

**Lean Operations: Introduction to Toyota Production
System,
MUDA (8 type of Waste), MURI, MURA**

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IIM Rohtak

Why a Firm exists?

❖ To create **VALUE**

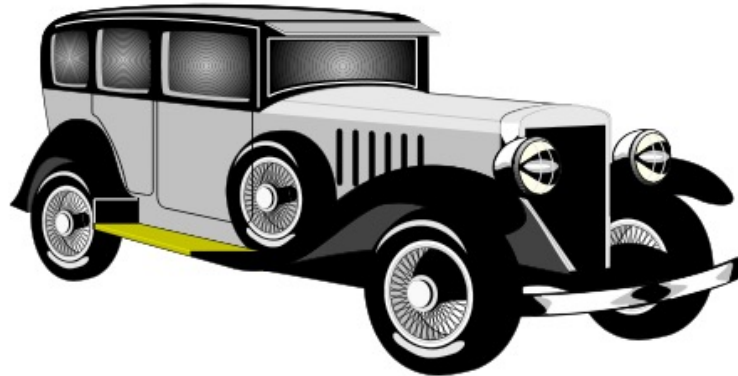
- Value for Customers
- Value for Employees
- Value for Supplier

Discussion Points

- About TPS
- TPS to Lean
- Lean Principles
- Lean Tools

CRAFT Manufacturing

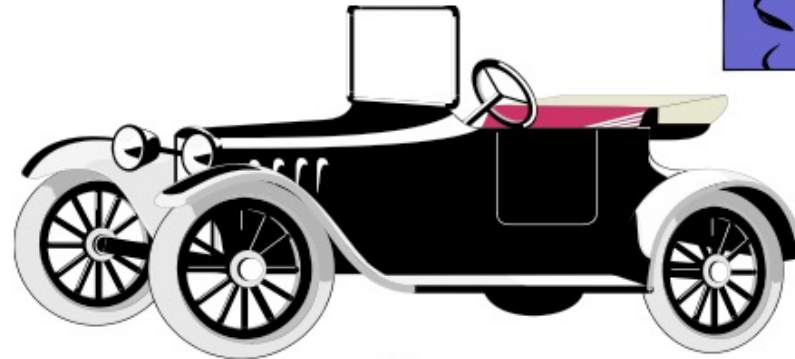
- Late 1800's
- Car built on blocks in the barn as workers walked around the car.
- Built by craftsmen with pride
- Components hand-crafted, hand-fitted
- Excellent quality
- Very expensive
- Few produced



More than 100s of companies in **Western Europe and North America**. Each made fewer than 1000 a year, rarely made 50 from a single design.

Mass Manufacturing

- Assembly line - Henry Ford 1920s
- Low skilled labor, simplistic jobs, no pride in work
- Interchangeable parts
- Lower quality
- Affordably priced for the average family
- Billions produced - identical

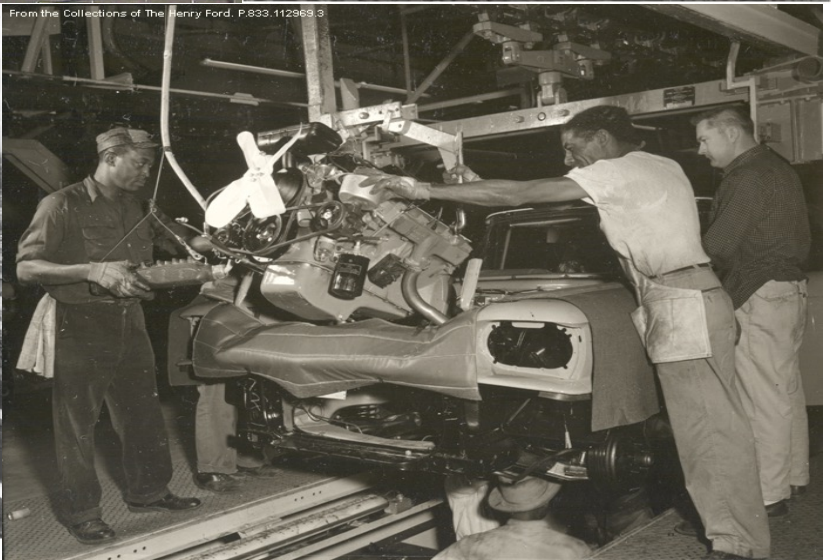
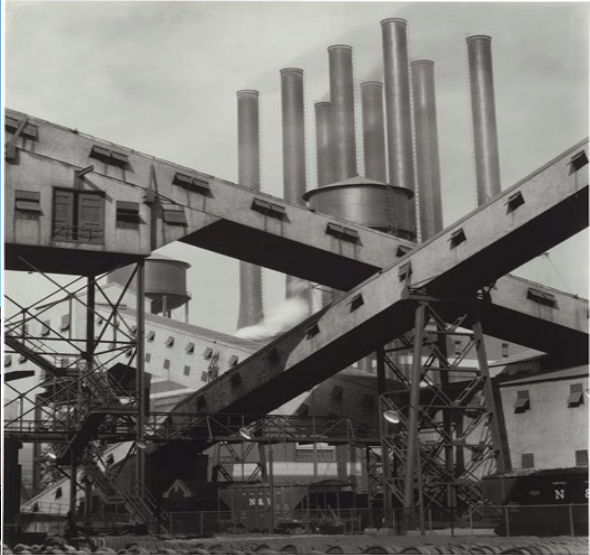


1920's to 1927 Ford **only** produced Model T.
One end raw material ...**other end** rolled cars 7000 /day
(Ford River Rouge Plant)

History of Japan Auto Sector

- https://www.youtube.com/watch?v=F5vtCRFRAK0&ab_channel=BloombergOriginals

Ford River Rouge plant near Detroit



History of Japan Auto Sector

- 1927-1935: Big 3 of US (Ford, GM, Chrysler) produced 208,967 vehicles (domestic production 12,127 vehicles)
- 1937: Toyota Motor Company Established (CEO Kiichiro Toyoda)
- 1940: Toyota's productivity was estimated to be roughly one-tenth of the major U.S. makers
- 1950: Facing the threat of bankruptcy
- Kiichiro Toyoda resigned as CEO

Emergence of Toyota Production System (TPS)

Eiji Toyoda: Visited Ford River Rouge plant in early 1950's



- Eiji Toyoda (born -1913) was the former chairman of Toyota motors co.
- For over 25 years he was in the driver seat of Toyota motor co.
- After his retirement he continue to hold the title of the honorary chair of the company.

It is easy to make money when everyone is making money.
The key is to be able to make money when times are bad.

-Eji Toyoda

Taiichi Ohno: Principle founder TPS, visited
Detroit



CONSTRAINTS FOR TOYOTA AND IMPLICATIONS

Taichi Ohno's observation :

- **Shortage** of **capital** for equipment/facilities
 - Cannot afford specialized equipment
- **Shortage** of **markets to serve**
 - Must be able to produce a variety of products in the same facility
- **Shortage** of **workers** and other resources
 - Must employ workers able to do a variety of different tasks

Constraints for Toyota: Emergence of TPS

- Shortage of capital for equipment/facilities
- Cannot afford specialized equipment
 - *Must be able to use in a variety of ways*
 - **Quick changeover procedures; flexible layout**
- Shortage of markets to serve
 - *Must be able to produce a variety of products in the same facility*
 - **Small batch production; mixed model production**
- Shortage of workers
 - *Workers must be able to do a variety of tasks*
 - **Employee involvement**
 - *Processes cannot be wasteful*
 - **Pull production, standard operations, TPM**
 - *Because of these shortages, emphasis on*
 - **Elimination of waste (Seven Mudass), continuous improvement (Kaizen)**

Eiji Toyoda....

- **Problems** are rolling all around in front of your eyes, **whether you pick** them up and treat them as problems is a **matter of habit**. If you have the habit, then you can do whatever you have a mind to
- One of the **features** of the **Japanese workers** is that they use their **brains** as well as their **hands**
- Our workers provide 1.5 million suggestions a year, and 95 percent of them are put to practical use. There is an almost tangible concern for improvement in the air at Toyota.

Criticism By the Communist Party Against T P S

....the Toyota Motor Company, Ltd. has earned the current profit of 210 billion yen (about \$1 billion). Behind this huge profit how many subcontractors have dropped tears? Toyota's completely rationalized production system strictly instructs its subcontractors to deliver the required parts within today or by tomorrow. Therefore, there is no excessive parts inventory at Toyota....

....serious matter which cannot go unnoticed is that this Toyota system is now prevailing among many industries and a vast number of subcontractors are likely to fall victims to this system. If this practice of bullying the subcontractors is left unrestricted, the Japanese economy will be thrown into chaos....

-(Proceedings at the Japanese House of Representatives, No.4: October 7, 1977, p. 63.)

Eiji Toyoda in 1985 at the company's joint factory with General Motors, known as Nummi.



Sept. 12, 1913, - Sept, 16, 2013

Core of TPS..

On Feb 24, 2010, Mr Akio Toyoda, President of Toyota Motors testified by US House of Representatives Committee on Oversight and Govt. Reform :

“.....In the name of the company , its long standing tradition and pride , we **never run away from our problems** or pretend **we do not notice** them. By making **continuous improvements**, we aim to continue offering even **better products for society**. That is the **core value** we have kept closest to our heart...”

...at Toyota , we believe that the key to making quality products is to develop quality people...

Lean Manufacturing Since 1980's

- Cells or flexible assembly lines
- Broader jobs, highly skilled workers, proud of product
- Interchangeable parts, even more variety
- Excellent quality mandatory
- Costs being decreased through process improvements.
- Global markets and competition.



History

Era	Volume	Variety	Quality	Price	Lead time
Craft Manufacturing (after 1800's)	Low	Low	Good	High	High (Almost 1 year)
Mass Manufacturing (Pre WW-II Era) Till 1960s	High	Low to Medium	Average	Medium	Medium (Almost 6 months)
Lean Manufacturing (since 1980s)	Low	High	Excellent	Low	Just It Time

History of the word “Lean”



Field Work: Completed visits to 70 assembly plants worldwide between 1986 and 1989 (usually involved three different visits)

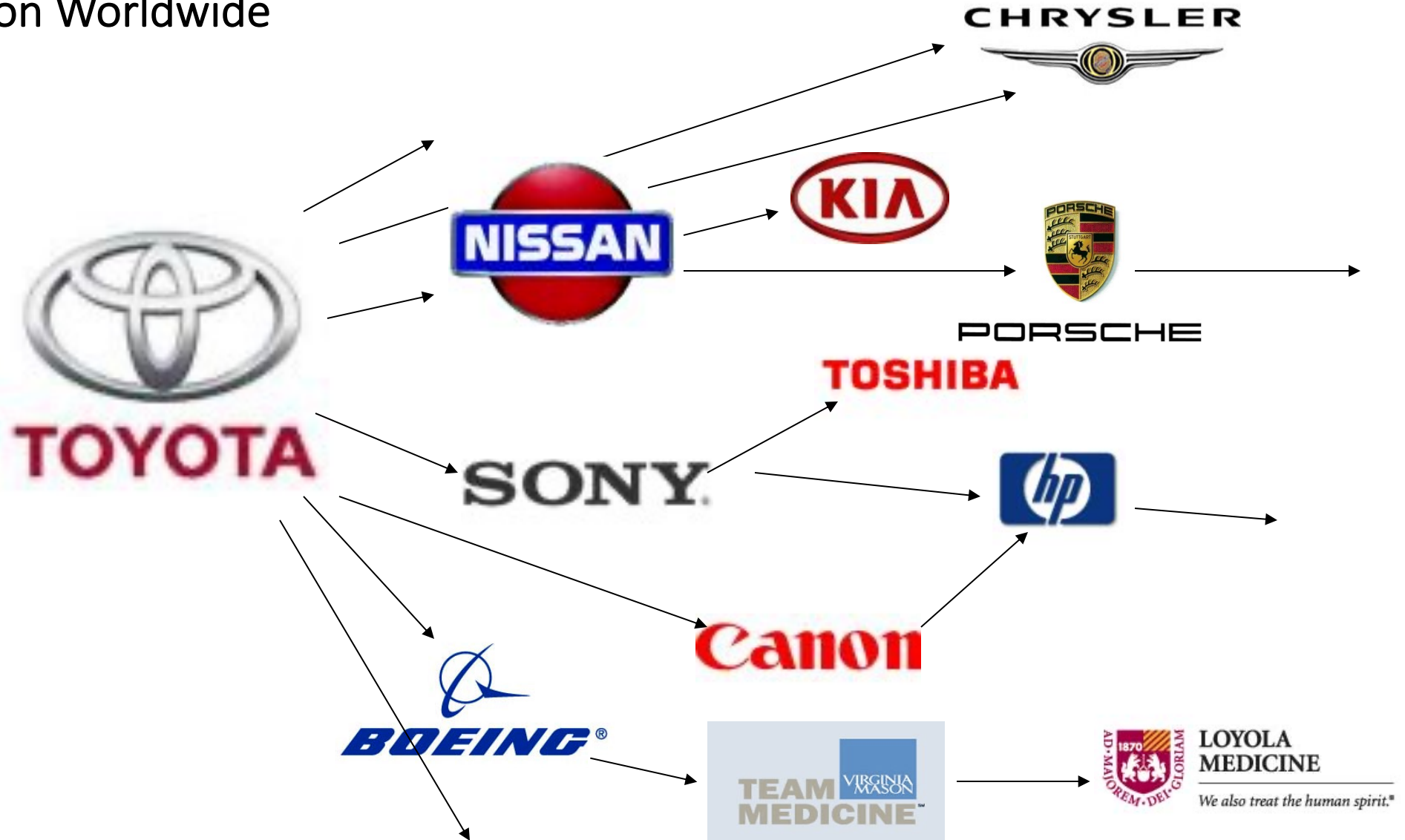
Findings:

- **Production management policies** has tremendous effect on **plant performance**. Some North American plants has achieved the efficiency level of Japanese plant with lean production policy.
- Lean plants can achieve better quality, productivity and complexity.
- Corporate parentage and culture are as important while checking plant performance.
- Level of technology has little effect on performance.
- Lean management policy **can improve productivity and quality performance** but **has inherent risks** that can be managed with **discipline, skills, proper training, flexible workforce.** (Introduced the term *Lean*)

XPS

Alfa Laval Production System (ALPS)	Ecco Production System (EPS)
Audi Produktionssystem (APS)	Electrolux Manufacturing System (EMS)
Bosch Production System (BSP)	JCB Production System
Aluminium Metal Production System (AMPS)	LEGO Production System (LPS)
John Deere Quality and Production System	Mercedes Production System(MPS)
Volvo Production System(VPS)	Whirlpool Production System (WPS)
Boeing Production System (BPS)	Caterpillar Production System (CPS)

Just-in-Time/Lean Production Diffusion Worldwide



Definition of Lean?

Definition of Lean

- Lean is a **management philosophy** focused on improving productivity by **identifying and eliminating waste** throughout a **product's entire value stream**, extending not only within the organization but also along the company's supply chain network.
- A systematic approach to identifying and eliminating waste (**non-value-added activities**) through **continuous improvement** by flowing the product through flow processes based on a signal from the **customer**.
- Thus, increasing customer satisfaction.

PRINCIPLE OF LEAN

VALUE?

VALUE

Defn: Value is the **inherent worth** of a **product** as judged by the **customer** and reflected in its **selling price** and **market demand**".

For an **activity** to be considered **value added**, it must meet three criteria:

1. The customer must be willing to pay for the activity.
2. The activity must transform the product or service in some way.
3. The activity must be done correctly the first time.

SPECIFY VALUE

- **What can I do to improve my teaching in every class and every course?**
- **How can I improve students' learning experience so that they will actually apply in the real world what they learned in the classroom?"**
- **How you create value for your customer?**

VALUE STREAM

Whenever there is a product for a customer ,
there is a value stream, the challenge lies in
seeing it....John Shook

VALUE STREAM

- **All of the actions**, both value-creating and non value-creating, required to bring a product from concept to launch (also known as the development value stream) and from order to delivery (also known as the operational value stream).
- These include **actions to process information** from the **customer** and **actions to transform the product** on its way to the **customer**.

Tool: Value Stream Mapping

- Value stream mapping is a method for documenting business processes, allowing project managers and analysts to analyze the different states and identify areas of improvement
-
- Every business has processes for making and selling products and services. The more you know about those processes, the more effectively you can manage and improve them.

FLOW

.....out of all secrets of the river, he today only saw one, this one touched his soul. He saw: this water ran and ran, incessantly it ran, and was nevertheless always there, was always at all times the same and yet new in every moment!....

[Hermann Hesse](#), [Siddhartha](#)

FLOW

Make products flow is the third pillar of lean thinking and involves keeping materials and information moving so that materials ‘flow’ to customers without delay or interruption.

“WHY DO WE STRIVE TO CREATE FLOW?”

“We strive to create flow because it is most efficient way to produce?”

PULL

The universe demands balance.

PULL

Pull production at the rate of consumption is used when it is not possible to complete flow products to customers (due to the number of customers, short lead times, the needs of your technology and batch sizes or other constraints).

.

PERFECTION

When you aim for perfection, you discover it is a moving target.

G.F Fisher

PERFECTION

Pursue perfection in all processes. Global competition is a brutal .“race without a finish line,” requiring continuous improvements of processes and products

Mutual Respect

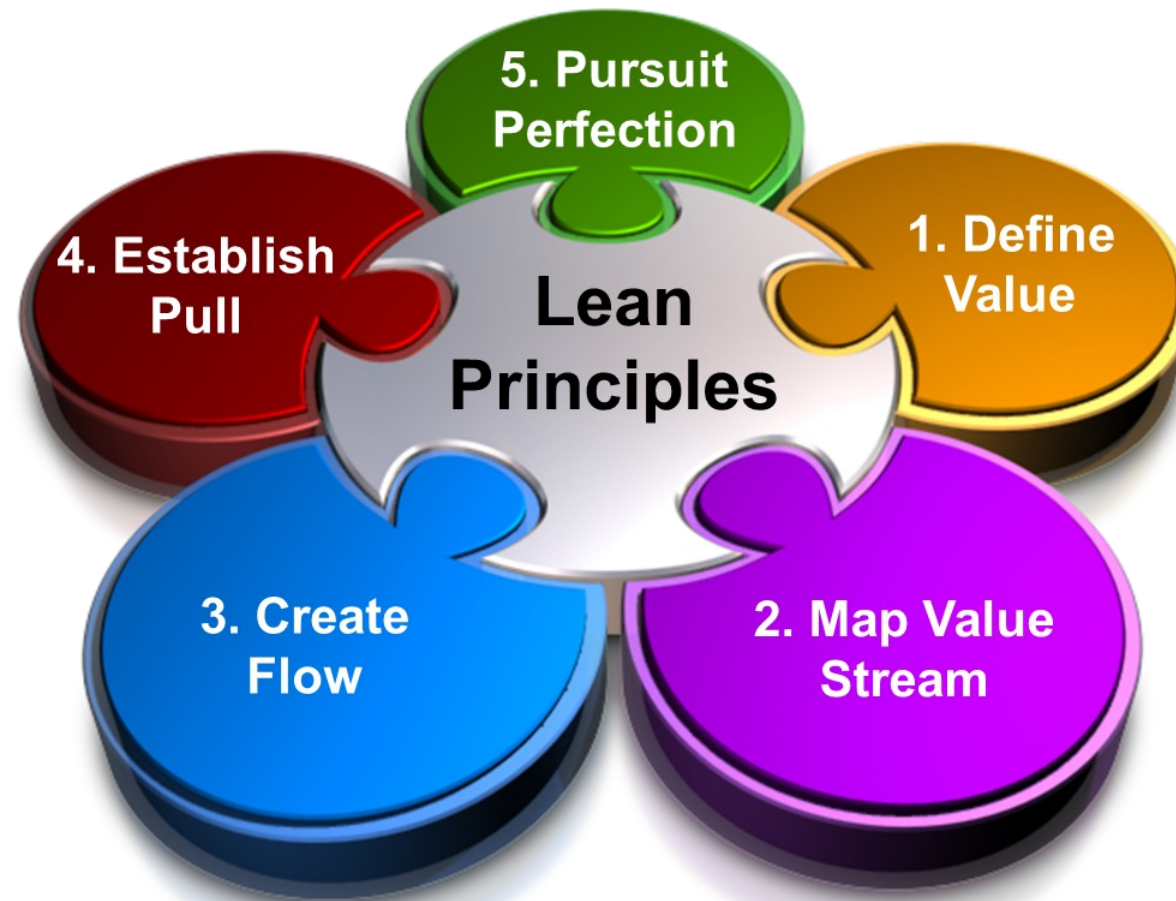
Sangchhadhwam Sanvadadhvam Sam Vo Manasi Janatam |
Deva Bhagam Yatha Purve Sanjanana Upasate (Rigveda)

Come together! Speak together! Let our minds be all of one accord just as the ancient gods sat together in harmony. That is why they are worshipped.

MUTUAL RESPECT

People are most important resources ...

LEAN PRINCIPLES



Lean Principles

➤ **Principle 1: Define Value**

Capture the value defined by the customer stakeholders

➤ **Principle 2: Map Value Stream**

Map the value stream (plan the program) and eliminate waste

➤ **Principle 3: Create Flow**

Flow the work through planned and streamlined value adding steps and processes

➤ **Principle 4: Establish Pull**

Let customer stakeholders pull value

➤ **Principle 5: Pursuit Perfection**

Pursue perfection in all processes

➤ **Principle 6: Respect people**

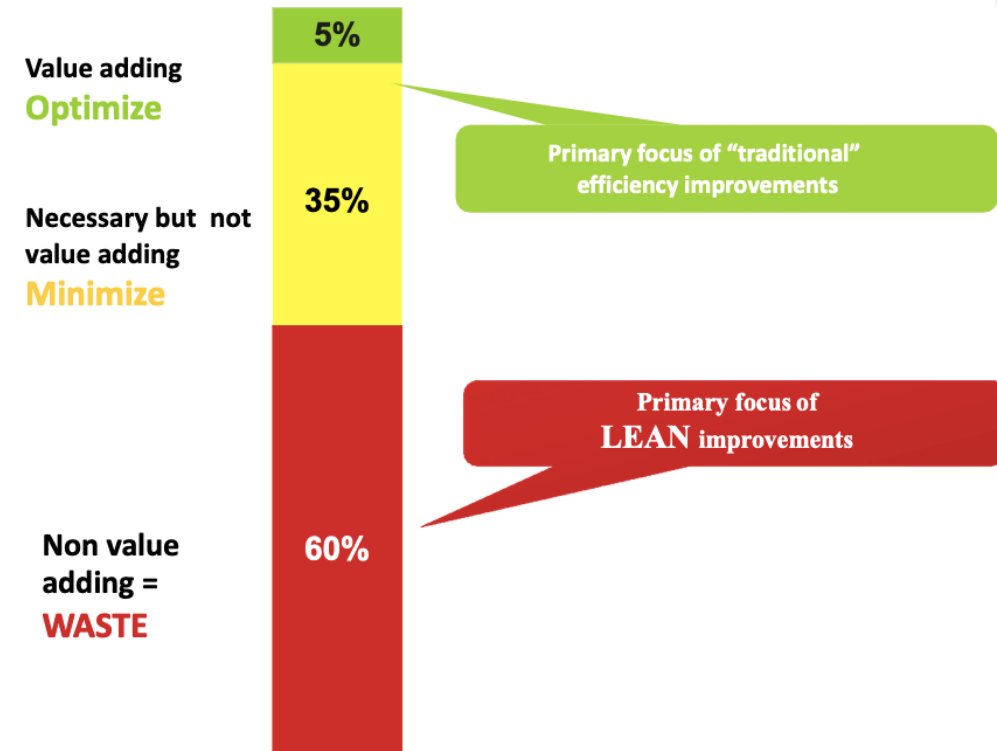
Respect the people in your work places

Summary

- **Value added (VA):** Activities are classified as value added as long as the **customer is willing to pay** for that activity
- **Non-value added (NVA):** All those activities for which the **customer may not want to pay** are classified as non-value added activities
- **Necessary but non-value added (NNVA):** the set of activities that are to be eventually eliminated as and when better systems are developed in an organization
- **Waste:** Any process or a set of activities that do not add value as perceived by the customer
- **Value stream:** All activities that need to be performed (VA and NNVA) from the time the customer order is received to the time the order is fulfilled will make up the value stream

- **Lean Management:** Process by which continuous efforts of all concerned parties enables an organization to create a channel for the value stream by eliminating waste from the system

- **LEAN is all about improving Throughput Time**



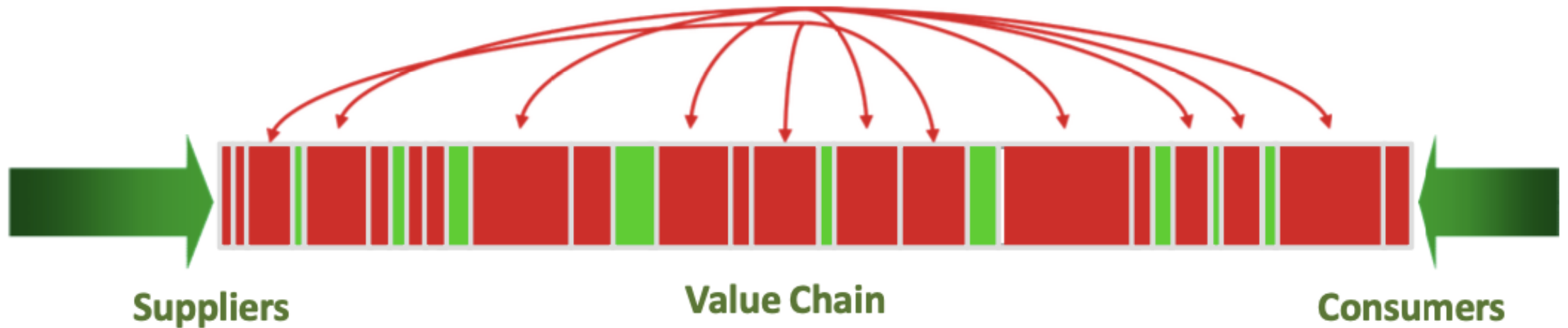
[https://www.youtube.com/watch?v=Kgevg68wSBA&ab_channel=Paras
Shenmare](https://www.youtube.com/watch?v=Kgevg68wSBA&ab_channel=ParasShenmare)

Criteria for Comparison	Japan [@]	U.S. [*]
Production of Vehicles (Million)	4	8
Number of employees	37,000	850,000
Parts on which detailed engineering is done	30%	81%
Number of employees in Purchasing	337	6,000
Number of suppliers for upholstery	1 [#]	25 ^{**}

Based on the data available in Womack, J.P., Jones, D.T. and Roos, D. (1990), “The Machine that changed the world”, Rawson Associates.

Eliminating Waste

Eliminate **Non Value Added** activities



Reduce Lead Time

Higher
flexibility

Reduced
stocks

Better
Service

Reduced
Complexity

Less
cost

Revived
Freshness

Look at this Company, Process & Activities....



Common Sources of Waste

Category	Manufacturing Organizations	Service Organizations
Inventory Related Waste	<ul style="list-style-type: none"> • Accumulating Inventory • Waiting for material to work on • Stock verification • Counting the number of parts • Temporary Storage • Parts Shortage 	<ul style="list-style-type: none"> • Overflowing “In Baskets” • Duplication of work • Too much of paper work • Incomplete information leading to pending decisions
Waste Due to Processes	<ul style="list-style-type: none"> • Defects & Rework • Machine Breakdowns • Watching the machine run 	<ul style="list-style-type: none"> • Payments not made on time • Wrong service delivery (Service Failure) • Proposals not completed on time for the bid • Customer Orders taking too long to be filled
Waste Due to Planning	<ul style="list-style-type: none"> • Looking for tools • Carrying heavy pieces • Transferring parts over long distances • Over Production & Double Handling 	<ul style="list-style-type: none"> • Complicated office layouts • Poorly planned meetings • Documents handled many times before a decision is taken • Extra signature needed that hold up completion • Teams with incomplete or no direction.

Types of problems

MUDA :

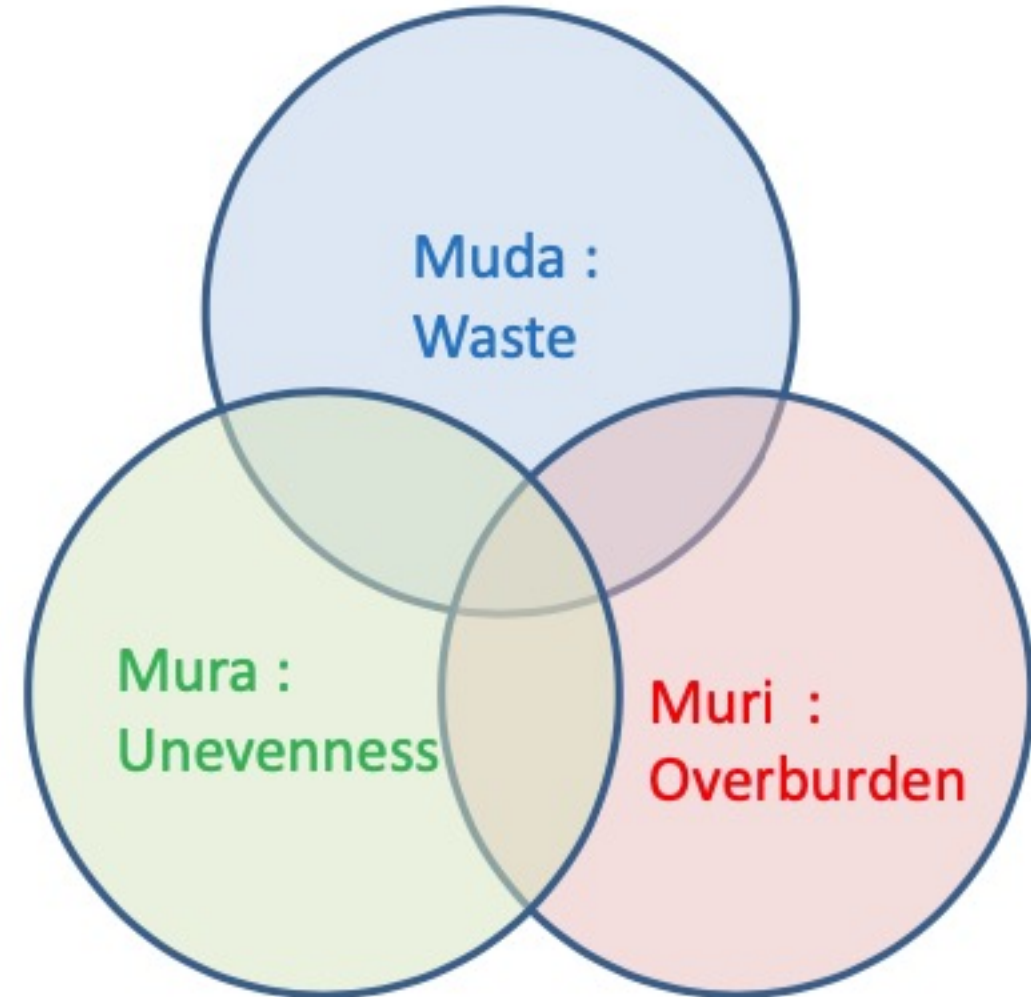
Anything that is non value adding is waste.
There are typically 8 types of waste. Waste has negative effect on time, efforts, energy and money.

MURA :

Unevenness results from an irregular production schedule, or fluctuating production volumes due to internal problems like down time, missing parts or defects.

MURI :

Muri is overburdening people or equipment beyond natural limits. Overburdening people results in safety and quality problems. Overburdening equipment results in breakdowns and defects.



3 Ms of Lean



Muri = overburdened



Mura = unevenness, fluctuation, variation



Muda = waste



No Muri, Mura, or Muda

Muri – Overburden

MURI

Overburden means going beyond one's natural limits.

e.g.

Bottleneck machine has more work.

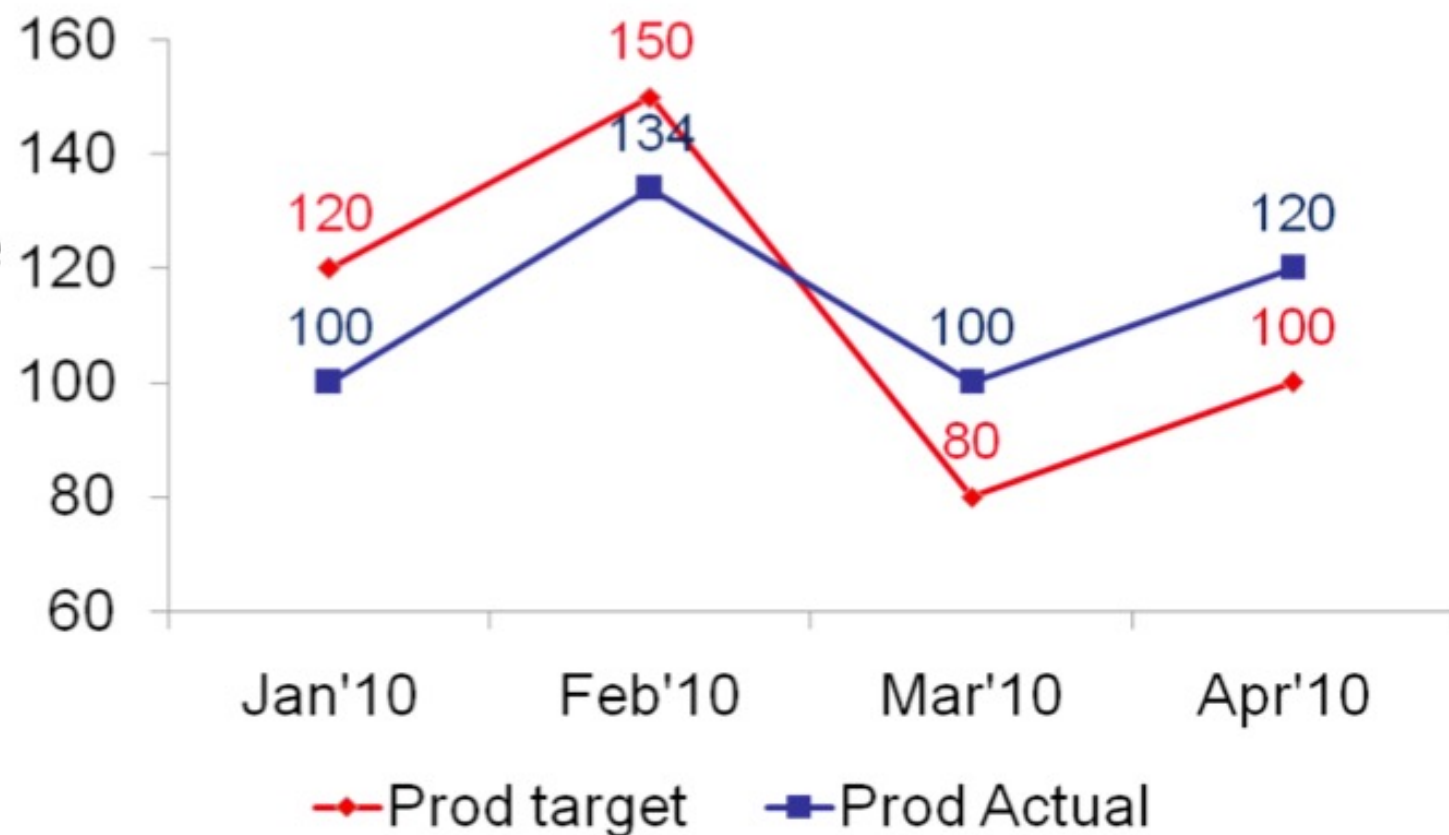
Capable person gets more responsibilities.



Mura – variation

MURA

Nothing remains constant.
Everything changes.
Variation creates situations leading to waste or overburden.
e.g.
Continuously Changing production targets, causes either shortages or overproduction.



Toyota's Seven Waste

- Transportation
- Inventory
- Motion
- Waiting Time
- Overproduction
- Over Processing
- Defects

(T I M W O O D)

Overproduction



Waiting



Waiting



Eliminate *sources* of waiting

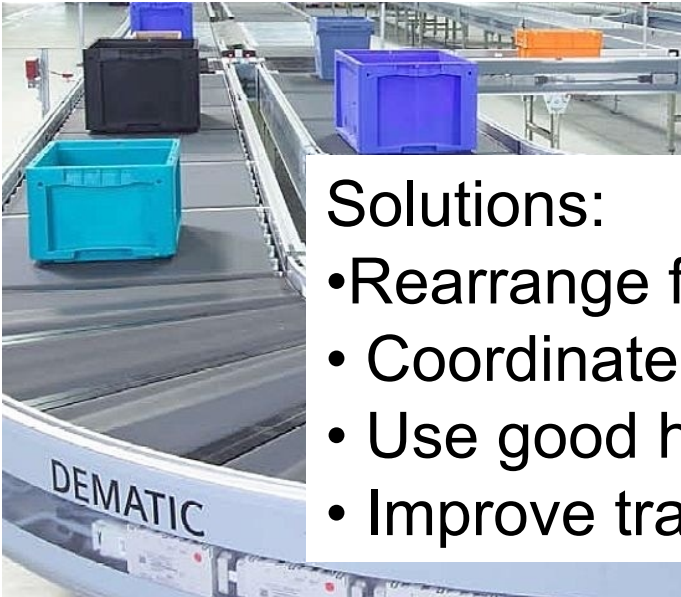
- Setup time
- Equipment breakdown
- Erratic schedules
- Large-batch production
- Defects



Transportation



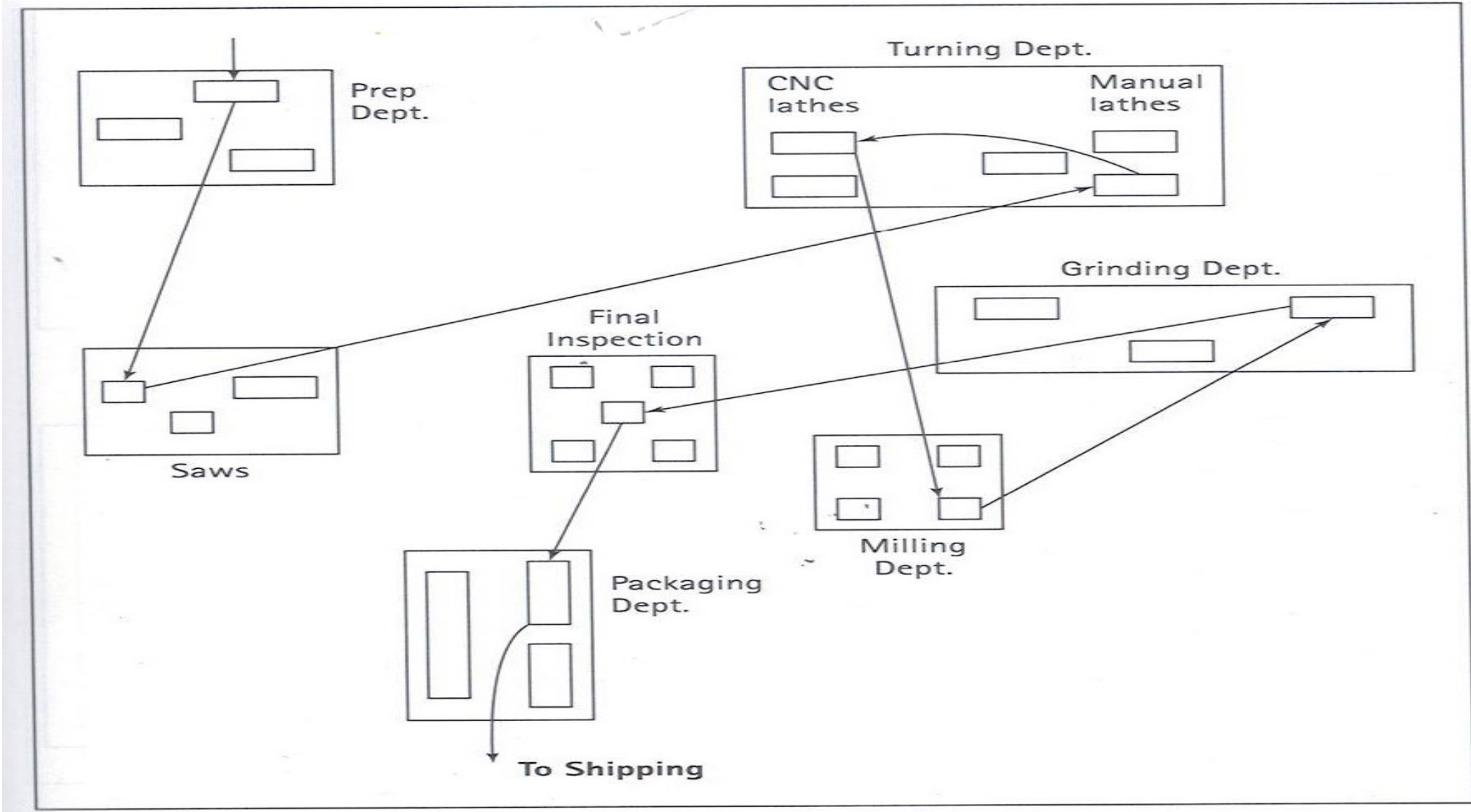
Transportation



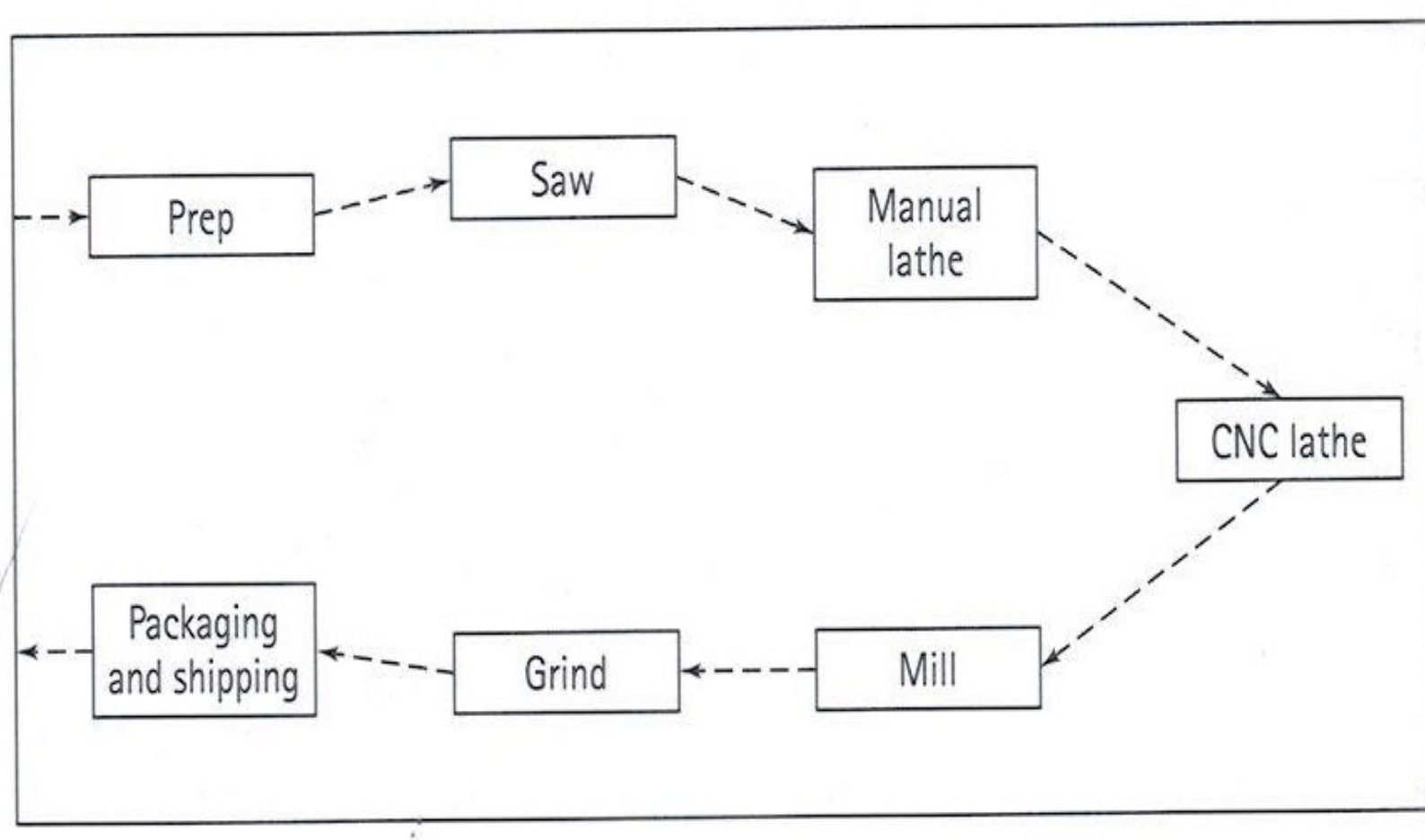
Solutions:

- Rearrange facility layout to shorten distances
- Coordinate stages of process
- Use good housekeeping
- Improve transportation methods

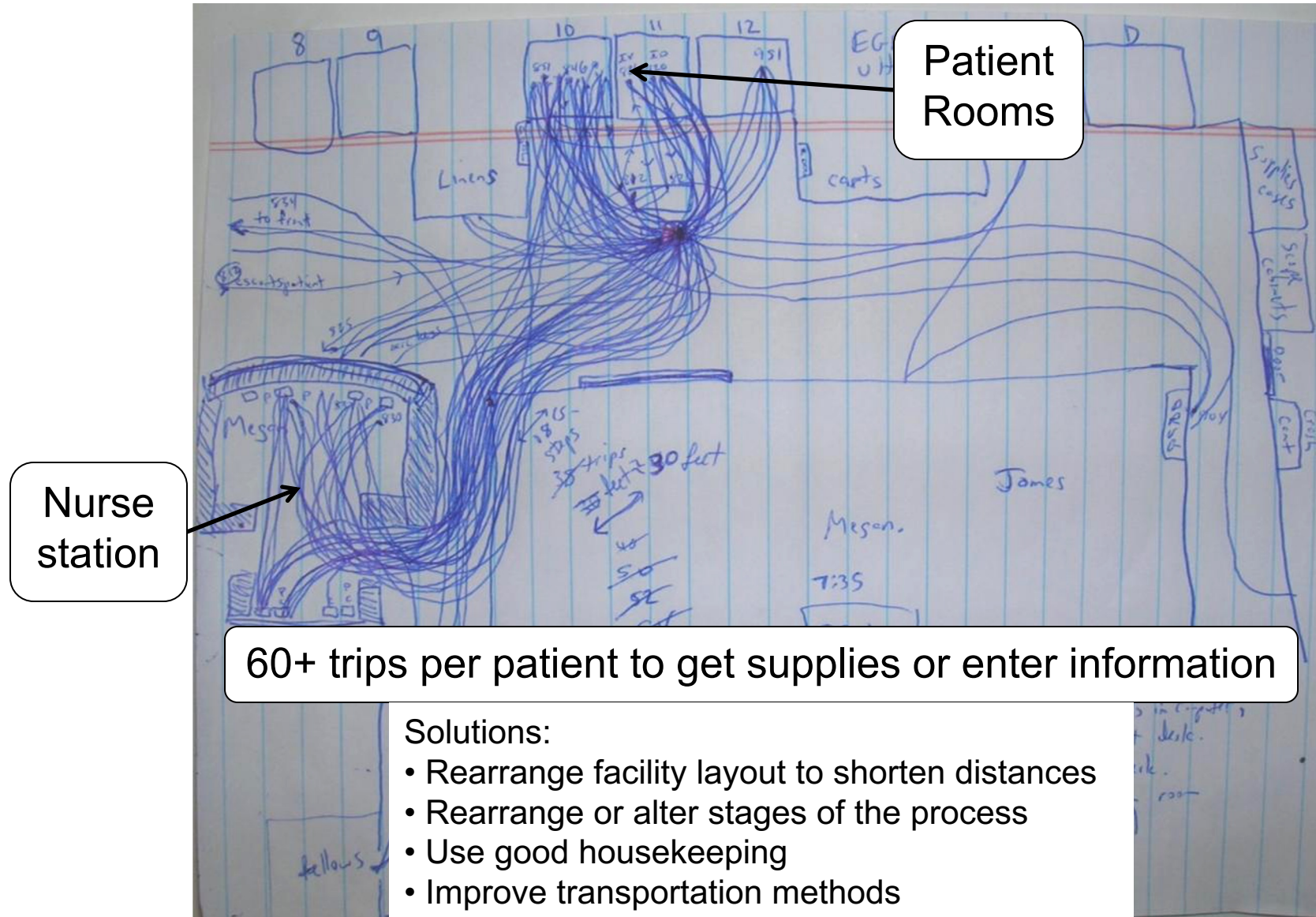




Proposed Layout



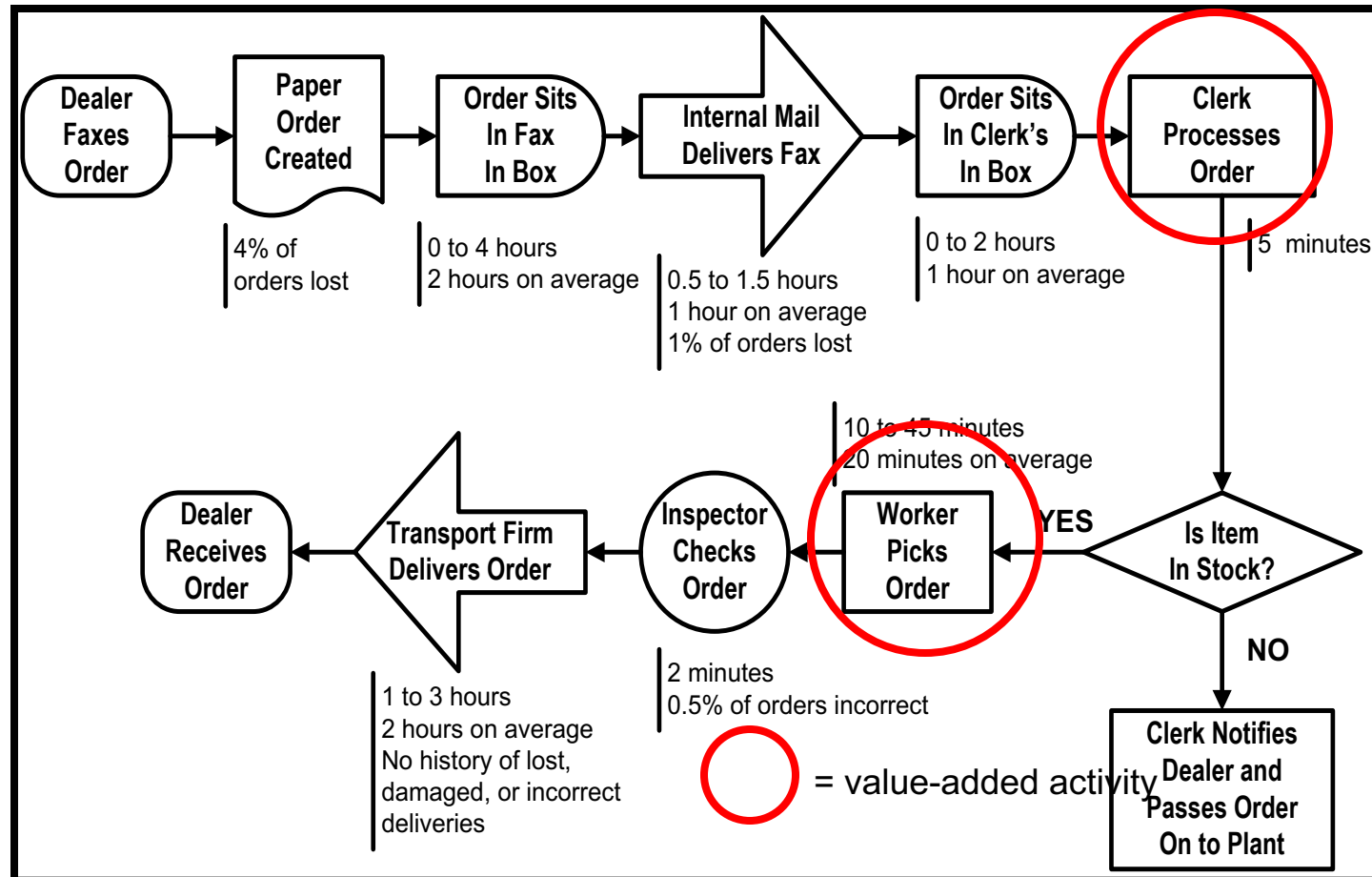
Spaghetti Chart



Processing

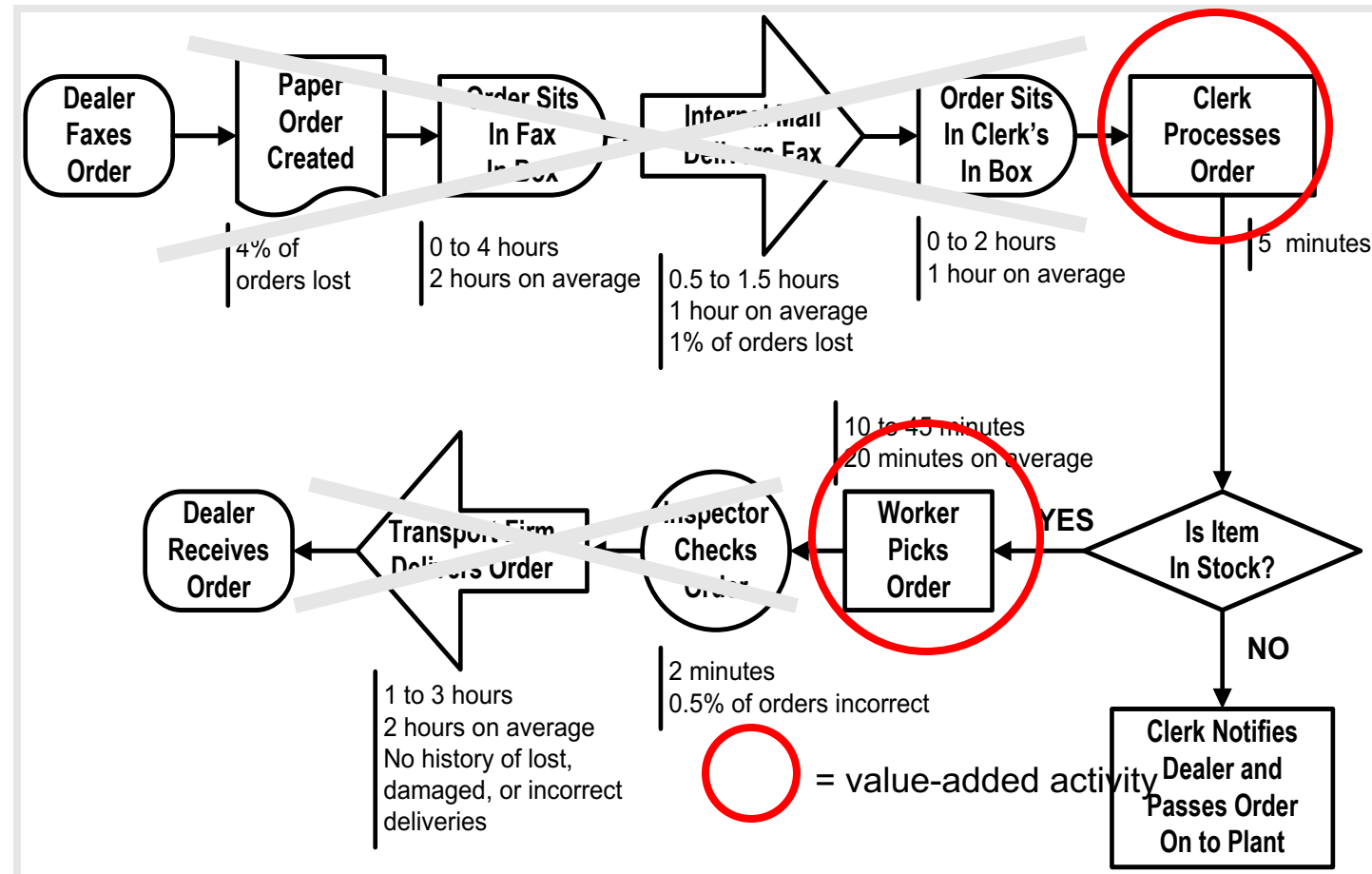
A process may itself contain steps that are ineffective or unnecessary .Opportunity in Manufacturing and servicing as well.

Processing



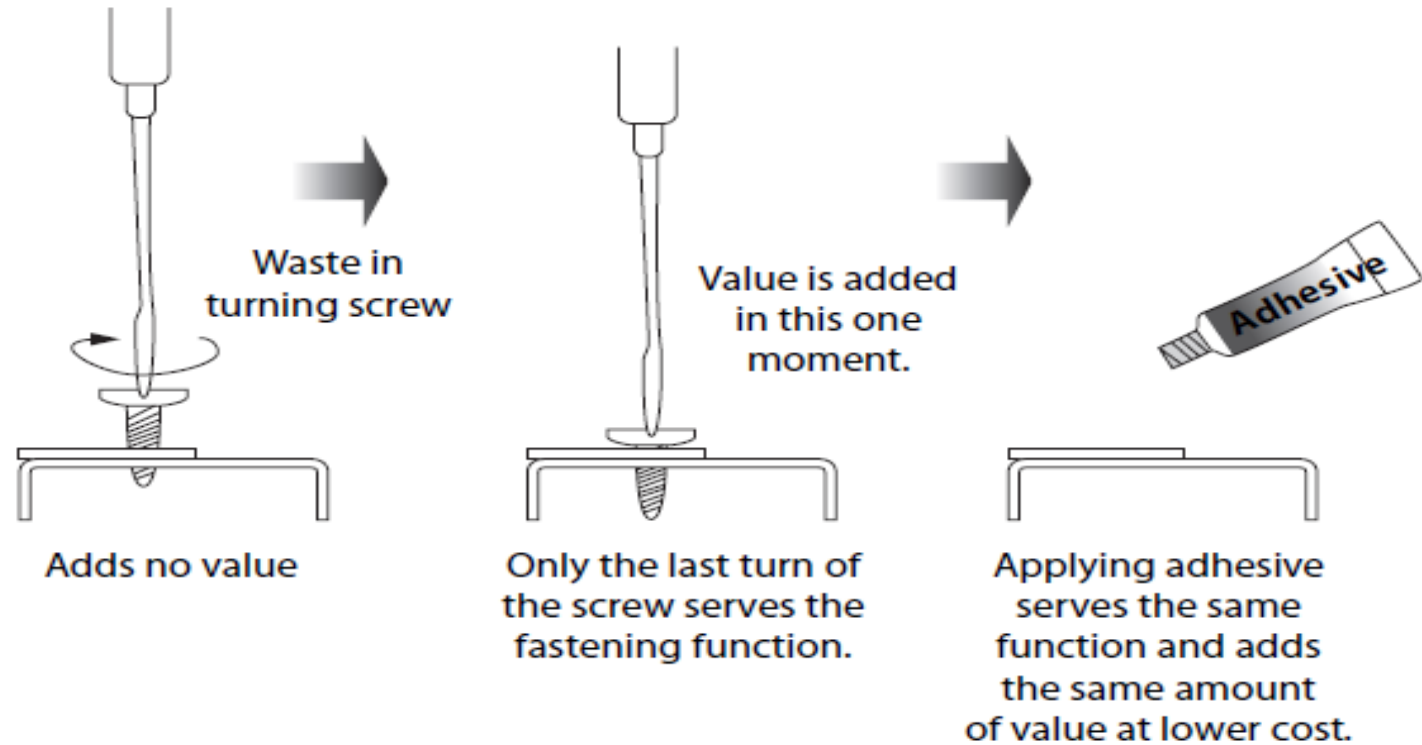
Processing

Solution: Analyze steps; identify non-value added ones; try to eliminate them



Fastening Operations

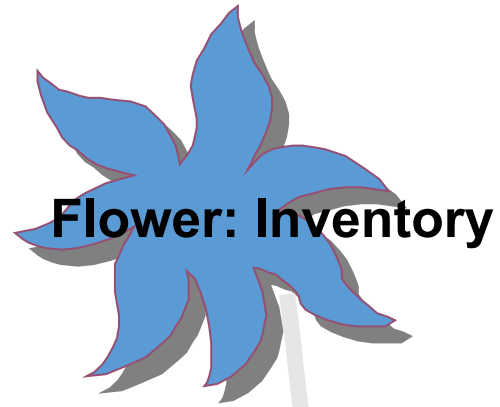
FUNCTION:
Fastening two workpieces so that
they will not become separated



Inventory



Inventory (the “Flower of all Evil”)



Root: Bad management practices



Motion (non-work)



Motion (non-work)



Solutions

- Improve facility layout
- Improve process and job design
- Clean up and organize workplace



Defects



Defects



Solutions

- Implement a system to *preclude* defects (pokayoke)
- Implement system to *immediately* identify and rectify defects (source inspection)

Examples of Waste...

MANUFACTURING

- Transportation
- Motion
- Defects
- Processing
- Waiting
- Inventory
- Overproduction

BUSINESS PROCESSES

- Transportation of documents
- Unnecessary motion
- Errors in documents
- Process steps and approvals
- Waiting for the next step
- Backlog of work
- Doing more/faster than reqd

Exercise

- Identify 8 Types of waste (TIMWOODS) in your Company and their reasons

