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School of management studies

UNIT – I– LEAN MANAGEMENT –SBAA7030

INTRODUCTION

Basics of Lean Management approach and the basics of Lean Management philosophy - Basics of TPS 14 principles, including relations with the Lean Management tools - Ideal Lean Management tool (Lean Management (Tool Box) based on the situation;

1.1. BASICS OF LEAN MANAGEMENT APPROACH

1.1.1. Evolution of Lean Management

The history of lean management can be traced to the automotive process that was started by Henry Ford. When Ford came up with the idea of making a motorized car, he invented the process known as flow production. For the viewing public, the most prevalent example of flow production is that of the assembly line, where part after part comes down a conveyor belt, each being fitted to another part that has also traveled down the belt or one that has been fitted by an employee.

The system was of course revolutionary from the standpoint of a new way of manufacturing, however, in terms of how it furthered sales of the Model T, Ford initially failed. While the Model T was again a starting point of what would become a huge industry, the world wanted more, like variety - something that Ford did not have at the time.

Subsequently, Toyota started looking at Ford's flow production and came up with a way to keep the assembly line idea going, as well as providing the variety that consumers were looking for.

This would become the Toyota Production System; this system did not focus on just the manufacturing process, but that of the process of the product itself.

With the above start of lean management, there is a misconception that lean management is only for manufacturing jobs and businesses, however that is not the case. Lean management can be used in all types of business settings, such as health care or government companies. Many companies and businesses actually don't use the word 'lean' when they describe the type of management they use, usually phrasing the title with their business name, such as the Toyota Production System. This is to show that lean management isn't just a program or a cost reduction program, but something that can be defined by that of the organization and how they operate.

1.1.2. Meaning

Lean management is an approach to running an organization that supports the concept of continuous improvement, a long-term approach to work that systematically seeks to achieve small, incremental changes in processes in order to improve efficiency and quality.

Lean management seeks to eliminate any waste of time, effort or money by identifying each step in a business process and then revising or cutting out steps that do not create value.

1.2. BASICS OF LEAN MANAGEMENT PHILOSOPHY

1.2.1. Lean Philosophy

Here are some ways of describing lean philosophy or culture:

- Lean is a culture of continuous improvement practiced at every level of the organization and by every team.
- Lean is the application of the scientific method of experimentation and study of work processes and systems to find improvements.
- Lean is respect for people. It is respect for the voice of the customer and it is respect for those who do the work, who are “on-the-spot” and are, therefore, the “world’s greatest experts” in their work.

- Lean is the elimination of waste in all its forms. Lean is the ability to distinguish between work that actually adds value to the customers and work that does not. By eliminating waste, it frees resources to devote to value-adding activity that serves the customers.
- Lean is a work environment that assures the quality and safety of all work for both customers and staff.
- Lean is a focus on improving the work process and not on blaming people or creating fear.
- Lean is a culture of teamwork, shared responsibility and ownership that cuts through organization walls or silos.
- Lean is a culture that returns the joy to work. Honda speaks of the three joys of buying, selling and making the product. We do our best work when we have joy in our work.
- Lean is flow. Lean is an interruption free process that flows from beginning to end without interruption.

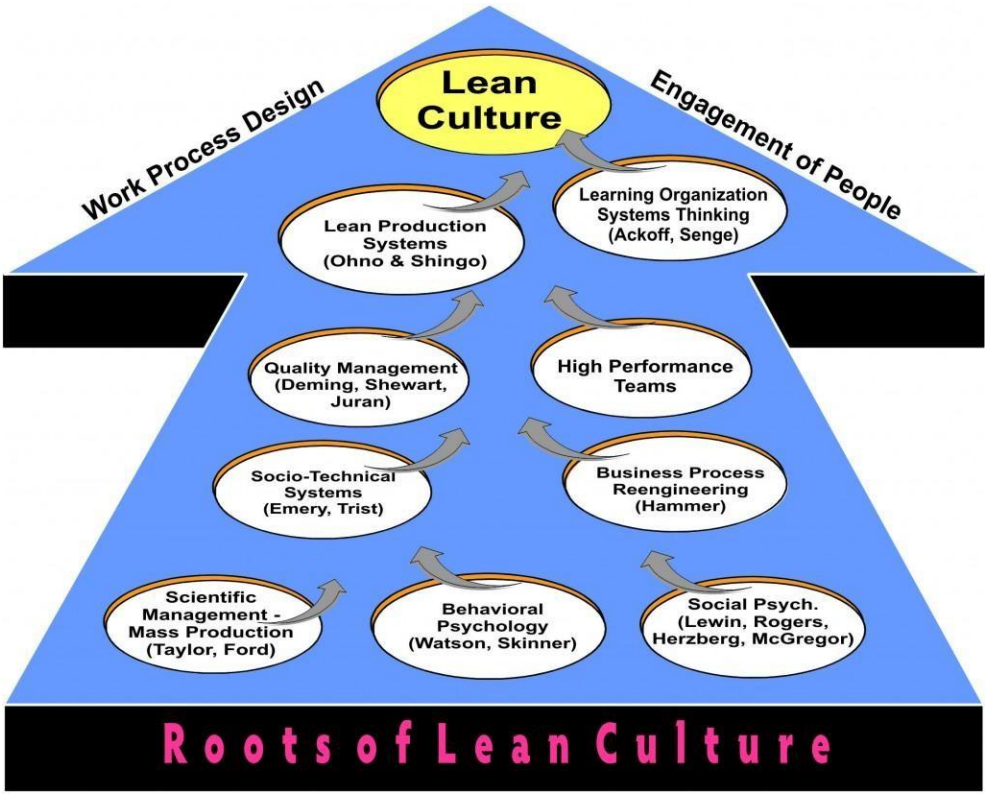


Fig 1: Roots of Lean Culture

1.2.2. Guiding Principles of Lean Management

i. Defining value from the standpoint of the end customer.

ii. Identifying each step in a business process and eliminating those steps that do not create value.

iii. Making the value-creating steps occur in tight sequence.

iv. Repeating the first three steps on a continuous basis until all waste has been eliminated.

1.2.3. Wastes Associated With Lean Management

The core concept of Lean Management is reducing wastage as much as possible. For this reason, it is worth looking at various wastages associated with Lean Management. Such wastages may include:

- **Overproduction:** The problem with overproduction is it creates excess inventories as well as extra storage space and extra employee requirements.

- **Overprocessing:** This means employees exceed actual/normal requirements when working on products.

- **Unnecessary motion:** This involves employees leaving their workstations and moving around aimlessly.

- **Unnecessary downtime:** A good example of this is when employees sit idly waiting for raw materials or orders from their bosses.

- **Unused employee creativity:** This happens when an employer fails to encourage or foster an environment where employees can pitch new ideas.

1.3. BASICS OF TPS 14 PRINCIPLES

The Toyota Production System (TPS) is an integrated socio-technical system, developed by Toyota that comprises its management philosophy and practices. The TPS organizes manufacturing and logistics for the automobile manufacturer, including interaction with suppliers and customers. The system is a major precursor of the more generic "lean manufacturing". Taiichi Ohno and Eiji Toyoda, Japanese industrial engineers, developed the system between 1948 and 1975.

Fig.1 14 Principles of 4P

1P: Long Term Philosophy

Principle 1: Base the management decisions on a long term philosophy, even at the expense of short-term financial goals

- Have a philosophical sense of purpose that supersedes any short-term decision making. Work, grow and align the whole organisation toward a common purpose that is bigger than making money. Understand the place in the history of the company and work to bring the company to next level. The philosophical mission is the foundation for the other principles.

- Generate value of the customer, society and the economy - it is the starting point. Evaluate every function in the company in terms of ability to achieve this.
- Be responsible. Strive to decide the own fate. Act with self reliance and trust in own abilities. Accept responsibility for own conduct and maintain improve the skills that enable to produce added value.

2P: The Right Process Will Produce the Right Results

Principle 2: Create continuous process flow to bring problems to the surface

- Redesign work process to achieve high value-added, continuous flow. Strive to cut back to zero the amount of the time that any work project is sitting idle or waiting for someone to work on it.
- Create flow to move material and information fast as well as to link processes and people together so that problems surface right way.
- Make flow evident throughout the organizational culture. It is the key to a true continuous improvement process and to developing people.

Principle 3: Use "Pull" system to avoid overproduction

- Provide the downline customers in production process with what they want, when they want it and in the amount they want it. Material replenishment initiated by consumption in the basic principle of just-in-time.
- Minimize the work in process and warehousing of inventory by stocking small amounts of each product and frequently restocking based on what the customer actually takes away.
- Be responsive to the day-by-day shifts in customer demand rather than relying on computer schedules and systems to track wasteful inventory.

Principle 4: Level out the workload (heijunka). (Work like a tortoise, not the hare)

- Eliminating waste is just one-third of the equation for making lean successful. Eliminating overburden to people, equipment and eliminating unevenness in the production schedule is just as important - yet generally not understood at companies attempting to implement lean principles.
- Work to level out the workload of all manufacturing and service processes as an alternative to the start/stop approach of working on projects in batches that is typical at most companies.

Principle 5: Build a culture of stopping to fix problems, to get quality right at the first time

- Quality of the customer drives the value proposition
- Use all the modern quality assurance methods available
- Build into the equipment the capability of detecting problems and stopping itself. Develop a visual system to alert team or project leaders that a machine or process needs assistance. Jidoka (machines with human intelligence) is the foundation for "building in" quality.
- Build into the organisation support systems to quickly solve the problems and put in place countermeasures.
- Build into the culture the philosophy of stopping or slowing down to get quality right the first time to enhance productivity in the long run.

Principle 6: Standardized tasks are the foundation for continuous improvements and employee empowerment

- Use stable, repeatable methods everywhere to maintain the predictability, regular timing and regular output of the processes. It is the foundation for the flow and pull.
- Capture the accumulated learning about a process upto a point in time by standardizing today's best practices. Allow creative and individual expression to improve upon the

standard; then incorporate it into the new standard so that when a person moves on they can be handed off the learning to the next person.

Principle 7: Use Visual Control so no problems are hidden

- Use simple visual indicators to help people determine immediately whether they are in standard condition or deviating from it.
- Avoid using a computer screen when it moves the worker's focus away from the workplace.
- Design simple visual system at the workplace where the work is done, to support flow and pull.
- Reduce the reports to one piece of paper whenever possible, even for the most important financial decisions.

Principle 8: Use only reliable, thoroughly tested technology that servers the people and process

- Use technology to support people not to replace people. Often it is best to work out process manually before adding technology to support the people.
- New technology is often unreliable and difficult to standardize and therefore endangers "flow". A proven process that works generally takes precedence over new and untested technology.
- Conduct actual tests before adopting new technology in business processes, manufacturing systems or products.
- Reject or modify technologies that conflict with the culture or that might disrupt stability, reliability and predictability.
- Nevertheless encourage people to consider new technologies when looking into new approaches to work. Quickly implement a thoroughly considered technology if it has been proven in trials and it can improve flow in the processes.

3P: Add value to the organisation by Developing people and partners

Principle 9: Grow leaders who thoroughly understands the work, live philosophy and teach it to others.

- Grow leaders within, rather than buying them from outside the organisation.
- Do not view the leader's job as simply accomplishing tasks and having good people skills. Leaders must be role models for the company's philosophy and the way of doing business.
- A leader must understand the daily work in great detail so that he or she can be a best teacher of the company's philosophy.

Principle 10: Develop exceptional people and teams who follow the company's philosophy

- Create a strange, stable culture in which company values and beliefs are widely shared and lived out over a period of many years.
- Train exceptional individuals and teams to work within the corporate philosophy to achieve exceptional results. Work hard to reinforce the culture continually.
- Use Cross functional teams to improve quality and productivity and enhance flow by solving difficult technical problems. Empowerment occurs only when people use the company's tools to improve company.
- Make an ongoing effort to teach individuals how to work together as teams together toward common goals. Team work is something that has to be learned.

Principle 11: Respect the extended network of partners and suppliers by challenging them and helping them improve

- Have respect for partners and suppliers and treat them as an extension of business.

- Challenge the outside business partners to grow and develop. It shows that they are valued. Set challenging targets and assists partners in achieving them.

4P: Continuously Solving Root Problems Drives Organisational learnings

Principle 12: Go and see for yourself to thoroughly understand the situation (Genchi Genbutsu)

- Solve problems and improve processes by going to the source and personally observing and verifying data rather than theorizing on the basis of what other people or the computer screen tells.
- Think and speak based on personally verified data.
- Even high-level managers and executives should go and see things for themselves, so they will have more than a superficial understanding of the situation.

Principle 13: Make decision slowly by consensus, thoroughly considering all options; implement decisions rapidly

- Do not pick a single direction and go down that one path until the alternatives are thoroughly considered.
- Nemawashi is the process of discussing problems and potential solutions with all of those affected, to collect their ideas and get agreement on a path forward. This consensus process, though time - consuming, helps broaden the search for solutions, and once a decision is made, the stage is set for rapid implementation.

Principle 14: Become a learning organisation through relentless reflection (hansei) and continuous improvements(Kaizen)

- Once a stable process has been established, use continuous improvement tools to determine the root cause of inefficiencies and apply effective countermeasures.

- Design processes that requires almost no inventory. This will make wasted time and resources visible for all to see. Once waste is exposed, have employees use a continuous improvement process (kaizen) to eliminate it.
- Protect the organisational knowledge base by developing stable personnel, slow promotion and very careful succession systems.

1.4. LEAN MANAGEMENT TOOLS

1.4.1. 5 S

5S is a method that uses a list of five Japanese words: seiri, seiton, seiso, seiketsu, and shitsuke. It describes how to organize a work space for efficiency and effectiveness by identifying and storing the items used, maintaining the area and items, and sustaining the new order. The following are the translations of the 5 Japanese words:

1.4.1.1. Sort (Seiri)

- Make work easier by eliminating obstacles.
- Reduce chances of being disturbed with unnecessary items.
- Prevent accumulation of unnecessary items.
- Evaluate necessary items with regard to cost or other factors.
- Remove all parts or tools that are not in use.
- Segregate unwanted material from the workplace.
- Define Red-Tag area to place unnecessary items that cannot immediately be disposed of. Dispose of these items when possible.
- Need fully skilled supervisor for checking on a regular basis.
- Waste removal.
- Make clear all working floor except using material.

1.4.1.2.Set In Order (Seiton)

- Arrange all necessary items so that they can be easily selected for use.
- Prevent loss and waste of time by arranging work station in such a way that all tooling / equipment is in close proximity.
- Make it easy to find and pick up necessary items.
- Ensure first-in-first-out FIFO basis.
- Make workflow smooth and easy.
- All of the above work should be done on a regular basis.
- Maintain safety.
- Place components according to their uses, with the frequently used components being nearest to the work place.

1.4.1.3.Shine (Seiso)

- Clean the workplace on daily basis completely or set cleaning frequency
- Use cleaning as inspection.
- Prevent machinery and equipment deterioration.
- Keep workplace safe and easy to work.
- Keep workplace clean and pleasing to work in.
- When in place, anyone not familiar to the environment must be able to detect any problems within 50 feet in 5 secs.

1.4.1.4.Standardize (Seiketsu)

- Standardize the best practices in the work area.
- Maintain high standards in workplace organization at all times.
- Maintain orderliness. Maintain everything in order and according to its standard.
- Everything in its right place.
- Every process has a standard.

1.4.1.5.Sustain (Shitsuke)

- Not harmful to anyone.
- Also translates as "do without being told".
- Perform regular audits.
- Training and discipline.
- Training is goal-oriented process. Its resulting feedback is necessary monthly.
- Self discipline
- To maintain proper order

1.4.2. VALUE STREAM MAPPING

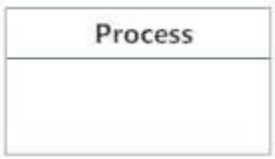
VSM is a tool used to visually map the flow of production. It shows the current and future state of processes in a way that highlights opportunities for improvement.

1.4.2.1. Value Stream Mapping Symbols and Components

A Value Stream Map is made up of a three distinct looking parts: a process map, a corresponding timeline and information flow. The process map is comprised of the steps and the information associated with the steps of the process. The timeline automatically builds from the process map and calculates the data entered. The information flow further explains the interaction and activity between the stations of the value chain.

Value stream mapping uses a set of unique symbols to visualize a process.

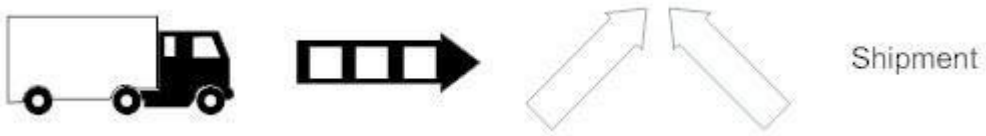
Process: A process is represented with a rectangle and the word "Process". To make the value stream map more readable, a process will often represented the collective processes of an entire department.



Process

Inventory: A triangle with an "I" inside represents the exchange of inventory during the process.

Shipment: A shipment of raw materials from suppliers are represented with blank wide arrows. A pushing of materials from one step in the process to another is usually marked with a black arrow with three white squares inside. Shipments made using external suppliers are represented with a truck or another vehicle where applicable such as boat or train.



Supplier and Customer: Suppliers and customers share the same symbol that looks like an abstract, geometric representation of a factory. A supplier usually will mark the beginning of a process and will be found to the left of the value stream, while a customer is often found as the last step, to the far right of the value stream map.

Electronic flow: A line with a zig-zag in the middle refers to electronic information and data exchanges. While a lot of value stream mapping focuses on raw materials and products, electronic exchanges should also be examined because they can be the root of delays and waste.

Kaizen burst: A Kaizen burst, also known as a Kaizen blitz, refers to a short burst of activity that solves a problem with intensity and urgency. Appropriately, it's represented with what looks like a cartoon explosion.

Kaizen burst

Go see: A go see refers to confirming something visually during the process and it's often represented with a pair of glasses.

Go see

Quality: A quality problem anywhere along the chain can be marked with an octagon, like a STOP sign, with the letter Q inside.

Quality problem

1.4.2.2. How to Create a Value Stream Map

1. **Identify the product or process.** That is, what is it that to map? If multiple products are involved, it may want to start with those with the highest value, volume, or potential.
2. **Define the scope of the mapping project.** Most value stream maps follow the production process from supplier to customer. Some map the supply chain, which would continue upstream to raw materials.
3. **Map the process steps.** This may take some time and will certainly require "working the floor." Some document the process from customer back to supplier, others go from start to finish. We are not breaking down tasks; these are the major steps in the operations performed on the product.
4. **Include information flow.** How does communication flow during the order, production, and delivery steps?
5. **Collect process data.** This will require some effort to develop a clear understanding of important aspects of each step in the process. Some of the data needed may include:
    - Inventory

- Cycle time (how long it takes to make one unit of product)
- Actual work time versus unused/wait time (including number of operators, shifts, etc.)
- Machine uptime and downtime
- Unnecessary movement (of items, material, and workers), scrap rate, etc.

6. **Create a time line**. This information tells us about total process time, inventory demands, and total lead time. This usually shows how lead times may be considerably longer than processing times, indicating how much waste exists in the system.

1.4.3. KAIZEN

Kaizen is a strategy where employees work together proactively to achieve regular, incremental improvements in the manufacturing process. Kaizen is a Japanese word for 'continuous improvement.

1.4.3.1. Requirements for Kaizen

Start with training. Everybody needs to know that Kaizen is becoming part of the workplace culture.

Support Kaizen from the top. Employees need to know that they will get support when they need it.

Get ideas flowing. Use Kaizen boards, quality circles, and suggestion boxes. Employees need a way to communicate effectively.

Keep ideas coming. Let employees implement their own suggestions when possible. This will encourage participation.

Remove barriers. Kaizen boards are especially useful here. They allow workers to post ideas, track their progress, and see the benefits of each improvement.

1.4.3.2. Benefits of Kaizen

Using Kaizen will result in many benefits. Some of the expected benefits will be:

- Increased productivity

- Improved quality
- Better safety
- Lower costs
- Improved customer satisfaction

Other benefits improve the overall culture of the company and increase employee retention:

- Improved communication and cooperation
- Improved morale and employee satisfaction
- Greater personal investment in the company among employees and management.

1.4.4. KANBAN

Kanban is a method of regulating the flow of goods both within the factory and with outside suppliers and customers. Based on automatic replenishment through signal cards that indicate when more goods are needed.

1.4.4.1. Basic Principles of Kanban

- **Visualize what is done today (workflow):** seeing all the items in context of each other can be very informative
- **Limit the amount of work in progress (WIP):** this helps balance the flow-based approach so teams don't start and commit to too much work at once
- **Enhance flow:** when something is finished, the next highest thing from the backlog is pulled into play.

1.4.4.2.Benefits:

- Shorter cycle times can deliver features faster.
- Responsiveness to Change:
- When priorities change very frequently, Kanban is ideal.
- Balancing demand against throughput guarantees that most the customer-centric features are always being worked.
- Requires fewer organization / room set-up changes to get started

- Reducing waste and removing activities that don't add value to the team/department/organization
- Rapid feedback loops improve the chances of more motivated, empowered and higher-performing team members

1.4.5. GEMBA

Gemba is a philosophy that reminds us to get out of our offices and spend time on the plant floor – the place where real action occurs.

1.4.5.1.Application

The practice of regularly going to the Lean workplace to see the actual practices is known as gemba walking. Executives should expect to spend 45 to 60 minutes every week or two gemba walking with a Lean teacher, or Sensei, for six months to a year. Thereafter, they should regularly gemba walk on their own. Gemba walks are crucial to maintaining the disciplined adherence to Lean process designs, part of the Lean support role permeating all leadership positions. Gemba walks form the connective tissue that maintains the gains from Lean and the muscle that drives further improvement.

1.4.6. OVERALL EQUIPMENT EFFECTIVENESS (OEE)

OEE is a framework for measuring productivity loss for a given manufacturing process. Three categories of loss are tracked:

- Availability (e.g. down time)
- Performance (e.g. slow cycles)
- Quality (e.g. rejects)

OEE is useful as both a benchmark and a baseline:

- As a benchmark it can be used to compare the performance of a given production asset to industry standards, to similar in-house assets, or to results for different shifts working on the same asset.

- As a baseline it can be used to track progress over time in eliminating waste from a given production asset

1.4.6.1. Benefits

When using OEE with these systems the benefits become significant:

- Directly tie production efficiencies to fiscal reporting
- Reduce investigation time for root cause analysis
- Shorten equipment ROI through increased utilization
- Decrease costs through waste elimination
- Increase customer satisfaction through quality improvement

1.4.7. TAKT TIME

Takt time is the maximum amount of time in which a product needs to be produced in order to satisfy customer demand. The term comes from the German word "takt," which means "pulse."

Takt time can be first determined with the formula:

Where

T = Takt time, e.g. [work time between two consecutive units]
Ta = Net time available to work, e.g. [work time per period]
D = Demand (customer demand), e.g. [units required per period]

Net available time is the amount of time available for work to be done.

1.4.7.1. Benefits

Once a takt system is implemented there are a number of benefits:

- The product moves along a line, so bottlenecks (stations that need more time than planned) are easily identified when the product does not move on in time.

- Correspondingly, stations that don't operate reliably (suffer frequent breakdown, etc.) are easily identified.
- The takt leaves only a certain amount of time to perform the actual value added work. Therefore, there is a strong motivation to get rid of all non value-adding tasks (like machine set-up, gathering of tools, transporting products, etc.)
- Workers and machines perform sets of similar tasks, so they don't have to adapt to new processes every day, increasing their productivity.
- There is no place in the takt system for removal of a product from the assembly line at any point before completion, so opportunities for shrink and damage in transit are minimized.

1.4.7.2. Downsides

- When customer demand rises so much that takt time has to come down, quite a few tasks have to be either reorganized to take even less time to fit into the shorter takt time, or they have to be split up between two stations (which means another station has to be squeezed into the line and workers have to adapt to the new setup)
- When one station in the line breaks down for whatever reason the whole line comes to a grinding halt, unless there are buffer capacities for preceding stations to get rid of their products and following stations to feed from. A built-in buffer of three to five percent downtime allows needed adjustments or recovery from failures.[2]
- Short takt time can put considerable stress on the "moving parts" of a production system or subsystem. In automated systems/subsystems, increased mechanical stress increases the likelihood of breakdown, and in non-automated systems/subsystems, personnel face both increased physical stress (which increases the risk of repetitive motion (also "stress or "strain") injury), intensified emotional stress, and lowered motivation, sometimes to the point of increased absenteeism.
- Tasks have to be leveled to make sure tasks don't bulk in front of certain stations due to peaks in workload. This decreases the flexibility of the system as a whole.

1.4.8. HEIJUNKA (LEVEL SCHEDULING)

A form of production scheduling that purposely manufactures in much smaller batches by sequencing (mixing) product variants within the same process.

1.4.8.1. Core Concepts of Heijunka

- **Takt time:** The time it takes to finish a product in order to meet customer demand; can be thought of as the customer buying rate. It is the guidance for the entire heijunka implementation.
- **Volume leveling:** Manufacture at levels of long-term average demand and keep a buffer inventory proportional to variability in demand, stability of production process and shipping speed.
- **Type leveling:** Essentially, make every product every day and reserve capacity for changeover flexibility; use a heijunka box to visualize the production flow and schedule.
- **Heijunka box:** A working diagram of type leveling and production schedule.
- **Work slowly and consistently:** Taiichi Ohno, founder of the Toyota Production System, says it best: "The slower but consistent tortoise causes less waste and is much more desirable than the speedy hare that races ahead and then stops occasionally to doze. The Toyota Production System can be realized only when all the workers become tortoises."
- **Changeover time:** Efficiency of changeover is the fulcrum of heijunka; narrowing changeover times helps tighten the value stream between supply and demand.
- **Buffer inventory:** Having some product ready to ship at the beginning of each production cycle is essential to smoothing production and leveling demand at consistent rates and quality so that resource waste is minimized on the line.
- **Type standardization:** By manufacturing one of each product or service a day, knowledge can be more readily shared across types to benefit every process.

1.4.8.2. Benefits

Heijunka helps avoid the inefficiencies of manufacturing in large lots by putting the production process closer in line with customer demand. The flexibility that Heijunka instills brings three benefits to manufacturing:

- **Predictability –** Happens when demand is level
- **Flexibility –** Achieved by reducing changeover time
- **Stability –** Averaging production volume and type over the long term

Organizations that implement a Heijunka leveling schedule in their manufacturing processes can create a number of advantages over their competitors:

- Flexibility to produce what the customer wants when they want it.
- Reduced inventory of unsold goods.
- Balanced use of labor and machines.
- Predictable demand on the upstream processes and suppliers.

1.4.9. POKA YOKE (Error Proofing)

Poka Yoke is to design error detection and prevention into production processes with the goal of achieving zero defects. It is the use of any automatic device or method that either makes it impossible for an error to occur or makes the error immediately obvious once it has occurred.

1.4.9.1. When to use Poka Yoke?

- When a process step has been identified where human error can cause mistakes or defects to occur, especially in processes that rely on the worker's attention, skill or experience.
- In a service process, where the customer can make an error which affects the output.
- At a hand-off step in a process, when output or (for service processes) the customer is transferred to another worker.
- When a minor error early in the process causes major problems later in the process.
- When the consequences of an error are expensive or dangerous.

1.4.9.2. Benefits of Poka Yoke

A typical feature of Poka Yoke solutions is that they don't let an error in a process happen. But that is just one of their advantages. Others include:

- Less time spent on training workers;

- Elimination of many operations related to quality control;
- Unburdening of operators from repetitive operations;
- Promotion of the work improvement-oriented approach and actions;
- A reduced number of rejects;
- Immediate action when a problem occurs;
- 100% built-in quality control.

1.4.10. JIDOKA (Autonomation)

It may be described as "intelligent automation" or "automation with a human touch." This type of automation implements some supervisory functions rather than production functions. At Toyota this usually means that if an abnormal situation arises the machine stops and the worker will stop the production line. It is a quality control process that applies the following four principles:

1. Detect the abnormality.
2. Stop.
3. Fix or correct the immediate condition.
4. Investigate the root cause and install a countermeasure.

Autonomation aims to prevent the production of defective products, eliminate overproduction and focus attention on understanding the problems and ensuring that they do not reoccur.

QUESTIONS

PART A

1. Explain the evolution of lean management
2. What are the guiding principles of lean management?
3. Discuss the wastes associated lean.
4. Explain VSM symbols
5. How to create a Value Stream Map?
6. What are the requirements of Kaizen?
7. Explain the principles and benefits of Kanban
8. What is Takt Time? List it advantages and disadvantages.
9. When to use Poka Yoke?
10. Discuss the core concepts of Heijunka.

PART B

1. Trace the evolution of lean management
2. Discuss the Lean Philosophy with diagram
3. What are the guiding principles of lean management and also explain the wastes associated with lean management.
4. Write in detail about the basics of TPS 14 principles
5. Write notes on 5S approach
6. Describe the Value Stream Mapping approach
7. Briefly explain about Kaizen.
8. Explain in detail about OEE
9. Write notes on Heihunka
10. Enumerate the lean management tools

Reference books

1. The Toyota Way: 14 Management Principles from the World's Greatest Manufacturer (GENERAL FINANCE & INVESTING Jeffrey K. Liker
2. Lean Thinking: Banish Waste and Create Wealth in Your Corporation https://www.amazon.in/James-P-

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School of Management studies

UNIT – II– LEAN MANAGEMENT – SBAA7030

METHODS

Applying various methods and techniques of Lean Management -isolated -complex situations for improving the efficiency and effectiveness -supporting processes of the organization-- interpret calculations of processes, processes' layouts, lean six sigma

2.1. SUPPORTING PROCESSES OF THE ORGANISATION

Activity or function that supports the day-to-day operations of an organization, such as accounting, communications, maintenance, sales are the supporting processes of the organisation.

The key to enterprise-wide business process architecture is a good description of the entire core processes the organization supports. They may all lie within a single Value Chain, or in more than one, but the core processes in each Value Chain are linked from certain initial events to the delivery of products and services to the ultimate external customer. Support processes are just as important to the success of the organization as core processes. The inability to hire key employees or the failure to properly account to government agencies can result in bankruptcy just as not satisfying customer needs can lead to failure. Often, however, there is no flow among the support processes that approximates the logical flow we observe in the core processes. Even the various processes within a given support group – like HR and IT – may have only tangential relationships to one another. HR and IT are collections of processes that may or may not be related to each other, but are linked to most of the core processes and used as needed.

2.2. INTERPRETING CALCULATION OF PROCESSES

2.2.1. Definitions

Process Capability *C*p: A simple and straightforward indicator of process capability.

Process Capability Index *C*pk: Adjustment of *C*p for the effect of non-centered distribution.

Process Performance *P*p: A simple and straightforward indicator of process performance.

Process Performance Index *P*pk: Adjustment of *P*p for the effect of non-centered distribution.

2.2.2. Interpreting Cp, Cpk

*C*pk is an index (a simple number) which measures how close a process is running to its specification limits, relative to the natural variability of the process. The larger the index, the less likely it is that any item will be outside the specs.

*C*pk measures how close we are to the target and how consistent we are to around the average performance. A person may be performing with minimum variation, but he can be away from his target towards one of the specification limit, which indicates lower *C*pk, whereas *C*p will be high. On the other hand, a person may be on average exactly at the target, but the variation in performance is high (but still lower than the tolerance band (i.e., specification interval). In such case also *C*pk will be lower, but *C*p will be high. *C*pk will be higher only when you r meeting the target consistently with minimum variation.

2.2.3. Interpreting Pp, Ppk

Process Performance Index basically tries to verify if the sample that you have generated from the process is capable to meet Customer CTQs (requirements). It differs from Process Capability in that Process Performance only applies to a specific batch of material. Samples from the batch may need to be quite large to be representative of the variation in the batch. Process Performance is only used when process control cannot be evaluated.

2.3. PROCESSES' LAYOUT

Another critical aspect of Lean is the organization of the production facility. Since one of the keys to lean is waste elimination, the layout of any system should be arranged in such manners that waste of motion (material handling and material transport) and elimination of inventory is part of the object for the layout. There are two traditional forms of layout in manufacturing: process and product. In a process layout (or job shop as it is informally called), machines are organized and clustered by type, where typically all mills are in one department, all lathes in another, etc. In a product layout (or flow shop), machines are located so that sequential operations are performed at adjacent machines.

Process layout is typically employed for a large variety of products that are made in very small batches (ones or twos).

The advantages of Process Layout are:

1) The flexibility of the system to product almost any part that fits within the volume metric boundaries of the machines,

2) An in depth understanding of a specific process can be obtained, and

3) Some tooling and fixtures can be shared.

The disadvantages of process layout are:

1) The spaghetti flow is difficult to manage and control,

2) There is usually a lot of inventory in front of each machine,

3) Set up is usually expensive,

4) Material handling times are large, and

5) It is difficult to automate these types of systems.

Product layout systems are used effectively for the economic production of high volume goods. The advantages of these systems are:

1) Large batches can be produced inexpensively,

2) Material handling is minimal,

3) in-process materials are minimized,

4) It is easy to control these systems, and

5) Automation is more achievable and justifiable.

The disadvantages of these systems are:

1) They are inflexible, in that only one or very few products can be produced on them,

2) Set up time for these systems is very large, and

3) Duplicate tooling is required to replace worn tooling so that maintenance can be minimized.

Process systems work effectively on "one of a kind" type of production. As batches get larger, these systems fail to produce the required "economies of scale", and that production time and cost remains relatively constant.

Product systems work very effectively on single item production. For instance, high volume products like soda, beer, canned foods, and cigarettes are effectively produced on these flow systems. The reason that these items are so inexpensive is in part because of the way they are produced. Unfortunately, the high capital cost and long set-up for these systems mandates large volumes to offset these initial cost and then the changeover costs for the system.

In general, very low volume items should be produced on process type systems, and very high volume items should be produced on product type systems. A problem facing most manufacturers is that the general trend today is for medium volume batches that change regularly. This means that process and product layout fails to meet the requirements for much of what is demanded today. The result is that a hybrid of the two systems has been developed. It is called a manufacturing cell. Cells are used to make families of parts, rather than just one-of-a-

kinds or high volume items. Cells are logical clusters of machines organized to produce a variety of parts requiring the same equipment type, tooling and fixtures. Cells are intended to provide as many of the benefits of process and product layouts as possible.

In many ways, **cellular layout** separates and groups products within a manufacturing system into smaller units. The strategy here is to identify parts that belong to the same "product families". A product family is a group of products that normally look similar and require the same (or similar) processing steps to produce. Traditionally, designers have formed product families by grouping products that provide similar functions into a common product family. Examples might be: springs, clips, brackets, etc. The problem however becomes one where functional names may create very large families (for instance, brackets typically form a large portion of products the automotive industries make) or function may require different processes as the size scales.

Group technology (GT) was introduced as a method to characterize products into code-able families. A descriptive code was used to characterize the product geometry, function and/or method used to make the part. As database systems have become more powerful, the code has been replaced with descriptive fields in a database. Today, more formal techniques are used to identify cells. In the following section, a methodology

2.4. LEAN SIX SIGMA

Lean Six Sigma is a combination of two powerful process improvement methods: Lean and Six Sigma. Lean and Six Sigma complement each other. Lean accelerates Six Sigma, delivering greater results than what would typically be achieved by Lean or Six Sigma individually.

Combining these two methods gives your improvement team a comprehensive tool set to increase the speed and effectiveness of any process within your organization – resulting in increased revenue, reduced costs and improved collaboration.

2.4.1. What is Lean?

Lean is popular for its methodical approach to streamlining both manufacturing and service processes by eliminating waste while continuing to deliver value to customers.

Although Lean is widely known for these benefits, it's not just a set of tools. It stems from cultural roots which manifest in the business world as a particular approach to management: a Lean Culture.

A Lean Culture (also known as Lean Management) is the foundation of Lean process improvement. When a Lean Culture exists, improvement is exponentially more likely to be sustained and an environment for continuous improvement is created. It is a combination of defining customer value, aligning around a common purpose, striving for perfection while at the same time respecting and developing employees.

Lean originated with both Henry Ford and his storied assembly line and, more famously, with Taiichi Ohno who codified the Lean Management Philosophy and Practices into the Toyota Production System.

A Lean process:

- Is faster
- Is more efficient and economical
- Delivers satisfactory quality

Lean is achieved by removing "Waste," which is activity not required to complete a process. After removing Waste, only the steps required to produce a product or service that is satisfactory to a Customer will remain.

2.4.2. What is SixSigma?

Six Sigma is simply a method of efficiently solving a problem. Using Six Sigma reduces the amount of defective products manufactured or services provided, resulting in increased revenue and greater customer satisfaction. Six Sigma identifies the cause(s) of your problem to efficiently develop effective solution(s). Six Sigma originated at Motorola in 1986 and since then has saved organizations billions of dollars in virtually every industry.

Six Sigma is named after a statistical concept where a process only produces 3.4 defects per million opportunities (DPMO). Six Sigma can therefore be also thought of as a goal, where processes not only encounter less defects, but do so consistently (low variability).
Basically, Six Sigma reduces variation, so products or services can be delivered as expected reliably.

2.4.3. Benefits of Lean Six Sigma

Lean Six Sigma Increases Profit:

Lean Six Sigma increases your organization's revenue by streamlining processes. Streamlined processes result in products or services that are completed faster and more efficiently at no cost to quality. Simply put, Lean Six Sigma increases revenue by enabling your organization to do more with less – Sell, manufacture and provide more products or services using less resources.

Lean Six Sigma Decreases Costs

Lean Six Sigma decreases your organization's costs by:

- Removing "Waste" from a process. Waste is any activity within a process that isn't required to manufacture a product or provide a service that is up to specification.
- Solving problems caused by a process. Problems are defects in a product or service that cost your organization money.

Basically, Lean Six Sigma enables you to fix processes that cost your organization valuable resources.

Lean Six Sigma Improves Efficiency & Effectiveness

Lean Six Sigma improves the efficiency and effectiveness of your organization by:

- Maximizing your organization's efforts toward delivering a satisfactory* product or service to your customers
- Allowing your organization to allocate resources/revenue produced from your newly improved processes towards growing your business

Simply put, Lean Six Sigma enables you to create efficient processes so that your organization can deliver more products or services, with more satisfied customers than ever before.

Lean Six Sigma Helps Develop People/Employees

Lean Six Sigma develops effective people/employees within your organization by:

- Involving employees in the improvement process. This promotes active participation and results in an engaged, accountable team.
- Building trust. Transparency throughout all levels of the organization promotes a shared understanding of how each person is important to the organization's success.

Basically, Lean Six Sigma develops a sense of ownership and accountability for the employees. This increases their effectiveness at delivering results for any improvement project they are involved in. Quite often, this benefit is overlooked by organizations who implement Lean Six Sigma, but its underlying advantages dramatically increase the chances of continued success of Lean Six Sigma, and the business.

2.4.4. Phases of Lean Six Sigma

- **Define:** Define the problem and what is required to satisfy your customer.
- **Measure:** Map the current process to collect data.
- **Analyze:** Investigate and identify what causes the problem.
- **Improve:** Implement a fix that will solve the problem.
- **Control:** Sustain the improved results.

2.4.5. Who benefits from using Lean Six Sigma?

Organizations of All Sizes

Lean Six Sigma works for small, medium (SMBs) and large businesses. In fact, often times, the same success that is achieved within large businesses can be achieved in small and medium businesses since smaller organizations can move faster because less people, fewer resources and lower levels of red-tape are involved.

The benefits are boundless, as Lean Six Sigma increases revenue and reduces costs, while freeing up resources that can be utilized toward any endeavour your organization wishes to pursue.

For example:

- A new product or service
- Other improvement projects
- Expanding your sales force

People & Morale

Lean Six Sigma not only increases revenue and reduces costs, it positively affects people by engaging them in improving the way they work. Since employees are the closest to the actual

work (production of a product or delivery of a service) of any organization, they become the best resources to understand how to improve the efficiency and effectiveness of business processes.

By participating in successful Lean Six Sigma projects, employees are able to build the confidence and develop the capability to become your business' most important assets. Studies show that when employees feel that they have a positive effect on the organization, they perform better, are more accountable and live happier lives. And once your employees get comfortable with Lean Six Sigma skills, they can continue to find and remove problems and waste in your organization.

Industries

Healthcare

Healthcare costs are skyrocketing across the country and an aging population means increased stress on healthcare services. Lean Six Sigma can help you increase the amount of time care providers are able to spend with patients, reduce the time spent on paperwork, and reduce the time people spend waiting for care, waiting for claims or waiting for a call.

Technology

As consumers increasingly rely on technology, Lean Six Sigma helps businesses by delivering products with fewer defects, decreasing returns and more.

Financial Services

Budgets continue to tighten and resources are more limited than usual. Lean Six Sigma shortens the time to sign up new customers, reduces the time to provide customer service and brings revenue in faster.

QUESTIONS

PART A

1. Discuss the applications of lean management
2. Explain the complex situations for improving the efficiency and effectiveness
3. What are supporting processes of the organisations?
4. How to interpret Cp and Cpk?
5. How to interpret Pp and Ppk?
6. Explain lean, six sigma and lean six sigma
7. Write notes on cellular layout and Group Technology
8. What are the phases of lean six sigma?
9. Discuss the benefits of lean six sigma to industries
10. Write the benefits of lean six sigma to people

PART B

1. Write the applications of various methods and techniques of lean management
2. Discuss the isolated complex situations for improving the efficiency and effectiveness
3. Explain in detail about the various supporting processes in the organisations.
4. How to interpret calculations of processes?
5. Write in detail about the various process layouts
6. Write notes on lean six sigma and its pahses.
7. Discuss the benefits of lean six sigma

REFERENCE BOOKS

1. Toyota Production System: Beyond Large-Scale Production Taiichi Ohno

2. The Lean Turnaround: How Business Leaders Use Lean Principles to Create Value and Transform Their Company by Art Byrne, James P. Womack

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UNIT – III– LEAN MANAGEMENT – SBAA7030

INTRODUCTION TO LEAN MANUFACTURING

Objectives of lean manufacturing-key principles and implications of lean manufacturing-traditional Vs lean manufacturing. Standard work -communication of standard work to employees -standard work and flexibility –visual controls -quality at the source -5S principles -preventive maintenance-total quality management total productive maintenance -changeover/setup time -batch size reduction-production leveling

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3.1. OBJECTIVES OF LEAN MANUFACTURING

3.1.1 Quality: Improvement in quality means elimination of number of errors. The main objective of lean manufacturing is to attain optimum level in quality without any or low fluctuation in operating cost.

3.1.2 Productivity: Productivity is the result of lean manufacturing because same amount of resources which were used earlier now produces better result leading to increase productivity.

3.1.3 Waste: The other main objective of lean manufacturing is to reduce waste like waste of time, waste of efforts, waste of resources etc which will help to get higher productivity and higher profit level.

3.1.4 Help To Keep In Order: Lean manufacturing help to keep everything in order, which will help to find right tool at immediate situation, clean and tidy work place, economics of scale and leading to fast functioning of operations.

3.1.5 Standardized: Adopting Lean manufacturing result in standardized of resources like place for everything and everything in its right place. This makes performance of operation smooth and steady.

3.1.6 Optimum Utilization of Resources: Lean manufacturing aims at optimum or full utilization of resources (time, money, efforts, humans, machines etc.) full utilization in accordance to set standards of organization are always beneficial to organization.

3.1.7 Thorough Checking: Lean manufacturing involves in depth examination of the process as soon as the task is over. As a result short comings are sought out at the very first step before moving to next stage and efficiency is maintained at every stage.

3.2. KEY PRINCIPLES AND IMPLICATIONS OF LEAN MANUFACTURING

For the process to work effectively, the manufacturing industry should consider the following five principles that will help in implementing lean techniques:

3.2.1. Value

When manufacturing any product, as a manufacturer, we should consider value as what the customer needs. At many times, manufacturers tend to think that value is created from what they think is best. However, they forget that the end user of their products is the customer. Therefore, if we want to create the highest value in your product, we have to find ways of determining customer needs. There are different ways that you can use to identify the various customer needs before manufacturing your product:

- Quality function deployment
- Brainstorming
- Identifying market gaps
- Providing different choices and identifying the most preferred choice
- Issuing out questionnaires

Engage only in activities that improve the value of the product or service to the customers to minimise or eliminate wastage. Remember, your customers are the key determinant of what value means to your products. Involving them in creating value of your products is inevitable.

3.2.2. Value stream

In order to create value, we will have to go through various processes, which make up the value stream. The processes range from finding the most suitable raw materials to the final use of the

product. These processes engage steps that add value and others that do not add value. As a lean principle, it is the duty of the manufacturer to limit the processes only to value adding steps as much as we can. While some of the non-value adding steps may not be fully avoidable, lean manufacturing advocates for total removal of these steps.

One best way of identifying the value stream in a manufacturing company is departmentalisation. Departmentalisation helps in choosing the right staff for the different functions found in different departments. There is no overlapping of functions and time is used efficiently.

3.2.3. Inventory flow

As we continue improving the value of a product from one process to another, it is essential to ensure a one-piece-flow system. Lean manufacturing requires a smooth flow of processes as the raw material is being designed to suit the customer needs. The processes need to flow in such a way that there is a systematic way of creating the value of the customer's needs. Creating a value stream is essentially important in that the processes would continue even after reshuffling of employees. This is because there is a perfectly designed way of going through all these processes.

3.2.4. Value pull

This principle requires setting out ways that will make the customers look for the product rather than pushing the product to them. If we did not design the product to suit the customer's needs, we would have a hard time persuading customers to purchase the product.

3.2.5. Striving for perfection

Lastly, always be driven by the urge of perfecting the products. Remove waste processes from the operation. Deliver products within the designated time, employ continuous improvement tools like Kaizen, and establish a positive relationship with your employees and customers.

3.3. TRADITIONAL VS LEAN MANUFACTURING

Traditional: Production driven by sales forecast (Push).

Lean: Production is driven by customer demand; items are only produced when an order is placed (Pull - one of the 5 lean principles).

Traditional: Problems are viewed as just that, problems.

Lean: Problems are viewed as opportunities for improvement often through root cause analysis.

Traditional: Work in process (WIP) is viewed as a normal part of operations.

Lean: WIP is a sign that a process needs to improved and is considered a type of waste that should be reduced or eliminated (the same is true for inventory).

Traditional: Improve system (disregarding all of the types of waste in the process).

Lean: Improve system by 1) Eliminating waste and 2) Improving current processes.

Traditional: Management is the primary driver of change.

Lean: Everyone is empowered, trained in the principles of lean and encouraged to look for ways to improve processes.

Traditional: If a process is working (if it ain't broke) don't fix it.

Lean: Always look for ways to improve processes.

Traditional: Standardized work (people performing the same task the same way) only exists in documents like SOPs, rarely in reality.

Lean: Everyone performs the same task the exact same way until a better way is discovered; then everyone performs the task the new and improved way.

Traditional: Focuses on training and relies on people to not make mistakes.

Lean: Focuses on building processes that are error proofed (a person cannot make a mistake or it would be difficult to do so).

Traditional: Systems thinking (views the organization as a whole), often ignoring or unable to see the enormous opportunities for improvement.

Lean: Views the organization as a series of interrelated processes that can and should be improved.

3.4. STANDARD WORK

Standard Work is a formally defined and documented process to produce at a specified pace. Standard Work has three main components:

- It is balanced to the takt time.
- It specifies standard work-in-process (WIP).
- It defines the sequence of operations for a single operator.

3.5. COMMUNICATING STANDARD WORK TO EMPLOYEES

- Engage employees in the development process
- Encourage team members to collaborate and identify the current best practice (if one does not currently exist)
- Be realistic for current state of the process
- Guide through the creation and provide final feedback / approval
- Design with the intent to make problems visible
- Capture takt time of the process

3.6. STANDARD WORK AND FLEXIBILITY

Flexible work schedules are those that vary from the standard work schedules of an organization. Since flexible schedules must meet the needs of both the employer and the employee, flexible work schedules are based on worker needs within set parameters approved by a supervisor.

3.7. VISUAL CONTROLS

Visual controls are a system of signs, information displays, layouts, material storage and handling tools, color-coding, and poka-yoke or mistake proofing devices. The visual control system makes product flow, operations standards, schedules and problems instantly identifiable to even the casual observer.

The purpose for visual controls in lean management is to focus on the process and make it easy to compare expected vs. actual performance. These comparisons highlight when the process is not performing as expected and where improvement might be needed.

3.7.1. TYPES OF VISUAL CONTROLS

There are two groups in visual controls. Displays group and controls group.

- A visual display group relates information and data to employees in the area. For example, charts showing the monthly revenues of the company or a graphic depicting a certain type of quality issue that group members should be aware of.
- A visual control group is intended to actually control or guide the action of the group members. Examples of controls are readily apparent in society: stop signs, handicap parking signs, no smoking signs, etc.

3.7.2. BENEFITS OF VISUAL CONTROLS

Visual control methods aim to increase the efficiency and effectiveness of a process by making the steps in that process more visible. The theory behind visual control is that if something is clearly visible or in plain sight, it is easy to remember and keep at the forefront of the mind. Another aspect of visual control is that everyone is given the same visual cues and so are likely to have the same vantage point.

There are many different techniques that are used to apply visual control in the workplace. Some companies use visual control as an organizational tool for materials. A clearly labeled storage board lets the employee know exactly where a tool belongs and what tools are missing from the display board. Another simple example of a common visual control is to have reminders posted on cubicle walls so that they remain in plain sight. Visual signs and signals communicate information that is needed to make effective decisions. These decisions may be safety oriented or they may give reminders as to what steps should be taken to resolve a problem. Most companies use visual controls in one degree or another, many of them not even realizing that the visual controls that they are making have a name and a function in the workplace. Whether it is recognized by the name of "visual control" or not, the fact is that replacing text or number with

graphics makes a set of information easier to understand with only a glance, making it a more efficient way of communicating a message.

Visual controls are designed to make the control and management of a company as simple as possible. This entails making problems, abnormalities, or deviations from standards visible to everyone. When these deviations are visible and apparent to all, corrective action can be taken to immediately correct these problems.

Visual controls are meant to display the operating or progress status of a given operation in an easy to see format and also to provide instruction and to convey information. A visual control system must have an action component associated with it in the event that the visually represented procedures are not being followed in the real production process. Therefore visual controls must also have a component where immediate feedback is provided to workers.

3.8. 5S

5S is a method that uses a list of five Japanese words: seiri, seiton, seiso, seiketsu, and shitsuke. It describes how to organize a work space for efficiency and effectiveness by identifying and storing the items used, maintaining the area and items, and sustaining the new order. The following are the translations of the 5 Japanese words:

3.8.1. Sort (Seiri)

- Make work easier by eliminating obstacles.
- Reduce chances of being disturbed with unnecessary items.
- Prevent accumulation of unnecessary items.
- Evaluate necessary items with regard to cost or other factors.
- Remove all parts or tools that are not in use.
- Segregate unwanted material from the workplace.
- Define Red-Tag area to place unnecessary items that cannot immediately be disposed of. Dispose of these items when possible.
- Need fully skilled supervisor for checking on a regular basis.

- Waste removal.
- Make clear all working floor except using material.

3.8.2. Set In Order (Seiton)

- Arrange all necessary items so that they can be easily selected for use.
- Prevent loss and waste of time by arranging work station in such a way that all tooling / equipment is in close proximity.
- Make it easy to find and pick up necessary items.
- Ensure first-in-first-out FIFO basis.
- Make workflow smooth and easy.
- All of the above work should be done on a regular basis.
- Maintain safety.
- Place components according to their uses, with the frequently used components being nearest to the work place.

3.8.3. Shine (Seiso)

- Clean the workplace on daily basis completely or set cleaning frequency
- Use cleaning as inspection.
- Prevent machinery and equipment deterioration.
- Keep workplace safe and easy to work.
- Keep workplace clean and pleasing to work in.
- When in place, anyone not familiar to the environment must be able to detect any problems within 50 feet in 5 secs.

3.8.4 Standardize (Seiketsu)

- Standardize the best practices in the work area.
- Maintain high standards in workplace organization at all times.

- Maintain orderliness. Maintain everything in order and according to its standard.
- Everything in its right place.
- Every process has a standard.

3.8.5. Sustain (Shitsuke)

- Not harmful to anyone.
- Also translates as "do without being told".
- Perform regular audits.
- Training and discipline.
- Training is goal-oriented process. Its resulting feedback is necessary monthly.
- Self discipline
- To maintain proper order

3.9. PREVENTIVE MAINTENANCE

Preventive maintenance refers to regular, routine maintenance to help keep equipment up and running, preventing any unplanned downtime and expensive costs from unanticipated equipment failure. It requires careful planning and scheduling of maintenance on equipment before there is an actual problem as well as keeping accurate records of past inspections and servicing reports.

3.9.1. Steps in designing an effective preventive maintenance program

PM procedure design: Doing the effective things

To define the process, begin at the end: What results does the company want from a PM program? If it's savings, this should come from achieving minimal unplanned downtime and minimal lost production opportunity time, minimal spare parts costs, minimal maintenance labor costs, minimal manufacturing interruptions, maximum manufacturing time available per machine, maximum quality of products and maximum machine life spans. These areas are where the majority of the savings will be found.

The best PM procedures are written by people who understand OEM recommendations. These individuals also understand their machines' performance history and service requirements in your plant environment. They look at the age of each machine. They examine its static and dynamic systems. They look at its foundation, support, mechanical, electrical, electronics, control, pneumatic and hydraulic systems. They analyze how power losses, power spikes, environmental impacts and operator errors can affect each machine.

To catch and repair machine problems before their components fail, a detailed analysis must take place. If the PM program architects don't closely examine these causes of machine failures, they'll also miss some of the inspections that will need to be baked into your program's task list.

The PM procedures should also include a list of specialty tools that will be needed, such as torque wrenches, drills, scissors lifts, forklifts, etc. Procedures should spell out how to safely work with and maintain these tools.

PM procedure scheduling: Efficient use of people and resources

Once the proper procedures are written and uploaded in the Computerized Maintenance Management System (CMMS), each needs to be scheduled. In most plants, this means setting up daily, weekly, monthly, quarterly, semi-annual and annual PM events. While not all machines require daily or weekly preventive maintenance checks, most will require monthly, quarterly, semi-annual and annual exams. To develop a quarterly PM schedule, many take their monthly PM and add a few things that don't need to be inspected monthly but do need to be inspected more than twice per year. This also applies to semi-annual and annual PM's, which are quarterly PM's that contain additional inspections twice per year or more. If these schedules are set up properly, your PM time will be kept to a minimum.

PM lubrication engineering

As one performs lubrication tasks, some visual and maybe a few physical inspections can be made. Based on these tasks, PM procedures can be written.

Get trained professionals involved with choosing the best lubricant for each application. All the major lubricant OEM's have these services available—take advantage of them! It's important to

understand what lubricant should be used, how much to be used per application and at what intervals. After the first application, track each machine to determine where changes need to be made to lubricant types, application quantities and application frequency.

Lube lists and instructions need to be added to each PM task with lube procedures for critical machines. Where will lubes be stored and in what controlled environment? Does the oil and grease storage area meet all environmental, legal, sanitary and safety requirements? Who will be doing the inventory and ensuring that adequate lubrication supplies are maintained? Are the proper procedures in place for disposing of waste oils and lube-contaminated materials? Review, adopt and implement the lubrication best practices that work for your facility and machines.

PM training: Back on the chain gang

Training for PM tasks is critical. It can make the difference between catching a seemingly-small issue that prevents a hugely expensive repair, or missing a problem that shuts down your line for days or weeks.

PM program management Plan

Metrics drive everything these days, and PM management is no exception. If the facility has a good work order (WO) system in place that captures maintenance labor hours, materials and reasons for each WO, these could be measured:

- How many corrective WO's have been required for each piece of your equipment
- Which WO's address breakdowns
- Which WO's require spare parts
- How many man-hours are required per WO

Capturing WO detail will also help you track surges and decreases in equipment costs, and fine-tune the frequency of PM tasks.

Communicate

The best PM program ever designed will still fail if maintenance workers don't understand how they will benefit and put their efforts into making it a success. If they haven't seen benefits from past PM programs, prepare to turn around negative perceptions.

While PM program design is crucial, communicating to workers is essential. They need to know what will be done. Who will be doing what, and when. What performance measures they need to meet. Workers need to know that the PM program is fluid, that continuous improvement is the goal and that everyone's input is valued. Besides the all-important training, your communications must help workers understand that PM will remove work from their plates.

3.9.2. Benefits of Preventive Maintenance

Preventive maintenance offers companies a number of important benefits including

- Prolonged life of company equipment
- Less unplanned downtime caused by equipment failure
- Less unnecessary maintenance and inspections
- Fewer errors in day-to-day operations
- Improved reliability of equipment
- Fewer expensive repairs caused by unexpected equipment failure that must be fixed quickly
- Reduced risk of injury

3.10. TOTAL QUALITY MANAGEMENT

Total Quality Management (TQM) is a management approach focusing on the improvement of quality and performance in all functions, departments, and processes across the company to provide quality services which exceed customer expectations. TQM expands the scope of quality of every department from top management to lower level employees. It enables management to adopt a strategic approach to quality and put more effort on prevention rather than on inspection.

3.10.1. CHARACTERISTICS OF TQM

The above definitions revealed the following characteristics of TQM:

- TQM is a customer oriented.
- TQM required a long term commitment for continuous improvement of all processes.

- TQM is a teamwork.
- TQM requires the leadership of top management and continuous involvement.
- TQM is a strategy for continuous improving performance at all levels and in all areas of responsibility.

A successful TQM programme requires the following six basic concepts.

- **Top Management Commitment:** Top management should participate and completely involve in the total quality programme. They should ensure their complete commitment to the approach through management meetings, company magazines or newsletters. Also, top management should make sure that everybody within the organization from top to bottom is communicated about the TQM programme.
- **Focus on the customer:** Achieving customer satisfaction is the heart of TQM. Customers include both internal and external customers. So focus on the customer is the key for any TQM programme.
- **Effective involvement and utilization of the entire work force:** This concept is sometimes referred as 'principle of employees involvement' or 'respect for people'. TQM is a team work. Total quality recognizes that each person is responsible for the quality of his work and for the work of the group. All persons must be trained in TQM, Statistical Process Control (SPC), and other appropriate quality improvement skills so that they can effectively participate on quality teams.
- **Continuous improvement:** TQM is based on the quest for progress and improvement. TQM believes that there is always a better way of doing things, way to make better use of the company's total quality resources, a way to be more productive. For this purpose various quality tools and techniques may be used.
- **Treating suppliers as partners:** Since the suppliers influence the company's quality, therefore a partnering relationship should be developed between the management and the suppliers.
- **Establishing performance measures for the processes:** As we know, quantitative data are necessary to measure the continuous quality improvement activity. Therefore performance measures such as uptime, productivity, sales turnover, absenteeism, percent

non- conforming, customer satisfaction, etc., should be determined for each functional area. These results can be used for further improvement activities.

3.10.2. Elements of TQM

A framework summarizing the important elements of TQM discussed in this text. Three elements of TQM include

- The philosophical elements of TQM stress the operation of the company using quality as the integrating element.
- The generic tools consist of various statistical process control (SPC) methods that are used for problem solving and continuous improvement by quality teams. Quality function deployment is typically used by managers to drive the voice of the customer into the organization.
- Tools of the QC department consists of statistical quality control (SQC) methods such as sampling plans, process capability and Taguchi methods.

3.10.3. Principles of TQM

14 principles of Quality management:

- Create and publish to all employees a statement of the aims and purposes of the company. The management must demonstrate their commitment to this statement.
- Learn the new philosophy.
- Understand the purpose of inspection – to reduce the cost and improve the processes.
- End the practice of awarding business on the basis of price tag alone.
- Improve constantly and forever the system of production and service.
- Institute training
- Teach and institute leadership. 8. Drive out fear. Create an environment of innovation.
- Optimize the team efforts towards the aims and purposes of the company.
- Eliminate exhortations for the workforce.
- Eliminate numerical quotas for production.

- Remove the barriers that rob pride of workmanship.
- Encourage learning and self-improvement.
- 14. Take action to accomplish the transformation

3.10.4. Barriers to TQM Implementation

Many organization especially small ones with a niche are comfortable with their current state. They are satisfied with the amount of work being performed, the profits realized, and the perception that the customers are satisfied. Organizations with this culture will see little need for TQM until they begin to lose market share. Once an organization embarks on TQM, there will be obstacles to its success implementation The barriers to TQM Implementation were:

- Lack of management commitment
- Lack of faith in and support to TQM activities among management personnel
- Failure to appreciate TQM as a cultural revolution. In other words, inability to change organizational culture
- Misunderstanding about the concept of TQM
- Improper planning
- Lack of employees commitment
- Lack of effective communication
- Lack of continuous training and education
- Lack of interest or incompetence of leaders
- Ineffective measurement techniques and lack of access to data and results
- Non-application of proper tools and techniques
- Inadequate use of empowerment and team work
- Incompatible organizational structure and isolated individuals and departments

3.11. TOTAL PRODUCTIVE MAINTENANCE (TPM)

Total Productive Maintenance (TPM) is defined as keeping the running plant and equipment at its highest productive level with the co-operation of all areas of the organization. Predictive and

Preventive maintenance are essential to building a foundation for a successful TPM environment. Predictive Maintenance is the process of using data and statistical tools to determine when a piece of equipment will fail. Preventive Maintenance is the process of periodically performing activities such as lubrication on the equipment to keep it running.

3.11.1. Objectives of TPM :

- To maintain and improve equipment capacity.
- To maintain equipment for life.
- To use support from all areas of the operation.
- To encourage input from all employees.
- To use teams for continuous improvement.

3.11.2. TPM PHILOSOPHY – CONCEPT OF TPM :

Total Productive Maintenance (TPM) is an extension of the Total Quality Management (TQM) philosophy to the maintenance function. TPM has the following steps:

- Management should learn the new philosophy of TPM.
- Management should promote the new philosophy of TPM.
- Training should be funded and developed for everyone in the organization.
- Areas of needed improvement should be identified. Loss measurements to identify improvement needs are
    - Down time losses
    - Reduced speed losses
    - Poor quality losses
- Performance goals should be formulated.
- An implementation plan should be developed.
- Autonomous worth groups should be established.

3.12. CHANGEOVER / SETUP TIME

Setup time: The time taken to prepare the manufacturing processes and system for production.

Changeover time: The time taken to modify the production line for different products or new batches of the same product. Changeover times can last from a few minutes to as much as several weeks for new models.

3.12.1. Changeover Time Reduction Techniques

Specific techniques to reduce changeover time are:

Staged Tooling and Fixtures

If a part or tool must be placed into a fixture prior to an operation, such as machining, add a fixture so that while one part or tool is in the machine, the second can be set up in the fixture.

Operations Conducted in Parallel

Standardization

Tools that are the same size with the same attachment location can be changed much more quickly. Standardized attachment points and methods reduce confusion helps in saving time. Standardization also applies to tool storage organization so that tools can be quickly located.

Quick Attachments

No-Adjust Tooling

Duplicate Tooling

Duplicate tooling can minimize or eliminate the need for changeovers, and the cost can quickly be offset by reduction in inventory and set-up labor costs. Simple pre-set gauges and templates can speed up changeovers without large expense.

Assisted Tool Movement

Large dies or other heavy tools can be moved much faster using dedicated die carts, roller tables, or small conveyors than with forklifts or cranes. Mechanized tool change equipment allows pre-staging of the replacement tool, and may also facilitate changeovers by the base equipment operator without additional indirect labor.

3.12.2. Benefits of reduced changeover time

By incorporating the above methods, massive dies are commonly changed in less than 10 minutes - setups that used to take hours. Benefits of reduced changeover time extend beyond the direct reduction of inventory to include:

- Reduced lead times and improved responsiveness to customers.
- Flexibility to respond to changes in demand.
- Improved product quality from quicker information feedback.
- Improved visual control and plant communication.
- Reduction of indirect costs for material movement, counting, and transaction processing.

3.13. BATCH SIZE REDUCTION

Another essential component of decreasing the risk of releases is to reduce batch size. In general, reducing batch size is one of the most powerful techniques available for improving the flow of features from brains to users. When we reduce batch size we can deploy more frequently, because reducing batch size drives down cycle time

3.13.1. BENEFITS OF REDUCTION IN BATCH SIZE

- Less Work in Progress
- Faster feedback
- Greater visibility
- Improved quality
- Less risk of delays and cost overruns
- Reduced complexity
- Improved decision making

3.14. PRODUCTION LEVELLING

Heijunka (hi-JUNE-kuh) is a Japanese word for leveling. It is part of the lean methodology of process improvement that helps organizations match unpredictable customer demand patterns and eliminate manufacturing waste by leveling the type and quantity of production output over a fixed period of time.

3.14.1. How Does Heijunka Work?

It may be easier to understand Heijunka and how it can improve the production process by contrasting it with the traditional production method of batching.

Batching has been a commonly used method for organizing the manufacturing process since the invention of mass production. Batching produces large lots of products without taking into account the fluctuation of customer demand. The output that is not immediately purchased by the customer is placed in inventory.

The traditional method of batching has several drawbacks:

- Customer demand is rarely predictable. When customers follow an unanticipated buying pattern, the manufacturer may experience confusion and disorder.
- The demand on upstream processes is erratic.
- The cost of unsold goods held in inventory decreases profitability.

Batching also results in uneven product quality and overworked equipment and personnel, which combine to create waste.

3.14.2. What's so Great About Heijunka?

Heijunka helps avoid the inefficiencies of manufacturing in large lots by putting the production process closer in line with customer demand. The flexibility that Heijunka instills brings three benefits to manufacturing:

- Predictability – Happens when demand is level

- Flexibility – Achieved by reducing changeover time
- Stability – Averaging production volume and type over the long term

Organizations that implement a Heijunka leveling schedule in their manufacturing processes can create a number of advantages over their competitors:

- Flexibility to produce what the customer wants when they want it.
- Reduced inventory of unsold goods.
- Balanced use of labor and machines.
- Predictable demand on the upstream processes and suppliers.

Heijunka requires adjusting production to mirror customer demand as closely as possible. When the company makes all product types and maintains a small inventory buffer throughout a year, there is greater flexibility to meet changing customer demand patterns. The buffer inventory will be liquidated during the year and production will be able to meet periods of peak demand and erratic customer purchasing.

3.14.3. Process Adjustments for Heijunka

Lean six sigma encourages manufacturing every type of product every day. This requires manufacturers to minimize the changeover time needed to convert the line from producing one product to another. The effectiveness and financial viability of Heijunka are determined by the efficiency of the changeover process.

3.14.4. How to Implement Heijunka

The first step in leveling production to match customer demand is to set the pace of manufacturing according to what Heijunka calls Takt time. This is the customer buying rate, or the time it takes to finish a product to meet customer demand. Matching the production rate to customer demand helps create a level manufacturing process that is free of bottlenecks.

Manufacturers exist to meet customer demand as smoothly and predictably as possible. However, the customer buying behavior is frequently unpredictable. Using Heijunka to match customer buying patterns helps manufacturers fulfill the customer’s needs and reduce waste in the production process.

QUESTIONS

PART A

1. What are the objectives of lean manufacturing?
2. Discuss the principles of lean manufacturing
3. What is standard work? Explain the difference between standard work and flexible work
4. What is visual control? State its benefits.
5. What is preventive maintenance? List its advantages
6. What is TQM? Explain its characteristics.
7. Discuss the elements of TQM
8. What are the objectives of TPM?
9. What is batch size reduction? State its benefits
10. Explain the working of Heijunka

PART B

1. Write in detail the objectives, principles and implications of lean manufacturing
2. Differentiate traditional and lean manufacturing
3. What is standard work? How will you communicate to employees?
4. Write notes on 5S Approach
5. Discuss the steps in preventive maintenance
6. Explain the principles of TQM
7. What are the barriers to TQM implementation?
8. Explain TPM Philosophy
9. Write notes on set up and changeover time
10. Discuss in detail about production leveling

REFERENCE BOOKS

1. The Lean Book of Lean: A Concise Guide to Lean Management for Life and Business John-Earley
2. Lean Production Simplified, Second Edition: A Plain-Language Guide to the World's Most Powerful Production System by Pascal- dennis Productivity Press; 2nd edition (2 March 2007)

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School of management studies

UNIT – IV– LEAN MANAGEMENT – SBAA7030

VALUE STREAM MAPPING:

Application to the factory simulation scenario–line balancing– Poke Yoke – kanban – overall equipment effectiveness. Value stream mapping and Spaghetti charts. Lean production preparation- system assessment, process and sources of waste. Employee involvement – importance of quality culture

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4.1. POKA YOKE (Error Proofing)

Poka Yoke is to design error detection and prevention into production processes with the goal of achieving zero defects. It is the use of any automatic device or method that either makes it impossible for an error to occur or makes the error immediately obvious once it has occurred.

4.1.1. When to use Poka Yoke?

- When a process step has been identified where human error can cause mistakes or defects to occur, especially in processes that rely on the worker's attention, skill or experience.
- In a service process, where the customer can make an error which affects the output.
- At a hand-off step in a process, when output or (for service processes) the customer is transferred to another worker.
- When a minor error early in the process causes major problems later in the process.
- When the consequences of an error are expensive or dangerous.

4.1.2. Benefits of Poka Yoke

A typical feature of Poka Yoke solutions is that they don't let an error in a process happen. But that is just one of their advantages. Others include:

- Less time spent on training workers;
- Elimination of many operations related to quality control;
- Unburdening of operators from repetitive operations;
- Promotion of the work improvement-oriented approach and actions;
- A reduced number of rejects;
- Immediate action when a problem occurs;
- 100% built-in quality control.

4.2. KANBAN

Kanban is a method of regulating the flow of goods both within the factory and with outside suppliers and customers. Based on automatic replenishment through signal cards that indicate when more goods are needed.

4.2.1. Basic Principles of Kanban

- **Visualize what is done today (workflow):** seeing all the items in context of each other can be very informative
- **Limit the amount of work in progress (WIP):** this helps balance the flow-based approach so teams don't start and commit to too much work at once
- **Enhance flow:** when something is finished, the next highest thing from the backlog is pulled into play.

4.2.2. Benefits:

- Shorter cycle times can deliver features faster.
- Responsiveness to Change:
- When priorities change very frequently, Kanban is ideal.
- Balancing demand against throughput guarantees that most the customer-centric features are always being worked.
- Requires fewer organization / room set-up changes to get started
- Reducing waste and removing activities that don't add value to the team/department/organization

- Rapid feedback loops improve the chances of more motivated, empowered and higher-performing team members

4.2.3. OVERALL EQUIPMENT EFFECTIVENESS (OEE)

OEE is a framework for measuring productivity loss for a given manufacturing process. Three categories of loss are tracked:

- Availability (e.g. down time)
- Performance (e.g. slow cycles)
- Quality (e.g. rejects)

OEE is useful as both a benchmark and a baseline:

- As a benchmark it can be used to compare the performance of a given production asset to industry standards, to similar in-house assets, or to results for different shifts working on the same asset.
- As a baseline it can be used to track progress over time in eliminating waste from a given production asset

4.3.1. Benefits

When using OEE with these systems the benefits become significant:

- Directly tie production efficiencies to fiscal reporting
- Reduce investigation time for root cause analysis
- Shorten equipment ROI through increased utilization
- Decrease costs through waste elimination
- Increase customer satisfaction through quality improvement

4.4. VALUE STREAM MAPPING

VSM is a tool used to visually map the flow of production. It shows the current and future state of processes in a way that highlights opportunities for improvement.

4.4.1. Value Stream Mapping Symbols and Components

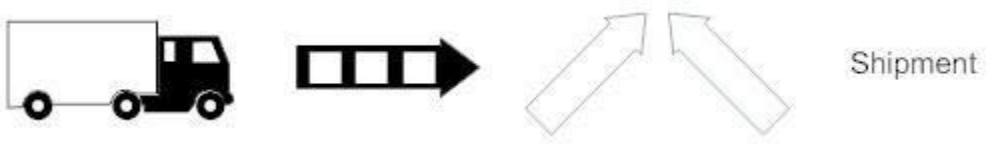
A Value Stream Map is made up of a three distinct looking parts: a process map, a corresponding timeline and information flow. The process map is comprised of the steps and the information associated with the steps of the process. The timeline automatically builds from the process map and calculates the data entered. The information flow further explains the interaction and activity between the stations of the value chain.

Value stream mapping uses a set of unique symbols to visualize a process.

Process: A process is represented with a rectangle and the word "Process". To make the value stream map more readable, a process will often represented the collective processes of an entire department.

Inventory: A triangle with an "I" inside represents the exchange of inventory during the process.

Shipment: A shipment of raw materials from suppliers are represented with blank wide arrows. A pushing of materials from one step in the process to another is usually marked with a black arrow with three white squares inside. Shipments made using external suppliers are represented with a truck or another vehicle where applicable such as boat or train.



Supplier and Customer: Suppliers and customers share the same symbol that looks like an abstract, geometric representation of a factory. A supplier usually will mark the beginning of a

process and will be found to the left of the value stream, while a customer is often found as the last step, to the far right of the value stream map.

Electronic flow: A line with a zig-zag in the middle refers to electronic information and data exchanges. While a lot of value stream mapping focuses on raw materials and products, electronic exchanges should also be examined because they can be the root of delays and waste.

Kaizen burst: A Kaizen burst, also known as a Kaizen blitz, refers to a short burst of activity that solves a problem with intensity and urgency. Appropriately, it's represented with what looks like a cartoon explosion.

Go see: A go see refers to confirming something visually during the process and it's often represented with a pair of glasses.

Quality: A quality problem anywhere along the chain can be marked with an octagon, like a STOP sign, with the letter Q inside.

4.4.2. How to Create a Value Stream Map

1. **Identify the product or process.** That is, what is it that to map? If multiple products are involved, it may want to start with those with the highest value, volume, or potential.
2. **Define the scope of the mapping project.** Most value stream maps follow the production process from supplier to customer. Some map the supply chain, which would continue upstream to raw materials.
3. **Map the process steps.** This may take some time and will certainly require "working the floor." Some document the process from customer back to supplier, others go from start to finish. We are not breaking down tasks; these are the major steps in the operations performed on the product.
4. **Include information flow.** How does communication flow during the order, production, and delivery steps?
5. **Collect process data.** This will require some effort to develop a clear understanding of important aspects of each step in the process. Some of the data needed may include:
    - Inventory
    - Cycle time (how long it takes to make one unit of product)
    - Actual work time versus unused/wait time (including number of operators, shifts, etc.)
    - Machine uptime and downtime
    - Unnecessary movement (of items, material, and workers), scrap rate, etc.
6. **Create a time line**. This information tells us about total process time, inventory demands, and total lead time. This usually shows how lead times may be considerably longer than processing times, indicating how much waste exists in the system.

4.5. SPAGHETTI CHARTS

Spaghetti diagrams or layout diagrams they are often called are a really useful lean process improvement tool used to monitor the movement of personnel or material within a predefined part of an organization. While this tool has its origin in manufacturing, these diagrams can be used in lots of different business environments and are even great when analyzing an office environment.

4.5.1. Need for Sphagetti Diagram

A spaghetti diagram, also known as spaghetti chart, spaghetti model, or spaghetti plot, is a particular tool for determining the distance traveled by (usually) man or (in some cases) material. Hence, a spaghetti diagram can help to reduce the distance traveled by either parts or people. Obviously, this works best for a repetitive environment where the work repeats in the same or similar style multiple times.

This allows analyzing and optimizing the distances. The benefit can be either faster delivery or the same delivery with less effort.

4.5.2. Steps

1) Record the processes on the side and ask questions if not clear on the activity.

2) Start at the beginning of the scope, the start of the first process. Use directional arrows for the routes that are traced on the paper.

3) Do not leave out any flow movement even if the paper becomes cluttered and difficult to follow. This probably indicates opportunity. Most often, the perceived unusual flow or "exceptions" are actually happening more often that is realized. Capture these!

4) Record the amount of time within each activity.

5) Shows the areas where materials stops, staged, held, inspected and picked up. Look for point-of-use opportunities for materials, tools, and paperwork.

6) Record the names of those involved, dates, times, and other relevant information.

7) Calculate the distance, times, shift, starts, stops, to provide baseline performance.

8) Create a separate diagram showing the ideal state of flow for each that eliminates as

much non-value added tasks as possible. The team should target the ideal state and the Project Manager and Champion should remove obstacles that may prevent this objective.

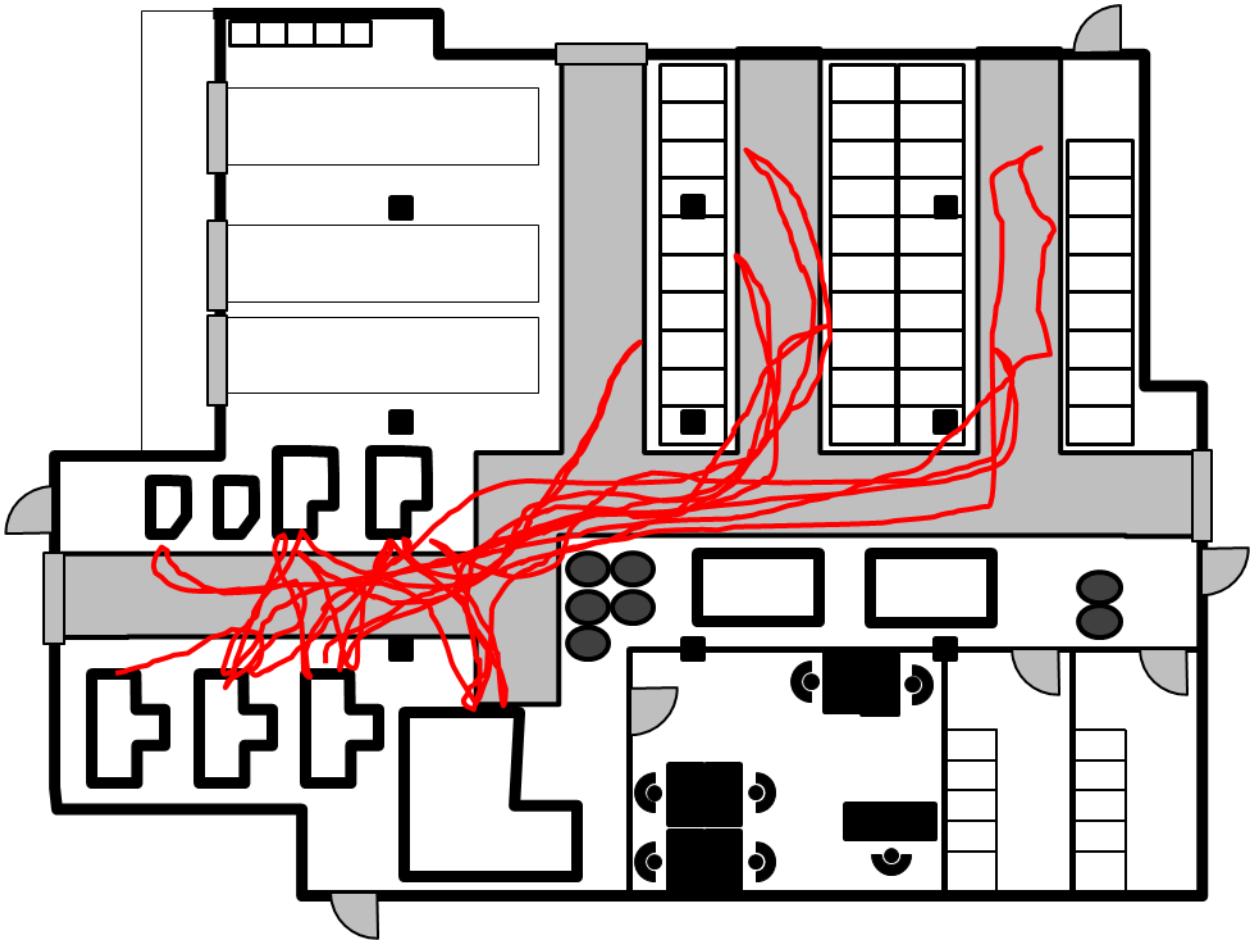


Fig 1: Spaghetti Diagram to estimate the distance walked by a person or the distance a part was transported.

4.5.3. Do's and Don’ts

Don’ts:

- Draw the diagrams the way people *think* the process flows.
- Make assumptions.
- Start this exercise without commitment for management.
- Ignore any steps.

Do's:

- Engage the operators of process.
- Draw the process the way it actually flows.
- Use different colors to represent various people or machines (forklifts, tuggers)
- Select people who are passionate about the need for eliminating waste.
- Train the people that will be drawing the diagram.
- Prepare (don's scramble for pencils, paper, etc. in the middle of the exercise).
- Record all the steps regardless it is is an "anomally"
- Try to capture some of the "what-if" routes in your notes. Such as "If this happens, then the operator would have to go to this area for this reason".

4.6. LEAN PRODUCTION PREPARATION PROCESS (3P)

The basic steps for a 3P event are:

- Define theme and scope of your project: Think about what you wish to accomplish, not what is currently being done.
- Use keywords to define Functions (Roll, Lock, Drill, swivel…)
- Develop Sketch options: Sketch examples, examine, research and work as a group to look deeply into the functions required.
- Evaluate the Process: Each of the sketches is evaluated to a set criteria.
- Build: Build full scale mockups of the top three sketches and evaluate.
- Conduct trials: Perform trials on mockup to collect real time data, combine the best features and evaluate each proposal.
- Proceed to Trail: Have the final design mockup tested by more of the production team to review and improve on any missing ideas.
- Proceed to implement new process: Develop the action plan for proceeding after the 3P team finished.

4.7. SOURCES OF WASTE

From a Lean and process improvement perspective, waste is any step or resource allocation for which the customer has no value.

There are eight types of waste.

D – Defects/scrap/rework
O – Overprocessing
W – Waiting
N – Non-utilized employee ideas/creativity
T – Transportation
I – Inventory
M – Motion
E – Excess production

4.8. EMPLOYEE INVOLVEMENT

Employee involvement means that every employee is regarded as a unique human being, not just a machine, and each employee is involved in helping the organization meet its goals. Each employee's input is solicited and valued by his/her management. Employees and management recognize that each employee is involved in running the business.

Employee empowerment is a somewhat different concept. It means that in addition to involving employees in running the business, employees and management recognize that many problems or obstacles to achieving organizational goals can be identified and solved by employees. Employee empowerment means that management recognizes this ability, and provides employees with the tools and authority required to continuously improve their performance. The management states its expectations about employees recognizing and solving problems, and empowers them to do so.

4.8.1. Objectives

Employee involvement is a long – term commitment, a new way of doing business, a fundamental change in culture. Employees who have been trained, empowered, and recognized for their achievements see their jobs and their companies from a different perspective. They no

longer punch a clock, do what they are told, and count the minutes until the weekend rolls around. They "own" the company, in the sense that they feel personally responsible for its performance. The best way to obtain a genuine commitment from people is to involve them in the project from the beginning. Even if the original ideas are not theirs, the process of designing, planning and assessing will automatically pull them into the stream of things. Managers who try to take back some of that power end up with bitter, frustrated, and disillusioned employees. Performance will suffer, and future attempts to involve employees will be met with cynicism.

Organizations operating with the involvement of their employees, have evolved beyond merely telling people what is going on, to actively seeking their contribution to the decision making process. Only a minority of organizations in industry could be truly said to be operating with the involvement of their employees, but the trend over the last 10 years has certainly been to move towards this direction, often following the link of inward investors such as the Japanese, Germans and Americans, and the opportunities presented by reconstruction and Greenfield sites.

The cultural effect being sought is a sense of ownership of the company among its employees. This can have remarkable effects on employees' commitment to the company and the type of activities they will undertake.

The keys to involvement are several and complex:

(a) Financial: Share ownership and profit distribution plans can help to foster an interest in a company's affairs at the competitive level which is often hard to get across in the normal day to day routine of workplace activity. If a company wishes to increase its employee share ownership an incentive is essential. One of the most common forms of incentive is the use of Employee Share Ownership Plans (ESOPs). These typically offer a one for one share purchase arrangement, with the company issuing matching shares from a share trust for every ordinary share purchased.

(b) Job security: The structure of the work organization determines many facets of the employment relationship; in particular, job design can influence the degree of control an employee has over his or her work and, with that, the degree of personal responsibility felt for the outcomes and quality of work. Traditional systems of shifts, absence coverage and in-line production methods tend to stifle personal accountability; the job will be done whether or not the

employee turns up and nothing is left incomplete at the end of the day, unlike most managerial and professional jobs. Consequently employees constrained by such systems feel little sense of ownership of the total process.

4.9. QUALITY CULTURE AND ITS IMPORTANCE

An organizational value system that results in an environment that is conducive to the establishment and continual improvement of Quality.

Activities and initiatives that can enhance the quality culture of a firm's employees are listed below:

-Regular customer visits to the company's operations including site tours, product presentations, and meeting staff at all levels.

-Regular visits of not only sales reps, but managers and staff to customer plants, job sites or operations in order to understand their operations and uses for the products and services they buy.

-Continuous improvement initiatives and programs relating to product and service quality.

-Education and continuous up-skilling of the workforce in quality standards, customer requirements and industry best practices.

-Management support from all levels for the pursuit of quality, continuous improvement, and customer satisfaction.

QUESTIONS

PART A

1. What is Poka Yoke? When to use it?
2. Explain Kanban and its benefits
3. What is OEE? State its benefits
4. Explain the symbols in VSM
5. Discuss about the need for spaghetti chart.
6. Explain the dos and don'ts in spaghetti chart.
7. Describe the sources of waste
8. Explain employee involvement
9. Discuss the objectives of employee involvement
10. Briefly explain the importance of quality culture.

PART B

1. Write notes on Poka Yoke
2. Explain Kanban
3. Discuss about OEE
4. What is VSM? Explain the steps in VSM
5. Write in detail about spaghetti charts, its needs, dos and don'ts.
6. Explain the steps in drawing spaghetti chart
7. Explain the various sources of waste
8. Write in detail about employee involvement
9. Discuss quality culture and its importance

REFERENCE BOOKS

1. The Lean Book of Lean: A Concise Guide to Lean Management for Life and Business John-Earley
2. Lean Production Simplified, Second Edition: A Plain-Language Guide to the World's Most Powerful Production System by Pascal- dennis Productivity Press; 2nd edition (2 March 2007)

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SCHOOL OF MANAGEMENT STUDIES

UNIT V — LEAN MANAGEMENT – SBAA7030

JUST IN TIME MANUFACTURING:

Introduction -elements of JIT -uniform production rate-pull versus push method-Kanban system - small lot size-quick, inexpensive set-up-continuous improvement. Optimized production technology. ONE-PIECE FLOW: Process razing techniques –cells for assembly line

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5.1. JUST IN TIME MANUFACTURING

Just-in-time (JIT) is an inventory strategy companies employ to increase efficiency and decrease waste by receiving goods only as they are needed in the production process, thereby reducing inventory costs. This method requires producers to forecast demand accurately.

5.2. Basic Elements of JIT

- Flexible resources
- Cellular layouts
- Pull production system
- Kanban production control
- Small-lot production
- Quick setups
- Uniform production
- Quality at the source
- Total productive maintenance
- Supplier networks

5.2.1. Flexible Resources

- Multifunctional workers
- General purpose machines
- Study operators & improve operations

Standard Operating Routine

5.2.2. Cellular Layouts

- Group dissimilar machines in manufacturing cell to produce family of parts
- Work flows in one direction through cell
- Cycle time adjusted by changing worker paths
- Cells operated by worker teams who are cross-trained
- Frequently light systems are used to indicate potential problems. A worker experiencing difficulty can turn on warning lights and others will assist.

5.2.3. Kanban Systems ("Sequential Just-In-Time")

Kanban system:

- a pull system where the production or movement of the next batch of material is not started until the user signals a need for it
- the user comes to the producer to withdraw materials in the quantity needed at the time needed
- the producer produces only the exact quantity withdrawn by the user

Kanban is based on "visibility" and control of production - a unit is produced only if one has been called for by downstream (closer to the customer) operation. The signal can be made in any one of a number of ways.

- cards, authorizing workers to move or make an item
- containers, indicating need to start making an item
- flags, indicating need to start making an item

- squares painted on the floor, indicating need to start making an item
- computer screens authorizing production and displaying production directions

5.2.4. Small-Lot Production

- Requires less space & capital investment
- Moves processes closer together
- Makes quality problems easier to detect
- Makes processes more dependent on each other

Inventory Hides Problems - Lower Levels of Inventory to Expose Problems

Continuous Improvement - JIT systems gradually reduce the amount of inventory in the system

- reduce costs associated with carrying and handling
- expose production problems so that they can be addressed
- reduce the number of kanbans until the problem is exposed
- temporarily return inventory to former level
- correct the problem and start removing kanbans again

5.2.5. Reducing Setup Time

- Preset desired settings
- Use quick fasteners
- Use locator pins
- Prevent misalignments
- Eliminate tools
- Make movements easier

5.2.6. Uniform Production

Results from smoothing production requirements

Kanban systems can handle +/- 10% demand changes

Smooths demand across planning horizon

Mixed-model assembly steadies component production

5.2.7. Trends in Supplier Policies

- Locate near to the customer
- Use small, side loaded trucks and ship mixed loads
- Consider establishing small warehouses near to the customer or consolidating warehouses with other suppliers
- Use standardized containers and make deliveries according to a precise delivery schedule
- Become a certified supplier and accept payment at regular intervals rather than upon delivery

5.2.8. BENEFITS OF JIT

- Reduced inventory
- Improved quality
- Lower costs
- Reduced space requirements
- Shorter lead time
- Increased productivity
- Greater flexibility
- Better relations with suppliers
- Simplified scheduling and control activities
- Increased capacity
- Better use of human resources
- More product variety

5.3. PUSH VS PULL METHOD

“Push type" means Make to Stock in which the production is not based on actual demand. "Pull type" means Make To Order in which the production is based on actual demand. In supply chain management, it is important to carry out processes halfway between push type and pull type or by a combination of push type and pull type.

Supply Chain Management (SCM) is to create a solution i.e. "supply" for a goal or issue, i.e. "demand". Supply chain models of "Push type" and "Pull type" are opposite in terms of a demand and supply relationship. "Push type" is represented by "Make to Stock" (MTS) in which the production is not based on actual demand and "Pull type" is represented by "Make To Order" (MTO) in which the production is based on actual demand.

One of the major reasons why supply chain management currently receives so much attention is that information technology enables the shifting of a production and sales business model from "Push type" to "Pull type". Pull-type supply chain management is based on the demand side such as Just-in-Time (JIT) and CRP (Continuous Replenishment Program) or actual demand assigned to later processes. Therefore, unlike the Push-type method it is not Make to Stock, which is based on demand forecast. While inventory is kept to a minimum, products can be supplied with short lead times and at high speed. At the point where "Pull type" starts to supply operations triggered by actual demand, it is like an elevator. An elevator starts when a button is pressed even if there is only one passenger. On the other hand, the "Push type" can be considered as an escalator. An escalator continues to supply (push) regardless of whether there is actual demand (passenger). In addition, "Push type" corresponds to a model for trains, buses, and airplanes for which supply (push) is based on demand forecast by time period and route. There may be various forms between "Push type" and "Pull type" depending on inventory forms of materials, work in progress (WIP), and finished items and how to deal with the actual demand in supply chain management.

5.4. OPTIMISED PRODUCTION TECHNOLOGY (OPT)

Production scheduling and inventory control system that recognizes bottlenecks (capacity constraints) and does not aim at full capacity utilization at all times. OPT's objective is to simultaneously raise throughput while reducing inventory and operating costs, and achieve a smooth, continuous flow of work in process.

5.4.1. OPT Operational Measures

- **Throughput:** "the rate at which the system generates money through sales"
- **Inventory:** "all the money that the system has invested in purchasing things which it intends to sell"
- **Operational Expense:** "all the money the system spends to turn inventory into throughput"

5.4.2. Obstacles

- Knowing what to change
- What to change to
- How to institute the change

5.4.3. Ten Rules of OPT

- Utilization and activation of a resource are not the same
- The level of utilization of a non-bottleneck is determined not by its own potential but by some other constraint in the system
- An hour lost at a bottleneck is an hour lost for the total system
- An hour saved at a non-bottleneck is just a mirage
- Bottlenecks govern both the throughput and inventory in the system
- The transfer batch may not and often should not be equal to the process batch
- The process batch should be variable, not fixed
- Capacity and priority should be considered simultaneously, not sequentially
- Balance flow, not capacity
- The sum of local optima is not equal to the global optimum

5.5. ONE PIECE FLOW

It is a condition that exists when products move through a manufacturing process one unit at a time, at a rate determined by the needs of the customer.

One Piece Flow Creates

- Quicker delivery
- Reduction in storage and transportation.
- Less damage, deterioration, or obsolescence.

5.5.1. Benefits

5.5.1.1. Improved quality and fewer defects:

When batching and lot production are eliminated, there is less opportunity to manufacture defects. Since the batch size will be just 1, there will not be mountains of inventory to count, move, store and pick. Furthermore, single piece flow ensures that if there is a quality problem, we know that the defect has affected only that single part.

5.5.1.2. Reduced Inventory:

Implementing single piece flow will require each operation to only produce what is needed by the next operation. When followed properly, the process will eliminate any opportunity to build ahead. Consequently, inventories will not be allowed to build up.

5.5.1.3. Requires less space:

As inventory levels are reduced, less space and manpower will be required to manage (receive, count, stock, store, pick and deliver) it. In addition, single piece flow usually results in manufacturing cells which squeeze machines close together so that a single operator can oversee many pieces of equipment with the least amount of walking motion.

5.5.1.4. Enhances overall manufacturing flexibility:

We know from our value steam maps that the less inventory in a value stream; the shorter the lead-time will be from customer order to product delivery. In a single piece flow environment, since we operate with fewer inventories, lead-times will also drop, thereby giving us more time to react to customer orders

5.5.1.5. Makes identifying future kaizens simpler:

In a single piece flow environment, defects and WIP inventories fall. As this happens, the shop floor will open up and it will become easier to see production problems. In this case, it will be easy to decide where to focus the next improvement activity.

5.5.1.6. Ensures a safer work environment:

Fewer inventories means less clutter, more light in the darkest corners of the factory and the opportunity to better lay out equipment and tools. Also, since manufacturing cells are occupied by a set number of employees who each know their repeating tasks (as defined by standard work), there is less opportunity for unexpected movements, which increase the chances of accidents.

5.5.1.7. Improves employee morale:

Since single piece flow results in production problems being identified and (hopefully) solved right away, team members will receive immediate feedback on their work. This in turn will give everybody more ownership in their production area. Also, provided they lead problem solving efforts by focusing on processes and not individuals, more trust will be gained in managers.

5.6. PROCESS RAZING TECNIQUES

Process razing is a technique of understanding current process conditions across a part family or process route, and then seeking ways to make the processing steps more common to accommodate flow.

5.7. CELLS FOR ASSEMBLY LINE

A workcell is a group of workstations, machines or equipment arranged so that parts can be assembled progressively from one station to another without having to wait for a batch to be completed or requiring additional handling between operations. Cells may be dedicated to a process, a subcomponent or an entire product. One of the main purposes of a cell is to achieve and maintain efficient continuous flow.

Cellular configurations can be in several forms, but equipment within the cell is normally arranged in close proximity to compress time and space. A cell is typically configured for speed and minimal material handling, and can reap substantial benefits in cost saving, time compression and inventory reduction.

To address flexible manufacturing requirements, assembly cells should be capable of easy and quick reconfiguration. Cells must be mobile to adapt to product changeovers and personnel fluctuations.

5.7.1. BENEFITS

Benefits of cellular assembly include shorter lead times, higher productivity, decreased throughput time, increased flexibility, improved quality and increased output. In addition, communication is usually enhanced, because operators work closer to each other. Assemblers can see each process-what is coming and how fast-and one person can perform multiple operations. Also, multiple cells can easily produce multiple product designs simultaneously, making the assembly line more flexible.

Changeovers are easier in a cell and, with better communication between workers, cross-training is simpler. Communication also yields better quality. A cell allows parts to be presented to operators from outside the work area, allowing the workflow to continue uninterrupted. In addition, visual control of work in process (WIP) is easier.
Assembly cells typically require greater operator involvement, because they are a key element in the success of the workstation operation. "Managers are interacting more with [operators] on a project level, working with them as a team," says O'Kelly.

But, contrary to popular belief, shape does not make a cell. Flow makes a cell. Many people incorrectly think that all cells have to be U-shaped. While that is the most popular shape, cells also come in other configurations. For instance, C- and T-shaped cells are often used. Neck-shaped cells, such as X or + configurations, allow four different subassemblies to come together.

A U-shape is commonly used when configuring cells because it minimizes walking distance and allows different combinations of work tasks for operators. Harris says this is an important consideration in lean production, because the number of operators in a cell will change with fluctuations in demand. A U shape also facilitates performance of the first and last steps in the assembly process by the same operator, which is helpful in maintaining work pace and smooth flow.

The size of the product being assembled also affects cell layout. For instance, automotive parts typically are larger than medical devices, so handling distances and parts replenishment inside the cell must be taken into consideration.

5.7.2. DOWNSIDES

Despite numerous advantages, workcells are not always the best solution. In fact, some assembly applications aren't conducive to cells.
When deciding whether or not to use cells, manufacturing engineers must consider factors such as assembly processes and the product being produced.

Assembly cells make sense in certain situations, but they don't work in all plants. In fact, some manufacturers have implemented cells, but then reverted back to traditional, linear assembly lines.

Many engineers fail to look at the fine details of operator activity in a cellular environment. They assume that implementing cells will automatically create an effective production team. However, there are often many important staffing issues that need to be addressed.

It can be hard for operators to adapt to cells. Because more teamwork is required and there is more dependence on others for personal success, personality conflicts can arise. Transition from individual incentives and rewards to team incentives and rewards can lead to problems.

Some engineers underestimate the training needs for workers who must now become adept at many tasks, often requiring new skills.

QUESTIONS

PART A

1. Explain JIT and its objectives
2. Briefly explain uniform production rate
3. What are the benefits of JIT
4. Discuss push and pull methods
5. What is OPT and its operational methods?
6. What are the obstacles in OPT?
7. Explain one piece flow
8. Discuss the process razing techniques

PART B

1. Write notes on JIT and its elements
2. Explain the benefits of JIT
3. Write in detail about OPT
4. Discuss about one piece flow and its benefits
5. Explain the process razing techniques in detail.
6. Discuss cells for assembly lines

REFERENCE BOOKS

1. Toyota Production System: Beyond Large-Scale Production Taiichi Ohno

2. The Lean Turnaround: How Business Leaders Use Lean Principles to Create Value and Transform Their Company by Art Byrne, James P. Womack