LEAN PRODUCTION

Fall 2023

Background

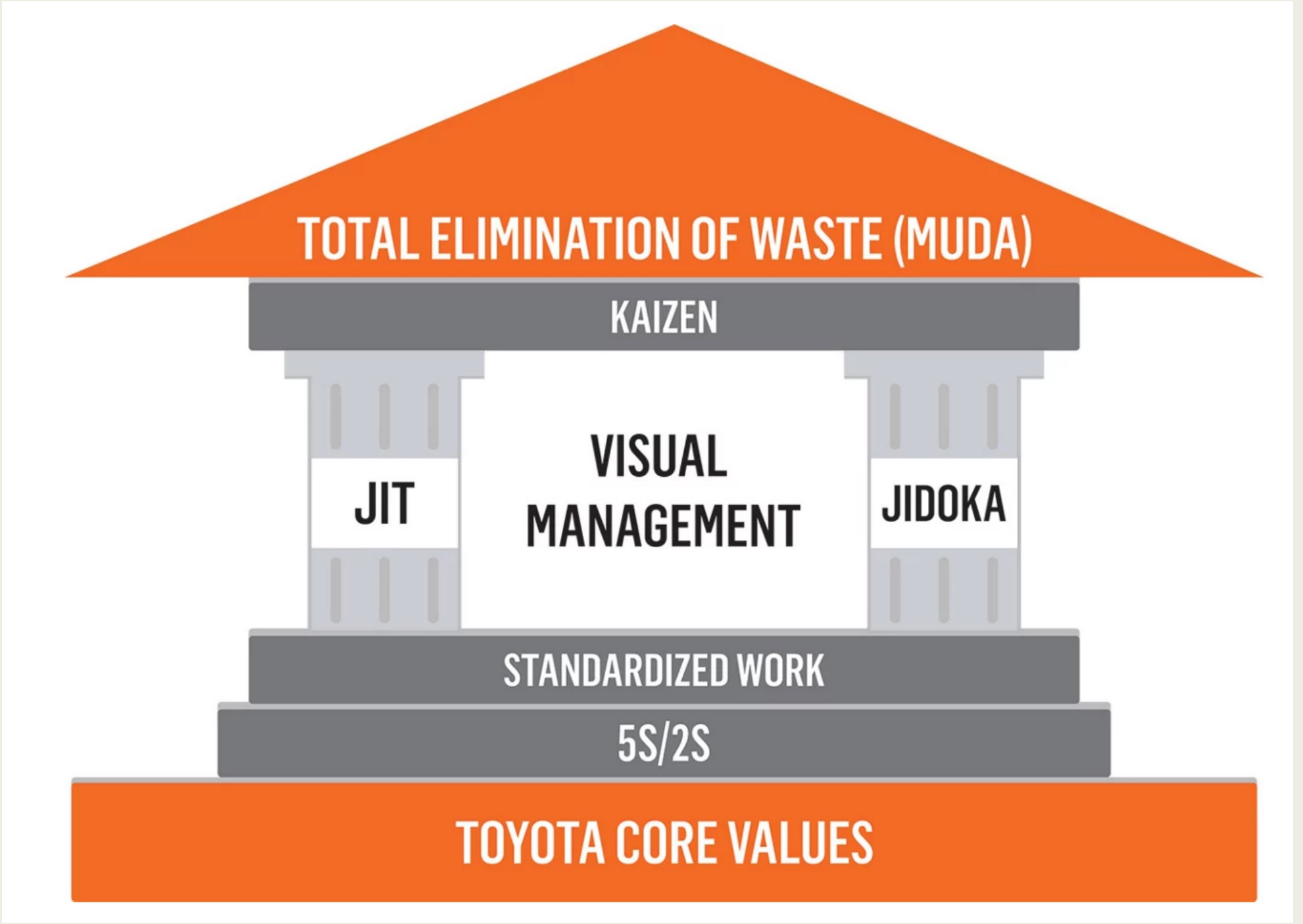
- ***Lean production*** means doing more work with fewer resources. It is an adaptation of mass production in which work is accomplished in less time, smaller space, with fewer workers and less equipment, and yet achieving higher quality levels in the final product.
- Lean production also means giving customers what they want and satisfying or surpassing their expectations.
- Lean production is based on the way manufacturing operations were organized at the Toyota Motors Company in Japan during the 1980s. Toyota had pioneered a system of production that was quite different from the mass production techniques used by automobile companies in the United States and Europe.
- The Toyota Production System, as it was called before the term "lean" was applied to it, began to evolve in the 1950s to cope with the realities of Japan's postwar economy (e.g., a much smaller domestic auto market than in the United States or Europe and a scarcity of Japanese investment capital for plant and equipment)

Background

- To deal with these challenges, Toyota developed a production system that could produce a variety of car models with fewer quality problems, lower inventory levels, smaller manufacturing lot sizes for the parts used in the cars, and reduced lead times to produce the cars.
- The ingredients of a lean production system are shown in the structure in the next Figure. At the base of the structure is the foundation of the Toyota system: elimination of waste in production operations. Taiichi Ohno was driven to reduce waste at Toyota. Standing on the foundation are two pillars: (1) just-in-time production and (2) autonomation (automation with a human touch). The two pillars support a roof that symbolizes a focus on the customer.
- The goal of lean production is customer satisfaction. Between the two pillars and residing inside the structure is an emphasis on worker involvement: workers who are motivated, flexible, and continually striving to make improvements. Table 1 identifies the elements of just-in-time production, worker involvement, and autonomation in the lean production structure.

TABLE 1 The Elements of Just-in-Time Production, Worker Involvement, and Autonomation in the Lean Production Structure

Just-in-Time Production	Worker Involvement	Autonomation
Pull system of production control using kanbans	Continuous improvement (kaizen)	Stop the process when something goes wrong (e.g., production of defects)
Setup time reduction for smaller batch sizes	Quality circles	Prevention of overproduction
Production leveling	Visual management	Error prevention and mistake proofing
On-time deliveries	The 5S system	Total productive maintenance for reliable equipment
Zero defects	Standardized work procedures	
Flexible workers	Participation in total productive maintenance by workers	


TOTAL ELIMINATION OF WASTE (MUDA)
KAIZEN
JIT
VISUAL MANAGEMENT
JIDOKA
STANDARDIZED WORK
5S/2S
TOYOTA CORE VALUES

Toyota house

- **1. Lean Management Foundation:** Before you can begin building a home, you need to start with a solid foundation. To ensure your process increases in efficiency and productivity, you'll need to make sure you have the proper pieces so every individual in your organization understands the expectations of going lean.
- A key component to Toyota's Lean Manufacturing methodology is 5S. This system aims to improve the bottom line by creating workspaces that are free from clutter to increase productivity, safety, efficiency, and employee satisfaction.
    1. **Sort:** Eliminate whatever is not needed by separating needed tools, parts, and instructions from unneeded materials.
    2. **Set in Order:** Organize whatever remains by neatly arranging and identifying parts and tools for ease of use.
    3. **Shine**: Clean the work area by conducting a cleanup campaign.
    4. **Standardize**: Schedule regular cleaning and maintenance by conducting *5s.*
    5. **Sustain**: Make 5S a way of life by forming the habit of always following the first four S's.

Toyota house

- ***Toyota Core Values***: Have you ever heard the saying “there’s no ‘I’ in team?” Lean isn’t just about identifying where you can do better; it’s about instilling a culture of respect and development to create an environment that employees enjoy working in. This is because success isn’t achieved alone.
- Achieving business goals and a leaner manufacturing process requires dedication and teamwork from each individual on the team. Likewise, encouraging open communication, generosity, creativity, and practicality ignites individuals to innovate and stay ahead of the curve.
- **2. Lean Management Pillars:** Just as a house can’t stand without pillars, a manufacturing process can’t become better without the structure that keeps it standing.
- ***Just-in-Time***: The just-in-time (JIT) concept stresses the importance of delivering only the materials necessary in a timely manner. Employing a JIT inventory management strategy for your operation allows for waste reduction, and increased efficiency, which reduces inventory costs.

Toyota house

- ***Jidoka***: which is translated “automation with a human touch” means that once a problem occurs in the process, humans are empowered to stop production. This prevents defective products from being produced. Stalling production during these times decreases inventory costs as well as warehouse space. Together, combining quality production with timely delivery allows your business to move closer to their goals.
- **3. Support Beams:** Before finishing the roof, a house requires an additional beam to ensure the structure is sound. Kaizen, which translates to “continuous improvement,” stresses the idea that no process is perfect, and challenges should be welcomed.
- Each day, improvements can be made to the process or product to create an operation that is more efficient than the day before. Doing so, can result in substantial cost and time savings as well as helping the organization, team members, and individuals increase their performance.

Toyota house

- **4. Roof (Eliminating Waste):** Building the roof is the final touch in completing the House of Toyota. Without a roof, the house is an incomplete structure that never reaches its full potential. Without establishing clear goals for your organization, your operation can never reach new heights, and you can miss out on many growth opportunities. Working toward your goals also means identifying anything that doesn't add value to your business.
- The Japanese term, *muda*, refers to eliminating excess inventory, overproduction, and defects to reduce your operational costs. Additionally, your business can achieve a streamlined operation by focusing on your main reason for business: your customer. Placing the customer at the heart of your daily operations by providing products of the utmost quality, in the shortest amount of time, is critical to achieving a lean warehousing or logistics operation process as well as satisfied customers.

ELIMINATION OF WASTE

- The underlying basis of the Toyota Production System is elimination of waste—called ***muda*** in Japanese. The very word has the sound of something messy (perhaps because it begins with the English word "mud"). In manufacturing, waste abounds. Ohno identified seven forms of waste in manufacturing that he wanted to eliminate by means of the various procedures that made up the Toyota system. Ohno's seven forms of waste are as follows:

- **1.** Production of defective parts
  2. Production of more than the number of items needed (overproduction) **3.** Excessive inventories
  4. Unnecessary processing steps
  5. Unnecessary movement of people
  6. Unnecessary transport and handling of materials
  7. Workers waiting.

Production of Defective Parts

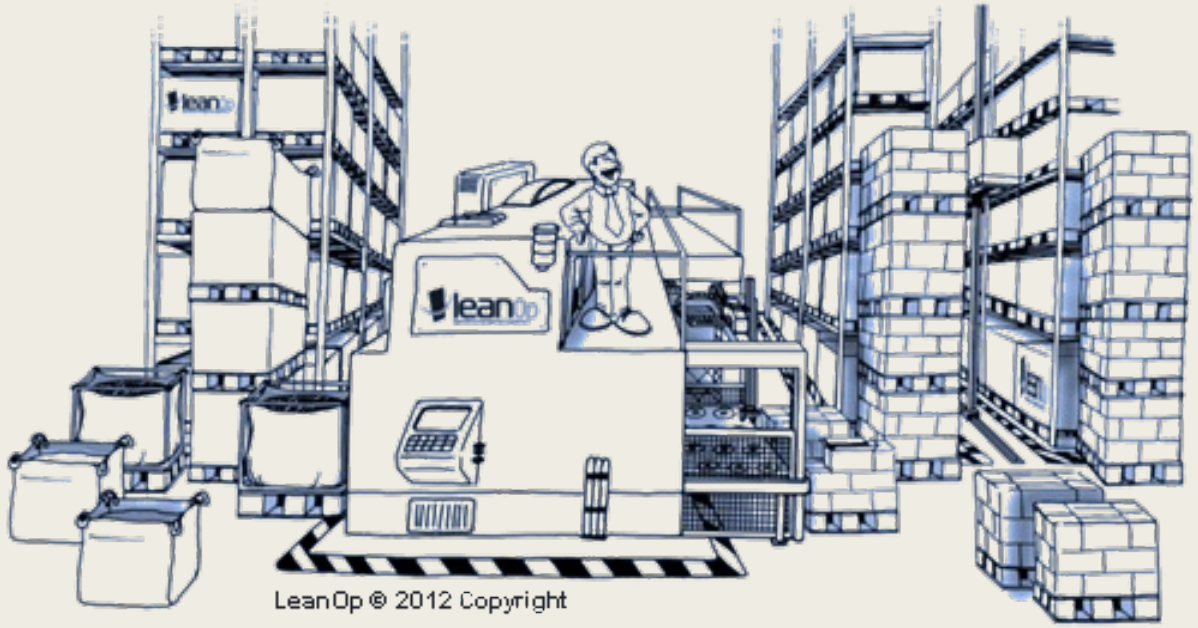
- Here are four counter measures for defects. Firstly, look for the most frequent defect and focus on it. Secondly, design a process to detect abnormalities and do not pass any defective items along the production process. Thirdly, redesign the process so that does not lead to defects. Lastly, use standardize work to ensure a consistent manufacturing process that is defect free.

Production of Defective Parts

- There is little or no inventory in a lean system to act as a buffer.
- **In mass production**, inventory buffers are used just in case these quality problems occur. The defective work units are simply taken off the line and replaced with acceptable units. However, the problem is that such a policy tends to perpetuate the cause of the poor quality. Therefore, defective parts continue to be produced.
- **In lean production**, a single defect draws attention to the quality problem, forcing corrective action and a permanent solution. Workers inspect their own production, minimizing the delivery of defects to the downstream production station.
- The reasons for defects are poor quality control, unclear specification and customer requirements, unskilled labor, poor maintenance of equipment and machinery, and poor 5s and safety controls.

Overproduction and Excessive Inventories

- Overproduction (waste form 2) and excessive inventories (waste form 3) are correlated. Producing more parts than necessary means that there are leftover parts that must be stored. Of all of the forms of muda, Ohno believed that the "**greatest waste of all is excess inventory**."



Overproduction and Excessive Inventories

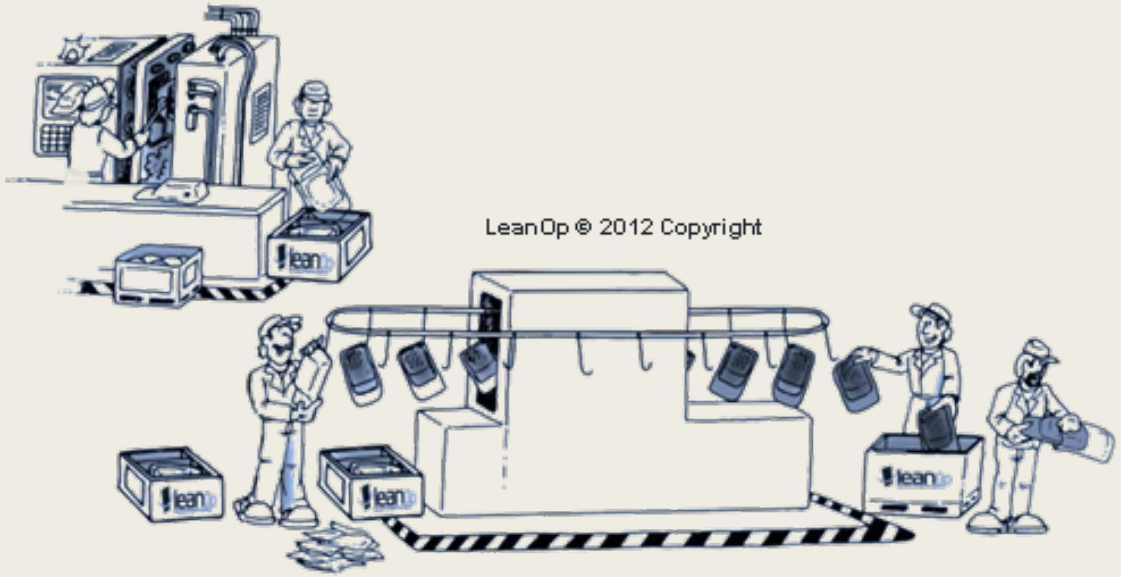
- Overproduction and excess inventories generate increased costs in the following areas:
  - *Warehousing(building, lighting and heating, maintenance)*
  - *Storage equipment(pallets, rack systems, forklifts)*
  - *Additional workers to maintain and manage the extra inventory*
  - *Additional workers to make the parts that were over produced*
  - *Other production costs(raw materials, machinery, power, maintenance) to make the parts that were overproduced and stored*
  - *Interest payments to finance all of the above.*

Overproduction and Excessive Inventories

- The kanban system for just-in-time production provides a control mechanism at each workstation to produce only the minimum quantity of parts needed to feed the next process in the sequence. In so doing, it limits the amount of inventory that is allowed to accumulate between operations.

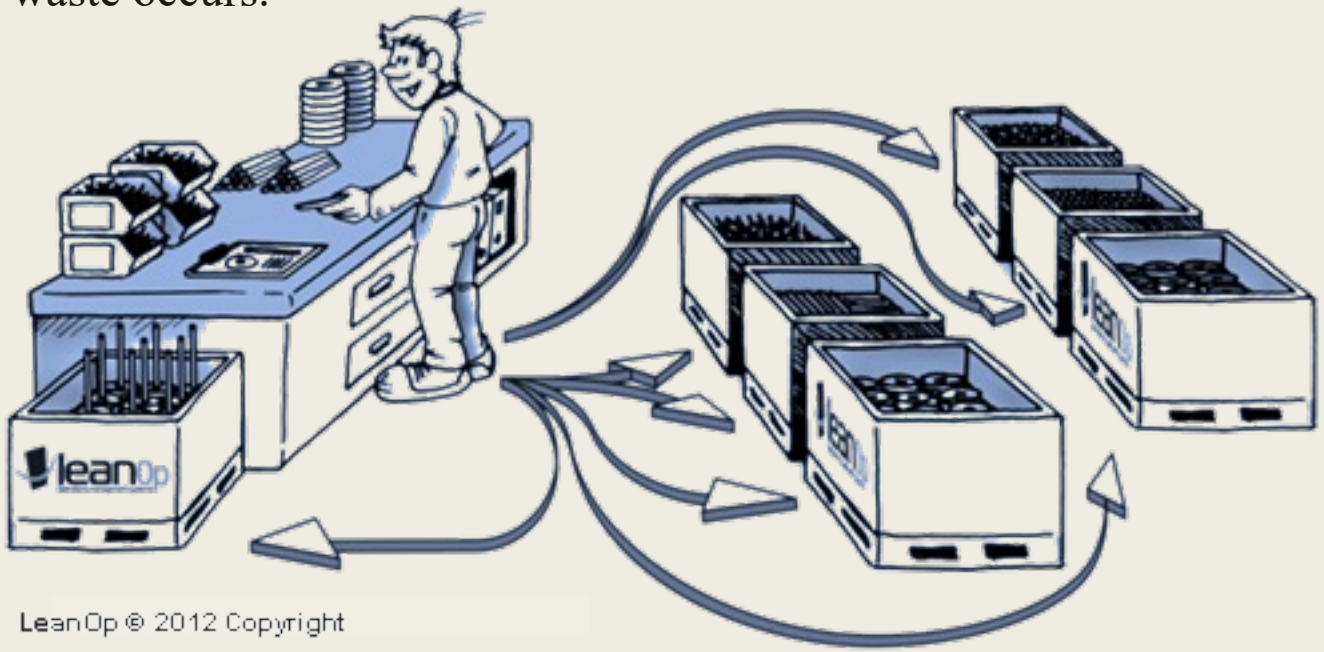
Unnecessary Processing Steps

- Unnecessary processing steps mean that energy is being expended by the worker and/or machine to accomplish work that adds no value to the product. An example of this waste form is a product that is designed with features that serve no useful function to the customer, and yet time and cost are consumed to create those features.
- Another reason for unnecessary processing steps is that the processing method for the given task has not been well designed. Perhaps no work design has occurred at all. Consequently, the method used for the task includes wasted hand and body motions, unnecessary work elements, inappropriate hand tools, inefficient production equipment, poor ergonomics, and safety hazards.



Unnecessary Movement of Workers and Materials

- The movement of people and materials is a necessary activity in manufacturing. Body motions and walking are necessary and natural elements of the work cycle for most workers, and materials must be transported from operation to operation during their processing.
- It is when the movement of workers or materials is done unnecessarily and without adding value to the product that waste occurs.

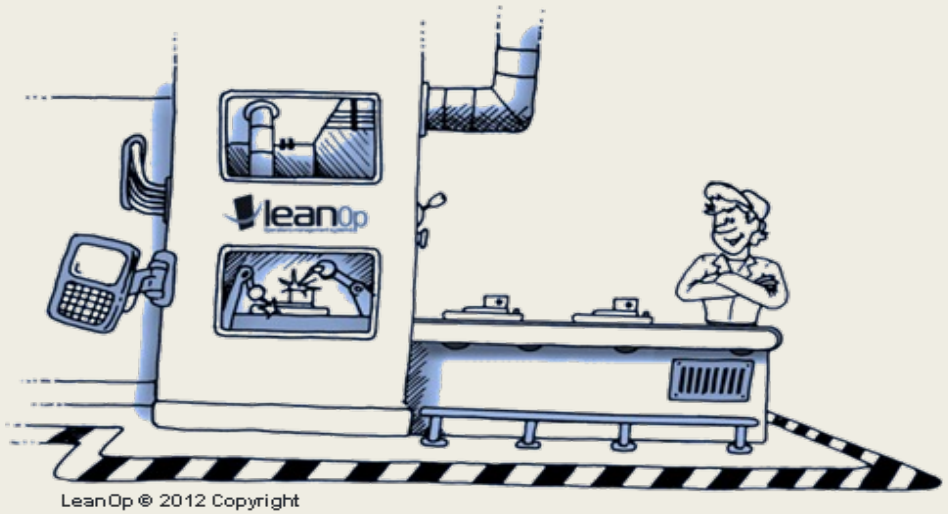


Unnecessary Movement of Workers and Materials

- The following reasons explain why people and materials are sometimes moved unnecessarily:
  - ***Inefficient workplace layout***. *Tools and parts are randomly organized in the workspace, so that workers must search for what they need and use inefficient motion patterns to complete their tasks.*
  - ***Inefficient plant layout***. *Workstations are not arranged along the line of flow of the processing sequence.*
  - ***Improper material-handling method***. *For example, manual-handling methods are used instead of mechanized or automated equipment.*
  - ***Improper spacing of production machines***. *Greater distances mean longer transit times between machines.*
  - ***Larger equipment than necessary for the task***. *Larger machines need larger access space and greater distances between machines.*
  - ***Conventional batch production***. *In batch production, changeovers are required between batches that result in downtime during which nothing is produced.*

Workers Waiting

- **Workers Waiting.** The seventh form of muda is workers waiting. When workers are forced to wait, it means that no work (either value-adding or non–value-adding) is being performed. There is a variety of reasons why workers are sometimes forced to wait:
  - *Materials have not been delivered to the workstation.*
  - *The assembly line has stopped.*
  - *A machine has to be repaired.*
  - *A machine is being serviced by the setup crew.*
  - *A machine is performing its automatic processing cycle on a work part.*



JUST-IN-TIME PRODUCTION

- Just-in-time (JIT) production systems were developed to minimize inventories, especially work-in-process. Excessive WIP is seen in the Toyota Production System as waste that should be minimized or eliminated.
- The ideal ***just-in-time production system*** produces and delivers exactly the required number of each component to the down- stream operation in the manufacturing sequence at the exact moment when that component is needed.
- Each component is delivered "just in time." This delivery discipline minimizes WIP and manufacturing lead time as well as the space and money invested in WIP. In the Toyota Production System, the just-in-time discipline was applied not only to its own production operations but to supplier delivery operations as well.

JUST-IN-TIME PRODUCTION

- While the development of JIT production systems is attributed to Toyota, many U.S. firms have also adopted the just-in-time philosophy. Other terms are sometimes applied to the American practice of JIT to suggest differences with the Japanese practice. For example, ***continuous flow manufacturing*** is a widely used term in the United States that denotes a just-in-time style of production operations in which work parts are processed and transported directly to the next workstation one unit at a time.
- Each process is completed just before the next process in the sequence begins. In effect, this is JIT with a batch size of one work unit. Prior to JIT, the traditional U.S. practice might be described as a "just-in-case" philosophy—that is, to hold large in-process inventories to cope with production problems such as late deliveries of components, machine breakdowns, defective components, and wildcat strikes.

JUST-IN-TIME PRODUCTION

- The just-in-time production discipline has shown itself to be very effective in high- volume repetitive operations, such as those found in the automotive industry.
- The potential for WIP accumulation in this type of manufacturing is significant, due to the large quantities of products made and the large numbers of components per product.
- The principal objective of JIT is to reduce inventories. However, inventory reduction cannot simply be mandated to happen. Three requisites must be in place for a just-in-time production system to operate successfully:
  (1) a pull system of production control
  (2) setup time reduction for smaller batch sizes
  (3) stable and reliable production operations.

Stable and Reliable Production Operations

- Other requirements for a successful JIT production system include

(1) production leveling

(2) on-time delivery

(3) defect-free components and materials

(4) reliable production equipment

(5) a workforce that is capable, committed, and cooperative

(6) a dependable supplier base.

Stable and Reliable Production Operations

- **Production Leveling.** If production is to flow as smoothly as possible, there must be minimum perturbations from the fixed schedule. Perturbations in downstream operations tend to be magnified in upstream operations.
- A 10% change in final assembly is often amplified into a 50% change in parts production operations, due to overtime, unscheduled setups, variations from normal work procedures, and other exceptions.
- By maintaining a constant master production schedule over time, smooth workflow is achieved and disturbances in production are minimized.
- The trouble is that demand for the final product is not constant. Accordingly, the production system must adjust to the ups and downs of the marketplace using ***production leveling***, which means distributing the changes in product mix and quantity as evenly as possible over time.

Stable and Reliable Production Operations

- Production leveling can be accomplished using the following approaches:
- Authorizing overtime during busy periods
- Using finished product inventories to absorb daily ups and downs in demand
- Adjusting the cycle times of the production operations
- Producing in small batch sizes that are enabled by setup time reduction techniques. In the ideal, the batch size is reduced to one. Instead of producing parts A and B according to a schedule that looks like this: **AAAAAAAAAABBBBBBBBBB.** the parts are instead scheduled like this: **ABABABABABABABABABAB.**
- The benefits of production leveling include greater responsiveness to changes in product demand, shorter lead times, smaller in-process and finished goods inventories, and regularity in the workload of production workers.

Stable and Reliable Production Operations

- **On-Time Deliveries, Zero Defects, and Reliable Production Equipment.** Just-in- time production requires near perfection in on-time delivery, parts quality, and equipment reliability. Owing to the small lot sizes used in JIT, parts must be delivered before stock- outs occur at downstream stations. Otherwise, these stations are starved for work and production is forced to stop.
- JIT requires high quality in every aspect of production. If parts are produced with quality defects, they cannot be used in subsequent processing or assembly stations, thus interrupting work at those stations and possibly stopping production.
- Such a severe penalty motivates a discipline of very high quality levels (zero defects) in parts fabrication. Workers are trained to inspect their own output to make sure it is right before it goes to the next operation.
- In effect, this means controlling quality during production rather than relying on inspectors to discover the defects later.

Stable and Reliable Production Operations

- JIT also requires highly reliable production equipment. Low work-in-process leaves little room for equipment stoppages. Machine breakdowns cannot be tolerated in a JIT production system.

- The equipment must be “designed for reliability,” and the plant that operates the equipment must employ total productive maintenance

Stable and Reliable Production Operations

- **Workforce and Supplier Base.** Workers in a just-in-time production system must be cooperative, committed, and cross-trained.
- Small batch sizes mean that workers must be willing and able to perform a variety of tasks and to produce a variety of part styles at their workstations.
- As indicated above, they must be inspectors as well as production workers in order to ensure the quality of their own output.
- They must be able to deal with minor technical problems that may be experienced with the production equipment, so that major breakdowns are avoided.

Stable and Reliable Production Operations

- The suppliers of raw materials and components to the company must be held to the same standards of on-time delivery, zero defects, and other JIT requirements as the company itself. New policies such as the following are required for JIT for dealing with vendors:
  - *Reducing the total number of suppliers, thus allowing the remaining suppliers to do more business*
  - *Entering into long-term agreements and partnerships with suppliers, so that suppliers do not have to worry about competitively bidding for every order*
  - *Establishing quality and delivery standards and selecting suppliers on the basis of their capacity to meet these standards*
  - *Placing employees into supplier plants to help those suppliers develop their own JIT systems*
  - *Selecting parts suppliers that are located near the company's final assembly plant to reduce transportation and delivery problems.*