The Lean Toolkit

The lean toolkit is comprised of a set of tools that are used in support of the Six Sigma DMAIC process, which is an acronym for define, measure, analyze, improve, and control (Figure 1). While this toolkit is not all inclusive, the set of tools that will be discussed over my next few columns will allow an organization to move through each of the DMAIC functions and facilitate implementation of any lean initiative (Figure 1). Beginning with this column, and after a brief prerequisite definition of both Six Sigma and DMAIC, each edition of this next series of columns will focus, in turn, on one of these DMAIC functions.

What Is Six Sigma?
Before we can talk about DMAIC, we need to briefly discuss Six Sigma and how it relates to the DMAIC process. Sigma (σ) is the 18th letter in the Greek alphabet and is defined and used in two different ways. First, as a mathematical measure of the amount of variation in a process. This is normally referred to as the standard deviation of a process; the lower the standard deviation, the better. Second, to describe the quantity of defects a process will produce. This is normally referred to as the sigma level of a process and is a measure of process performance; the higher the sigma level, the better. Although statistics are usually associated with Six Sigma, that is only part of the process; from a high level, Six Sigma is the problem-solving methodology called DMAIC.

What Is DMAIC?

DMAIC is a process that uses a collection of tools to identify, analyze, and eliminate sources of variation in a process. Six sigma can be an intimidating concept to grasp, particularly regarding the statistics and math part of the process. Distilling it down to the most basic level, the key takeaway is that to achieve a Six Sigma level, process variation must be cut in half from that of a Three Sigma level. Let’s now begin with the define function of the DMAIC process.

Define Toolset

This is the phase that identifies the opportunity and the process targeted for improvement.

Project Scoping

Project scoping is the activity of identifying and documenting the process that is targeted for improvement. Defining the project scope is critical; I think we have all been in meetings where two or three people leave with different impressions of not only the discussion but also of the actions that are to take place going forward. Formalizing the project scope is a key way to ensure that everyone is on the same page and gives the lean team the opportunity to review and assess the project before it officially goes live. This would include the initial process performance evaluation, defining of the team, developing a timeline, and attaching preliminary financial goals for the anticipated improvement.

Customer Benchmark Survey

The customer benchmark survey is part of the Voice of the Customer program that solicits information from the customer base. The ability to understand value from the customer’s perspective is a critical first step in the lean process. I would argue that before an organization can determine what processes need to be improved, it first needs to truly understand the customer’s needs as it applies to its product or service. One of the biggest mistakes companies make is trying to define value themselves; what is the value that they provide to the customer? This can only be defined by their customers through a formal information-gathering process such as a benchmark survey. The information gathered from a benchmark survey can provide valuable input on both short- and long-term decision-making in support of increasing customer satisfaction. The survey will not only highlight the areas where an organization holds strategic advantages over the competition but also the areas where the competition is superior. As stated in earlier columns, “perception is reality,” and I would argue that you can’t improve what you haven’t measured. The appropriate lean strategy can only be developed after measuring your customers’ needs, wants, and perceptions.

Critical to Quality Identification

Once customer needs have been established through the Voice of the Customer program, an analysis of the product/process characteristics that relate directly to meeting these needs must be completed. These characteristics are defined as being critical to quality (CTQ) as defined by the customer. CTQs are the key measurable characteristics of a product or process that directly correlate to a customer requirement. Often a CTQ is not a black and white specification; it may need to be translated from a qualitative customer statement into a quantitative requirement.

As we move through the various functions of the DMAIC process, how each function interacts and leads into the next should begin to bring clarity to the entire process. The next column will move on to the measure phase and the toolset that supports that function.

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The Lean Toolkit, Part 2

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he lean toolkit is comprised of a set of tools that are used in support of the six sigma DMAIC process, which is an acronym for Define, Measure, Analyze, Improve, and Control. While this toolkit is not all inclusive, the set of tools that will be discussed over the next few columns will allow an organization to move through each of the DMAIC functions and facilitate implementation of any lean initiative. After a brief prerequisite definition below of both Six Sigma and DMAIC, each edition of this next series of columns will focus, in turn, on one of these DMAIC functions.

DMAIC is a process that uses a collection of tools to identify, analyze, and eliminate sources of variation in a process. Six Sigma can be an intimidating concept to grasp, particularly regarding the statistics and math part of the process. Distilling it down to the most basic level, the key takeaway is that to achieve a six-sigma level, process variation must be cut in half from that of a three-sigma level. In the last column, we began with the Define function of the DMAIC process, so let’s move on now to the Measure function.

Process flowcharting is the use of a diagram, or picture, to represent the major elements of a process to determine how the process is really operating. Process flowcharting will define boundaries and constraints, and is the first step in measuring the current process. This process normally starts with a process team with an ample supply of Post-It® Notes. Once the basic process is hammered out, there are some very good software programs available that make this task much easier to manage. I would highly recommend utilizing software since most printed circuit companies have distinct processes that number in the high double-digits. Most process flowcharting experiences provide a significant “aha! moment” for both the process folks and management. It is amazing how a company does not really know what is happening in a process until they put it in a picture!

Value Stream Mapping
Value stream mapping is a lean planning tool used to visualize the value stream of a process, which takes a process flowchart to the next level, or as I like to say, value stream mapping is a process flowchart on steroids! This activity is the core fundamental method of identifying the areas of waste within any process (Figure 1). Value stream mapping analyzes each and every activity in a process and asks the question, “Is this adding value to the product?” Everything that is done in a process is either a Value Add activity, or a Non-Value Add activity. Since I previously defined value as anything the customer is willing to pay for, this analysis is one of the most critical ones that any business can perform. Value stream mapping is a two part process: 1) Developing a current state map representing how the process is operating today, and 2) Developing a future state map depicting the desired process operation. Value stream mapping is an iterative process in the continuous improvement realm since the improved future state will eventually become the current state, and the process will repeat.

Gauge R & R Study
A gauge R & R (repeatability & reproducibility) is basically a capability study of the measurement system used in an organization. I have always believed that a process cannot be improved until it has been measured, and accuracy of the measurement system is of paramount importance. A gauge R & R study is needed for two reasons: 1) There will be measurement variation from person-to-person, and 2) There will be measurement variation from tool-to-tool. A gauge R & R will give you an approximation of the variation of the total measurement system, expressed as percentage, including its component’s repeatability and reproducibility and part-to-part variations. The following are generally accepted guidelines for quantifying the results of a gauge R & R study:

• ≤10% satisfactory
• 11%-30% may be satisfactory, depending on the magnitude of the use, cost of new gauges, cost of repairs, etc.
• ≥30% unsatisfactory, requires corrective action

Capability Study: Baseline
The capability of the process needs to be established to use as a baseline for future improvement comparison, and is accomplished through Cpk analysis. To review, a Cpk value is an index representing the ability, or capability, of the process to meet customer requirements. To determine process capability, collect process data as you would if you were setting up a control chart, calculate the process mean and variation, and then compare the relationship between these values and the specification limits. Any SPC software, or even Excel, can calculate the Cpk of a process data set.

As we continue to move through the various functions of the DMAIC process, how each function interacts and leads into the next should begin to bring clarity to the entire process. The next column will move on to the Analyze phase and the toolset that supports that function.
**Recap: The Lean Toolkit**

The lean toolkit is comprised of a set of tools that are used in support of the six sigma DMAIC process, which is an acronym for Define, Measure, Analyze, Improve, and Control. While this toolkit is not all inclusive, the set of tools that will be discussed over the next few columns will allow an organization to move through each of the DMAIC functions and facilitate implementation of any lean initiative. In the last column we discussed the Measure function of the DMAIC process, so let’s continue on now to the Analyze function.

**Analyze Brainstorming**

Brainstorming is a Phase I problem-solving tool that is used to generate as many ideas as possible related to a given problem, with an emphasis on sheer quantity of ideas. Creative thinking should be encouraged during brainstorming, with no judgment or evaluation of ideas taking place during this activity. The goal is to identify as many potential causes of a problem as possible, even if some of these causes seem to be so off the wall that they couldn’t possibly apply. While the “crazy” ideas may not be feasible, they often enable a creative environment which stimulates valid ideas that may not have been otherwise considered. This environment should encourage critical thinking of a problem or process to gain a comprehensive perspective of causes, solutions, and potential consequences.

**Cause and effect diagram**

A cause and effect diagram is a Phase II problem-solving tool with the purpose of analyzing relationships between a problem and its causes. The cause and effect diagram is also known as a fishbone diagram (for obvious reasons), and an Ishikawa diagram, named after its inventor Dr. Kaoru Ishikawa. During this activity, all the ideas generated during the brainstorming session are evaluated and categorized as they relate to the subject problem. At this point, many of the ideas generated during brainstorming may be eliminated, while new ones may be added. The category names can be changed to fit the problem, but common categories are Methods, Machines, Environment, People, and Materials.

**5 Whys**

This technique can be used very effectively during the cause and effect analysis to drive to true root cause. Anyone with small children has first-hand knowledge of this problem-solving tool, although in the business environment, root cause should not end at “because I said so!” Although the word “Why?” may be your three-year-old’s favorite word, it could also teach you a valuable lean technique. By repeatedly asking the question, “Why?” (five is a good rule of thumb), you can peel away the layers of symptoms that can lead to the true root cause of a problem (Figure 1). The biggest mistake that most organizations make in the Analyze phase of DMAIC is to try to fix a symptom instead of the root cause. Only addressing a symptom will result in the root cause manifesting in the form of another symptom, and the problem will continue. Although this technique is called the “5 Whys,” it may be necessary to ask the question fewer or more times than five to drive to root cause in some instances.

**Pareto Analysis**

Around the turn of the 20th century, Italian economist Vilfredo Pareto made a couple of observations that led him to develop a principle that continues to be a powerful tool in the lean environment of today. He observed that 20 percent of the Italian population owned 80 percent of Italy’s wealth. He later observed that 20 percent of the pea pods in his garden produced 80 percent of his pea crop each year. This correlation led Pareto to postulate that, in most things, a small number of causes are responsible for a large percentage of the effect. In the late 1930’s, quality guru Dr. Joseph M. Juran recognized this principle as the “Vital Few and Trivial Many Rule,” which was later generalized into Pareto’s Principle, or the 80/20 Rule.

Pareto analysis allows management by fact instead of emotion; and as with most things, fact-based decision-making will yield the highest return on investment. The first step is to categorize the problems by type or defect code. Next, generate a simple histogram, which ranks the defects in descending order of magnitude. Then, using the data set in the histogram, graphically portray the data set in a simple bar chart format. Finally, add a trend line showing the accumulated relationship of the defects to the whole, to visually identify what defects make up roughly 80 percent of the total dollars. The strategy behind Pareto analysis is to identify the areas with the highest improvement potential while minimizing the number of improvement initiatives. What this means in simple terms is getting the biggest bang (improvement) for the buck (effort).

As we continue to move through the various functions of the DMAIC process, how each function interacts and leads into the next should begin to bring clarity to the entire process. The next column will move on to the Improve phase and the toolset that supports that function.

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Steven Williams’ Survival Is Not Mandatory: 10 Things Every CEO Should Know About Lean is available at www.survivaisnotmandatory.com.
The Lean Toolkit, Part IV

While this toolkit is not all inclusive, the set of tools that will be discussed over the next few columns will allow an organization to move through each of the DMAIC functions and facilitate implementation of any lean initiative. In the last column we discussed the Analyze function of the DMAIC process, so let’s continue on now to the Improve function.

**Improve Capability study: final**

The capability study completed during the Measure phase should be performed again to verify the effectiveness of the process improvements that have been implemented. It is generally accepted that a Cpk of less than 1.33 would indicate a process that is not capable of consistently meeting customer requirements, and a Cpk of 2.0 would represent a six sigma level (Figure 1). Through the use of lean tools, the goal is to improve the process capability from the original level to one in the range of 1.33–2.00 or higher.

![Sample Parameter Distributions](Image)

Five S are literally five Japanese words beginning with the letter S, which together form a systematic process for organizing a workplace. While this may seem to be a minor tool in the war on waste, the benefits include quality and safety improvements, lead-time reduction, reducing hidden waste, and of course, increased profits. Below we will explore what the Five S’s are and why they are important.

**Seiri**- (Sort) Ensuring each item in a workplace is in its proper place or identified as unnecessary and removed; getting rid of unnecessary “stuff.” Questions to ask: Can this task be simplified? Do we label items properly and dispose of waste frequently?

**Seiton**- (Set in order) Arrange materials and equipment so that they are easy to find and use. Prepare and label storage areas using paint, tape, outlines, or color-codes. Questions to ask: How much time is spent looking for things and putting things away? Can we improve the ergonomics of this task?

**Seiso**- (Shine) Repair, clean, and shine work area; “Everyone is a janitor” (this is a concept that U.S. workers have a difficult time embracing!). Questions to ask: Do we have a schedule for cleaning, sweeping, and wiping off for each department? Are we seeing the workspace “through our customers’ eyes?”

**Seitetsu**- (Standardize) Formalize procedures and practices to create consistency and ensure that all steps are performed correctly. Questions to ask: Does everyone know what they are responsible for doing? Is there a documented process that describes when and how to do it?

**Shitsuke**- (Sustain) Perhaps the most critical of the Five S’s is keeping the prior four processes going through training, communication, and organizational structure. Questions to ask: Does our senior management support this initiative by allocating the appropriate time and resources? Do we create awareness by publicizing and rewarding successes?

Five S projects need to be visual and placed in plain sight of all workers so everyone can understand the status of the system at a glance. Visualizing projects also support the Shitsuke process of publicizing and rewarding successes. Digital imaging has made documentation of “before” and “after” improvement easy to incorporate into the documents, posters, and reports that make up a good visual management system.

**Single Minute Exchange of Die**

Single Minute Exchange of Die (SMED) is a method based on the goal of switching tooling from one part to another in under a minute. The term is not to be interpreted literally, but refers instead to the activity of reducing setup time in a process operation. A more realistic objective would be a setup changeover in less than ten minutes; a single digit. SMED reduces waste in a process by providing a rapid and efficient way to convert from running the current product to running the next product. This rapid changeover is key to reducing lot sizes, improving process flow, and increasing flexibility.

**Poka-yoke**

Poka-yoke is the Japanese word for mistake-proofing (for us ancients, the pre-politically correct term was idiot-proofing) and has an interesting story of origin. One day Shigeo Shingo was explaining Baka-yoke, literally translated as fool-proofing, which had been created and implemented by workers on the Toyota factory floor. A young woman started to cry. “Why are you crying?” he asked. “Because I am not a fool!” she answered. “I am truly sorry,” Shigeo responded, and at that exact moment he changed the name from Baka-yoke to Poka-yoke, mistake-proofing.

Poka-yoke is not a new concept; some variation of this method has existed as long as people have been producing products. Mistake-proofing, error-proofing, fool-proofing; whatever label that is attached to it, poka-yoke is any method that eliminates the possibility of doing something incorrectly. Poka-yoke is, in essence, designing out the error. Common poka-yoke solutions include checklists, dowel and locating pins, fixtures, error and alarm detectors, limit or touch switches, etc. A properly designed poka-yoke will catch the errors before manufacturing defective product virtually 100 percent of the time. The three rules of poka-yoke are: 1) Don’t wait for the perfect poka-yoke, do it now! 2) If your poka-yoke idea has better than a 50 percent chance to succeed, do it! and 3) Do it now, improve it later! [ ]

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The Lean Toolkit, Part V

Recap: The Lean Toolkit

The lean toolkit is comprised of a set of tools that are used in support of the six sigma DMAIC process, which is an acronym for Define, Measure, Analyze, Improve, and Control. While this toolkit is not all inclusive, the set of tools that have been discussed over the last few columns will allow an organization to move through each of the DMAIC functions and facilitate implementation of any lean initiative. In the last column, we discussed the Improve function of the DMAIC process, so let's now finish with the Control function.

Control

The word control often has a negative connotation surrounding it, which in some usages is well deserved. However, in the context of lean, control simply means putting things in place to monitor and maintain the improvements that have been gained from the Define, Measure, Analyze, and Improve functions of the DMAIC process. Although this is the final step in the process, it bears repeating that the overall DMAIC process is an iterative, never-ending journey, if executed properly.

Control charts

Control charts are a graphical representation of the current state of a process and should be implemented at the operator level to maximize effectiveness. A control chart's true function is to provide real-time feedback to control and improve a process, which means that the data displayed on the charts must help front-line operators make better process decisions. All control charts have three basic components: 1) A process center, or mean, 2) An upper and lower control limit, and 3) An upper and lower specification limit. In a stable process, data will be randomly centered on the process mean and contained within the control limits. Data between the control limits and the specification limits signal that a process adjustment is needed. Data exceeding the specification limits would be considered out of acceptable limits and defective. The most common form of control charts are the X-Bar and R chart. X-Bar refers to the average of the data in each sample and plotted in the top half of the chart, and R stands for the range of the data in each sample and is plotted in the bottom half of the chart (Figure 1).

Cpk analysis

Every product has an optimum value, and because every process has variation, it also has a tolerance. This is defined as specification limits, with both an upper and lower spec limit (USL, LSL) surrounding the optimum value. Simply stated, when a product or process is outside of either of these spec limits, bad product is produced. How well the process variation is centered and contained within these spec limits is called process capability. The relationship of this variation to the mean and spec limits is the process capability, or Cpk. The less variation in a process, and the closer the variation is to the mean, the higher the Cpk number. With all the statistical tools available, the formula is not important for this purpose, but what is important is recognizing what this number means. It is generally accepted that a Cpk of less than 1.33 would indicate a process that is not capable of consistently meeting customer requirements, and a Cpk of 2.0 would represent a six sigma level. Calculating process Cpk levels is not a one time occurrence, it must be performed on a regular basis (quarterly is usually sufficient).

Audits

Developing a robust internal auditing system provides a methodology for monitoring and maintaining process improvements and sustaining the momentum created by a lean initiative. The audit program should include all lean process specific functions as well as areas such as training and quality system compliance. It is also a key tool for minimizing (or eliminating) undesirable findings during an external customer or quality system audit. With a solid program and skilled staff, an internal audit system will assure the success of lean efforts and operational excellence.

Management by Walking Around

Tom Peters, author of the “Excellence” series of books and one of my favorite management consultants, coined the phrase MBWA (Management by Walking Around). This is another of those concepts that seem so obvious, but how many of us actually do this? This is a rhetorical question, but really, how often do we go out on the shop floor and just observe what is going on? I don’t mean tracking down orders and making sure people are working, but how does the facility look? Do the workers look happy? Are we working smart or overcompensating by working hard? What would I think if I were the customer? You can’t answer these questions sitting in your office!

Do something now!

As we close out this series on the DMAIC process, my advice would be to do something now! Waiting for a plan to be perfect will only ensure that it never begins. Doing something now is always better than doing something later, and hopefully, this series has given you a roadmap for beginning this journey. ☑