COLUMN

POINT OF VIEW

Best Practices 101, Part 1

by Steve Williams
STEVE WILLIAMS CONSULTING LLC

Introduction

In the global economy that is today's business environment, there are no guarantees as indeed, survival is not mandatory! The need for best practices is present in every industry, but mandatory in technology industries such as printed circuit board manufacturing.

In this new series, I will convey some of the personal lessons gained through my intimate involvement with more than 1,000 manufacturing companies, which has allowed me the unique perspective of truly understanding best practices by witnessing both the best of the best and the worst of the worst.

Best Practice—n. In business, a technique or methodology that, through practical experience, has proven to consistently lead to superior results over other means. Applied as a system, it combines all the collective experience, knowledge and technology at one's disposal.

—*Williams Business Dictionary, 2014*

Process Analysis

One could argue—actually, *I would* argue—that before any improvement to a process can be made, the current state of the processes must be understood. Process analysis is just a fancy way to say this. If we consider waste to be anything in a process that is not adding value, then the question becomes, how do I identify waste in my process? The most effective method of identifying waste is by process mapping: from basic process flowcharting to advanced value-stream mapping. These two powerful tools will help any organization take the first step toward identifying the value, and non-value, activities in their processes. As my esteemed high school classmate Dr. Shigeo Shingo once famously said, "The most dangerous kind of waste is the waste we do not recognize."

Process improvement is the key to achieving both short- and long-term gains, which result in a significant increase in overall operational performance. By analyzing your current processes, you can determine which steps add value, as well as where and when defects occur. Process analysis is a careful evaluation of each step of the process from the input's perspective as it is transformed into the output. Each step needs to be questioned on both why and how it is being performed. Just because the standard, "we have always done it this way" may apply, does not mean that it is the best way, and this is the part most organizations struggle with the most. *Quantum improvement sometimes requires quantum change,* and the willingness to approach process analysis with an open mind is critical to the degree of success that can be achieved. Process analysis involves utilizing a team approach to map each of the processes at the appropriate level, and then analyzing each step for its value from the customer's perspective.

Most organizations have many processes that work together to bring a specific product from the point of a customer purchase order through the conversion process and ending with order fulfillment to the customer. The conversion process is simply turning (converting) inputs into outputs. From a big-picture perspective, raw materials are turned into finished goods, but within this macro-process there are many conversion cycles taking place as each process hands off a partially completed product to the next process. And again, remember that this could be one office function handing off to another just as easily as two manufacturing processes. The entire enterprise must be evaluated, from the problem-solving activity of taking a concept through engineering, to the information management activity involving order-taking and scheduling, to the physical transformation of converting raw material into finished product, delivered to the customer.

Process Analysis Terms

The following terms may be useful to an organization during the activity of process flowcharting, value-stream mapping, and analysis.

- **Blocking:** Occurs when the activities in a process stage must stop because there is no place to deposit the item just completed
- **Bottleneck:** Occurs when the limited capacity of a process stage causes work to pile up or become unevenly distributed in the flow of a process
- **Cycle time:** The average time between completions of successive units exiting a process
- **Make-to-order:** Process for producing in response to an actual order that results in minimum inventory levels
- **Make-to-stock:** Process for producing to meet expected or forecasted demand, shipped from stock, which results in high inventory levels
- **Process:** Any activity within an organization that converts inputs into outputs
- **Starving:** Occurs when the activities in a process stage must stop because there is no incoming work
- **Takt time:** Setting the pace of production to match actual demand; Takt time = available work time per day/daily total customer demand
- **Throughput time:** The time it takes a discrete unit to go from start to finish in a process
- **Utilization:** The ratio of the time that a resource is actually utilized relative to the time that it is available for use

Process Flowcharting

Process flowcharting is the use of a diagram to represent the major elements of a process; in other words, it is a picture of the process. There are many symbols used in process flowcharting, but the basic elements are tasks or operations, decision points, queue or storage, and directional process flow (Figure 1). The first

Figure 1.

step in many process improvement projects is to flowchart the process as it currently exists, which may not have any resemblance to company standard operating procedures (SOP). The realization that their SOPs do not reflect how the operation is really running is generally an "Ah-Ha!" moment for the company. Flowcharting also determines the parameters for process improvement since a process cannot be improved before it is understood. Although turning a process into a picture may sound very simple, it is an incredibly powerful tool to see what is really happening in a process. After a flowcharting session, the people actually doing the job are always amazed at the difference between how they perceive the process and what is really going on. A common result is a spaghetti diagram that highlights excessive travel, motion and redundancy. A picture truly is worth a thousand words.

As a working guideline, a flowchart should be used to: 1) understand how a whole process works; 2) identify the critical points, bottlenecks, or problem areas in a process; 3) see how the different steps in the process are related; and/or 4) identify the ideal flow of a process.

Next month, *Best Practices 101, Part 2* will dive deeper into process analysis by exploring the value-stream mapping tool. See you in June! **PCB**

Steve Williams is the president of Steve Williams Consulting LLC (www.stevewilliamsconsulting.com) and the former strategic sourcing manager for Plexus Corp. He is the author of the books, Quality 101 Handbook and Survival Is Not Mandatory: 10 Things Every CEO Should Know About Lean. To read past columns, or to contact Williams, click here.

Best Practices 101, Part 2

by Steve Williams
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A few months ago, Best Practices 101, Part 1 (May, 2014) was rolled out, focusing on process analysis as the first step in this process. This issue will discuss another powerful tool at our disposal: value stream mapping.

"But we already made a process flowchart—isn't that good enough?"

In a word, no. Process flow diagrams are a great first step, but they don't tell the entire story. Value stream maps add one critical ingredient that standard process flowcharts don't have: time. Process flowcharts, whether drawn by hand or electronically, do not capture this important element. They simply present a snapshot of the sequence of steps in the process. Time is essential to understanding how one operation affects another and where your resources are being spent.

Value Stream Mapping

A value stream map (VSM) takes the basic flowchart to the next level, kind of like a process flowchart on steroids. In addition to the basic action boxes with arrows showing the flow of work, a lot of other information is added, including material and information flow, operating parameters, process lead-times, inventory, a timeline depicting value-added time relative to non-value added time, and so on. Value stream mapping is the single most effective major process analysis step to identify the value stream, and conversely, the non-value waste in your processes. The value stream is the set of all of the specific actions and activities required from the beginning of a process to the end of a process. Imagine a long and winding deep blue stream flowing through cities, counties, and states. Next, visualize all the things that the river carries within it: water, fish, minerals, plants and a thousand other elements that combine to form the stream. Processes are very much like a stream; they flow in a natural direction and carry materials and information within them from one point to another.

The activity of value stream mapping is the core fundamental method of identifying the areas of waste which can be eliminated within any process. By finding the sources of waste and quantifying them, action plans for reducing or eliminating them can be prioritized. Apart from identification, value stream mapping can also help to streamline a process for higher productivity and efficiency. Each process needs to have a beginning and end clearly identified before this can occur. This sounds simple, but since many of these discrete processes often run together, it is critical to define the boundaries of the process from a value stream standpoint. Only through a detailed process analysis can you identify the non-value added steps that have become accepted, unquestioned parts of the process that result in "the way we have always done it."

There is what I call the value stream map paradox: Value stream mapping is the most effective Lean tool for identifying high payoff opportunities, yet value stream mapping is the Lean tool most likely not to be used by companies doing "drive-by Lean."

Value Stream Mapping Steps

Value stream mapping brings together Lean concepts and techniques and helps to avoid the "cherry-picking syndrome," in which processes that have very little impact on the product or service are chosen because they will be easy to improve. Value stream mapping forms the basis of an action plan (going from current state to future state), and illustrates the linkage between information and material flows. Like most things related to Lean, or any initiative, there are some basic steps to follow when creating a value stream map. The process of value stream mapping is self-perpetuating, meaning that eventually the future state becomes the new current state and the cycle continues (Figure 1).

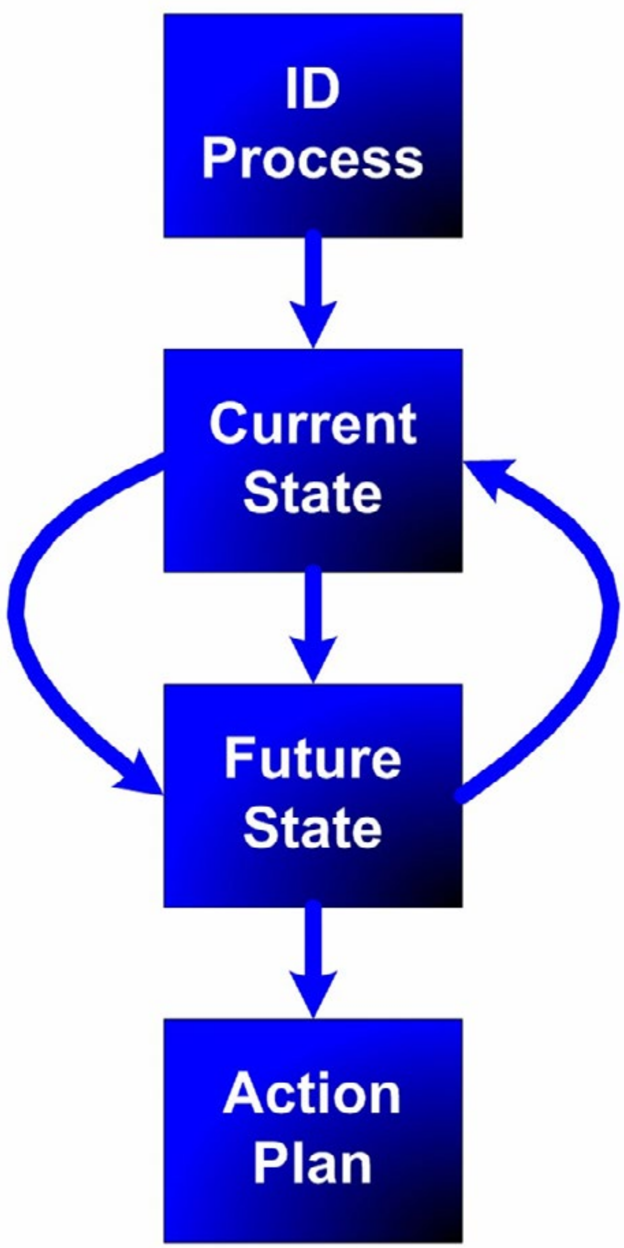

Figure 1.

Value Add vs. Non-Value Add

One of the most critical steps in the value stream creation process is recognizing non-value (waste) in the process. If we use the definition of value presented earlier, waste will be anything that the customer is not willing to pay for. Value-adding activities are tasks that that transform (add value to) the product in some way. This transformation can take the form of either hard changes to the product, or soft changes such as brand vs. private label products. Each step, of each task, of each process needs to be objectively evaluated against this criterion to successfully identify wastes that can be eliminated. The following five principles can be used to guide an organization in this evaluation:

1) Define value from the customer perspective
2) Identify the value stream for each product family
3) Make the product flow
4) Create pull to build only what is needed, when it is needed
5) Strive toward excellence

Throughout the process analysis activity, it is critical to remain focused on the right things; activities that impact improvement of the organization's products or services.

Next month, Part 3 will dive into the four critical steps of value stream mapping. **PCB**

Steve Williams is the president of Steve Williams Consulting LLC (www.stevewilliamsconsulting.com) and the former strategic sourcing manager for Plexus Corp. He is the author of the books, Quality 101 Handbook and Survival Is Not Mandatory: 10 Things Every CEO Should Know About Lean. To read past columns, or to contact Williams, click here.

Best Practices 101: Part 3

by Steve Williams
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As we deep dive into the four critical steps of value stream mapping, (VSM), by now you should have a good understanding of just how powerful some of these tools and techniques can be. And the best part? It is not rocket science; it's just common sense!

Step 1: Identify the Proper Process

This step cannot be stressed enough because it is often overlooked by many companies new to Lean. Fresh out of training, the VSM team often runs out and starts mapping the first process they see. While VSM, if anything, is better than nothing, efforts should be focused on the critical processes having the greatest impact on the product.

Let's look at a typical supply chain transaction from the point of a customer order through delivery of the product. Figure 1 example shows a macro view of the supply chain cycle to illustrate how VSM works. This high-level view would be one way to drive Lean down through the supply chain to sub-suppliers. Of course, discrete processes within each supplier would need to be value stream mapped to enable reductions in their respective lead times. This product depicts a process with an eight-week lead time, which, after value stream mapping the process, reveals that there are only seven hours of value-added time on this product. As unbelievable as these results sound, most organizations experience a similar disparity in their processes. The

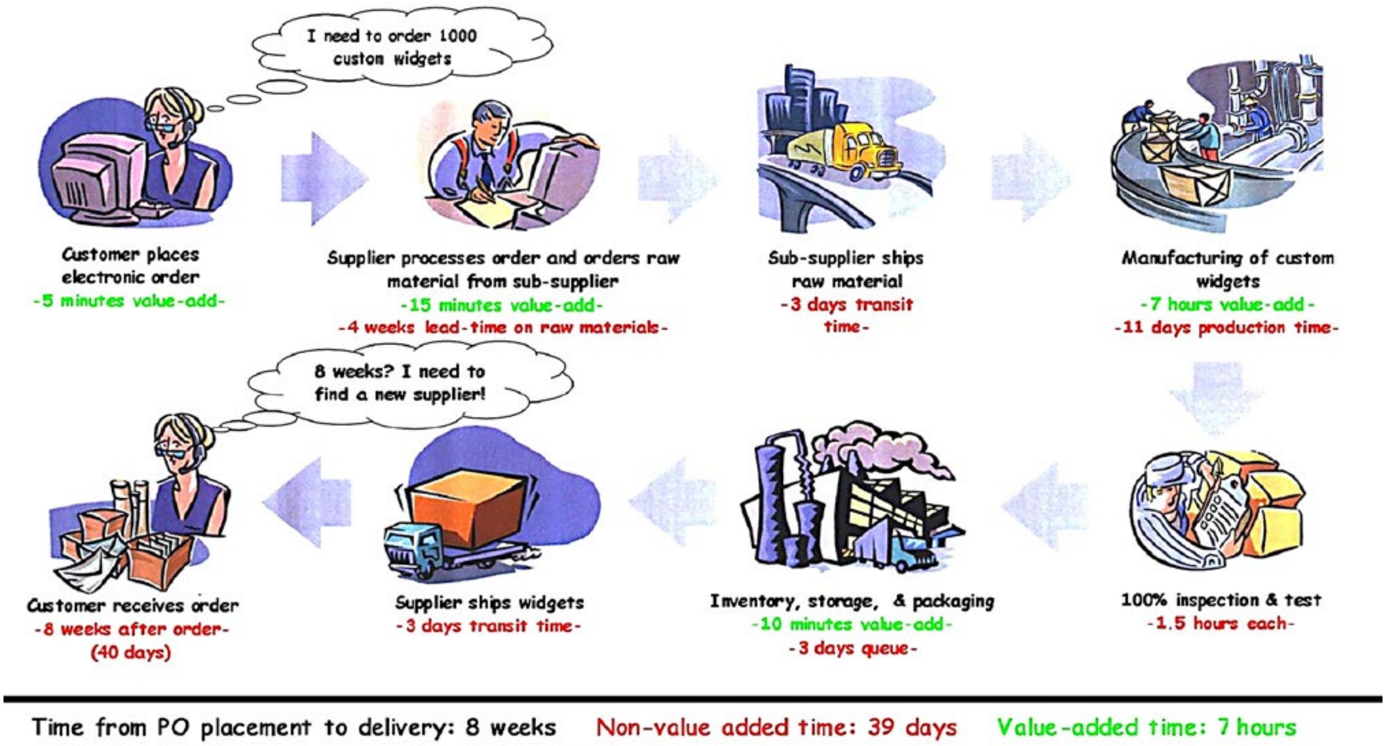

Figure 1: Supply chain cycle.

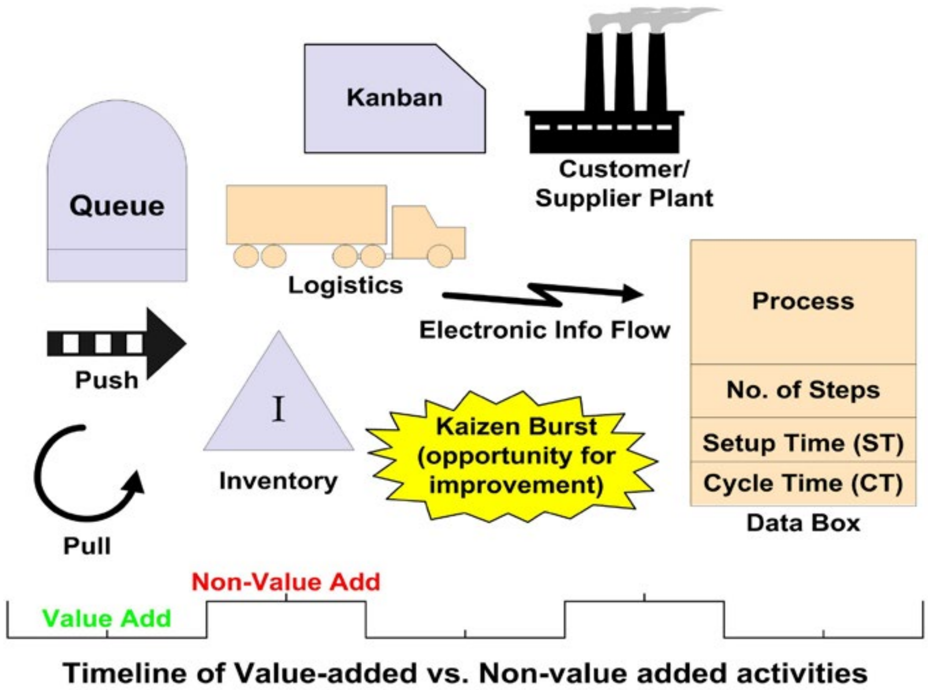

Figure 2: Value stream map symbols.

key takeaway of this scenario is that the excessive lead time has created enough customer dissatisfaction that the business is in jeopardy.

Step 2: Create a Current State Value Stream Map

Now let's turn this diagram into a current state value stream map. The original working session for developing a VSM is very manual, and as I mentioned earlier, is best done on a white board or with Post-it Notes. As the name implies, the goal is to find out how the processing is currently operating today, not how the SOP says things should be or how it was designed to be. The goal is to capture reality onto a piece of paper—the current state. Use a stopwatch for the time studies and determine the actual times where practical. While the VSM will eventually be finalized with software, the initial map should be created with Post-it Notes because there will be frequent changes as the team goes through this process. Once the process has been defined, the Post-it Notes map can be digitized with flowcharting software. Value stream maps use a variety of unique symbols that are not used in traditional flowcharts and diagrams, as shown in Figure 2. Word and Excel can be used for flowcharting, but for ease of use, professional flowcharting software like Visio should be used.

Step 3: Create a Future State Value Stream Map

Once the current state of the process has been established, which by the way, is usually the second "Ah-ha!" moment for the company, the next step is to picture the desired state of the process—the future state. This is the point where waste identified in the current state is targeted for elimination. Find the areas of waste and problem areas and try to eliminate them by looking for low-effort, high-benefit types of activities. Examples of these include:

1. Reducing unnecessary inventory
2. Pulling materials through visual controls
3. Using 5S to make materials and tools available at the point-of-use
4. Eliminating unnecessary step
5. Cross training personnel
6. Standardizing work
7. Reducing setup time
8. Balancing the work flow (Takt time analysis).

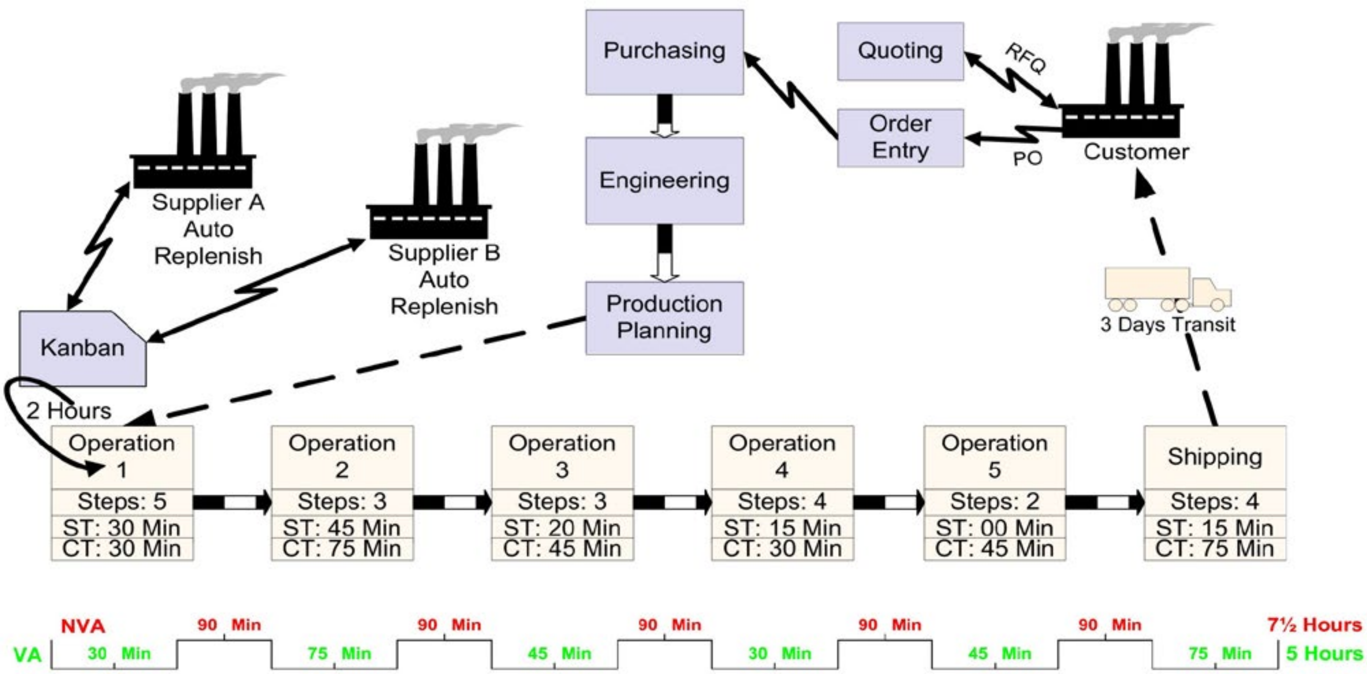

Figure 3: Future state value stream map.

Step 4: Create and Execute an Action Plan

An action plan is the method for transforming the process from its current state to the future state. The action plan for this process resulted in dramatic improvement, ultimately reducing the lead time to the customer from eight weeks to five days. This was accomplished in a number of ways, beginning with the implementation of a Kanban system at the raw material sub-supplier. Waste was minimized in the manufacturing process in three ways:

1. Elimination of inspection by placing quality responsibility at the source
2. Removing queue time by changing the flow from a push, to a pull process, and
3. Reducing the number of steps in each process.

All the results can be found in Figure 4. As the cycle repeats, further improvement could be achieved by implementing a Kanban system at the other end of the process—delivery of product to the customer.

	Current State		Future State
Total LT	8 Weeks	➡	5 Days
MFG Time	17 Days	➡	12 1/2 Hours
NVA	16 Days	➡	7 1/2 Hours
VA	7 Hours	➡	5 Hours

Figure 4: Waste reduction results.

This action plan was accomplished by using a combination of the best practices methodology that will be presented in my November column, Best Practices 101: Part 4. **PCB**

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COLUMN

POINT OF VIEW

Best Practices 101: Part 4

by Steve Williams
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Looking back through the annals of the U.S. PCB industry, when it comes to quality, we have evolved from a reactive, to a proactive mindset. This evolution has led to what is loosely called the zero-defects methodology (ZDM). The old gold standard of three sigma is no longer acceptable and has gone the way of the dinosaur.

Pipe Dream?

Are zero defects an achievable, sustainable goal 100% of the time? Of course not, but with six sigma levels we can come pretty close. Recognizing that we will occasionally fall short of any goal *mandates* that the goal be set at zero defects. The reasons why a zero defect mentality is required can be condensed down to the singular, bottom line principle of reducing costs, and as we all know, it's *always about the dollars*. Costs are always attached to defective product in the form of inspection/test, rework/repair, scrap, and warranty (customer returns). Reducing these costs results in increased customer satisfaction, and quite simply, happy customers mean higher revenue.

It is always an interesting study to compare the advertised capability of a company to its actual capability. The sales force touts world-class quality, which implies that they are operating at a six sigma level. However, an objective on-site assessment of their processes quickly separates the bluster from the facts, typically revealing that most organizations are operating at a true

- 32,000 babies dropped in the delivery room every year
- Unsafe drinking water for 15 minutes each day
- 2 short or long landings at most major airports each day
- 20,000 lost articles of mail per hour
- 5,000 incorrect surgical procedures each week
- 200,000 prescriptions filled incorrectly each year in the US
- 240 defective parts in the average new car
- No electricity for 88 hours every year
- 22,000 checks deducted from the wrong account each hour

Figure 1: Life at 99% Good. (Source: Elusive Lean)

yield somewhere between 93 and 99%—the old three sigma complacency. Statistics are a wonderful tool, but like most things in life, you will only get out of them what you put in. It all boils down to what the organizational objective is; superficial window dressing or honest-to-goodness improvement. Inflating process yields by excluding things like rework, customer waivers, or returns does nothing but mask problems and will not result in true improvement. If window dressing is indeed your goal, then I would suggest tossing this article and immediately picking up a copy of *Extinction for Dummies,* by Peter T. Platypus.

Why 99% is Not Good Enough

I remember the not-too-distant past when a 99% yield rate would earn bragging rights (myself included). Looking at what that really means by today's metrics shows that a 1% scrap rate converts to 10,000 defective parts per million (DPPM). As a customer, imagine a supplier striving to give you only 1% defective parts! World-class six sigma levels allow only 3.4 DPPM. If you are still reading at this point, I would hope that you agree with me that 10,000 DPPM is totally unacceptable and are prepared to do something about it.

(Note: It must be mentioned that the 3.4 DPPM attributed to six sigma levels was developed by Motorola, and based on the assumption that over time, a process is likely to have a shift in the mean of up to +/- 1.5 sigma. This potential shift is factored into the 3.4 DPPM. Statistical purists would argue that a six sigma level is actually .002 DPPM, but since the Motorola interpretation is universally accepted, I use 3.4 DPPM to represent a six sigma level.)

When companies like Motorola and General Electric began communicating six sigma expectations to their suppliers in the early 1980s, what began as a ripple quickly developed into a shockwave throughout the supply chain. To say that this concept was met with some resistance is a monumental understatement. Companies had absolutely no idea how they were going to effect a change of such magnitude that their process defect rate would drop from 10,000 to 3.4 DPPM. Through a slow and painful process, companies began to understand that the way to achieve these quantum paradigm changes was through Lean best practices. The interesting paradox is that none of us would accept 99% in our personal lives, so why do we accept it in our businesses? Figure 1 shows what life would look like if we settled for having things right only 99% of the time in some areas we can all relate to. This kind of changes the perception that 99% is good enough, doesn't it?

Contrast this with a six sigma level in which your local weatherperson's forecast would be correct every single day for 795 years in a row!

What is Six Sigma?

Sigma (σ) is the eighteenth letter in the Greek alphabet, and is defined and used in two different ways:

1) 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, and

2) 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 it; six sigma is the problem solving methodology called DMAIC (define, measure, analyze, improve, control). DMAIC is 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. The key takeaway is that to achieve a six sigma level, process variation must be cut in half from a three sigma level.

This concept will be explained in greater detail in the next issue, Best Practices 101: Part 5. **PCB**

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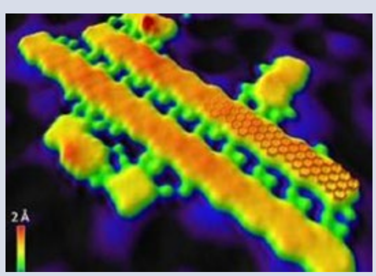
Graphene Nanoribbons to Revolutionize Electronics

Graphene is a two-dimensional material with extraordinary electronic and magnetic properties that can be tailored by cutting large sheets of the material down to ribbons of specific lengths and edge configurations. Scientists have theorized that nanoribbons with zigzag edges are the most magnetic, making them suitable for spintronics applications.

But this "top-down" fabrication approach is not yet practical, because current lithographic techniques for tailoring the ribbons always produce defects.

Now, scientists from UCLA and Tohoku University have discovered a new self-assembly method for producing defect-free graphene nanoribbons with periodic zigzag-edge regions. In this "bottom-up" technique, researchers use a copper substrate's unique properties to change the way the precursor molecules react to one another as they assemble into graphene nanoribbons. This allows the scientists to control the nanoribbons' length, edge configuration and location on the substrate.



This new method is a stepping stone toward the production of self-assembled graphene devices that will vastly improve the performance of data storage circuits, batteries and electronics.

Paul Weiss, a member of UCLA's California NanoSystems Institute, developed the method for producing the nanoribbons with Patrick Han and Taro Hitosugi, professors at the Advanced Institute of Materials Research at Tohoku University in Sendai, Japan. The report appears in the journal ACS Nano.

Best Practices 101, Part 5: Process Capability

by Steve Williams
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Early in my career, a wise old mentor told me, "Steve, never argue about what can be measured." As an engineer by trade and German by lineage, he knew a little about precision craftsmanship. This advice has stuck with me, and in the quest for continuous improvement it has translated into "How can we get better if we don't know where we are now?" followed by "How can we know where we are now without metrics?"

Process Capability

I will try to follow my KISS philosophy and stay away from all the scary math as much as possible, so let's begin by reviewing the fundamentals of statistical process control (SPC). It is important to note at this point that not every process is a good candidate for statistical control, and that in these instances alternate process control methods may be required. The laws of physics dictate that although every single process has variation, once a process is stable, that variation follows a repeatable pattern that is called a *normal distribution*. That means that only some of the product (any process output) will be exactly the same as the process average (mean). It also means that the rest of the product will either be less or greater than the average, and will occur in decreasing frequency the further away from the mean the data stray. If you were to draw this product data set in graphical form, it would take the shape of a bell, which is why a normal distribution is also called a *bell-shaped curve*. Another thing that is known about a normal distribution is that the relationship of the product that falls on either side of the mean is predictable. In other words, the data can be divided into groups based on the distance (deviation) from the mean. The term *standard deviation* is used to describe these groups.

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

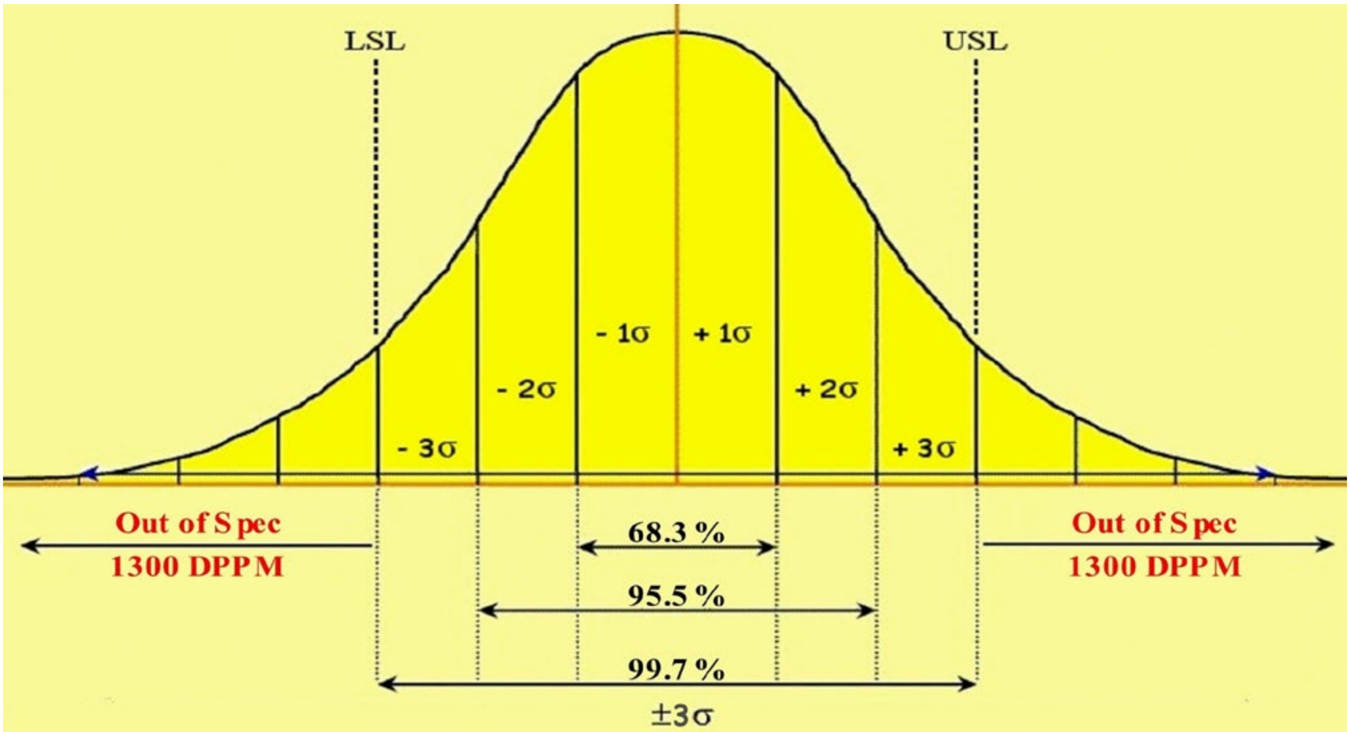

Figure 1: A normal distribution, where 99.7% of variation falls within +/– three standard deviations, or sigma levels.

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. The sigma level represents how many standard deviations, or sigmas, it takes to reach the spec limits on either side of the mean. In other words, in a three sigma process it takes three sigmas to reach the LSL and three sigmas to reach the USL.

Sigma Levels

The sigma level is a difficult concept to understand during the early stages of process improvement, so I will try to simplify this as much as possible. When a process is referred to in sigma terms, it is stating how many sigmas (standard deviations) it takes to reach the specification limits from the mean. Statistical rules state that the amount of variation that falls within each group, or sigma level, is repeatable and can be quantified. It is important to remember that these rules are constant regardless of what sigma level a process is operating under.

Most organizations have not achieved a 99% yield, much less a three-sigma level. As Figure 1 shows, in a normal distribution, 99.7% of the variation will fall within +/– three standard deviations, or sigma levels. While that may appear to be a very good yield on the surface, this translates into 2700 DPPM that will fall outside of the specification limits. The areas outside of the spec limits are called the process *tails,* and again referring to Figure 1, these tails fall outside the spec limits and represent defective product. As we saw earlier in this chapter, a three sigma process results in an awful lot of defective product.

Now let's look at a six sigma process, where it takes six standard deviations, or sigmas, to reach each spec limit. Again, statistical rules state that 99.9997% of the variation will fall

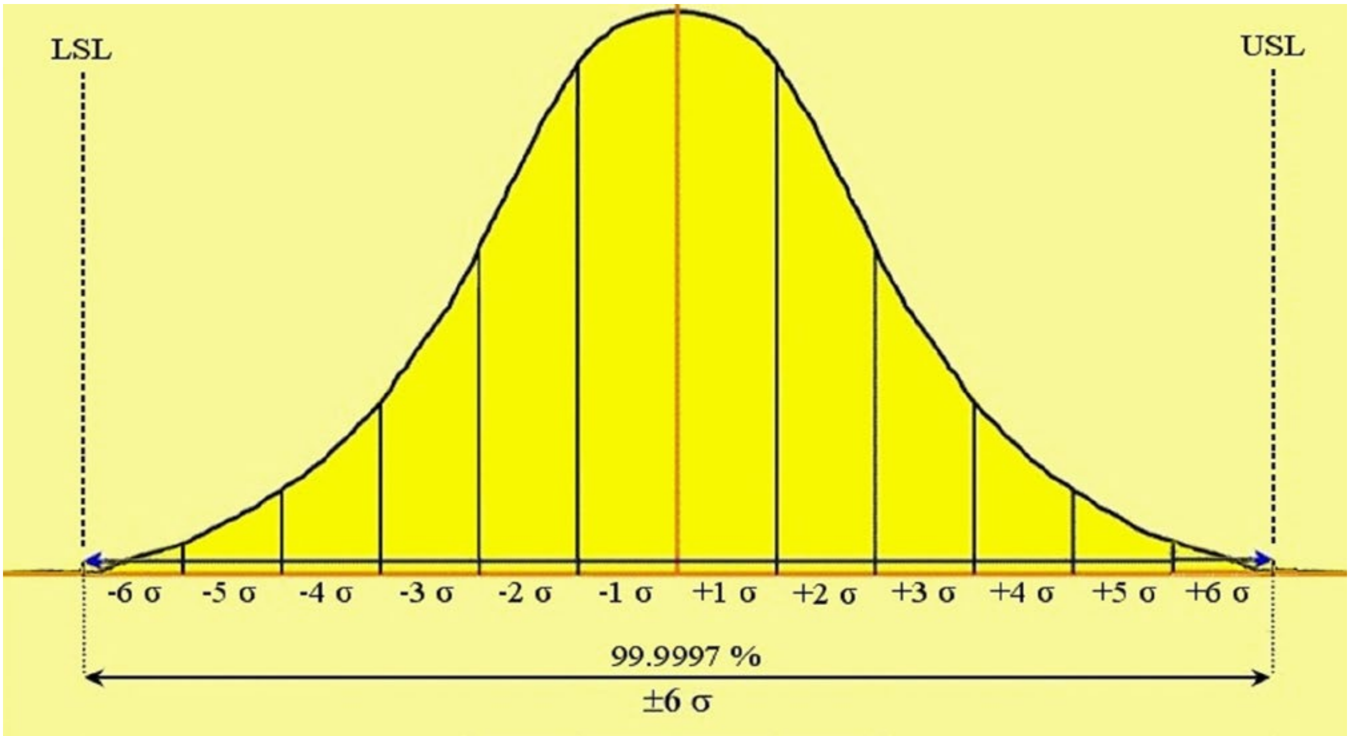

Figure 2: Tails are contained within the spec limits, assuring that virtually no product will be produced out of specifications.

within +/– six standard deviations, or six sigma levels. As Figure 2 indicates, the tails are contained within the spec limits, assuring that virtually no product will be produced out of specifications (3.4 DPPM, or two defects outside each spec limit).

It's OK To Take Baby Steps

The key takeaway here is that improvement should be taken in steps; don't expect to jump from three to six sigma overnight. Sigma levels range from one to six, and legitimate process improvement generally follows a natural progression from the current level up through this range. The first step is to make sure you are at a true three sigma level; most organizations are surprised to learn that they have a lot of work to do to reach this plateau. The next step is to make incremental improvements to begin moving up the sigma ladder. Quantum improvement can be realized by moving up just a single sigma level; remember that the key to success in improvement is to hit singles, not home runs!

Given the zero defect goal discussed here, and the general perception that six sigma levels are unachievable, I thought it appropriate to close with the following quote from the chief engineer of Toyota's first Lexus; a man called the "Michael Jordan of chief engineers":

"Even if the target seems so high as to be unachievable at first glance, if you explain the necessity to all the people involved and insist upon it, everyone will become enthusiastic in the spirit of challenge, will work together, and achieve it." –Ichiro Suzuki, Toyota Motor Corporation **PCB**

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Best Practices 101: Part 6

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Penny Wise and Dollar Foolish

One roadblock to achieving the true benefits of best practices is that traditional improvement efforts have always focused on reducing the time of value-added steps; in other words, reducing the amount of time it takes to do something to a product, or touch time. Let's take a look at a drilling operation for example, where the run time of this operation is 19½ minutes per part. Much effort is placed on fixturing, training, spindle feed and speed, etc., to reduce the run time. While this is obviously an important activity, we fail to attack the greatest opportunity for improvement: eliminating waste from this process. For example, zero effort has been expended to reduce the average two days of queue time this product waits before it can be drilled, the 25 minutes of transportation time to move this order to the next department located at the opposite end of the building, the two weeks added to the product's lead-time waiting for raw material to arrive, or the four days of various inspections throughout the process due to inferior quality and/or process control.

Contrast this to Figure 1, which graphically represents the results of a recent best practices project done by Calumet Electronics Corporation, a company that really gets it. Calumet is a printed circuit manufacturer that could have literally 100 process steps, so travel and motion is a big deal. By focusing on motion waste, this company was able to reduce one department's functional motion by 45%, taking it from 162' down to 88'. Saving seconds at the expense of minutes, hours, days or even weeks is saving a penny where you could be saving a dollar, and as I have said a thousand times before, "It's always about the dollars."

Where Do You Spend Your Money?

Now, let's take a macro look at where companies spend their money in terms of the cost of quality. The cost of quality refers to costs re-

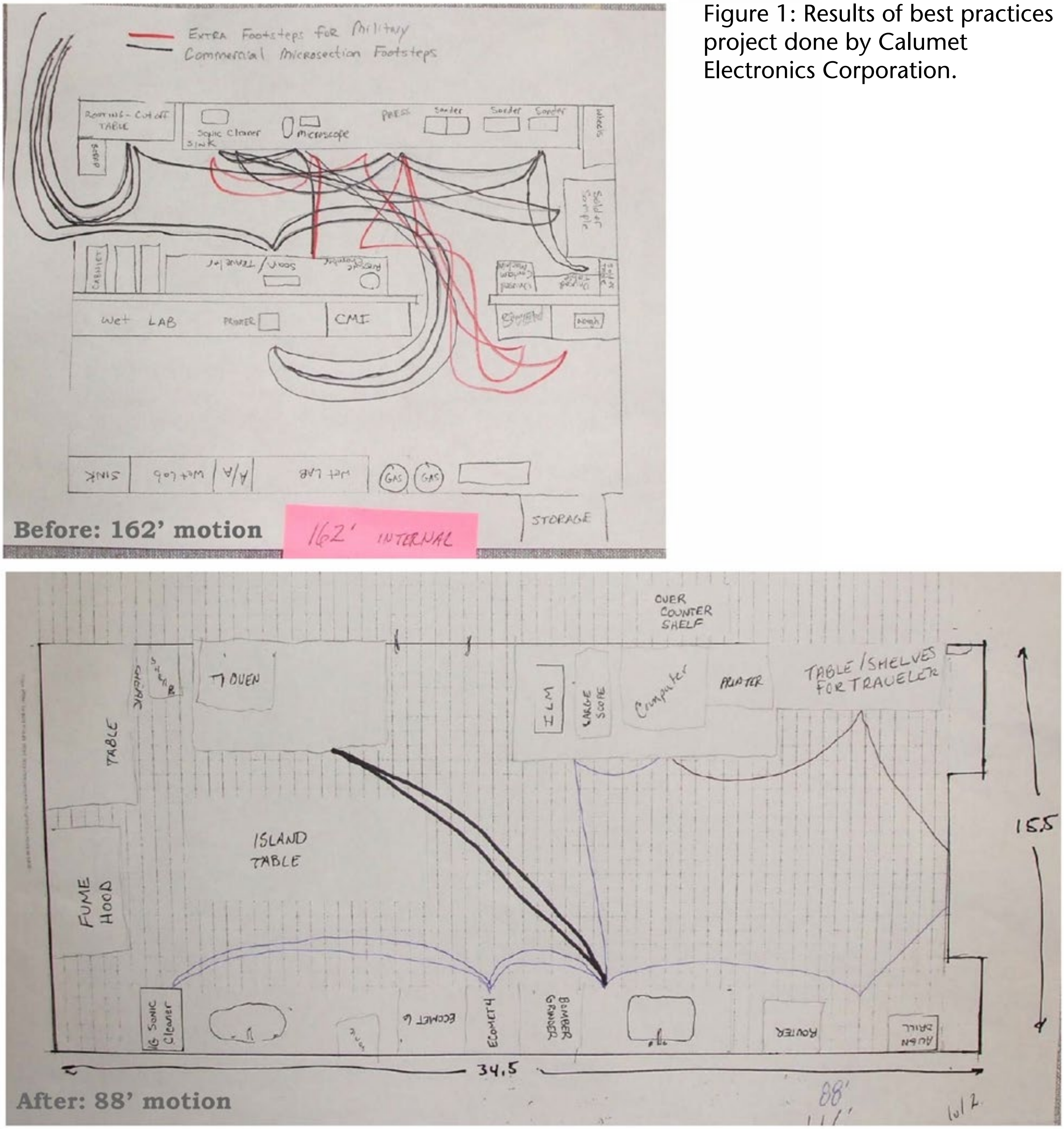

Figure 1: Results of best practices project done by Calumet Electronics Corporation.

lated to prevention, appraisal (inspection), rework, and scrap (customer returns are factored into either rework or scrap). Figure 2 shows the relative distribution of expenditures in a typical company, with the largest portion of expense resulting from bad quality (scrap).

The traditional business will spend about three times the amount of money on appraisal (inspection) than they do on prevention. When you combine appraisal costs with the exponential amount of dollars that are being wasted on rework and scrap, it is clear that this is not an effective model. Now, contrast that with the lean best practice business model. By spending a majority of their expenditures on prevention, appraisal costs can be greatly reduced and re-

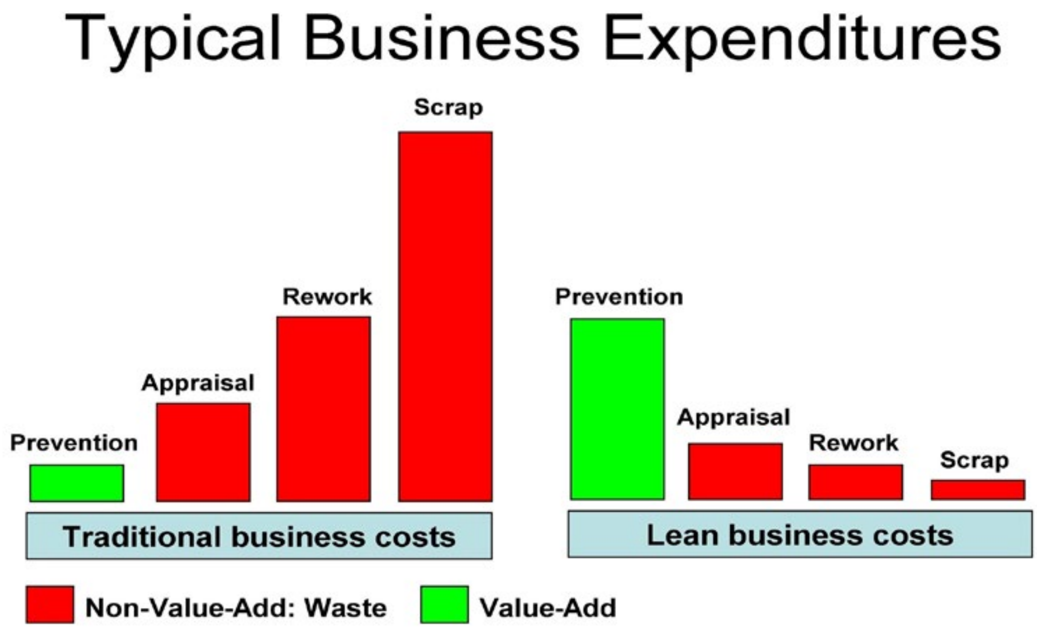

Figure 2: Relative distribution of expenditures of a typical company.

work and scrap are maintained at minimal levels. Not only are the dollars being spent in the right places, consider the order of magnitude of total cost. All the costs in the best practice business model, combined, amount to less than the money a traditional company is wasting in scrap alone. Talk about financial metrics; these savings transfer directly to the bottom line!

Defining Value & Waste

One of the most critical steps in identifying where to improve your process is recognizing non-value (waste) in the process. If we use my simple definition of value, which is "anything the customer is willing to pay for," then waste would be the direct opposite: "anything the customer is not willing to pay for." Value-adding activities are tasks that transform (add value to) the product in some way. This transformation can take the form of either hard changes to the product, or soft changes such as brand vs. private label products. Each step, of each task, of each process needs to be objectively evaluated against these two definitions to successfully identify wastes that can be eliminated.

Ironically, to my earlier point, the actual drilling time that is trying to be reduced is a cost the customer will pay for, while the time wasted in queue, transportation and waiting for raw material (which are not being addressed) are costs that the customer will not pay for.

The following five principles can be used to guide an organization in this evaluation:

1) Define value from the customer perspective
2) Identify the value stream for each product family
3) Make the product flow
4) Create pull to build only what is needed, when it is needed
5) Strive toward excellence

Throughout any best practice activity, it is critical to remain focused on the right things, which are activities that impact improvement of the organization's products or services. **PCB**

Steve Williams is the president of Steve Williams Consulting LLC and the former strategic sourcing manager for Plexus Corp. He is the author of the books, Quality 101 Handbook and Survival Is Not Mandatory: 10 Things Every CEO Should Know About Lean. To read past columns, or to contact Williams, click here.

POINT OF VIEW

Best Practices 101: Part 7

by Steve Williams
STEVE WILLIAMS CONSULTING LLC

Management by Walking Around

Tom Peters, author of the "Excellence" series of books and one of my favorite management visionaries, coined the phrase MBWA (Management by Walking Around). This is another concept that seems so obvious, but how many of us actually do this? This is a rhetorical question, of course, 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 more along the lines of, 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!

Gemba

Peters was on to something with his MBWA; in fact, the Japanese have a similar term for this, and that is "gemba." Roughly translated as "the real place," gemba means getting off your butt and going to see where the work is actually being done. Like many Lean buzzwords such as kaizen, gemba has transitioned from obscure to ubiquitous across our industry. I love gemba, but like anything worthwhile, you get out of it what you put into it. Gemba demands a few things from the user to be successful.

First, it requires a deep curiosity to know what is really going on in your organization. Not what you think is going on, or what you heard is going on, but what is actually going on. Next, gemba demands a skill set that includes the ability to actively observe and understand the work that's being done. While this may seem obvious, doing a drive-by surface observation won't accomplish anything, and may actually do some damage by providing a false sense of process well-being. The last demand is per-

haps the most important: an inherent respect for the people actually doing the work. These are your process experts that have the practical experience and tribal knowledge of the process. Gemba walks need to be approached from a place of mutual respect and overriding desire to make things better, faster, cheaper, easier, etc. Gemba means going to where the work is being done and engaging the people directly, not assuming you have solved all the problems from your office.

The Gemba Walk

The gemba walk provides company leaders, managers and supervisors a simple, easy means of supporting overall continuous improvement while directly engaging with the folks responsible for the key business processes. The best approach to a gemba walk is to start at the last process and work upstream. Why? This will highlight how well your process is operating from a high level in terms of pull vs. push, bottlenecks, inventory and other production control issues. Depending on the level of personnel participating and/or circumstances, gemba walks can be daily, weekly or monthly. Another suggestion is to focus on a different aspect (theme) for each gemba walk. For example, one day might focus on 5S in the facility; another may be on WIP inventory, etc. It is important to limit the focus because if you look for everything, you will accomplish nothing!

Instituting regular gemba walks into the culture will consistently demonstrate to employees a leadership commitment, alignment and support of the continuous improvement process. There are a couple of keys to a successful gemba walk, such as active and attentive listening, sharing what you learned during the gemba walk with the entire organization, discussing with department leaders conditions observed, and following up/monitoring the process where necessary.

What the Gemba Walk is Not

A gemba walk is not an opportunity to point fingers and find fault in employees while they are being observed. It is not punitive; employees will shut down and not openly engage at the first whiff of this. It is not a time to be the policy police; internal audits or other tools are appropriate for this. Finally, a gemba walk is not the time to solve; it is a time of observation, input and reflection. That does not mean disregarding operator ideas for improvements, but rather to physically go and see what is really happening. Any ideas or complaints should be noted and followed-up with after the walk. Be mindful not

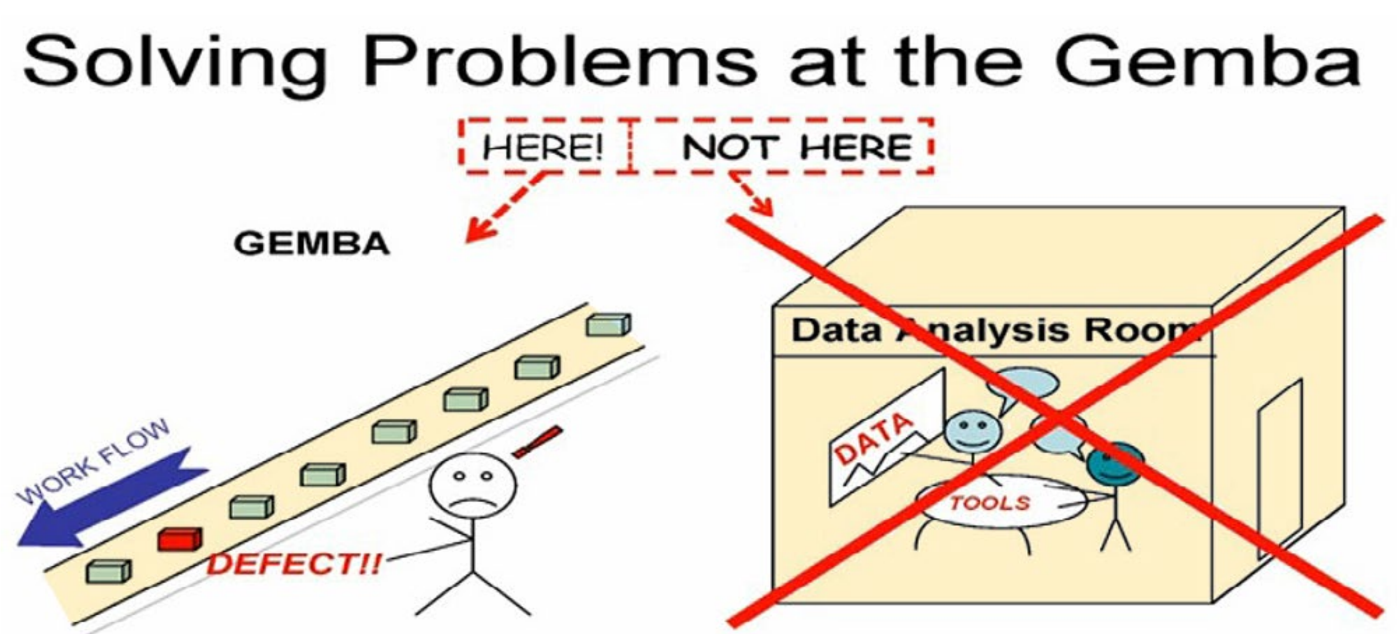

Figure 1.

to “miss the forest because of the trees,” as the saying goes.

Visual Management

I am a big fan of meaningful visual management everywhere possible to keep employees engaged, informed and foster a culture of ownership. Noticed my emphasis of the word “meaningful” when talking about visual management; what I mean by this is avoiding at all costs a wallpaper strategy of posting gratuitous charts, graphs, reports, etc., on walls to impress customers. The gemba walk provides a great opportunity to notice and question posted measures and charts and ask the following questions:

- What is this chart telling me?
- Who is responsible for updating them?
- Do the employees look at the charts? How often?
- What value do the charts have for employees?
- Do customers and/or suppliers ever look at the charts?
- Do the charts have an overall effect on operations?

The key to any process improvement is to question everything; do not just accept the status quo. Whether you manage by walking around, engage in gemba walks, or utilize some other method of going to where the work is done, the key is to get out of your office and go and see. **PCB**

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VIDEO INTERVIEW

Five Keys for Success in PCB Manufacturing

by Real Time with... IPC APEX EXPO 2015

All Flex VP of Sales and Marketing, Dave Becker, tells Kelly Dack, “It’s not about the technology.” He discusses the five core values that are part of the culture at All Flex, and as a final point, Becker explains how “culture beats strategy.”

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Best Practices 101, Part 8: Poka-Yoke

by Steve Williams
STEVE WILLIAMS CONSULTING LLC

One day, Shigeo Shingo was explaining baka-yoke, or foolproofing devices, created and implemented by workers on the Arakawa Body Company factory floor. A young woman started to cry. "Why are you crying?" Shingo 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 devices.

— from The Kaizen/Kaikuku Life

Poka-Yoke

Literally translated as mistake-proofing, poka-yoke is commonly pronounced a number of ways, but the Japanese pronounce it poh-kah yo-kay. So what is poka-yoke? It is a method that uses fixtures, tooling, sensors or other devices to eliminate, or design out, the errors within a process.

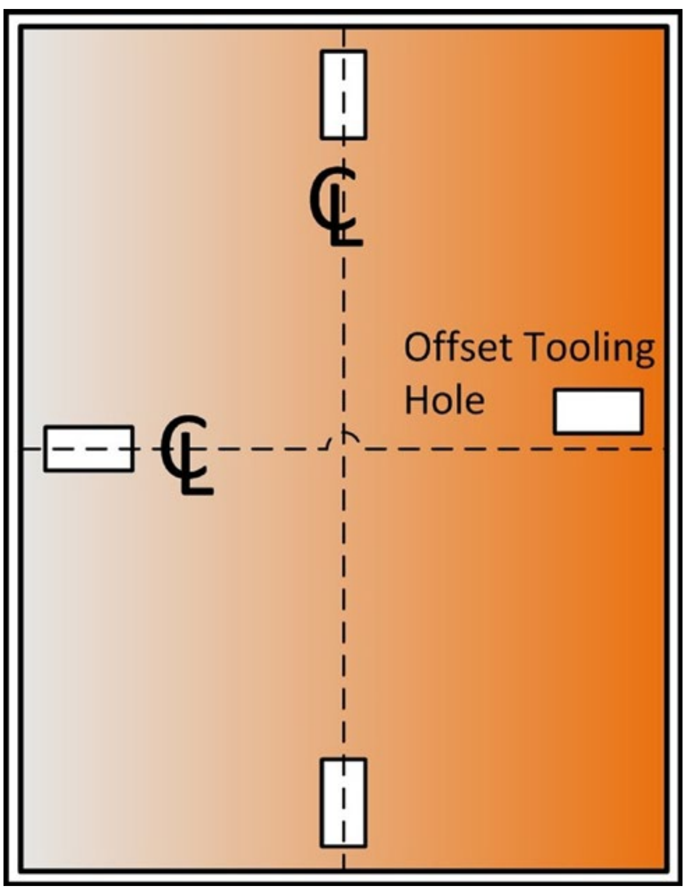

Figure 1: PCB offset tooling poka-yoke.

Cost of Quality

Poka-yoke is important because of its purpose: to reduce the cost of quality, or more accurately stated, the cost of poor quality. The cost of quality is comprised of all the costs that relate to poor quality. As I have discussed before, the Four "Rs" are the major components of the cost of quality: repairs, rework, rejects, and returns. Each of these components can be reduced, if not eliminated, by implementing an effective poka-yoke solution.

Defects and Process Variation

What causes defects? The answer is process variation, which begs the question, what causes process variation? Here are the 'big five' reasons for process variation:

1. Poor procedures
2. Equipment
3. Non-conforming material
4. Tooling, fixtures, jigs, etc.
5. Human mistakes

Except for human mistakes, these conditions can be predicted and addressed with corrective action to eliminate the cause of defects.

Poka-yoke detects process variation and shuts down the process before it produces an error. Poka-yoke will catch the errors before a defective part is manufactured 100% of the time. Poka-yoke focuses on the process, not on after-the-fact finger pointing.

Types of Poka-Yoke Systems

There are two basic systems for poka-yoking a process: the control system and the warning system.

Control System: This takes the human element totally out of the equation. This is as close as you can come to bullet-proofing a process. These solutions truly design out the potential for producing an error or defect. A common example that everyone can relate to is the polarized plug on electrical devices. One blade is wider than the other, which matches up with a corresponding polarized outlet. This effectively makes it impossible, short of damaging the outlet, to place the plug into the outlet incorrectly. Figure 1 shows an example specific to the printed circuit manufacturing industry: the four-slot offset tooling system which makes it impossible for an operator to place a panel onto a machine incorrectly.

As a side note, it is interesting to once again observe the generational impact that technology has had on us all. In my university classes, I often use the 5-¼ inch floppy disk as an example of a product that has been poka-yoked. With the proliferation of CD/DVD burning and jump drives, I am still surprised at the number of deer-in-the- headlight looks from traditional students (students right out of high school) when I mention a floppy disk. (By the way, the clipped upper right corner assures that the disk can only be inserted one way.)

Warning System: Sometimes an automatic shutoff is not a viable option, so warning systems are implemented. Lights, buzzers, beeps, messages, etc., can be utilized to alert the operator of a potentially undesirable condition. As you might imagine, the warning system is not as bullet-proof as the control system; it requires the operator to take some action in response to the warning. A perfect example would be your vehicle, which is loaded with bells and whistles to alert the driver when some action is needed. Remember that a good poka-yoke removes the human element. The flaw in this system is, for example, that when the oil light goes off, there is nothing forcing the driver to get the oil changed. Though not as robust as the control system, it certainly is the next best option in cases like this where shutting down the process is not feasible (you wouldn't want your vehicle to shut down every time a warning light goes off).

The following are some common error-proofing devices within these systems that can be used to poka-yoke your process. Check lists, dowel and locating pins, error & alarm detectors, limit or touch switches, detectors/readers/meters/and counters, non-symmetrical tooling/fixturing.

When to Use

Poka-yoke can be used wherever something can go wrong (basically anywhere a human is involved). It is a a tool that can be applied to any type of process be it in manufacturing or the service industry. Numerous error types are perfect for a poka-yoke solution, including:

- Processing error: Operations or tasks missed or not performed
- Setup error: Using the wrong tooling or improper machine settings
- Missing part(s): Not all parts included in the lamination, plating or other processes
- Improper part/item: Wrong part or revision used in the process
- Operations error: Carrying out an operation incorrectly
- Measurement error: Errors in inspection, test or dimensions of a part, either internally or from a supplier

The Three Rules of Poka-Yoke

1. Don't wait for the perfect poka-yoke. Do it now!
2. If your poka-yoke idea has better than a 50% chance to succeed…Do it!
3. Do it now…improve it later!

Following these three rules will give you an excellent chance of success as you look to poka-yoke your process. PCB

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