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**Learning Objectives**

Upon completion of this course, student will be able to:

- Define Lean and discuss its importance, benefits, and objectives
- Describe Lean tools, methodologies, and levels of deployment
- Identify the roles and responsibilities of the Lean implementation team
- Discuss how these roles can be integrated into an organization

**Introduction**

**Headlines**

Almost daily, the news headlines bring us stories of mergers, acquisitions, Chapter 11 filings, major market shifts, and other business woes. Mixed with the bad news, however, are success stories of organizations that are not only surviving, but thriving. As we continue, let’s consider the key ingredients for business survival, and beyond that, continued business success.

**Why Lean?**

In one way or another, everyone is a customer. Typically, customers choose to do business with companies that are committed to understanding and satisfying their needs. When they are not pleased by the company, customers look for a replacement. Customer focus with a commitment to provide a desired product or service is very important to an organization’s success. Responsiveness, the ability to understand what the customer desires and to provide it quickly, is fundamental to an organization’s success.

However, because many companies have similar capabilities, customer focus and responsiveness alone cannot guarantee success. To be successful, an organization must find ways to differentiate itself from the competition. Products and services must be provided efficiently, making good use of resources, and without waste. Finally, organizations are rarely successful over time without a commitment to continual improvement; stagnation does not bode well. What is acceptable today will be “old news” tomorrow. An organization’s leaders must have the vision and commitment to drive long term success.
What is Lean?

Now that you have a basic understanding of what it takes for an organization to be successful, let’s see how Lean fits in.

The core idea of Lean is to maximize customer value while minimizing waste. In other words, its focus is to create more value for the customer, using fewer resources, shorter cycle times, faster process times, and higher quality.

Six Sigma and Lean in Tandem

When organizations combine Lean with Six Sigma, the results are powerful. Used in tandem, Six Sigma and Lean endow organizations with a principle and structured culture of relentless waste reduction, which is empowered even further by the advanced techniques of process variability analysis and reduction.

Why Lean?

Accurate project selection sets a strong foundation for the successful implementation of Lean. The team must identify improvement projects that align with the organization’s strategic improvement initiatives. Furthermore, the selected projects must be based upon those metrics that shape the organization’s business strategy. By focusing on improvements to core processes in order to meet customer requirements, Lean becomes the framework for deploying the business strategy.
History of Lean - Taiichi Ohno

Let’s take a look back at the history of Lean. As with all valuable innovations, Lean was born from a need.

In the late 1940s and early ‘50s, following World War II, Toyota Loom Company wanted to move into automotive manufacturing. Taiichi Ohno, along with Eiji Toyoda and Shigeo Shingo, worked to improve Toyota’s manufacturing operations. The three men are credited as being the first to consider the central role of inventory and work in process, which is a key Lean principle today. With additional incentive from the oil crisis of the 1970s, Ohno is further credited with developing the Toyota Production System, a term now used interchangeably with Lean manufacturing.

History of Lean - James Womack


Although Lean’s roots are in manufacturing, it has equal application to non-manufacturing operations. In 1996, Womack joined Daniel T. Jones to write Lean Thinking, which further explored Lean’s application and benefits for manufacturing and non-manufacturing processes.

Principles of Lean

Now that we have discussed what it takes for an organization to achieve long-term success, and how Lean fits in, let’s look at how Lean works. Lean is guided by five key principles, as follows:

- Define Customer Value. In Lean, value is specified from the standpoint of the end customer.
- Map the Value Stream. Value Stream Mapping is the key to identifying waste in the process, and eliminating, whenever possible, those steps that do not create value.
- Enable Flow. When value-creating steps occur in tight sequence, the product will flow smoothly through the process.
- Develop Pull. When Continuous Flow is not possible, customers Pull value from the next upstream activity.
- Continuously Improve. As value is specified, Value Streams are identified, wasted steps are removed, and Flow and Pull are introduced. Once this process is completed, it begins again, and the steps are repeated. The improvement process continues until a state of perfection is reached, in which perfect value is created with no waste.
Define Customer Value

Let’s take a closer look at each of the five Lean principles.

The first key principle of Lean is to define customer value. Only by understanding what the customer values, can an organization effectively deliver it. To be successful, an organization must not only give the customer what it needs, but it must do so at the rate it’s needed, when it’s needed, in the quantity needed, and of the quality needed. Once an organization has defined value from the customer perspective, it seeks to deliver that value by reducing waste, improving quality, reducing lead time, and reducing costs.

It is important to remember that, in addition to the external customer, the customer is often the next process or operation in the Value Stream.

Map the Value Stream

Once an organization has defined customer value, the next step is to Map the Value Stream. The Value Stream consists of the series of process steps that create customer value. That is, all the activities and events that happen in order to get the product or service to the customer. To map the Value Stream, an organization analyzes this stream of process steps.

To get an accurate picture of its Value Stream, a Lean organization looks at its process from the perspective of the material flow (from supplier to customer) and information flow (from customer to supplier). This flow of materials and information supports the Value Stream activities. Value Stream Maps are used to capture and specify the activities, information, timing, and events that occur in the Value Stream. First, the Lean team will create a Current State Value Stream Map, which defines the Value Stream in its current state to see how the entire process works together. From there, it creates a Future State Value Stream Map to identify waste and improvement activities that will lead to an ideal future state.

There are three types of value in a process. “Value Adding” activities are the ones that transform material or information into customer requirements. Put simply, these are the activities that occur in a process for which the customer is willing to pay. “Non-Value Adding (required)” activities are those that do not add value from the customer’s perspective, but are necessary to operate the business. The third category, “Non-Value Adding” activities, are the ones that do not add value in any way; they are waste. Once the Lean team identifies Non-Value Adding activities, it
should begin taking actions to completely eliminate them, or to minimize them as much as possible.

When assessing the Value Stream, the team focuses on time, flow, and Value-Added Analysis. It creates a Value Stream Map for each major process area. When mapping the process areas, the team looks to see how much time each activity is currently taking; which activities are Value Adding versus Non-Value Adding; and how it can improve the flow of the process to reduce the time required to produce the product.

**Value Stream Maps**

Value Stream Mapping allows a delivery system for products or services to be viewed graphically, as a continuous flow of processes or activities that add value. Value Stream Mapping forms a basis for Lean implementation by initially focusing the team on the current state of a selected stream. Once the current state has been clearly mapped, it then serves as a basis for improvement to a future state.

A Value Stream Map allows teams to see the entire process flow of both materials and information. This, in turn, enables them to identify process communications and linkages.

Importantly, teams can use Value Stream Maps to calculate the Value-Added Time and compare it to the Total Cycle Time. The Value Stream Map shown here, for example, shows communication from customers to production control, which is then passed to suppliers and production supervision. Supplies are received on a weekly basis, and product is pushed through the five operations required to ready it for shipment. Operation specifics are described in terms of Cycle Time (C/T), Changeover (C/O), Yield, and Uptime. The amount of time a product spends from start to finish, including waiting between operations, is totaled and communicated as Total Cycle Time. This is compared with the total time that is actually spent adding value to the product. The difference between these numbers, combined with the customer demand, forms the basis for improvement and development of the Future State Map, which makes Lean possible. Value Stream Maps allow teams to identify problem areas, bottlenecks, excess inventory, waste and its sources, and potential safety or equipment issues.
Kaizen

Kaizen is a Japanese word meaning “improvement” or “change for the better”.

A Kaizen Event (also commonly called a Kaizen Burst) is a short-duration, highly-focused improvement activity during which a dedicated cross-functional team designs and implements improvements to a defined work area or process.

Kaizen Events are designed to bring rapid results; the Event itself is typically carried out within three to five days. These Events can bring substantial benefits to an organization by targeting effort and resources to fix a business crucial issue. For example, a team may wish to focus a Kaizen Event on a product quality issue or excessive lead time. Launching such a Kaizen Event lets the organization know that an issue exists, and it has a plan to resolve it.

Typical Kaizen Events focus on issues such as cycle time reduction, excessive changeover time, quality defects, excessive scrap, cleanliness and organization, excessive inventory, and process flow improvements.

Lean Focus

Before we discuss the next Lean principle, Enable Flow, let’s set the stage...

Conventional organizations are formed around functional and departmental thinking. Each department has its own set of targets to achieve, and performance is measured against their key performance indicators. For example, an organization’s sales department might measure performance based on its ability to win new business, to provide the customer with what they want, when they want it, and to sell it at a profitable price. The ordering department, on the other hand, might assess its ability to keep costs down and inventory at a minimum.

Meanwhile, for the operations department, performance might be based on its ability to achieve target efficiency, quality, and output. The problem with this type of functional and departmental thinking is that when it’s measured at the organizational level, key performance indicators from various departments are often conflicting.

In almost all organizations, work gets done in processes that cross organizational boundaries. With this in mind, Lean focuses on understanding the entire flow, across all process steps. It seeks to optimize the system based on the work, rather than on individual departmental metrics.

When each functional organization is optimized to run at peak performance against their performance indicators, without taking the other organization’s needs and performance metrics into consideration. This is referred to as “sub-optimization.” Typically, this results in a sub optimized process.
To be most successful, Lean organizations must keep their focus on the customer, balancing each process to meet customer quality, cost, and delivery goals. Some functions may need to operate at less than ideal in order for the entire Value Stream to operate at optimal performance.

Lean Thinking

Lean thinking changes the focus of management. Rather than striving to optimize separate functions, technologies, and assets, Lean focuses on optimizing the flow of products and services through the entire Value Stream, from the suppliers through to the customers. Creating a flow through the Value Stream requires thinking differently about departmental boundaries, organizations, performance metrics or any other barriers within an enterprise.

Flow in the Value Stream

When you turn on your kitchen faucet, you expect to have a consistent flow of clean, safe, drinking water. In Lean, this same concept of flow applies to the Value Stream. Consider what would need to happen in order for a product or service to flow consistently through the value adding process, from the supplier to the customer. In a production environment, achieving this type of flow would require minimum product or service variation, no excess inventory, and no equipment breakdowns.

Earlier in this module, you learned that true responsiveness to internal and external customer needs is achieved by giving the customer “what is needed, when it’s needed, and without issues.” Another word for this is “Value.”

The Lean concepts Just In Time (or JIT) and Continuous Flow focus on this issue of responsiveness by establishing operations that respond at the time of customer demand. JIT and Continuous Flow are based on workforce flexibility, not increased inventory levels.
Enable Flow

This brings us to the third key principle of Lean, Enable Flow.

In this step, teams begin by eliminating sources of waste. To improve yield and reduce variation, they can use Six Sigma projects and tools, such as documentation of Standard Work procedures and application of Poka Yoke processes. The team then implements visual instructions and controls to ensure the improvements are maintained. Changeover reduction and Total Productive Maintenance activities are performed to increase resource availability and reduce equipment overloads and downtime. The goal is to design processes that produce stable and predictable output, capable of producing within the determined cycle time.

Continuous Flow can only be achieved when each process can keep up with customer demand, and the product is defect free. Flow can be improved by optimizing the physical location of operations, where possible, and removing Non-Value Adding steps. 5S can be used to organize and improve the efficiency of work areas.

Eight Lean Tools

Standard Work

While control plans address an entire process flow, standardized work practices deal with the more specific details of producing a product or service. They document optimized operations and improvements, and serve to ensure these are carried out consistently.

The goal of Standard Work is effective use of people, materials, methods, and machines. It describes how a part or service is processed, and may be known as “work instructions.” Standard Work includes associate or equipment interactions, including safety, motion, and ergonomic studies.

Benefits include quality product and satisfied customers; motivated associates, functioning in a safe environment; and increased productivity based on reduced variation. These benefits are greatest when standardized work practices are used in all operations, across the entire facility.
Poka-Yoke

Poka-Yoke is a Japanese term for an error-proofing procedure or device used to prevent a defect from occurring during production of a product or delivery of a service.

Examples of Poka-Yoke include guide pins of different sizes; and shaping variations (such as the USB shown here); error detection and alarms, including automated shutdown when operations are out of control and producing defects; limit switches; counters; and checklists.

Quality at the Source

Inspection as a separate operation or step is not Value Added. Quality at the Source, or Built-in-Quality, refers to inspections or checks and balances that are performed as part of an operation—while the product or service is being produced, and not in a separate operation. Quality at the Source depends upon clearly defined customer requirements (either the external customer or the next step in the process); specifications for distinguishing good from bad product; and guides for monitoring and adjusting to meet these requirements. When requirements are not met, associates are empowered to “stop the line” in order to stop defects and to act to prevent them, or the machine stops itself. Poka-Yokes are key to Quality at the Source.

5S

Five S methodology guides organizations to create and maintain an organized, clean, and safe work environment as a foundation for achieving Lean. It starts with basic housekeeping, but is much more as it becomes a way of doing business.

The five steps or phases of this Japanese based process are: Sort, or Seiri, which focuses on keeping only what is required; Store and Set in Place, or Seiton, which focuses on arranging and identifying items for ease of use; Shine, or Seiso, which focuses on regular cleaning; Standardize, or Seiketsu, which focuses on eliminating causes, reducing variations, and making standards obvious; and Sustain, or Shitsuke, which focuses on ensuring everyone understands and sticks to the Five S methods put in place. Five S paves the way for improvement.
Continuous/One-Piece Flow

In Lean terms, the ideal flow is a continuous, one-piece flow of parts, information, or service which is delivered uninterrupted to the next operation or customer. This results in minimal inventory or shortened or eliminated wait times for performing a process or delivering a service.

Lean's focus is on: "what's needed, when needed." Continuous or one-piece flow supports Lean by focusing on two things. First, on a cellular environment where everything needed to produce a part or service is available. Second, the guidelines that nothing proceeds to the next process until complete and correct. Continuous or one-piece flow results in fewer errors, improved quality and higher overall efficiency as all required information, material, tools and equipment are in place and available. It may be more efficient for an operation to produce a batch, however, inventory may build and delivery to the customer may slow because parts or information waiting for the batch cannot add further value until the whole batch is completed. When flow is considered across the entire value stream, then batching, even where it seems to make sense for a particular operation, may be inefficient. When machines or operations are grouped to achieve an optimal process flow, we call this a Cellular Configuration. The goals of a Cellular Configuration include lead time reduction, operating cost reduction, increased labor flexibility, and increased labor utilization.

Changeover/Setup

Setup Reduction, Quick Change, and Single Minute Exchange of Dies (S.M.E.D.) focus on reduction of setup and changeover times. Setup or changeover time indicates the time elapsed from the unloading or completion of the last good part of one run, to the production of the first good part of the next run.

Setup Reduction, Quick Change, and S.M.E.D. support Lean goals and objectives through reduced costs, smaller lot sizes, and shorter lead times. Additional benefits include the following: reduced inventory generated from overproduction, and related cash flow improvement; elimination of waste from Non-Value Adding activities; improved facility capacity; increased flexibility and responsiveness; improved quality as lot sizes and lead times are reduced; and improved competitiveness.
Eight Wastes

Waste exists in many forms, including Transportation, Inventory, Motion, Waiting, Overproduction, Over-Processing, Defects, and Skills (under-utilized human potential). An easy way to remember the types of waste is the acronym TIMWOODS. By reducing waste, an organization reduces costs and increases flexibility.

Total Productive Maintenance

For Total Productive Maintenance (or TPM), team and shop floor associates work to maximize the effectiveness of manufacturing equipment, with the goal of preventing breakdowns and defects.

TPM is based on the following four components: preventive maintenance, which focuses on proactive maintenance to prevent breakdowns; corrective maintenance, which focuses on equipment improvements or modifications to prevent breakdowns or make maintenance easier; maintenance prevention, which focuses on minimizing required maintenance based on equipment design or installation; and breakdown maintenance, which focuses on repairing breakdowns.

Visual Management and Visual Controls

Remember the saying, “A picture is worth a thousand words.”? Visual Management and Visual Controls are based on that same simple philosophy.

Visual Management incorporates Visual Controls and process layouts to make it easy for anyone in the production area to easily spot an abnormal or unusual situation.

Visual Controls may be used to show the following: how to do a job, including standard, agreed-upon best practices; where things are stored; how to use a tool or device; required inventory levels;
Develop Pull

The next principle is Develop Pull.

In reality, Continuous Flow is not always achievable throughout the entire Value Stream. For example, Continuous Flow is often obstructed when one of the processes in the Value Stream takes much longer or is less predictable than the others. When this happens, these processes cannot be connected directly with the others in a Continuous Flow.

Rather than attempting to schedule these operations using a traditional scheduling function, teams allow these processes to be controlled by Pull Systems. Pull Systems produce products, services, or items based upon actual customer requests, orders, or consumption.

They provide an accurate indication of the type and quantity of product needed by downstream processes. Rather than predicting the demand, they indicate the exact demand that exists.

Sometimes, either product mix or customer demand needs to be leveled to allow product to flow smoothly through the operations.

Once Continuous Flow has been implemented, with Pull Systems included where necessary, the entire end-to-end Value Stream should be stable and capable of producing to customer demand.

Pull System

A Pull System is a system of communicating production and delivery instructions from downstream processes to upstream processes. In a Pull System, no product or service is moved downstream by the upstream supplier until the downstream customer signals a need. Put simply, no one from upstream produces a product or provides a service until the downstream customer asks for it.

In this diagram, Process B is the downstream customer for Process A, the supplier. Until Process B signals Process A that it is ready for work to flow, Process A will not produce, or have any work pulled, by Process B from its work cell.

There are many advantages to implementing a Pull System in a manufacturing process. Some of these advantages include reducing the amount of inventory without creating parts shortages; decreasing the amount of floor space required; decreasing lead time for customers by reducing the cycle time within a production process; and improving quality. In summary, Pull Systems can be characterized as “the right item, in the right quantity, at the right location, and at the right time.”
Level Production Demand

Customer demand for product is not consistent and steady. When demand is uneven over time, with large peaks and valleys, the result is extra burden on people, machines, and processes. Companies often react to uneven demand by holding extra inventory, releasing large batches of work to the operation, and expediting orders through production to meet changing customer demands. Unfortunately, all these actions result in various types of waste and increased overall lead time.

The goal of production leveling is to execute each process step at a constant and predictable rate. This includes regularly releasing small amounts of work, and evenly distributing the production of different products over time.

Smoothing demand over a period of time offers many advantages, including the following: it allows organizations to meet customer demand more efficiently; it reduces batch processing and moves organizations closer to One-Piece Flow; it requires minimum inventory; it reduces cost and lead time throughout the Value Stream; it makes it easier to recognize and correct quality issues; and it provides greater flexibility to react to changing customer demand.

Continuously Improve

The last key principle is Continuously Improve.

An organization’s Lean initiative does not end when the future state is realized. It continues to expand across other product families. Each Lean Value Stream is continuously revisited to identify more roadblocks for removal. The goal is zero waste and the minimum amount of time to deliver quality product to the customer. It takes continuous commitment to ensure all the implemented improvement programs, such as Visual Management and 5S, remain effective. When Lean improvements in one product family are successful, the organization takes the lessons learned and maps out a strategy to leverage this knowledge in other products or processes. Leaders of successful Lean initiatives can be a valuable resource within the organization. They can serve as mentors, trainers, and experienced consultants to assist with the deployment of Lean tools and techniques in other areas.

By focusing on continuous improvement, this fifth key principle builds a Lean culture throughout the organization, allowing it to profit from identified opportunities and realized savings.

Why Lean Implementation?

You have just learned Lean’s five basic principles. Now consider why an organization might implement Lean. By focusing on the true needs of the customer, Lean helps businesses prevent waste from being...
built into their systems. Organizations that have implemented Lean report many benefits, including the following:

Improved Customer Service: Delivering exactly what the customer wants, when they want it.
Improved Quality: Reductions in defects and rework.
Reduced Waste: Less transport, moving, waiting, space, and physical waste.
Improved Lead Times: Faster response, faster set ups, and fewer delays.
Improved Stock Turns: Less work in progress and inventory, resulting in less tied-up capital.
Improved Productivity: Improvements in throughput and Value Add per person.
Innovation: Fully involved staff, resulting in improved morale and participation in the business.

In addition to the positive financial impacts of these benefits, they also help organizations become even more responsive to customer needs. Next, we’ll take a closer look at some of these benefits.

**Value Adding & Non-Value Adding Activities**

![LEAD TIME Diagram]

How important is Lean’s focus on Value Adding and Non-Value Adding activities? Average companies are often surprised at the results when performing a Value Stream Analysis for the first time. They find that time spent on Non-Value Added activities is often 10 to 15 times longer than the time spent on Value Added activities.

Indeed, companies may be able to reduce lead times slightly through the use of traditional improvement efforts, using common sense to eliminate obvious Non-Value Added activities. However, by optimizing the time spent on Value Added activities and eliminating a large proportion of the Non-Value Added activities, Lean methodologies enable companies to achieve breakthrough results.

**Lean Benefits**

Many Lean benefits, such as increased customer satisfaction, improved quality, reduced waste, and shortened lead times, are linked to another very important benefit: lower costs.

Let's consider just how much savings can be achieved through a successful implementation of Lean. Industry reports, similar to these from NIST, report an 80% improvement in quality; 75% improvement in use of space; 80% reduction of work-in-process inventory; 90% reduction in lead time (or cycle time); and a 50% increase in productivity.
Lean for Service Providers

Spurred by the success of Lean manufacturing, Lean principles have been adapted for use by non-manufacturing processes and service providers. Numerous non-manufacturing industries use Lean as the basis for improvements, including insurance, accounting, and banking, as well as administrative and support processes of manufacturers.

Lean Implementation

At this point, we have discussed the focus and purpose of Lean, its five key principles, and the differentiation it offers. Now let’s walk through the overall roles and responsibilities related to Lean implementation.

This chart represents a structure for Lean implementation. Please note that it does not imply a managerial reporting structure. Click your mouse on each of the Lean roles to learn about its responsibilities for Lean implementation.
• Subject Matter Experts in process knowledge
• Trained in specific Lean tools to assist the Kaizen Team Leader through stages of the project
• May play key role in transitioning the project to the operational team