

Integrating Lean & Six Sigma

Applying the Best of Both for Operational Excellence

A Kaufman Global White Paper

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Introduction

Two of the most popular buzz-words in business today are **Lean** and **Six Sigma**. There is a great deal of confusion and misunderstanding about the benefits, content, limitations, overlaps and unique characteristics of these two approaches. This white paper provides some guidance through the hype and zealot-infested Lean / Six Sigma marshes of the business jargon jungle. This white paper teaches readers how to properly integrate and apply the best of both methodologies.

Definitions

The term *Lean manufacturing* was popularized in the book, The Machine That Changed the World, written by James Womack, et al, and published in 1990. Machine detailed the Toyota Production System (TPS), comparing and contrasting it to other, then prevalent, approaches to automotive manufacturing. Thus, *Lean* has become a generic term for a pull (versus push) system of manufacturing / operations and the great many tools and methods that support it. The Master Jargon Chart of Lean (Figure 1) displays several of these tools and methodologies.

CATEGORY OF WASTE	TYPE OF WASTE	WASTE REDUCTION APPROACH	METHOD	FOCUS POINTS	PRINCIPLE WORKSHEETS	DESIRED RESULT
PEOPLE	Processing	Workplace Management	Standard Work	Layout & Labeling Tools/Parts Arrangement Work Instructions Labor Efficiency (V/T) Visual Displays	Standard Work Sheet Time Observation Form	Highly Efficient, Safe Work Area With High Output
	Motion	Work Group Ownership	Kaizen	Hourly Status Checks Cell/Area Teams Shift Meetings Improvement Plans Cell Suggestion System Skills Training	Standard Work Combination Sheet Work Load Balancing	
	Waiting		Short -interval Coaching KCG 20 Keys SM		Kaizen Target Sheet Kaizen Action Sheet	
QUANTITY	Inventory	Just-in-time	Leveling	Work Balance WIP Location & Amount	Standard Work Sheet Standard Work Combination Sheet	What You Need When You Need It
	Moving Things		Kanban	Kanban Location Kanban Types Lot Sizes	Work Load Balancing Sheet Kanbans	
	Making Too Much		Quick Setup Preventive Maintenance	Changeover Analysis PM Analysis	Table of Production Capacity by Process PM Scheduling Sheet	
QUALITY	Fixing Defects	Error Proofing Autonomation	Detection Warning Prediction Prevention Jidoka	Appropriate Automated Assistance Fixture Modifications Successive Checks Limit Switches Check Sheets Photocells, Templates, Etc. Cross-Training	Standard Work Combination Sheet Error Proofing Action Sheet Error Proofing "To Do" List Skill Versatility Visual Display	Good Quality

Figure 1 –Master Jargon Chart of Lean

Although the fundamental Lean tools are those of the fully developed TPS (circa 1970), they have continued to evolve over the years. Kaufman's **20 Keys**[®] (developed with inspiration from Iwao Kobayashi and customized for various functional work areas) is one important addition. Other terms for Lean or pull systems are synchronous, flexible, cellular, just-in-time, one-by-one and so on. The word *kaizen* is often used in conjunction with, or as a substitute for Lean. *Kaizen*

is a Japanese word for small, ongoing (*kai*) changes for the better (*zen*). However, kaizen is not the same as Lean, but only a part of it.

Six Sigma was born within Motorola in 1979 out of frustration with quality problems and refers to six standard deviations (the lower case Greek letter sigma, σ), is used by statisticians as a symbol for the standard deviation). The model for outstanding quality was arbitrarily set at Six Sigma (6 σ) because such a controlled level of performance seemed almost unattainable at the time and thereby set a worthy process performance goal for a world-class organization. A Six Sigma process would have a distance of Six Sigma between the mean of the process and the closest specification limit.

What Are the Objectives of Lean and Six Sigma?

The primary thrust of Lean is to reduce waste. Taiichi Ohno's famous seven types of waste are shown in the second column of the Master Jargon Chart of Lean, shown in Figure 1. Lean installs a system that focuses on the elimination of small instances of waste (including people and material waiting, excess inventory, quality issues) in every worker's area every day, creating a pull system over time. A pull system is a dramatic innovation when compared to traditional push systems. Essentially, Lean creates a manufacturing revolution through the cumulative effects of many, many small improvements. Do not be misled by the term *small* when used in the context of Lean. Often, improvements in a work cell or entire manufacturing unit can, in the course of six months to two years, be on the order of magnitude of over 90 percent reductions in cycle time, defects and manufacturing labor with accompanying reductions in floor space of 50 percent or more.

Originally, the primary emphasis of Six Sigma was heavy on process measurement, analysis and improvement using Statistical Process Control (SPC) methods, design of experiments (DOE, Shainin, etc.) and general problem-solving tools. These tools include cause and effect diagrams, Pareto charts, flow charts, 8-D problem solving (an eight-step method) and so on. Six Sigma attacks specific problems with statistical thinking and techniques. The emphasis is on eliminating a problem through rigorous process definition, metric development and measurement, process capability studies, root cause analysis and installation of process improvements. The goal is to achieve (or begin to achieve) dramatic process improvements with an eventual Six Sigma (or better) objective.

The bottom line on the different objectives of Lean and Six Sigma is this: Lean (by any name) installs a philosophy and practice of waste reduction that attacks all of the wastes listed in Figure 1 with the intent to create a self-regulating, pull system that has minimal inventory. Six Sigma attacks problems with a range of statistically based, problem solving tools. Six Sigma has no inherent pull-versus-push philosophy or inventory reduction foundation built into it.

How Do Lean and Six Sigma Achieve Their Objectives?

The basic assumption of Lean is that no process is devoid of waste. Lean operates by installing and applying into each work group in the organization the methods and approaches shown in columns three, four and five of Figure 1. Leads, supervisors and managers conduct the implementation and maintenance of Lean. Almost always, these employees need coaching and

assistance in overcoming resistance to change, project management, Lean principles and the various tools in order to realize benefits in a timely manner. The design of a Lean initiative is generally directed by a cross-functional Executive Steering Committee (ESC), which is also coached by a Lean expert.

This Lean approach, supported by critical structures such as a **20 Keys**[®] assessment and improvement plan and Kaizen Action Sheet improvement system in each work group, allows kaizen to operate at the level of every employee. The objective is to install a system that pursues small improvements continuously and automatically in every work group as the “business as usual” work ethic. All employees support a culture in which they clearly understand key metrics and the Lean “way” of working (workplace organization and the like), and are able to anticipate and react to small problems with predetermined methods.

As each work group begins to self-manage, the other tools and techniques in Figure 1 begin to be applied selectively. Thus, error proofing (poka-yoke), changeover reductions (SMED: single minute exchange of die), work leveling, and so on are employed as required once the basic kaizen foundation is in place and when process improvement opportunities requiring them are encountered.

Six Sigma operates on an “expert model.” The often referred to *black belts* of Six Sigma are individuals who have been trained on the Six Sigma tools. The term *black belt* was borrowed from martial arts where, depending upon the tenets of the school of study, students earn belts of various colors as they increase their skills. The colors, in ascending order of skill from novice to teacher, typically run from white to yellow to brown to green to blue to red to black to 1st degree, 2nd degree and upward black belts.

Over the course of time, training companies and organizations have adopted similar color schemes to identify levels of training in Six Sigma that are lower than black belt. Thus, there are variously blue, green and yellow Six Sigma belts in many organizations. A yellow belt (the most common color belt, other than black) typically receives training in basic SPC charting, data collection and problem solving but not in more complex statistical methods, process controls or DOE. Lower level belts are employees who “have regular jobs.” As time allows, they give a little help to black belts on specific projects, usually in their areas. Lower level belts also work on problems in their work areas as their time and / or interests permit.

Black belts are the general practitioners of Six Sigma. They are trained in both the theory and practice of using statistical thinking, tools and problem solving methods to “fix” a process or problem. Six Sigma training typically involves two weeks of classroom training separated by a number of “in the field” weeks during which the trainee works on an actual Six Sigma project. If the teacher reviews the project as successful, the student is awarded a black belt. Most black belts are awarded by organizations that have developed their own internal programs, so there is a broad range of black belt skills and experience depending upon the rigor of the training.

Six Sigma *master black belts* are individuals who are trained in both typical black belt skills and the “soft” people skills of organizing and running complex, cross-functional problem solving and / or improvement projects. Master black belts lead improvement projects in a business area or unit. They work with business unit or site champions (executive level sponsors) to select and direct projects in a portion of the organization. In a very large organization (with many

locations), there is often a full-time Six Sigma master black belt at headquarters who helps design large projects and provides technical assistance to lower level belts as required. In smaller organizations, an executive with either a master or regular black belt usually provides such assistance on a part-time basis.

Typically, a Six Sigma project that is designed and directed by a master black belt consists of several individual problem solving and process control endeavors organized as one effort (e.g., to fix the quality problem in the paint department). The desired outcome may be lowered inventory, an in-control (statistically speaking) process, faster cycle times, lower costs, more machine uptime and so on (or all of the above).

Which Approach Contributes the Most?

It's difficult to determine which approach, Lean or Six Sigma, works best. These days, almost every organization is employing a host of methods, approaches and philosophies in a frenzied scramble to be competitive. Most organizations are doing some of both, although many efforts involving Six Sigma tools and Lean methods are functioning in a non-focused, poorly planned manner. It would be hard to find an organization that is not using some structured problem solving approaches here or there, along with some SPC. And even the most backward organization has been forced by customers to begin to implement some Lean techniques.

One of the best known Six Sigma efforts was conducted at General Electric (GE). While Six Sigma gets most of the publicly stated credit for GE's success, GE was aggressively pursuing Lean techniques during the same time period. It would be impossible to separate the contributions of each into discrete cause and effect categories, but Six Sigma is afforded the glory in most organizations. This is due in part to a variety of reasons, including:

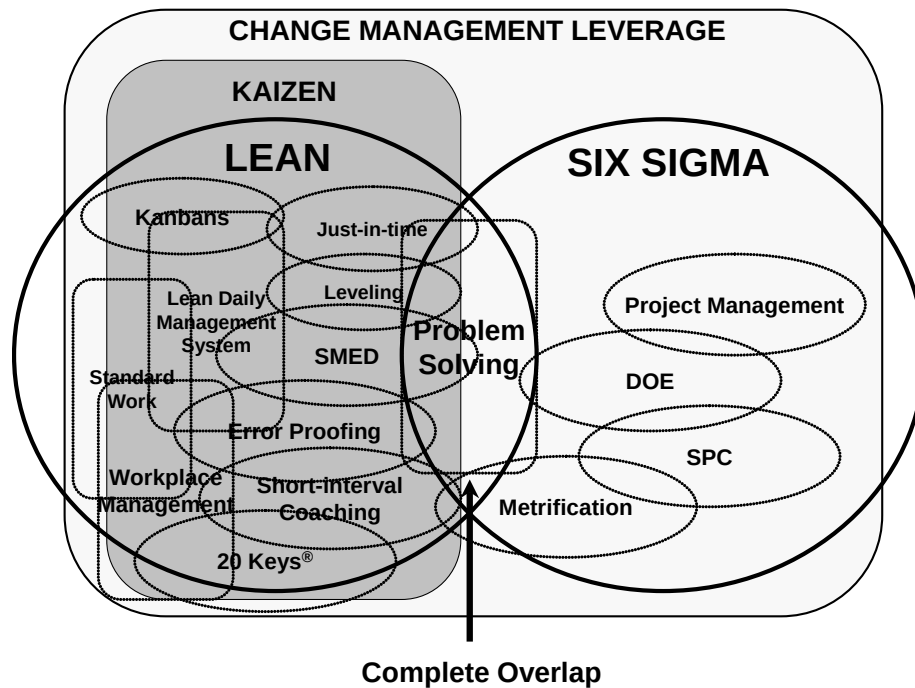
1. It is easy to describe what a black belt does.
2. Black belt status and the work performed can be associated with specific individuals.
3. Discrete projects can be trumpeted as victorious examples of the results Six Sigma can produce.

Aside from the difficulty of deciding what to call it, Lean (or pull, or kaizen...) is difficult to explain. The tools and methods displayed in Figure 1 are not easy to describe, particularly to someone lacking basic shop floor terminology. Further, Lean has no "heroes" that can be clearly identified (since everybody helps), and its many victories are often unglamorous and small. Yet, every world-class organization is practicing kaizen and elements of Lean while many have not trained a single black belt.

What Do Lean and Six Sigma Have in Common?

Figure 2 presents a conceptual illustration of the overlap of Lean and Six Sigma tools and methods. The Lean and Six Sigma "toolboxes" have many common elements; however, since these tools are applied toward the achievement of different objectives, they operate differently.

Figure 2 - The Overlap of Lean and Six Sigma Tools and Methods



For example, in the Six Sigma arena, a problem is pursued as a discrete effort by a black or yellow belt (based on complexity). Root causes are formally determined, metrics developed, process capability assessed, and various solutions tested. When the appropriate solution is found, it is installed.

In the Lean school of study, the problem is typically an identified waste that is noticed on routine measurements that are conducted in each work group on a periodic basis. Since all waste is a root cause of some loss, it is attacked automatically. By employing workplace management tools and just-in-time techniques, the waste is reduced. Lean has the benefit of a number of standardized techniques that can be applied within work groups. No “expert” is needed.

How Do Lean and Six Sigma Differ?

While it is easy to see the parallels between both types of problem solving, there is a considerable difference in how Lean and Six Sigma attack problems. Generally, Six Sigma is better suited for pursuing broad, complex issues that are beyond the grasp of a single work group. Conversely, it makes little sense to wheel the extensive arsenal of Six Sigma into place to reduce movement waste in a work group; the Lean tools of workplace management can easily minimize those wastes without extensive problem definition and / or the use of statistical methods.

Figure 3 presents a comparison of the types of issues / tools and approaches that Lean and Six Sigma employ as a matter of course. Project management issues and tools (how the overall Lean or six sigma effort is implemented) have been excluded, as they are dependent upon the leadership of the organization.

Figure 3 – Lean and Six Sigma Issues, Tools and Approaches

Issue, Tool, Approach	Lean	Six Sigma
Engages work groups as teams	YES	-
Defines key metrics for every work group	YES	-
Provides daily metrics feedback to all groups	YES	
Forces participation of supervisors / leads each day	YES	
Focuses on significant critical issues	YES**	YES
Employs structured problem solving approaches	YES	YES
Focuses on hundreds of micro-processes each day	YES	-
Establishes standard work (using TPS work sheets)	YES	-
Attacks movement, waiting and walking waste	YES	-
Attacks work-in-process (WIP) inventory	YES	-
Attacks raw and finished goods inventory	YES	-
Attacks work imbalances (leveling)	YES	-
Focuses on cycle time reductions	YES	-
Focuses on specific, individual defects	YES	-
Drives adjacent work groups / shifts to communicate	YES	-
Attacks changeover times	YES	-
Develops error proofing opportunities	YES	-
Uses kaizen blitzes	YES	-
Focuses on preventive maintenance issues	YES	-
Focuses on good housekeeping	YES	-
Focuses on developing a visual workplace	YES	-
Focuses on workplace organization issues (e.g., layout)	YES	-
Focuses on improvement planning in each work group	YES	-
Uses “as-is” process flow diagramming	YES	YES
Uses “to-be” process flow design	YES	YES
Employs Kaizen Action Sheet methodology	YES	-
Employs appropriate 20 Keys [*]	YES	-
Requires metrics development in each work group	YES	-
Employs benchmarking	YES*	YES
Standardizes and institutionalizes changes	YES	YES
Focuses on key safety issues	YES	-
Pursues large scale reengineering type innovations	YES**	YES
Requires concrete behavior changes in employees	YES	-
Requires concrete supervisory behavior changes	YES	-
Calculates process capability	-	YES
Uses statistical process control charts	-	YES
Uses design of experiments	-	YES
Calculates defects-per-million-opportunities (DPMO)	-	YES

* In the form of **20 Keys**^{*}

** Over time, as a result of many small changes

Figure 3 assumes the Lean and Six Sigma efforts being compared are well run and mature (at least six months in operation and aggressively true to their respective disciplines). A few tools (such as cause and effect diagrams and Pareto charts) are used so universally by organizations striving to become better that they are found everywhere. They have been excluded from this

analysis, because it is difficult to assign their presence to any specific initiative. It is also assumed that the application of Lean techniques to office areas is part of the Lean initiative.

At first glance, the comparisons shown in Figure 3 appear to cast Six Sigma in an unfavorable light, when in fact Six Sigma is an excellent methodology that will yield tremendous benefits, if applied properly. Yet, like any tool, Six Sigma has its limits. Six Sigma was not designed to create a new philosophy of work from the bottom up with every employee in every work group, or to evolve discrete, unleveled work groups into a smooth, pull system. These characteristics comprise the Lean agenda.

The basic pillars of Six Sigma are exhaustive process measurement, analysis, reengineering and institutionalization. The explicit agenda of Six Sigma is to fix enough critical processes so that the effectiveness of the organization dramatically improves in the targeted processes and / or areas. The implicit agenda of Six Sigma is to change enough processes so that a revolution of consciousness about problem solving and statistical thinking occurs.

A black belt applying Six Sigma is analogous to a surgeon and his / her surgical team working within a third-world country to heal as many people as possible, one surgery at a time. Every surgery is a work of art and the people of the villages and towns rejoice and celebrate the skill of the surgeon. One day a person is near death, and a few days later the patient is up and around.

A team applying Lean, on the other hand, is analogous to a public health specialist and / or an agronomist traveling to poor towns and villages and showing the people how to keep their drinking water clean, dig latrines, properly care for infants and increase their crop yields. Everybody benefits a little, but it is hard to see a dramatic change between one day and the next in any one person or the entire village. However, a year later, the changes will be marked, and three to four years later, quite dramatic.

What Are the Typical Barriers to Successful Implementation?

As you might expect, both Lean and Six Sigma fall prey to specific implementation diseases. While the diseases are different, the remedies are much the same: leadership and coaching. It is very difficult to implement change in any organization. Often leaders underestimate the amount of effort required and will dictate a solution by fiat (“Go get Lean” or “Go hire Six Sigma black belts”). Unfortunately, it’s not easy to get everybody to follow through in an organized, cost-effective manner. The lack of follow through is often blamed on the approach, but it’s almost always a failure to lead properly.

The biggest single killers of Six Sigma are the “executive curb appeal” and the “here come the suits” syndromes. Six Sigma can be associated with some of the biggest and more charismatic names in business. The fame of Six Sigma makes it appear as if results will be outstanding, low cost and fast—presenting excellent “curb appeal” to executives.

The “suits” syndrome spawns from “experts” riding in on white horses, like the cavalry, dictating solutions to problems that the workers have been faced with for years. However eager and well-intentioned, most process workers hate having “experts” come up with an answer - no matter how statistically cogent it is. Many elegantly designed experiments yield great results but never

get institutionalized because the area's work group wasn't involved with the solution's design. This is the reason why so many organizations that have spent hundreds of thousands of dollars on Six Sigma initiatives are now asking, "Why aren't we getting the results we need?"

Problems inevitably arise from delegating total responsibility for the successful implementation of significant changes to internal or external "experts." Management must own, lead, coach, direct and maintain all significant initiatives. Six Sigma black belts should be utilized as technical advisors. The soldiers and their commanders (management and the employees) must fight the war in every trench, every day.

Lean initiative shortfalls are due to a different leadership issue. Lean requires that the daily behaviors (communication meetings, measuring and tracking metrics, etc.) of each and every work group be changed a little every day. Changing behavior requires formal structure and a micro-process (or worker level) orientation created and supported by management. Without leadership, the initiative lacks commitment and results are not sustained.

What Should My Organization Do?

Which approach is best? It depends on what the specific problem is. In fact, both Lean and Six Sigma are needed because they do different things. One can't afford to let big, dangerous process problems and quality issues go unattended until after the installation of Lean systems. Conversely, one cannot afford to wait to implement Lean techniques if the rest of the market segment is already moving in that direction. Six Sigma cannot produce the required results in inventory reduction and cycle time on a sufficiently broad basis fast enough.

The best approach is to launch a Lean initiative that will begin to improve all micro-processes. At the same time, develop resources like Six Sigma black belts or similarly trained reengineering specialists to attack acute, complex issues. Armies win wars by focusing on bold victories, but the armies who have the most, bold victories are the ones who drill and train hardest on their micro-processes each day. Both are critical. In any successful complex system, a great many things are occurring simultaneously, sometimes adding up to more than the sum of their parts, sometimes causing friction. This is as it should be, for from this chaos will emerge the next great wave of improvement methodologies.

About Kaufman Global

Kaufman Global is a proven implementation partner that focuses on accelerating performance. For 20 years we have worked with clients around the world to drive enterprise-wide change initiatives and cultural transformations. Leveraging Lean, Six Sigma and proprietary change management techniques, Kaufman Global delivers structured implementation and transformation projects that enable sustainable operational and financial results.

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