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Lean systems and continuous improvement

Lean thinking

v2. Spring 2022

Lean Production

Set of **integrated activities** designed to achieve ***high production volumes*** while using ***minimum stocks*** (raw materials, WIP and finished products)

- Prescribes to **eliminate waste** in production
  → don't produce anything that is not necessary
- Provides for **parts to flow** quickly through the production system

components arrive 'just in time' where needed!

Lean Production

*In an ideal production system, every **product**, **component** or **raw material** should always be in only 2 possible conditions*

- ***processing***
- ***handling***

Value-Added activities

Customer value

- In the context of lean production, something for which **the customer is willing to pay**

Waste

- Anything that does **not add value from the customer's perspective**

Non–Value-Adding activities consume resources!

Toyota Production System (TPS)

"The ideal conditions for making things
are created when machines, facilities, and people
work together to add value without generating any waste"

Kiichiro Toyoda

*The **Toyota Production System (TPS)** was developed to improve quality and productivity and is predicated upon two philosophies central to the Japanese culture:*
elimination of waste** and **respect for people

Lean Systems strategies

Focus on the Time Line

The "time line" starts from the moment the customer places the order with the company to the moment the company receives the amount of money corresponding to the fulfilment of that order

- By focusing attention on this line, the goal is to reduce its length by activating flows and removing wastes

"Value stream" approach and Elimination of Waste

To focus on removing waste rather than accelerating value-added activities

Types of waste or **MUDA** (Fujio Cho – Toyota Motor Co.)

1. overproduction
2. waiting time
3. unneeded transportation
4. excess of inventory
5. processing waste
6. waste of motion (resources)
7. product defects

Lean Design Principles

1. (Production) System Design
   a. Layout (Group Technology (GT) and Production Cells)
   b. Quality at the source
   c. Just-in-Time (JIT) Production

2. Lean Operations Management
   a. Uniform loading and Leveling
   b. Kanban production control system

1a. Group technology

- Philosophy in which similar parts are grouped into **homogeneous families**
- Production processes are organised by **production cells**
- The elimination of handling and waiting times (queues) between activities makes it possible to reduce stocks and the number of employees required
- **Need for flexible operators**

1b. Quality at the source

- The product must be manufactured correctly **the first** time
- In the event of process **non-conformity**, the system must be **blocked**
- Operators become **inspectors and responsible** for product quality
- They autonomously carry out the **maintenance** of machines and equipment
- They autonomously carry out **analysis and troubleshooting** of the machines

1c. "Just in time" (JIT) *philosophy*

Producing what is required in the correct quantity and at the right time

Toyota Motors Production System (1973)

Primary Objective: to reduce production costs

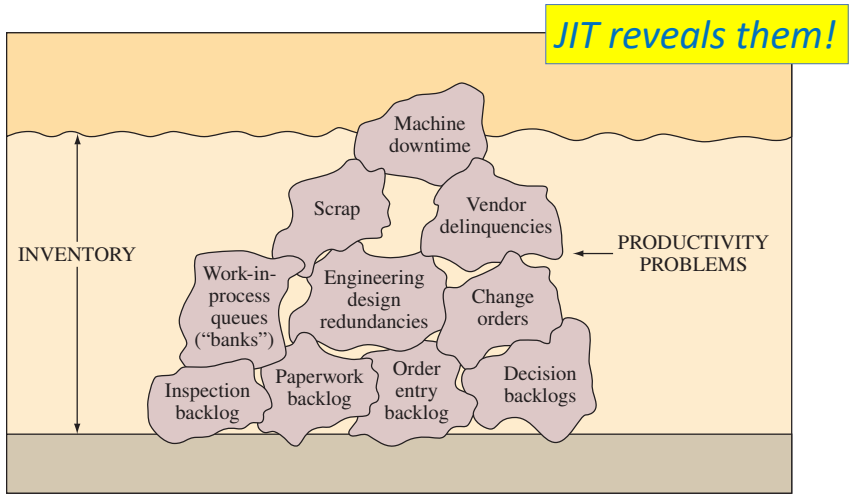
Secondary objectives

Quantity control	→	Kanban
Quality control		Jidoka
Respect for People		Shojinka

Just in Time Production

- Anything more than the minimum is waste
- Typically applies to repetitive production
- The ideal batch is "one piece"
- Suppliers make multiple shipments per day
- Highlighting problems that are otherwise hidden by inventory

Inventory hides problems



Source: Chase et al., 2018 - Chap. 14

Lean thinking

Critical success factors

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Critical success factors: Suppliers Management

- Suppliers define the production plan on the basis of the schedule provided by the main contractor each month
- Actual ordered quantities can be communicated on a daily basis

- Suppliers must be incentivised to produce with the JIT system in order to survive (supplier kanban)
- The whole supply chain is PULL managed

Critical success factors: Inventory Management

- Units (batches) must be produced without unnecessary delays or stocks
- The system tends to zero-level inventory

Finished Goods	Actual Orders activate the production
Components and Sub-assemblies	Kanban systems tends to one-piece flow
Raw Materials	Suppliers directly feed the production/assembly line

Pull System orders activate the production in the upstream processes

Kanban a signal used to control JIT flows

JIT (just-in-time) producing or delivering what is needed when needed and no more

PUSH vs PULL

PUSH

- Manages processes in advance of customer requirements; materials enter the system in advance to ensure the delivery time required by the market
- Uses forecasts; wrong forecasts generate stocks, lengthening the production time instead of shortening the delivery time
- Forecasts of what consumption will be and the consequent plan to synchronise the cascading activities regulate the progress of the production

PUSH vs PULL

- In a PUSH system, entities (materials, components, semi-finished products) are **transferred** to the downstream phase **regardless** of whether the latter is ready to receive them
- This immediately generates **WIP** (work in progress)

PUSH vs PULL

PULL

- The customers "pull" the production; customer consumption triggers production, so this is regulated downstream of the production process
- Therefore, the product does not go into production to anticipate the customer's actual demand but following his explicit request
- In a pull system, therefore, no one upstream process should produce goods or services until the downstream customer requests them

rather than "pushing" material through the system based on weekly schedules generated by production control, the entire process should be converted to a pull system that is operated directly in response to customer demand

Critical success factors: Production Planning and Control

Controlling the system downstream allows smoothing fluctuations in demand

There is the need of a *Flexible System*

Production

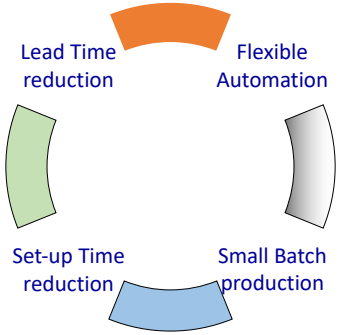
- Level the production Load
- Standardize production cycles

Organisation

- Visual control system
- Flexible workforce
- Continuous improvement

Production: Leveling (*heijunka*)

Levelling the flow of materials means creating balanced "work cells", whereby materials are advanced continuously and regularly without creating intermediate stocks



Organization: Visual Control

Quality control is "on-line" and autonomous (*jidoka*)

- The system is under control when both tools and machines are equipped with instruments that can detect defects when they occur and prevent defective parts from being processed further

Quality at the source Workers are responsible for the quality of their work

do the right job the first time!

Total productive maintenance

The goal of TPM is the continuous improvement of equipment effectiveness

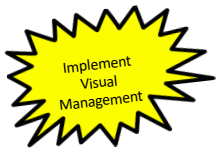
Organization: Flexible Workforce

*The **group technology** cells reduce movement and waiting time between operations, reduce inventory, and reduce the number of employees required*

- The layout is modified to allow each worker to carry out activities on different machines (**production cells**)
- The need of eliminating waste time and the principle of *job enrichment* need a **flexible worker**

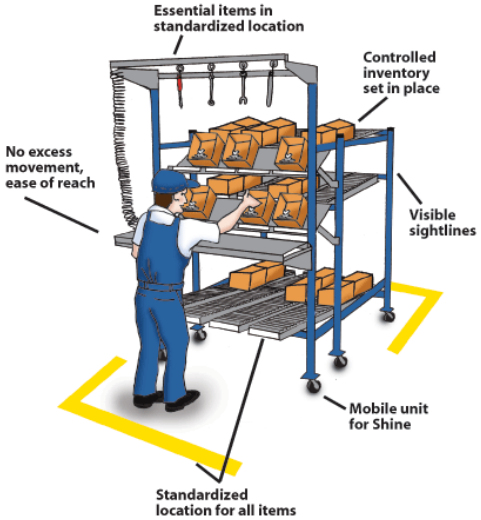
Organization: Continuous Improvement

- **Kaizen** is the Japanese philosophy that focuses on continuous improvement 改善
- The Kaizen bursts identify specific **short-term projects** (often referred to as "Kaizen events") that teams work on to implement changes to the process



Continuous Improvement is based upon rigorous analysis of processes!

“Lean” manual workstation



5S Workstation with Flow Cell Unit

Batch vs Lean Production

TRADITIONAL PRODUCTION (batches and queues)	LEAN PRODUCTION (flows)
Lines, departments and machines efficiency	Flow efficiency (short lead times)
High Resource Saturation	Over-capacity and Leveling
Reduction of Operating Time	Reduction of non value-added activities and unproductive times

Lean Production

IS	DOES
▪ Management «philosophy» ▪ Pull system	▪ Attacks Waste (time, inventory, scraps) ▪ Reveals inefficiencies and bottlenecks ▪ Accelerates/smoothes production
NEEDS	**PRECONDITIONS**
▪ Workforce engagement ▪ Industrial Engineering methods ▪ Continuous Improvement ▪ Total Quality Control ▪ Small Batches (one piece)	▪ Stable environment

Summary

- What lean production is
- How lean concepts can be applied to production processes
- The TPS principles
- Continuous improvement

- References:
  Ch. 12 and Ch. 14 Jacobs, Chase