

# Lean Production with Work Process Management

Enabling Standard Work to Increase Cost Savings  
and Maintain Lean Momentum

“When there is no standard, there can be no kaizen.”

Taiichi Ohno

*Father of Toyota Production System and Lean Manufacturing*



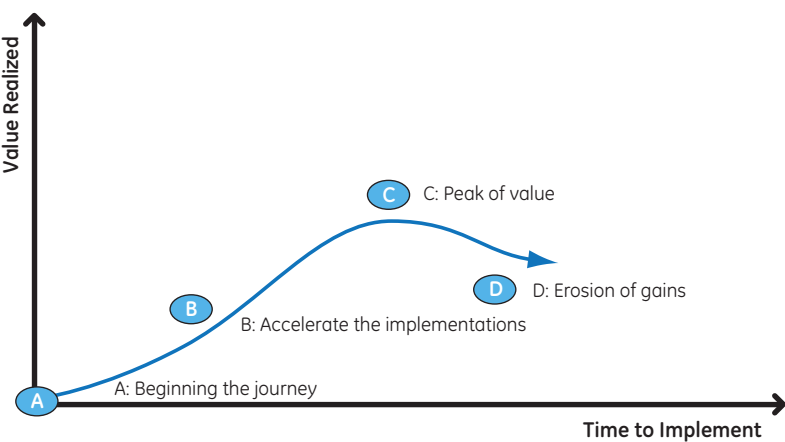
Many times in the lean journey, teams move through a methodology on projects, deliver improvements and move on to the next project. Six Sigma gives us the Control phase to maintain changes for improvements, but even with that, it can be difficult to keep delivering benefits because the Control phase itself can break down. Once momentum gets lost on the project, people can revert back to their former processes that include waste—or teams may need to make necessary changes and inadvertently add waste back into processes.

By maintaining automated control over a process with Work Process Management, companies can have a much better chance of reducing waste for the longer term. Standard work processes become embedded into the Work Process Management system, which can take lean initiatives to the next level. With true standard work and an electronic environment for Kaizen, momentum always remains high, waste is eliminated, work processes are monitored—and the gains grow year after year.

### Enabling Lean and Lean Six Sigma

Many lean initiatives start by looking at manual processes and defining them. Often, this exercise is the first time that a process is defined, documented and analyzed. Right away, teams can see benefits from this exercise as obvious areas of waste can be immediately eliminated. The exercise takes time, as it is a manual process, but can be worthwhile because it drives good benefit.

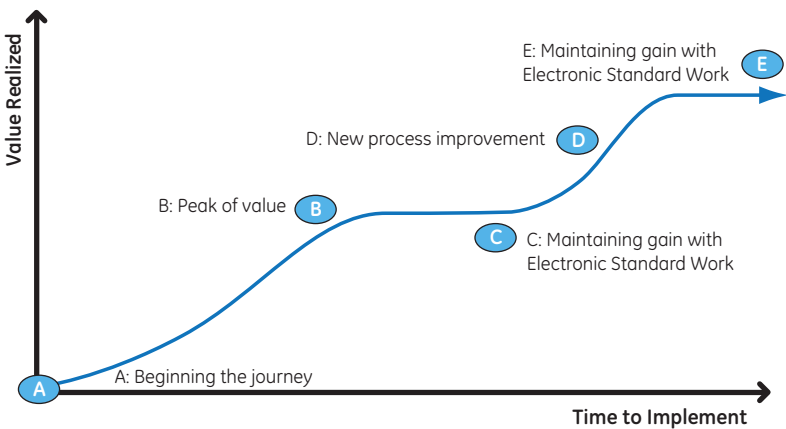
As teams continue along the lean journey, they start to roll out processes more broadly and develop spreadsheets to help execute processes and report on them. However, process modifications start to peak, and eventually teams see erosion begin to take place, as shown in **Figure 1**. People can go back to their old way of performing tasks without new processes being enforced. The value realized starts to decline, and leadership may move on to another type of improvement initiative.



**Figure 1** Typical Lean Implementation Cycle  
In the lean implementation lifecycle, process modifications start to peak, and eventually teams can see erosion begin to take place, as people can go back to their old way of performing tasks without new processes being enforced.

However, as shown in **Figure 2**, the lifecycle of lean projects and initiatives can continue to deliver value for the long term through Electronic Standard Work—digitized processes and Work Process Management, also called industrial Business Process Management or iBPM. Work Process Management supports lean and lean Six Sigma efforts in the following ways:

- Graphically define and document work processes—making it much easier to start the lean journey
- Find and eliminate the non-value add activities more quickly and easily
- Execute work processes through a controlled, electronic system—ensuring that processes are followed
- Improve processes in real time—not “after the fact”
- Automatically capture, store and analyze production data—closing the loop for continuous improvement
- Digitize the control plan and its execution
- Keep process improvements consistent, so projects keep adding value



**Figure 2** Lean Implementation Cycle With Electronic Standard Work  
The lifecycle of lean projects and initiatives can continue to deliver value for the long term through Electronic Standard Work—digitized processes and Work Process Management.



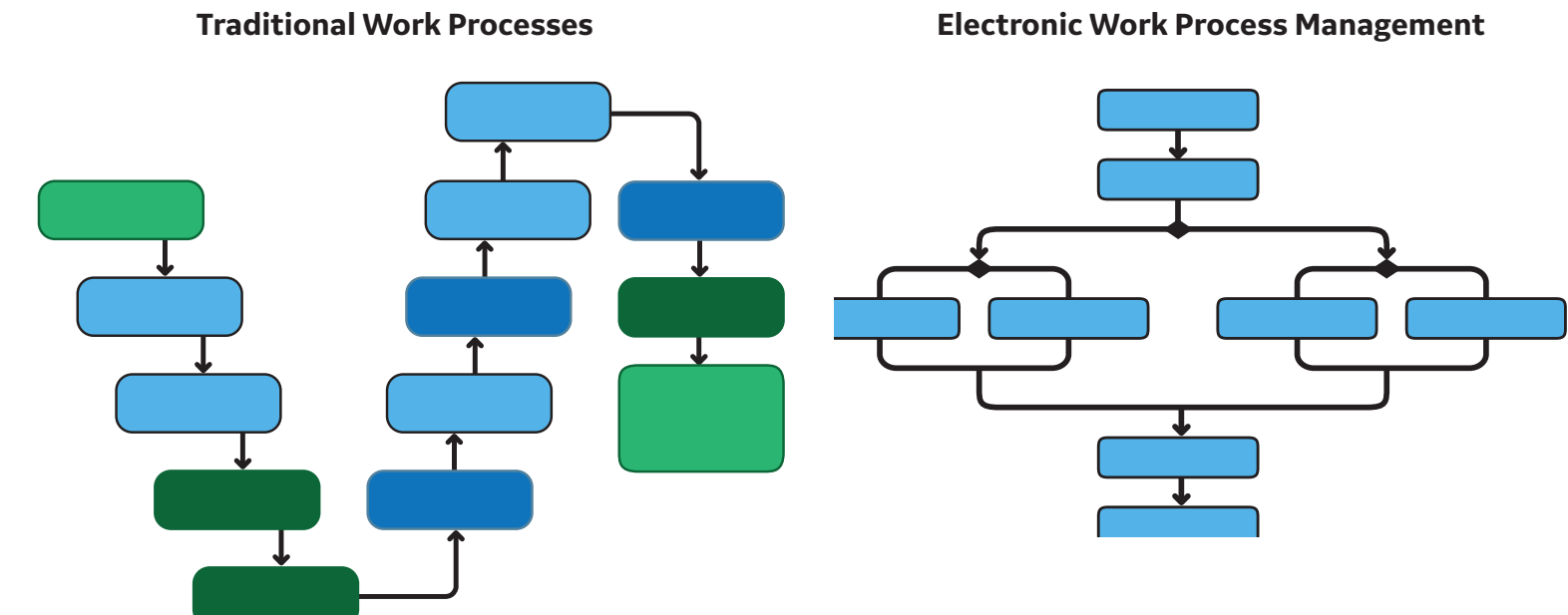
## Digitizing Work Processes to Eliminate Waste

Digitizing—or electronically defining and executing—production processes significantly impacts the value realized and time to implement. Value realized will increase, and time to implement will decrease. With Work Process Management, teams have a chance to sustain long-term lean improvement and consistency of processes.

In support of this idea, let's look at the experiences of a major Tier 1 automotive supplier. A vice president at this manufacturer has implemented between 70-80 lean Six Sigma rollouts. He states, "You can lean without software, but it will take about seven years. With software, you can do it in three years and prevent gains from slipping away." In other words, by leaning with some type of digitization, companies can boost the velocity and sustainability of improvement processes.

As an example, teams can look at processes graphically and more easily find areas of non-value add. The electronic workflow graphically displays all steps in the process, and teams can easily analyze steps that can be removed and steps that could be performed in parallel, as shown in **Figure 3**.

Digitization also helps teams put in place and define real-time Critical to Quality (CTQ) and Critical to Process (CTP) measures. Using Work Process Management, you can set up a system that notifies certain people or takes corrective action when CTQ values are exceeded. Furthermore, the system records values associated with CTQs and CTPs, so historical data is always on hand to support the improvement process.



**Figure 3** Eliminating Steps and Performing Steps in Parallel  
The electronic workflow, as shown on the right side of the illustration, graphically displays all steps in the process, and teams can easily analyze steps that can be removed and steps that could be performed in parallel.



### Evolving Work Processes

In any organization, there are three categories of processes and policies, organized in a hierarchy.

- **All the Processes:** This category represents the set of all processes and policies within the enterprise. Every single task within an enterprise is carried out in the context of a “process.” Processes can be ad hoc or undocumented, very short or one-time instances—but still a process. Most of the processes today are not documented or are documented in policy and procedure manuals. Also, many processes and business rules are embedded within application programming code or in some cases, only with an individual.
- **Modeled processes:** As a subset of all processes, the second category contains modeled processes, when you have a formal or semi-formal representation of the process or policy in a repository. This includes flowcharts, as an example. While the process is still static in this category, the organization has taken the time to graphically document it.
- **Automated processes:** The most important category—and the one to strive for—is the automated and executing processes. This category takes the repository of models and adds electronic execution for agility and continuous process improvement. To achieve continuous improvement, this smallest subset of processes must grow. In fact, the differentiations between modeled and automated/executing processes should disappear as more and more ad-hoc, undocumented, legacy embedded or documented processes move toward automation and digitization. Once digitized and automated, organizations can achieve consistency in execution and a way to record performance in process, so they can continue on the improvement cycle.

### Defining, Complying With and Improving Standard Work

Work Process Management digitizes both automated and manual processes, which are mixed in most production environments. In many cases, the processes within an organization are not documented—or if they are documented, the information is located in a policy and procedure manual that is on a shelf, static and rarely looked at.

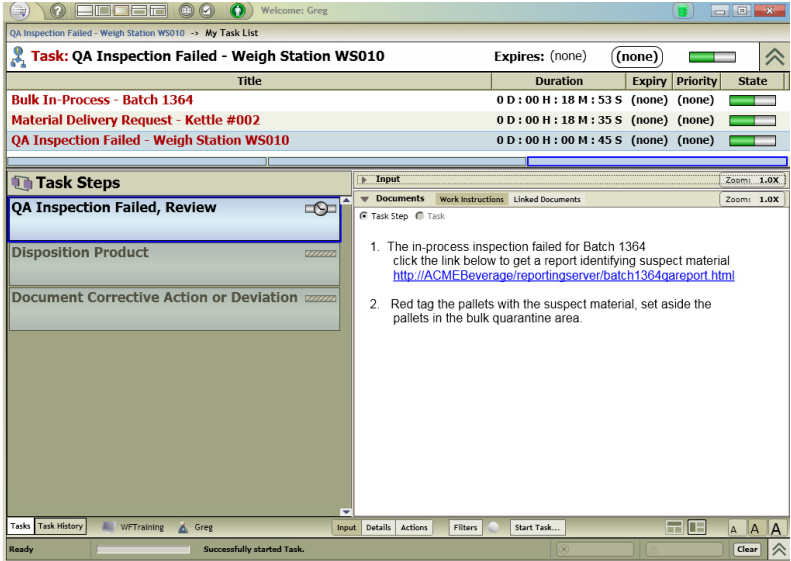
Perhaps its greatest value to lean, Work Process Management makes it much easier for organizations to define and enforce standard work. As stated by Taiichi Ohno of Toyota Motor Corporation and father of Lean Manufacturing, “When there is no standard, there can be no kaizen.” Standard work is the foundation of lean and continuous improvement. Without standard work, gains can too easily become lost.

There are many philosophies on how to encourage managers—and subsequently operators and other line staff—on ways to maintain standard work once it is put in place. But, in the end, processes that are not enforced slip outside of the standard. Therefore, there needs to be an automated way to maintain improvements.

While manual tools can require a great amount of time, which takes away from the lean effort, standard work can be incorporated right into a Work Process Management software system, providing a way to:

- Create standard work instructions
- Deliver standard work instructions to operators as they perform tasks
- Capture completion of standard work steps
- Analyze performance to identify best practices
- Easily modify standard work instructions and disseminate for approvals and automatic implementation

Work Process Management offers a closed-loop system for creating, deploying, analyzing, improving and redeploying standard work. With an easy-to-use system, teams have less frustration and backsliding as opposed to that experienced with poor tools such as stopwatches and clipboards. Work Process Management reduces mundane work and frees people to focus on core tasks and true continuous improvement of them.



**Figure 4** Work Process Management – Task Client  
An operator on the plant floor would view a screen with a set of assigned tasks. The system includes the standard work instructions associated with the steps and any manual data entry.

As shown in the example in **Figure 4**, in addition to viewing a screen with a set of assigned tasks, operators can easily view the standard work instructions associated with the steps and any manual data entry. Additionally, operators can easily access any documentation that would help with the process, such as equipment manuals. The system records operator and equipment performance for analysis and compliance documentation.

While the Work Process Management system monitors and manages execution of standard work, supervisors can also navigate the system's higher-level views. Supervisors can view all of the workflows running within the system, assess performance, determine and deploy a new best practice as standard work, generate reports, and more.

A Work Process Management system can also help during an Action Work Out. During the work out, teams can not only make decisions to improve processes and eliminate waste – but can actually implement right away. Power users who are production domain experts often can make changes immediately to work processes, rather than waiting for and requiring assistance from IT. This speeds the results of the Action Work Out and keeps momentum high.

In addition to helping teams drive lean initiatives, Work Process Management also helps enable Six Sigma, reducing defects and controlling variation.

## Driving Six Sigma With Digitization

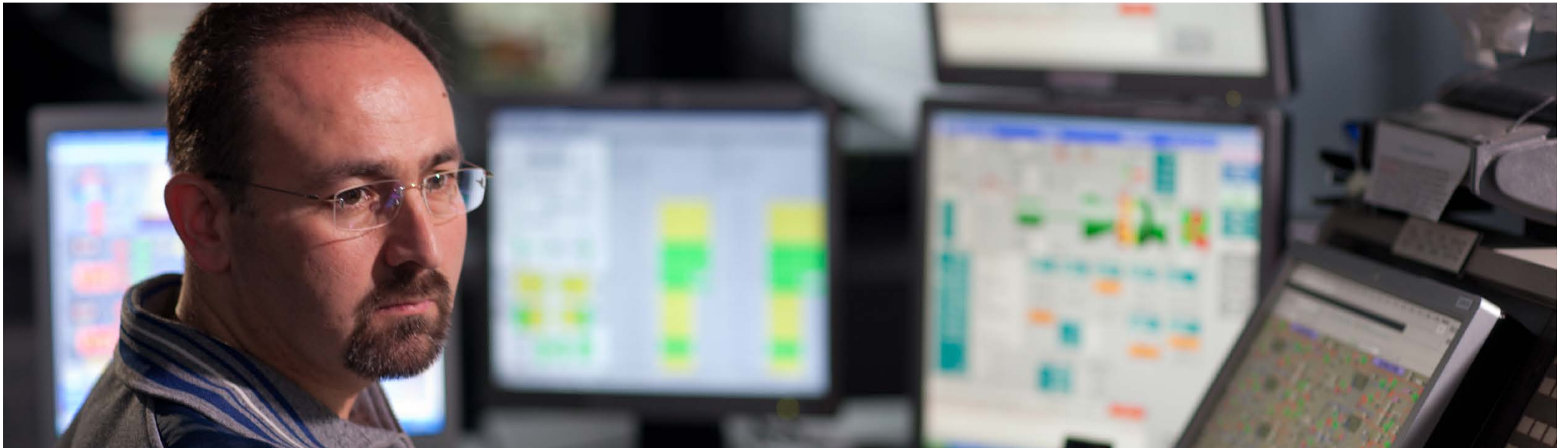
Work Process Management can help satisfy each of the five process steps within DMAIC—combining real-time data with Six Sigma tools. Teams can digitize work rules and processes that directly capture the CTQ and CTP measures and their relationships through:  $Y = f(X1, X2, ..., Xn)$ . These expressions can be mapped directly into a Work Process Management data repository for real-time data values.

For example, in a production process, you could have a Y that represents a queue time. This Y is expressed as:  
 $QueueTime = NextTaskStart - TaskCompleted$

With the execution of workflows or business process rules in the system, organizations can feed data into CTQ expressions and use that data for execution and exception management.

**Define** In the Define phase of DMAIC or DMADV, teams define the “as-is” and “to-be” process maps. A Work Process Management tool can greatly speed the diagramming and mapping of processes – and also helps teams move quickly into the next phase of Six Sigma. Additionally, teams can build templates within the software, which allows for building a process and applying it repeatedly in different production situations. The workflow template can have inputs and outputs, allowing it to be easily applied in many areas. This ability to create templates saves time and increases quality with repetition of correct process maps and work processes.

**Measure** During the Measure phase, teams typically develop a plan to collect data for analyzing capabilities. With Work Process Management, once processes are graphically defined and automated, there is no need in most cases for a separate data collection plan, as all relevant data will be readily available. The system is collecting data as production is executing.





For example, the Work Process Management system manages all of the data, the task allocation, the attachments, etc. There is no incremental work needed to gather the data. In addition, all the CTQ and CTP measures are built in, collected and historically recorded.

**Analyze** During the Analyze stage, teams need to analyze the process capability and identify sources of variations. This is typically accomplished with the help of a statistical package such as Minitab. A Work Process Management system can provide ad-hoc reporting to generate the process instance data needed for analysis. This data can then be exported to Excel or directly to Minitab for analysis. Another alternative is to directly connect to the process data repository through SQL/JDBC queries.

**Improve** A Work Process Management system can greatly enhance the results of the Improve phase. Traditionally, teams using DMAIC make changes using “after the fact” data, and there is a lag in the timing of improvement. With processes digitized and automated, the improvement of the process can be controlled in real time. Teams can designate escalation rules to specific task assignments. The escalation rules can specify, for example, that if a task assignment reaches within 25% of the CTQ upper specification limit, the system will immediately inform the managers or re-assign the task to another participant. Thus, since all the Y’s and X’s of the process are properties, the system associates rules that can trigger events if the values of CTQs or CTPs are getting close to their upper or lower limits. This means that teams can potentially avoid exceptions and increase the performance of processes in real time.

Additionally, real-time support is not limited to “production rules.” Other areas where a Work Process Management system can provide real-time support for Six Sigma processes include:

- **Corrective Actions:** These workflows could be triggered dynamically during the execution of a work process. For instance, in an in-process quality check, if measurements are out of spec, a corrective action workflow is triggered, allowing correction action to be taken immediately.
- **Events activated whenever there is a change in the state of the process or in any of the process properties (the Y’s or X’s):** For example, if an OEE value for a unit of equipment falls below a specific target, the system can trigger a workflow to determine the problems with the process.
- **System Workflows:** Teams can use system workflows to monitor processes and automatically take action—such as escalating a work item to another party, sending notification or raising the item’s urgency—or make changes to process instance properties.

**Control** Work Process Management automates the Control plan within DMAIC. Given that work processes are now digitized, any improvements to them will remain consistent from that point forward.

In a manual process, teams go through the first four phases, make improvements, and have visibility within the organization regarding the improvements. Eventually, however, projects can lose momentum, and the new processes or improvements can break down. By automating the control plan and control process, the project stays alive. Teams can have workflows that enforce consistent execution of the processes and have a system that generates reports related to the control plan. Improvements remain in place, focus stays on the benefits, and visibility and commitment stay high within the organization for continuing the initiative.

Additionally, a Work Process Management system can allow later versions of the processes to be maintained, referenced, and sometimes activated again.

The combination of digitized processes and an event system can ensure that work processes do not revert back to their former state of poor performance—and that gains remain high for the long term.

For more information on Work Process Management from GE Digital, visit [www.ge.com/digital/products/workflow](http://www.ge.com/digital/products/workflow).



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## Lean Six Sigma Glossary

**5S** Building Blocks for shop floor discipline and control; Sort, Sweep, Standardize, Self Discipline, Sustain.

**Action Workout** (Kaizen) A 3-5 day event with the teams focused on taking action and making changes quickly. Solving problems empirically, through physical simulation, observation and iteration.

**Andon** A visual device, usually a specialized light that operators use to call attention to an abnormality. The use of this is to request immediate attention and action to the problem.

**Automation** The use of machines working independently of or in conjunction with manpower.

**Autonomation** The process of separating the work of people and machines characterized by: work not movement, quality built into the process and visual management. (see Jidoka)

**Black Belt** A process improvement project team leader who is trained and certified in Six Sigma methodology and tools and who is responsible for successful project execution.

**Capability Index** A mathematical calculation used to compare the process variation to a specification. Examples are Cp, Cpk, Pp, PpK, Zst, and Zlt. General Electric uses Zst and Zlt as the common communication language on process capability.

**Cell** The optimal physical layout of machines and manpower.

**Chaku-Chaku** A method of conducting single-piece flow in which the operator proceeds from machine to machine (in a counter-clockwise fashion), taking a part from the previous operation and loading it in the next machine. Then taking the part just removed from that machine, checking it and loading it into the following machine, etc.

**Champion** An executive level business leader who facilitates the leadership, implementation and deployment of Six Sigma philosophies.

**Critical to Quality (CTQ)** A drawing characteristic determined to be important for variability reduction based on a requirement

from production, engineering, customer application, or regulatory agency. Can also apply to transactional or service delivery processes.

**Cycle Time** The total time required for a task to be complete. Cycle time is process specific, and many cycle times will exist within an overall lead time of making a product.

**Defects per Million Opportunities (DPMO)** Quality metric used in the Six Sigma process, calculated by the number of defects observed divided by the number of opportunities for defects normalized to one million units.

**DMADV** Define-Measure-Analyze-Design-Verify – the Six Sigma methodology used to create new product or process designs.

**DMAIC** Define-Measure-Analyze-Improve-Control – the Six Sigma methodology used to improve an existing business process.

**Flow** Work done simultaneous to or in conjunction with transportation or conveyance. e.g., (1) an assembly is moving down a line while a person is performing work, (2) a person acts as a conveyor carrying a part to the next machine in a Chaku-chaku fashion. The main purpose of flow is to quickly and continuously identify and eliminate waste.

**Heijunka** The process of level loading and sequencing the timing of customer demand for products or services.

**Jidoka** (Autonomation) One of the three main principles of Lean, it has two main elements: (1) Stopping the process when an abnormality has been detected; (2) Building “human intelligence” into machines or software, giving automation the ability to make a decision to shut down automatically in the case of an abnormality in order to stop defective products from flowing into the next process.

**JIT** (Just in time) One of the three main principles of Lean, it is the philosophy of production characterized by three elements; each must be present to ensure JIT functions properly. (1) single piece flow, (2) producing according to TAKT time, (3) pulling of material from upstream process.

**Kaizen** “Change for the better” or “Continuous Improvement.” A hands-on process of short duration to develop iterative solutions, with each iteration an improvement on the last.

**Kanban** A method/device of pulling from previous processes in order to control material flow, cap inventory levels and to take “pulse” of the customer.

**Kitting** Grouping component parts used in a process or build. (see Material Presentation)

**Lead Time** The total time it takes the product to go from raw inventory to the finished product. Order to remittance lead time refers to the total time from when an order is placed until the finished product is shipped.

**Material Presentation** Introducing material to the line or cell in a manner that is easy and effective for the operator.

**MUDA** Any type of waste elements that add no value to the product – Waiting, Transporting, Over production, Excess Motion, Inventory Defects, Human Touches.

**Non-Value Added** Any activity (human, machine, process) that adds no real value to the product or service that absorbs resources. The physical transformation of raw material to Finished Goods Inventory is considered to be the only activity that adds true value. Any other activities are considered waste (MUDA).

**Poka-Yoke** Mistake proof: Usually refers to the use of fail-safe devices in the process in order to prevent defects from occurring and to ensure quality. This ingredient added to automation will yield autonomation. (see Jidoka)

**Process Router Analysis** A study of the process and machine sequence for a group of similar parts. It can be used to standardize product flow for ease of cell implementations.

**Process Quantity Analysis** A study of the quantities demanded of different products produced at a work location. This picture of the volume and variety of products can be used to identify high impact areas to concentrate efforts or identify the need to use process razing to make products more similar.

**Pull System** System of manufacturing in which each process withdraws the parts/materials it needs from the preceding process when they need them, in the exact standardized amount needed.

**Queue Time** The time a part/material sits waiting to be worked on.

**Set-up, External** Machine changeover steps that are performed while the machine is processing parts/materials or off-line from production time.

**Set-up, Internal** Machine changeover steps that are performed while the machine is stopped during production time.

**Shingijutsu** A company founded by C. Nakao and K. Iwata, former employees of Taiichi Ohno, the creator of the Toyota Production System. The word Shingijutsu translates as “new technology” or “better way.”

**Single Piece Flow** Production system in which only one part/material at a time is processed, and the work is verified before being sent along the production line to following processes. The two elements of SPF are 1) a “Do” and 2) a “Check” or verification that the “Do” was done correctly. This introduces a feedback loop into the system.

**Six Sigma** A term coined to express process capability in parts per million. A Six Sigma process generates a maximum defect probability of 3.4 parts per million (PPM) when the amount of process shifts and drifts are controlled over the long term to less than +1.5 standard deviations.

**SMED** Single Minute Exchange Die (i.e., under 10 min) has become a title for the category of improvement devices used in manufacturing to allow for quick changeover of machine/fixture set-ups.

**Standard Operations** The combination of people and machines required to accomplish production in such a way as to minimize waste and variation by establishing only one way to perform the process.

**Standard WIP** Minimum and standardized amount of work in process required to perform operations.

**Standard Work** Sequence of repeatable tasks that an operator performs.

**Standard Work Sheet** Shows the outline of work for each worker in an area. Recorded on it are: Takt time, work sequence, standard WIP, quality checks, safety precautions, etc.

**Standard Work Combination Sheet** A table that clarifies how much time is spent doing manual work and traveling at each production process.

**Super Market** A visual system that has a predetermined amount of inventory and all facets of 5S in order to detect abnormalities.

**Takt Time** The pace that is set for the system to operate at. Customers establish Takt Time...the following equation is used to establish it:

Available production time / required production  
(fcst & act demand) must be like units; e.g.,

1 shift = 1980 min/wk ÷ 10 min/unit

fcst ÷ 198 units/wk

**TPM** Total Productive Maintenance is the total involvement of all employees in an area to improve the process.

**Value Added** Only necessary direct work to manufacture a product. Anything that the customer is willing to pay for or an operation that changes the form, fit, or function of the part/material.

**Value Stream** The specific activities required to design, order, and provide a product from concept to launch – order to delivery – raw materials to finished goods.

**Value Stream Mapping** The process of detailing the process of converting raw material to finished goods. This is typically mapped with the seven flows (info, people, equipment, raw material, sub-assembly, assembly, engineering) one at a time, or in a combination.

**Visual Management** Refers to the means by which anyone can tell at a glance if production activities are proceeding normally or not. A communication, discipline and pacing tool.

**Waiting Time** The time that a worker is idle when no work is available.

**WIP** Work In Process – inventory of materials that has already started processing.





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