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Lean Six Sigma – getting better all the time

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Abstract

Purpose – The purpose of this paper is to assess Lean Six Sigma to identify important advances over the last ten to 15 years and discuss emerging trends that suggest how the methodology needs to evolve. The goal is to aid those who want to use the method to improve performance as well as assist those developing improvement methodologies.

Design/methodology/approach – The use and development of Lean Six Sigma is reviewed including the origins of the method, the what, why and benefits of the method, how the approach is different, the integration of Lean and Six Sigma, implementation mistakes made, lessons learned and developments needed in the future.

Findings – It is found that organizations have many different improvement needs that require the objectives and methods contained in the lean and Six Sigma methodologies. It is also found that deployment and sustaining improvements are major issues that can be overcome by building a sustaining infrastructure and making improvement a business process. Critical issues include using Lean Six Sigma to generate cash in difficult economic times, development of data-based process management systems and the use of working on improvement as a leadership development tool.

Practical implications – These findings suggest that improvement is most effective when approached in an holistic manner addressing improvement in all parts of the organization using a holistic improvement methodology such as Lean Six Sigma. Improvement must address the flow of information and materials thorough processes as well as the enhancement of value-adding process steps that create the product for the customer. This leads naturally to making improvement a business process that is planned for, operated and reviewed as any other important business process is.

Originality/value – The roadmaps, guiding principles, and deployment pitfalls identified will be of value to those initiating and operating improvement processes in their organizations enabling them to rapidly create useful and sustainable improvements. The discussion of needed enhancements will be of value to those who are working to improve the effectiveness of the approach.

Keywords Leadership, Lean production, Six sigma, Performance management systems, Business improvement

Paper type Viewpoint

1. Improvement is needed today, perhaps more than ever before

Businesses are always on the lookout for ways to improve their bottom line. This has never been more critical than in these difficult financial times. Approaches to business improvement come and go but improving the bottom line never goes out of style. Business improvement methodology has been developing for the last century (Snee, 2004a, b). While improvement has always been an endeavor of business, but improvement as we think about it today began with the seminal work of Taylor (1911) on scientific management.

Lean Six Sigma is the latest generation of improvement approaches. I argue that improvement approaches are not fads but steps along the way in evolution of business improvement methodology. Each approach builds on previous approaches adopting

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the effective aspects of previous approaches and adding new concepts, methods and tools to remove limitations that have been identified.

Much has been learned in the last ten to 15 years as Six Sigma; and now Lean Six Sigma has received considerable use around the world. Now is a good time, with the founding of this journal dedicated to Lean Six Sigma to assess the approach: What is the current state? What have been the critical drivers? What do we need to pay attention to in the future? This paper will address these questions and more.

2. Six Sigma began at Motorola

Six Sigma was developed at Motorola by an engineer Bill Smith in the mid-1980s. Six Sigma is credited with playing a major role in the turnaround Motorola accomplished in their quality at the time culminating in Motorola winning the 1988 Baldrige National Quality Award. Significant deployments lead by the chief executive officers (CEOs) at Allied-Signal and general electric (GE) was the next major step for the approach. Welch promoted Six Sigma aggressively inside and outside GE. The initiative received major usage across business and industry; first in the USA and then globally.

GE capital, the financial services arm of GE, introduced Six Sigma to the financial services industry and use in improvement of transactional processes in 1995. GE also introduced Six Sigma to the R&D function in the form of design for Six Sigma (DFSS) in the late 1990s.

Most would agree that the state of "process excellence" is the ultimate goal of Six Sigma improvement. To my knowledge the use of the term became strategically used at a company for the first time at Johnson & Johnson in 1998. Their approach to business improvement had three critical elements: business assessment using the Baldrige Award criteria, process design using DFSS, and process excellence using Six Sigma for process improvement and innovation.

While lean manufacturing, in the form of the Toyota Production System has been around for decades, it did not get integrated with Six Sigma until the late 1990s and early 2000s (George, 2002, 2003). As I will discuss later adding lean concepts, methods and tools to Six Sigma strengthened the approach in the areas where improvements could be identified and implemented quickly (one to four weeks), many of which involved the flow of information and materials through a process. Today Lean Six Sigma is the improvement approach of choice.

3. Lean Six Sigma – what and why?

Lean Six Sigma is a business strategy and methodology that increases process performance resulting in enhanced customer satisfaction and improved bottom line results ($). It is also being widely recognized that Lean Six Sigma is an effective leadership development tool. Welch and Welch (2005) points out that "Perhaps the biggest but most unheralded benefit of Six Sigma is its capacity to develop a cadre of great leaders."

Leaders enable an organization to move from one paradigm to another; from one way of working to another way of working. In making these shifts, work processes of all kinds get changed. Lean Six Sigma provides the concepts, methods and tools for changing processes. Lean Six Sigma is thus an effective leadership development tool in that it prepares leaders for their role, leading change.

Lean Six Sigma is needed because organizations and individuals need a methodology for improvement and problem solving. Processes do not get better by

themselves. In fact, if not improved on some periodic basis, processes deteriorate over time. We know this because of the second law of thermodynamics which states that things become more variable if not interfered with.

A systematic approach to improvement is needed to improve performance as measured by quality, cost, delivery and customer satisfaction. Customer needs are ever changing and increasing. Cash flow is always critical to the success of an organization. Bottom line improvements provide the cash needed to fuel innovation and growth.

Lean Six Sigma works better than previous approaches because it integrates the human and process aspects of process improvement as summarized in Table I (Snee, 2000).

Many improvement approaches focus on a subset of the elements summarized in Table I but none integrate them all, as does the Lean Six Sigma approach. In fact a major company I am aware of focused over a ten-year period first on process management, then customer focus, then on process improvement followed by management leadership with little or no linking and integration of the elements. Each new effort was seen as a new program rather than part of some larger strategy to improve. Each of the elements in Table I is important and produces benefits but it is the integration that is needed to produce breakthrough results.

Ten years later, this company adopted Six Sigma on a corporate-wide basis. A few years after that lean was combined with Six Sigma. This company is not more than ten years into its use of Lean Six Sigma.

Six Sigma places a clear focus on getting bottom line results. Identification of the business impact is part of the methodology. No Lean Six Sigma project is approved unless the bottom line impact has been identified. Bottom line impact gets the attention of top management for, as quality expert Joseph Juran has pointed out, their language is money ($).

The five-phase improvement process: define, measure, analyze, improve, control (DMAIC) sequences and links in a useful way key statistical and other tools that have been found to be effective in improving processes. While not totally new (Hoerl and Snee, 2002), no improvement process has done this so effectively.

These three features: integration of the human and process elements of improvement; clear focus on getting bottom-line results ($); and a method that sequences and links improvement tools into an overall approach, when combined with other aspects of Lean Six Sigma, produce a deployment approach that is better than the deployment approaches used by other improvement initiatives.

4. Benefits have been obtained by many different sectors of the global economy

As the definition of Lean Six Sigma states the approach creates process improvements that enhance customer satisfaction and the financial performance. From a project

Human issues	Process issues
Bottom line focus ($)	Process improvement
Management leadership	Analysis of variation
Sense of urgency	Disciplined approach
Customer focus	Quantitative measures
Project teams	Statistical thinking and methods
Culture change	Process management

Table I. Human and process aspects of improvement

perspective, green belt (GB) and black belt (BB) projects typically return in excess of $50k and $175k per project, respectively, (Harry, 1998). A Lean Six Sigma deployment typically passes the breakeven point in six to 12 months.

Experience has shown that companies considered to be doing an effective job of deploying Lean Six Sigma get the following returns: large companies return 1-2 percent of sales/year and small to medium size companies return 3-4 percent of sales/year (Snee, 2004a, b). These percentages translate into sizeable savings. For example, a company with $1 billion in sales with 3 percent savings rate will generate $30 million in savings each year.

The excitement grows when you realize that savings accumulate year over year: for example, a company getting 2 percent/year return get 2 percent in the first year, $2 + 2 = 4$ percent in the second year, $2 + 2 + 2 = 6$ percent in the third year, etc. This of course assumes that the savings are sustained over time; hence sustaining improvement becomes a critical issue (Snee, 2006).

These levels of savings have been experienced in a wide variety of industries around the world including; chemical, automotive, finance, electronics, pharmaceuticals, health care, and government. The companies involved are easily recognizable including GE, Du Pont, Merck, Johnson & Johnson, W.R. Grace, Allied-Signal/Honeywell, Bank of America, Cummins, and so on (Snee and Hoerl, 2003, 2005).

5. Comparing lean to Six Sigma is not productive

It seems that whenever lean and Six sigma are mentioned in the same breath, a discussion ensues as to which is the best approach, which approach should be used when, what are lean tools, what are Six Sigma tools, etc. Such discussions are unproductive. As we will see below improvement is the issue and both bodies of knowledge are needed to effectively solve the problems encountered by an organization. The question is how to use the integrated approach.

Let us talk about improvement. Problems and improvement needs come in many different forms. When developing and using a common approach to improvement it is helpful to look at process from:

- *Top-down* – how can improving processes help us meet our business goals?
- *Bottom-up* – how can solving process problems improve process performance?

To create a common improvement methodology you must create an integrated system for managing projects rather than separate systems for lean or Six Sigma projects. As Juran (1989) admonished us, "improvement happens project-by-project and in no other way."

The project management system should therefore employ a project-by-project selection and management approach. And, as with any effective project management system, there should be processes to guide and sustain improvement: project tracking and review, communications, recognition and reward, and training.

For drawing on both lean and Six Sigma as effectively as possible – that is, to achieve and sustain desired improvements – nothing is more critical than project selection. Before the project starts, the project selection process identifies the right improvement approach and thus identifies the right personnel and tools to be used.

This principle not only takes project selection to a new level but also puts the selection of both the project and the improvement approach ahead of personnel selection. Many organizations mistakenly begin with personnel selection.

This enhanced project selection process should identify the right projects, those that will:

- produce the highest value in relation to business goals;
- improve performance of processes that are producing the pain; and
- improve flow of materials and information while reducing waste and cycle time.

Figure 1 schematically shows a novel and powerful approach to selecting the right projects that includes elements both of Six Sigma and lean, all with the ultimate goal of achieving maximum sustainable process improvements (Snee and Hoerl, 2007).

Although there are many types of improvement projects, process improvements typically result from three major types of projects, requiring varying amounts of time for completion:

(1) Quick-hit projects can be accomplished almost immediately and, should they fail, cost little in lost time and resources.

(2) Kaizen projects, sometimes called rapid improvement projects, are typically completed in 30 days or less.

(3) Six Sigma projects are typically completed in three to six months but are often completed more quickly.

As Figure 1 shows, all these different types of projects are generated directly or indirectly from business goals or performance gaps. A top-down approach employs business goals to generate projects, while the bottom-up approach addresses performance gaps that arise from within the operations of the organization.

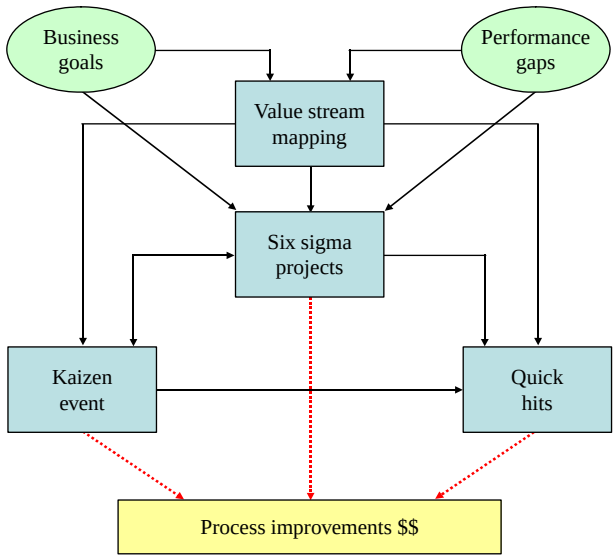

Figure 1. Improvement project selection

Business goals and performance gaps can directly generate Six Sigma projects, which is the customary approach for project selection in purely Six Sigma improvement systems. But in the holistic approach described here, goals and gaps can also provide inputs for value stream mapping (VSM), a technique often employed in lean that can also be used to generate Six Sigma projects. For example, Six Sigma is usually used to address complex problems for which the solution is unknown. If a VSM effort uncovers a complex problem with no known solution, then a Six Sigma project might result.

A Six Sigma project might uncover quick hits or generate Kaizen projects in the course of its execution. If VSM uncovers non-value-added activity for which lean tools might be appropriate, then a Kaizen event might be convened to brainstorm solutions. The Kaizen event might then initiate a Kaizen project. Employing lean tools, it might uncover a quick fix or find there is no known solution, which would then generate a Six Sigma project.

The Lean Six Sigma projects category is conspicuously absent from this framework. That is because in a holistic improvement methodology, in which the overarching goal is improvement – no matter how it is achieved – all projects are, in effect, Lean Six Sigma projects. They draw on a common toolbox that contains tools that have in the past been kept apart.

Improvement objectives and needs of an organization are shown in Figure 2.

Depending on the nature of the problem, of course, tools traditionally regarded as lean or tools associated with Six Sigma may dominate. Consider, for example, the types of commonly encountered improvement needs, including the need to:

- streamline process flow to reduce complexity, decrease downtime, shorten cycle time and reduce waste;
- improve product quality;
- achieve consistency in product delivery;
- reduce process and product costs;
- reduce process variation to reduce waste (such as the waste of defective products);
- improve process control to maintain stable and predictable processes;
- find the sweet spot in the process operating window; and
- achieve process and product robustness.

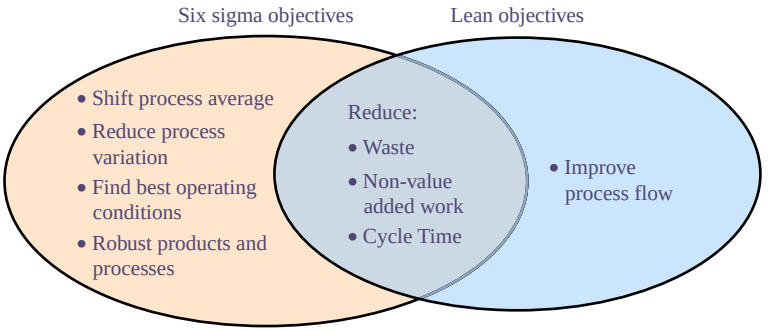

Figure 2.
Improvement objectives

In all these cases and others, the nature of the improvement to be pursued and the root causes standing in the way help define the appropriate approach and tools to be used.

In cases when shifting the process average or reducing process variation is appropriate for the problem at hand, Six Sigma will dominate. In cases when improving process flow or reducing process complexity is appropriate, lean tools may dominate.

Contrary to popular belief, however, both lean and Six Sigma approaches can be used to deal effectively with reduction of waste, cycle time, and non-value-added work (Figure 2). This is another indication of the desirability of truly integrating lean and Six Sigma to make available the best possible tools, regardless of the origin of their method.

A deeper look at improvement

In reality, an opportunity for process improvement and the problems associated with it are rarely one-dimensional. Such opportunities often consist of multiple process steps as well as process flows between the steps.

As Figure 3 shows, information and material flow between the process steps (between the boxes) are often the root cause of poor process performance. But value adding transformation takes place at the process step within the box, which may also harbor root causes of poor performance. Lean principles are typically most effective when used to deal with the flow of information and materials, while Six Sigma approaches are typically most effective when used to address poorly performing value adding transformations.

It is critical to remember that the goal is get at the root causes of poor process performance, not simply to focus where symptoms appear. For example, a poorly performing transformation can cause process flow problems, and poor flow can result in problems in the transformations (for example, due to excessive aging of materials). It is therefore far more effective to draw on lean and Six Sigma simultaneously to achieve the maximum improvement possible and to address the root causes of poor process performance.

Value-adding transformation

In the current state of improvement methodology, issues of material and information flow, and the ability of lean principles to address them are relatively well understood. The power of those principles to simplify and streamline processes, as well as the

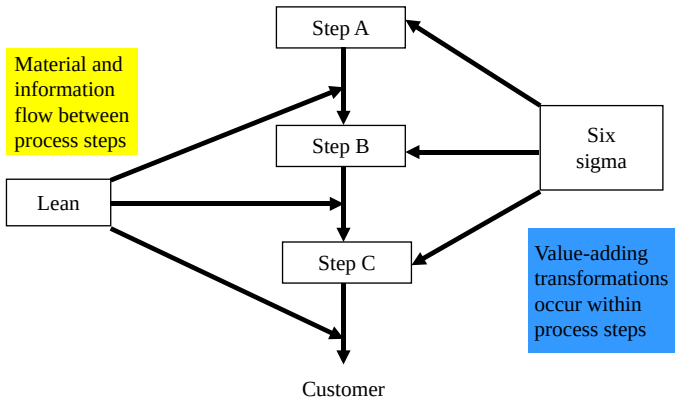

Figure 3. Improvement opportunities occur between and within process steps

relative simplicity of the principles themselves, is impressive. Indeed it is that relative simplicity that is part of their appeal.

Less well understood, however, is the value-added transformation that occurs inside the process steps, where the challenge is often to manage and optimize the complexity of the process step rather than simplify it.

More complex processes will have more action going on within the process steps, while simpler processes may have more action going on between the process steps. For example, consider assembly processes in which a product is created by bolting parts together. Little transformation occurs inside the process step – where the bolting takes place – but there may be significant issues of material and information flow.

Contrast that with a process in which the product is created by process inputs coming together under the right process conditions and being physically or chemically changed to produce the product. For example, when two pieces of metal are welded together, critical factors include current level, weld material, and thickness and type of metal. In those processes, the transformation that occurs inside the box – where the welding takes place – is where problems are likely to occur.

The case is even clearer in the extremely complex value adding transformations typically found in the chemical, pharmaceutical, biotechnology and high-tech industries. Often, in those situations, developing functional models of the form $Y = f(X)$ is frequently needed to understand what is going on within the process steps.

This is not to argue that one approach is superior to another but that both are needed to optimally address performance gaps because both affect the outcomes that have traditionally been seen as dependent on one or the other's approach.

Cycle time reduction has usually been regarded as best attacked by lean principles. But cycle time can be a function of both variation within the value adding transformation and process design inefficiencies, such as availability of materials, information, and other resources.

For example, in a mixing process associated with batch chemical production, an improvement project resulted in the development of a $Y = f(X)$ model that showed batch cycle time was related to type and quantity of raw material as well as the amount of mixing time.

Using this model, the organization was then able to find the operating sweet spot by reducing the batch cycle time and increasing batch size, thereby increasing capacity 20 percent for an annual savings of $280,000. Thus, the cycle time was influenced by the value adding transformation – a chemical reaction in this case – rather than information and material flow.

Regardless of the type of process, the model $Y = f(X)$ is always applicable. In some cases the model is obvious because of the linear/additive form of the model, as when total process cycle time is the sum of sub-process cycle times.

In other more complex situations, more complicated models are needed to understand the process, such as when product performance (Y) is a function of interactions between raw materials (X) and process operating variables (X).

Models can be both quantitative (when the form of the functional relationship is known) and qualitative (when the direction of effects are known but not the quantitative magnitude of effects or the functional form of the model). We use qualitative models all the time in our daily lives. Body weight gain or loss, for example,

is a function of calorie intake and exercise (Snee, 2003). Many lean principles are based on qualitative models developed from years of experience.

In determining the improvement approach to be used, look at the steps in the process and determine whether the root cause of the problem – not the symptom – lies in the value adding transformation within one or more process steps or in the flow of information and materials between one or more process steps.

The improvement of value adding transformation typically benefits from the use of $Y = f(X)$ models. Information and material improvements typically benefit from process streamlining, bottleneck reduction, and reducing waste and cycle time.

Many projects call for both approaches to improvement to achieve maximum benefit. For example, a pharmaceutical company needed to improve the capacity of a manufacturing process to meet market demand for a highly successful product. The strategy for improvement included increasing the process yield to get more product out of existing raw materials and getting the product to the customer faster (Snee and Hoerl, 2005).

Systems and process analysis identified the batch release process – specifically the batch record release – to be a problem. Prior to the release of a drug batch to the market, batch records required by corporate standards and government regulators must be complete and indicate compliance with standard operating procedures. Until the batch records are complete, the batch is held up, often resulting in late or missed shipments, high inventory costs, and customer dissatisfaction.

A DMAIC analysis focused on manufacturing's review of the batch records. Using lean principles, the project team reduced review cycle time by 35-55 percent, depending on the product, a one-time saving of $5.2 million in inventory and $200,000 per year in operating costs.

Meanwhile, a DMAIC analysis employing the $Y = f(X)$ model to understand the value adding transformation showed the raw material batch to have a major effect on yield. When the batch-to-batch differences were reduced, yield increased 25 percent.

Integration of lean manufacturing and Lean Six Sigma

Another aspect of improvement that needs to be discussed is the use of lean manufacturing systems in which the product is pulled through the system based on customer demand. No product is produced unless it is needed as signaled by the kanban system the Lean Six Sigma methodology commonly used with DMAIC in executing improvement projects integrates with lean manufacturing as shown in Figure 4.

You begin with a business analysis to decide what the nature of the lean manufacturing system should be. The business case typically creates two different types of work streams: installation of lean manufacturing systems (also called pull systems) and process improvement projects aimed at improving the performance of the value-added steps. The need for improved flow of information and material is addressed in the installation of the pull manufacturing systems.

Both the improvements and the new pull systems produce improved bottom line performance. But you are not done; to sustain the new manufacturing system over time and deal with the problems that inevitably arise (processes tend to deteriorate over time if left alone) you need to put a continuous improvement (CI) system on place.

From a methodology and tools perspective lean principles and process design tools and methods are used to install the pull systems. Lean Six Sigma and its improvement

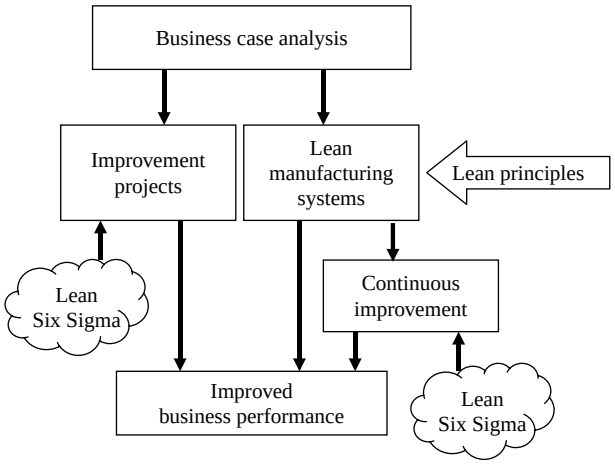

Figure 4.
Integration of lean manufacturing systems and Lean Six Sigma

framework DMAIC are used to execute the initial process improvement projects and to keep the CI process running effectively.

6. Challenges in the implementation

As with any change in how we work there are challenges to the new way of working that must be overcome. The first is resistance due to lack of understanding of Lean Six Sigma and a lack of belief that it will work. All are susceptible to these challenges, management and others alike. Education can help, but successful projects are usually the best vehicle to reduce this concern. In the final analysis, it is leap of faith that the approach will work in your organization. Successful projects silences the doubters, increases the self-confidence of the proponents of the approach and justifies the leap of faith.

Another challenge is the lack of roadmaps to follow. This should not be a problem today because there are a number of roadmaps that can be adapted to specific organizational needs. An approach that I have found useful and effective is the construction of deployment plan the critical elements of which are listed as follows.

Elements of a Lean Six Sigma deployment plan:

- strategy and goals for Six Sigma;
- process performance measures;
- project selection criteria;
- list of projects for project hopper;
- lists of champions, master black belts (MBB), BB, and GB;
- roles of management, champions, MBB, BB, GB, and functional groups;
- training plan;
- project and Six Sigma initiative review schedule;
- project reporting and tracking system;
- recognition and reward plan; and
- communication plan.

An example of a deployment plan is discussed by Snee and Hoerl (2003). A properly constructed deployment plan will lay out the project selection process and how the initiative will be sustained over time. Project selection and sustaining the effort are arguably the two most difficult aspects of Lean Six Sigma deployment.

Another difficult aspect of Lean Six Sigma deployment is the collection of data. This is particularly true when working on service processes where collection data is not part of the culture. This can be overcome by management review of projects checking on the appropriate use of data and providing the resources needed to collect, retrieve, and analyze the data.

Every company, function, business, etc. will resist the use of Lean Six Sigma because "we're different" and it does not apply here and will not work here (Snee and Hoerl, 2005). This is of course a legitimate concern but is not as big as most people think in the beginning. Service organizations, from an improvement perspective, have many, many things in common with manufacturing organizations. All have processes that are not performing properly and can be improved by collecting data, using scientific thinking and the concepts, methods and tools of Lean Six Sigma. This approach may not feel natural in the beginning but over time as the organization sees it work, Lean Six Sigma will become part of "how we do improvement here."

Throughout Lean Six Sigma deployment and particularly as the initiatives move from a project completion focus to a CI culture change leadership is a critically important issue. The issue will be addressed later in this paper.

7. Lean Six Sigma is different from other improvement approaches

In the past, the deployment process for the improvement initiatives has been the Achilles heel. Failure of improvement initiatives has been typically due to poor deployment. Lean Six Sigma works because the eight key characteristics, listed as follows, are built into the approach:

(1) creates bottom line results ($);
(2) active senior management leadership;
(3) uses a disciplined approach (DMAIC);
(4) rapid project completion (three-six months).
(5) clear definition of success;
(6) infrastructure created (MBB, BB, GB);
(7) focuses on customers and processes; and
(8) sound statistical approach.

These characterizations all relate to the deployment of Lean Six Sigma.

Lean Six Sigma projects produce significant bottom line results; as much as $175,000/project and $1 million/year/BB (Harry, 1998). This gets the attention of senior management, who must lead the effort. I believe that these two success factors: bottom line results and active senior management leadership including periodic (weekly, monthly, and quarterly) project and program (collection of projects) reviews is what is different about Lean Six Sigma and why it is more successful than other approaches.

Lean Six Sigma is also successful because it uses a disciplined, systematic improvement approach, DMAIC, which emphasizes rapid project completion in

three-six months (sense of urgency). The importance of a sense of urgency is discussed by Kotter (2008). Efforts of longer duration are divided into a series of three- to six-month projects, some of which may be handled in parallel. Success is clearly defined by financial impact and goals for performance metrics such as defects, cycle time, scrap, rework, and capacity. The infrastructure needed for success is clearly specified: senior management leadership, Champions, MBB, BB, and GB. Lean Six Sigma works because it focuses on improving processes in a way that improves the outputs that are of critical interest of customers and other stakeholders.

The approach is based on the scientific method utilizing statistical thinking and methods. Statistical thinking is fundamental to the approach which focuses on the processes we use to serve our customers, reducing defects by reducing variation, improvement as the goal, and is action oriented (ASQ, 2004; ASQ Statistics Division, 1996; Snee, 1990; Hoerl and Snee, 2002). The creation of champions, MBB, and BB with knowledge of, and skills in, statistical thinking and methods is in line with Shewhart's (1939) view that "the long-range contributions of statistics depends not so much on getting a lot of highly trained statisticians into industry as it does in creating a statistically-minded generation of physicists, chemists, engineers and others who will in anyway have a hand in developing and directing the production processes of tomorrow."

8. Mistakes commonly made by organizations deploying improvement initiatives

We now have considerable experience with deploying Lean Six Sigma; what works and what does not. The problems are found primarily in two areas, the pitfalls of which are listed:

(1) The management systems required to administer and monitor the overall improvement program:
- little leadership from top management including deployment plans – strategy, goals, etc.;
- poor or infrequent management reviews;
- top talent not used;
- poor support from finance, IT, HR, maintenance, and QC Lab.;
- focus is on training, not improvement;
- poor communication of initiative and progress; and
- lack of appropriate recognition and reward.

(2) The selection and management of individual improvement projects:
- projects not tied to business goals and financial results;
- poorly defined project scope, metrics, and goals;
- wrong people assigned to projects;
- project leaders and teams do not have sufficient time to work on projects;
- many projects lasting more than six months;
- little technical support from improvement master (MBB);
- large project teams – more than four to six persons per team; and
- infrequent team meetings.

As you move through your deployment, frequently ask yourself if you have fallen into any of those traps, either in the way the program is being managed or the way the projects are being pursued, to ensure that you do not derail the program. Some comment is helpful regarding these pitfalls.

Top management involvement

Whether you are part of top management initiating improvement or a mid-level executive proposing an improvement initiative to superiors, you should understand that without the full support and involvement of top management the improvement effort is likely to wither on the vine. That does not mean mere cheerleading or statements of support through E-mail, newsletters, and the like. It means creating a real sense of urgency about the need to improve and doing things that increase the likelihood of success: removing obstacles, allocating financial and human resources to the effort, regularly reviewing its progress, and ensuring recognition and rewards for participants. In comprehensive, high-level improvement programs designed to radically change the organization's way of working, senior leaders should directly oversee implementation.

Need to focus on improvement, not on training

Many companies shy away from large-scale improvement programs because they do not want to make large investments in training employees in unfamiliar improvement methods. Further, there is often a perceived long lag time between the end of training and the emergence of concrete results from subsequent improvement projects. Mid-level executives especially are sometimes reluctant to propose and push improvement programs with such high training costs and deferred payback.

There is, however, an elegant solution to the problem: as is the practice in most Lean Six Sigma deployments; combine training with real improvement projects, not academic exercises (Snee, 2001). Project-based training offers a number of advantages. First, it produces immediate financial and business results that pay for the training right away. Second, participants take real-world projects far more seriously than empty exercises and devote their best energies to the effort. Third, by linking training projects to business priorities, training is transformed into improvement. With a clear, measurable business benefit as the goal of every training event, a doubly compelling business case can be made on the basis of the benefits from the improvements themselves and on the basis of the cost-effective approach to training.

Use of top talent to conduct improvement initiatives

If improvement is truly important to your company's success, the effort will be entrusted to your most talented people. In fact improvement and changing how work gets done is too difficult a problem to be left to anyone but your most capable people. Assigning top talent to improvement initiatives also sends the unmistakable message to everyone in the organization that leadership regards it as an important priority. Further, most people are savvy enough to recognize whether really talented people have been assigned to improvement or merely people who are deemed expendable on other projects. If it is the latter, other personnel can justifiably conclude that they need not take the improvement program seriously.

Building the supporting infrastructure

Faced with the imperative to improve continuously, it is short sighted to regard improvement initiatives as *ad hoc* undertakings in need of no permanent infrastructure to support and execute them efficiently and repeatedly. The requisite infrastructure includes four elements:

(1) *A structured approach to problem solving.* This could be, for example, Lean Six Sigma's DMAIC for improving existing processes and DFSS for generating and designing new processes – generalized of course for a holistic improvement framework.

(2) *Proven analytical techniques.* To better understand, trouble-shoot, and improve manufacturing and non-manufacturing processes alike, your analytical techniques should be both qualitative and quantitative. Qualitative techniques include interviewing, expert opinion, brainstorming, hypothesis-generation, process and VSM and cause and effect matrix. Useful quantitative techniques include Pareto charting, control chart analysis, regression modeling, multi-vari studies and design of experiments (DoE), to name only a few.

(3) *Personnel skilled in improvement.* These are the leaders through whom projects are realized. As they become increasingly skilled in leading improvement and training colleagues, they form a permanent cadre of improvement experts who can be relied upon to deliver superior improvement efficiently and expertly. These persons are also candidates for future assignments with increasing levels of responsibility.

(4) *Management systems.* To realize the potential synergies of differing projects and to keep the organization tightly focused on its overriding strategic objectives, you should create an overall improvement system that guides and integrates all types of organizational improvement and creates the supporting management systems required to sustain it. It is not necessary to create new management systems but to integrate improvement management systems with existing management systems. Improvement management systems include communications, project selection, project portfolio management, measurement, and recognition and reward systems. The measurement system is the most frequently overlooked such system – and one of the most important. In the absence of an adequate and appropriate measurement system, it is virtually impossible to improve the performance of a manufacturing or a business process, increase customer satisfaction, or ensure the quality of a product or service.

With these four elements in place, you can begin to establish an enterprise-wide culture of CI.

Select the right projects

Few components of improvement programs are as critical as selection of the right projects. The project selection process identifies the right improvement approach and thereby identifies the right personnel and tools to be used. There are a number of criteria for identifying the right projects but above all, you should pursue projects that produce the highest value in relation to business goals. This means that before beginning a project, you should know what its worth to the bottom line. This makes

Finance an active participant in the improvement program, a role that is new for Finance in most organizations but one that is critical for the project selection process.

A top-down approach to project selection employs business goals to generate projects, while the bottom-up approach addresses performance gaps that arise from within the operations of the organization and the improvement of which can be justified financially. In both cases, projects should be doable in three to six months. Organizations typically lose interest in projects running longer than six months – people get transferred to other jobs, priorities change, deferred results sap motivation. To avoid these pitfalls, projects lasting eight to 12 months or longer can be divided into sub-projects of shorter duration and then conducted sequentially or in parallel.

Plan for sustaining the improvements at the beginning of the initiative

Many organizations focus on sustaining the gains only after improvement has been achieved. That is backwards. You should begin to focus on sustaining improvement gains before an improvement project begins and during the first six months of its implementation – that is, at the strategic and tactical levels, respectively. Otherwise, improvements are unlikely to last (Snee, 2006).

9. Are we ready to implement Lean Six Sigma?

This is a commonly asked question. Sometimes it reflects a legitimate concern. Other times it is a way of throwing up a barrier, creating resistance. In some sense you if you wait for the time to be right, you will very likely never get started. Sometimes you have to jump in and get started. Leadership expert, Kotter (1996, 2008), emphasizes that you need to begin with a sense of urgency.

There is one situation when delaying the start is a wise move; when the organization is already focused on one or two major initiatives, such as installing a new enterprise resource planning system or a new quality system such as ISO 9000. Such initiatives take considerable resources, it may be wise to postpone initiating Lean Six Sigma.

Another concern is that the CEO or chief operating officer (COO) is not supportive, being focused on other things. Long-term the CEO or COO must be supportive to have a broad Lean Six Sigma deployment to be implemented and sustained over time. But all is not lost if top management is not able to lead the effort. The improvement needs and associated bottom-line effects are still there waiting to be reaped.

One way to reap those benefits, at least partially, is by doing partial deployment; deploying Lean Six Sigma in a part of the business for which the deployment leader has responsibility. As we will see in the following examples partial deployment takes longer and as a result bottom-line savings are accumulated more slowly.

The deployment at W.R. Grace, a $1.5 billion company, was a top-down deployment lead by the CEO, Paul Norris. In the first year, $26MM was saved to the bottom-line. In the following two years annual savings of $40MM and $47MM were reported (Snee and Hoerl, 2003).

Crompton Chemical, a $2.5 billion company at the time will be used for comparison. The Lean Six Sigma was deployed in a part of the company in the first year and grew in breadth and depth of application. In the first year of the partial deployment six demonstration projects returned $2.3MM. In the next year, the initiative was expanded to a major business unit and $5MM was put on the bottom line. The CEO got interested at this point, appointed a Vice-President of Six Sigma and directed the initiative to be

deployed across the firm but did not actively lead the effort. A bottom-line contribution of $9MM resulted. In the fourth year of deployment, the CEO took on an active leadership role and $20MM in savings was reported. Partial deployment works; it just takes longer and produces less return in the early years.

The value of "demonstration projects" should not be overlooked; but the term "pilot projects" should not be used. It suggests that the methodology may not work giving the doubters a reason to take a wait and see attitude. The demonstration projects communicate to the organization that the approach works and we are going to show you how effective it can be. Prudent leaders select demonstration projects that have "significant impact" are doable in less than three-six months and easy for the organization to see the benefit. Remarks like "if Lean Six Sigma can solve this problem we should use the approach to solve a number of other problems we have around here such as [. . .]," typically result from such projects.

10. A theory for Lean Six Sigma is needed

A fundamental of a good approach is the availability of an underlying theory to guide its use and to enhance the approach over time. Dictionary definitions of theory are typically something to the effect of: theory is a plausible or scientifically acceptable set of general principles offered to explain a phenomenon. Theory is conceptual, based on general principles, and is not limited to mathematics. Deming (1993) admonished us several years ago that:

> [. . .] there is no knowledge without theory [. . .] Experience teaches nothing without a theory [. . .] Without theory you have nothing to revise, nothing to learn from [. . .] You have no way to use the information that comes to you.

Fortunately, Lean Six Sigma has a strong underlying theory. Hoerl and Snee (2010) point out that the effectiveness of this approach over a couple of decades has in large part been due to the following:

- Utilizing project teams of four-six people. Research on this topic reported in the *Fortune* magazine (Useem, 2006) concluded that the optimal project team size is 4.6 members; well within the range of four to six member typically recommended in Lean Six Sigma publications (Snee and Hoerl, 2003).
- Lean Six Sigma focuses on finding the critical drivers of a process, typically three to six. The Pareto principle, popularized by Juran and discussed in numerous publications (Box *et al.*, 2005), provides an underlying theory for this practice.
- Improvement happens project-by-project, and in no other way as emphasized by Juran (1989). This tells us that improvement will not be successful in the long run without a system of improvement project selection, execution, and review.
- Lean Six Sigma emphasizes the use of tools proven via research to be effective in practice in diverse application areas, such as DoE, statistical process control, and measurement systems analysis. Interestingly, these methods tend not to be emphasized in many introductory statistics courses in academia, which often focus more on probability and hypothesis testing.
- DMAIC is used by Six Sigma as a generic problem solving methodology (theory) that applies across cultures, processes, functions, types of industry (service or manufacturing), and so on. The current framework has evolved from the use of

this or similar approaches around the globe in many different improvement circumstances.

The framework used for improvement was originally MAIC. GE added the D, for define, in the late 1990s to create DMAIC. This was done because the existing framework, or theory, did not do an adequate job of defining the problem and its business context. Lean methods were added to Six Sigma in the early 2000s to enable the methodology to more effectively deal with improving process flow issues (Snee and Hoerl, 2007).

Simply stated, when developing a methodology, including Lean Six Sigma, we should utilize existing theory, and then continually update this theory as we obtain more information and experience about the methodology. This is what happened with Lean Six Sigma, which helps explain its success over decades. Of course theories are rarely complete. The Lean Six Sigma theory needs to be continually challenged and enhanced to make the approach better.

11. Lessons learned

Much has been learned over the past ten to 15 years regarding the deployment of improvement initiatives and the associated methodology such as Lean Six Sigma. I have distilled many of these learnings in the following guiding principles for deploying improvement initiatives:

- have a sense of urgency;
- leadership is required;
- use process thinking – all work is a process;
- recognize variation is the critical issue – all processes vary;
- focus on breakthrough improvement in performance;
- keep all aspects of change initiatives focused on the most important issues at all times;
- require those requesting change to "show me the data" and "show me the money";
- work to sustain the gains; and
- celebrate the successes.

These principles are self-explanatory and I will not comment further. There are some other lessons that merit discussion. First it has been learned that the DMAIC improvement framework is arguably the best available today. It is easy to understand and has been used effective by businesses, functions, process and cultures around the world. DMAIC is elegant in its simplicity.

A critical power of Lean Six Sigma is it's focus on finding the variables (*X*s) that account for the majority of variation in the process; the so-called critical derivers. Experience has shown that there are three to six critical *X*s. When these critical variables are known and understood, you understand the process and are in a position to effectively optimize and control the process.

We have learned that management leadership, use of top talent, and a holistic methodology are critical to sustaining improvement. It is also critical to focus on

building the sustaining infrastructure at the beginning of the initiative, not after you have been working on the deployment for 12-18 months like many organizations do.

The guiding principle is that we want improvement to be a business process just like other process used to run the business, i.e. finance, legal, HR, etc. This is accomplished by building the needed management systems, such as strategy, goals, budgets, management review, recognition and reward, communication, and the like. If you want improvement to happen on a regular and ongoing basis you must have management systems in place to guide and sustain the effort.

12. Future of Lean Six Sigma – bottom-line improvement never goes out of style

The future of Lean Six Sigma is likely on the minds of all who read this paper and users of the approach. I will close this paper by addressing some trends and needs of the users that I see developing.

As I pointed out at the top of this paper improvement approaches come and go, but improving the bottom line never goes out of style. The financial crisis is encouraging leaders and organizations to view Lean Six Sigma as an approach to reduce costs and keep the cash flowing. I believe that CI can be the "cash cow" that organizations wish they had at this difficult time (Snee, 2009a, b).

Next, I see professionals in the field recognizing that it is about improvement not Lean Six Sigma *per se*. Lean Six Sigma is the method to realize improvement. As a result organizations will be focusing on what is called "holistic improvement," which is defined as "An improvement system that can successfully create and sustain significant improvements of any type, in any culture for any business" (Snee, 2008, 2009a, b). The results will the broadening and deepening the use of Lean Six Sigma.

As holistic improvement becomes a reality we will see Lean Six Sigma solutions developed from projects becoming "embedded" in how the organization runs it business (Pfeifer *et al.*, 1988). A critical element of this embedding will be the development of data-based process management systems involving process design, improvement and control being driven by the voice of the process and voice of the customer in the form of process measurements and customer feedback (Snee and Gardner, 2008). Such systems provide the fuel that drives the CI culture.

We also see several companies using improvement as a vehicle to drive leadership development. Some leaders in this area include GE, Allied-Signal now Honeywell, Du Pont, and American Standard. Welch and Welch (2005) pointed this out early on. The approach is easy to grasp; GB, BB, or MBB experience is needed to be considered for promotion up the management ladder. The job of leaders is lead change, which involves changing work processes. Improvement using Lean Six Sigma methodologies provided the experience as well as the concepts, methods and tool to lead change.

Part of the move to holistic improvement will be the recognition that moving from a sole focus on improving project-by-project to a culture of CI will take the organization a long way toward sustaining the improvement culture and the gains made along the way.

All of these trends – holistic improvement, CI culture, leader development using Lean Six Sigma experience, keeping a keen focus on the bottom line – requires change both individually and organizationally. Change happens one person at a time. To this end leaders of improvement systems will have to become skilled in change leadership

concepts, methods and tools (Holman *et al.*, 2007; Snee, 2007a, b). There is an abundance of literature on this topic. I have found the following guiding principles useful in leading change:

(1) Have a sense of urgency – produce results quickly.

(2) Review progress on a regular basis.

(3) Understand human behavior:
   - change happens one person at a time;
   - understand what is in it for each person involved; and
   - change will be required by all those that get involved.

(4) Make it easy – to see, understand and do:
   - provide roadmaps, software, work aids, etc.

(5) Always have an impact focus, process performance and bottom-line ($$).

(6) Use improvement as a leadership development tool.

Several of these principles are based on Kotter's eight stages of change model (Kotter, 1996) and my experience in leading change focused on improvement for the last 25 or so years. I believe that these principles may be a good place to start as you develop your approach to change associated with improving the performance of your organization.

References

ASQ (2004), *Glossary and Tables for Statistical Quality Control*, 4th ed., Quality Press, Milwaukee, WI.

ASQ Statistics Division (1996), *Statistical Thinking*, Quality Information Center, American Society for Quality, Milwaukee, WI (special publication).

Box, G.E.P., Hunter, J.S. and Hunter, W.G. (2005), *Statistics for Experimenters – Design, Innovation and Discovery*, 2nd ed., Wiley-Interscience, New York, NY.

Deming, W.E. (1993), *The New Economics – For Industry, Government and Education*, MIT Center for Advanced Engineering Study, Cambridge, MA.

George, M.L. (2002), *Lean Six Sigma – Combining Six Sigma Quality with Lean Speed*, McGraw-Hill, New York, NY.

George, M.L. (2003), *Lean Six Sigma for Service – How to Use Lean Speed and Six Sigma Quality to Improve Services and Transactions*, McGraw-Hill, New York, NY.

Harry, M.J. (1998), "Six Sigma: a breakthrough strategy for profitability", *Quality Progress*, May, pp. 60-4.

Hoerl, R.W. and Snee, R.D. (2002), *Statistical Thinking – Improving Business Performance*, Duxbury Press, Pacific Grove, CA.

Hoerl, R.W. and Snee, R.D. (2010), "Statistical thinking and methods in quality improvement: a look to the future", *Quality Engineering*, Vol. 22 No. 2 (in press).

Holman, P., Devane, T. and Cady, S. (2007), *The Change Handbook*, 2nd ed., Berrett-Koehler, San Francisco, CA.

Juran, J.M. (1989), *Leadership for Quality: An Executive Handbook*, The Free Press, New York, NY.

Kotter, J.P. (1996), *Leading Change*, Harvard Business Press, Boston, MA.

Kotter, J.P. (2008), *A Sense of Urgency*, Harvard Business Press, Boston, MA.

Pfeifer, C.G., Marquardt, D.W. and Snee, R.D. (1988), "Statistics – a road to the future: a time for change", *Chance*, Vol. 1 No. 1, pp. 39-42.

Shewhart, W.A. (1939), *Statistical Methods from the Viewpoint of Quality Control*, US Department of Agriculture, The Graduate School, Washington, DC.

Snee, R.D. (1990), "Statistical thinking and its contribution to total quality", *The American Statistician*, Vol. 44, pp. 116-21.

Snee, R.D. (2000), "Impact of Six Sigma on quality engineering", *Quality Engineering*, Vol. 12 No. 3, pp. ix-xiv.

Snee, R.D. (2001), "Focus on improvement, not training", *Quality Management Forum*, Spring, pp. 7, 8 and 16.

Snee, R.D. (2003), "Develop useful models – finding the critical few *X*s allows you to better control and optimize a process", *Quality Progress*, Vol. 2003, December 2002, pp. 94-6.

Snee, R.D. (2004a), "Can Six Sigma boost your company's growth?", *Harvard Management Update*, June, pp. 2-4.

Snee, R.D. (2004b), "Six Sigma: the evolution of 100 years of business improvement methodology", *International Journal of Six Sigma and Competitive Advantage*, Vol. 1 No. 1, pp. 4-20.

Snee, R.D. (2006), "The hard part: holding gains in improvement: sustaining the gains begins when the improvement initiative is launched not after the improvements are achieved", *Quality Progress*, September, pp. 52-6.

Snee, R.D. (2007a), "Managing Six Sigma's most profound change of all: a new way of thinking", *Six Sigma Forum Magazine*, February, pp. 41-3.

Snee, R.D. (2007b), "The Six Sigma approach to improvement and organizational change", *The Change Handbook: The Definitive Resource on Today's Best Methods for Engaging Whole Systems*, 2nd ed., Berrett-Koehler, San Francisco, CA.

Snee, R.D. (2008), "W. Edwards Deming's 'Making a New World': a holistic approach to performance improvement and the role of statistics", *The American Statistician*, Vol. 62 No. 3, pp. 251-5.

Snee, R.D. (2009a), "Digging the holistic approach: rethinking business improvement to improve the bottom line", *Quality Progress*, October, pp. 52-4.

Snee, R.D. (2009b), "Get moo-ving", *Six Sigma Forum Magazine*, May, pp. 30-1.

Snee, R.D. and Gardner, E.C. (2008), "Putting it all together: continuous improvement is better than postponed perfection", *Quality Progress*, October, pp. 56-9.

Snee, R.D. and Hoerl, R.W. (2003), *Leading Six Sigma – A Step-by-step Guide Based on Experience with GE and Other Six Sigma Companies*, *Financial Times*/Prentice-Hall, New York, NY.

Snee, R.D. and Hoerl, R.W. (2005), *Six Sigma Beyond the Factory Floor – Deployment Strategies for Financial Services, Health Care, and the Rest of the Real Economy*, *Financial Times* Prentice-Hall, New York, NY.

Snee, R.D. and Hoerl, R.W. (2007), "Integrating lean and Six Sigma – a holistic approach", *Six Sigma Forum Magazine*, May, pp. 15-21.

Taylor, F. (1911), *The Principles of Scientific Management*, Norton, New York, NY.

Useem, J. (2006), "How to build a great team", *Fortune Magazine*, June 1.

Welch, J. and Welch, S. (2005), *Winning*, Harper Business, New York, NY.

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