean Six Sigma initiative. By proactively dealing with the cultural issues associated with our deployment upfront we were able to break down barriers, better manage the cultural change and gain the support of the design community.

Conclusions

In Lean Six Sigma, the integration of Lean and Six Sigma methods and tools have a synergistic relationship and both are equally important to an organization's overall productivity. A similar synergistic relationship exists between the evolutionary deployment of Lean Six Sigma and innovation. DMAIC and Process DfLSS are essential first steps on the journey to innovation as the help eliminate the embedded waste in product delivery teams' work processes thus freeing up the precious resources for new product development. These internally generated resources are especially important when product research and development resources are flat and customers and the marketplace as a whole demands products with more features, at lower cost and quicker time to market. The identification and elimination of waste within research and design teams is an ongoing challenge given the fact that even in world class organizations the non-value added time is at least three time greater than the customer value added time.

With efforts to minimize and/or eliminate waste in place, Product DfLSS is the next step to optimize the portion of customer value added activities and "rev up" the product development engine. Without an efficient, effective and predictable development engine, it becomes exceeding difficult to have the ability to get innovative products, offerings and services to the market quickly and to sustain that capability over time. With these other three Lean Six Sigma steps in place the table is set for systematic innovation with the support of tools such as TRIZ. Not only can organizations identify incremental and breakthrough innovations, they will have the process capability to deliver them to an awaiting marketplace.

Within a specific product development and delivery, there is often a constant creative tension that exists between innovation and execution. Like Lean and Six Sigma, again you need both to be successful. The challenge is to know how much of each is needed and when it's needed. As one would expect, innovation dominates in the early phases of the product delivery process and conversely execution dominates at the tail end. It is suggested that the transition from innovation to execution dominated activities is at the end of the Concept Phase where architectures and product specific features are set, technologies are selected and the product is poised to sprint to market. At this point, though innovation techniques are often used in the following phases, the emphasis is placed on disciplined product delivery execution. The addition of new innovative features or functions post Concept Phase only tends to delay launch and ultimately miss the narrow window of opportunity that exists for companies who wish to be first to market.

Finally, for Lean Six Sigma and Innovation initiative to be successfully deployed, one needs to pay attention and proactively deal with cultural barriers. In many cases an organization's resistance to change and the impact of group norms on individuals to "stay the course" often become even more important to a successful deployment than the tools, methods and practices themselves. Therefore, do not underestimate the power of an organization's culture. Two tools, the Eckes' stakeholder analysis and Shapiro's seven levers of change were just two of many culture oriented tools and models people can use to proactively deal with transformations and new initiatives.

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