Lean Production Part I

Course: Production Management and Logistic Systems [10592713]

Economia e management (Latina Campus)

AA 2024-2025 | Prof. Alessandro Pietrogiacomi

SAPIENZA
UNIVERSITÀ DI ROMA

Latina 25 March, 2025

Lesson Plan for Tuesday, March 21

Overview of the lesson, and educational objectives,

Topic: **Reducing Production Timelines and Improving Quality.**

Part I Lean Production

Time: **14:00–17:00**

Duration**: 3 hours**

Learning Objectives

By the end of this lesson, students will be able to:

- Understand the principles of Lean production and how they reduce waste and improve efficiency.

Lesson Outline

1. Introduction (15 minutes)
2. Lean Production (45 minutes)
3. Just-in-Time (JIT) (45 minutes)
4. Total Quality Management (TQM) (45 minutes)
5. Recap, Q&A and Homework Assignment (15 minutes)

Introduction

- Welcome students and recap the previous session (Selection of Technological Structures).

Definition and Principles of Lean Production

Definition: A systematic approach to identifying and eliminating waste (non-value-adding activities) in production processes.

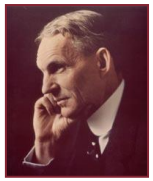
Key Principles:

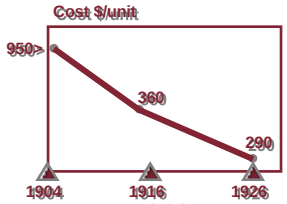
- **Value**: Define what adds value from the customer's perspective.
- **Value Stream:** Map the flow of materials and information to identify waste.
- **Flow:** Ensure smooth and uninterrupted production processes.
- **Pull:** Produce only what is needed, when it is needed.
- **Perfection**: Continuously improve processes to eliminate waste

Types of Waste in Lean Production (Muda)

- **Overproduction:** Producing more than needed.
- **Waiting**: Idle time between processes.
- **Transportation:** Unnecessary movement of materials.
- **Overprocessing**: Adding more value than required.
- **Inventory**: Excess raw materials or finished goods.
- **Motion:** Unnecessary movement of workers.
- **Defects:** Products that do not meet quality standards

Henry Ford and Frederick Taylor introduced methods to achieve mass production





1894 | 1903 | 1908 | - 1911 | 1913 | 1923 | 1930s

Craft production → **Mass Production**

- 1st car in the UK
- Ford builds his 1st car – model "A"
- Ford builds the first model "T"
- F W Taylor developed Scientific Management
- Ford builds the first moving line
- Ford reach 2.1 million vehicles/ year
- Ford's decline starts

- Shops were equipped with general purpose machines
- Each part was unique and had to be reworked
- Being a fitter was a highly skilled job
- 1 fitter built 1 car
- The workers controlled the production rate
- Annual volumes were low

- Ford had revolutionary ideas:
- Standardise parts
- Optimise work patterns
- F W Taylor similarly developed;
- Production Planning method
- Time Studies

- The moving line concept ensures every fitter works at the same pace
- It increases productivity by removing the need for people to move about

- Ford is the biggest manufacturing company in the world

- Companies have copy the Ford production principles
- European companies, while adopting mass production, provide better designed cars with lower fuel consumption

The pitfalls of Mass Production

Mass Production companies ran into problems:

- **Many companies focused on individual process productivity, buying huge, rapid machinery which were inflexible and required batch production**
- **It was good for "you can have any colour you want so long as its black"!**
- **But the market was changing …**

Craft production → Mass Production

TPS expands in its use in the last 90 years

1933 | WWII | 1946 | 1950 | 1960 | 1970 | 1980 | 1990 | 2025

TOYOTA

Lean Manufacturing

TPS as a system

Supplier development

Transplants

75 years of development

Toyota founded

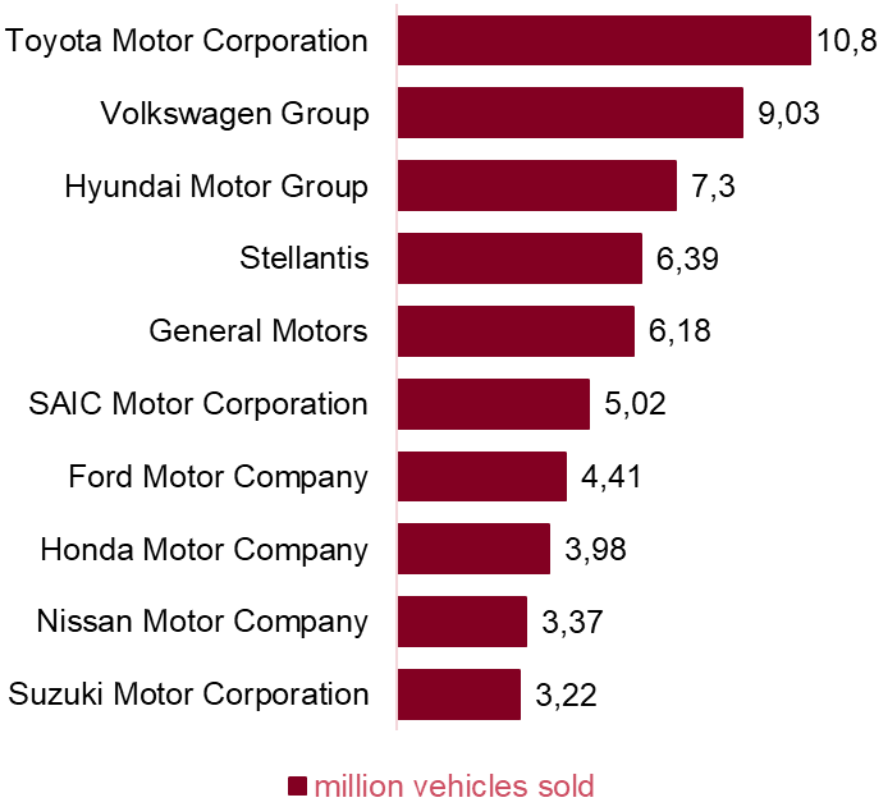
- Toyoda father and son moved from the Toyoda Automated Loom company to work on vehicles
- They changed the name of the company into Toyota for marketing purposes

- Post war restrictions caused depression
- Toyota faced the biggest strike in its history as Toyota struggled to even pay its employees

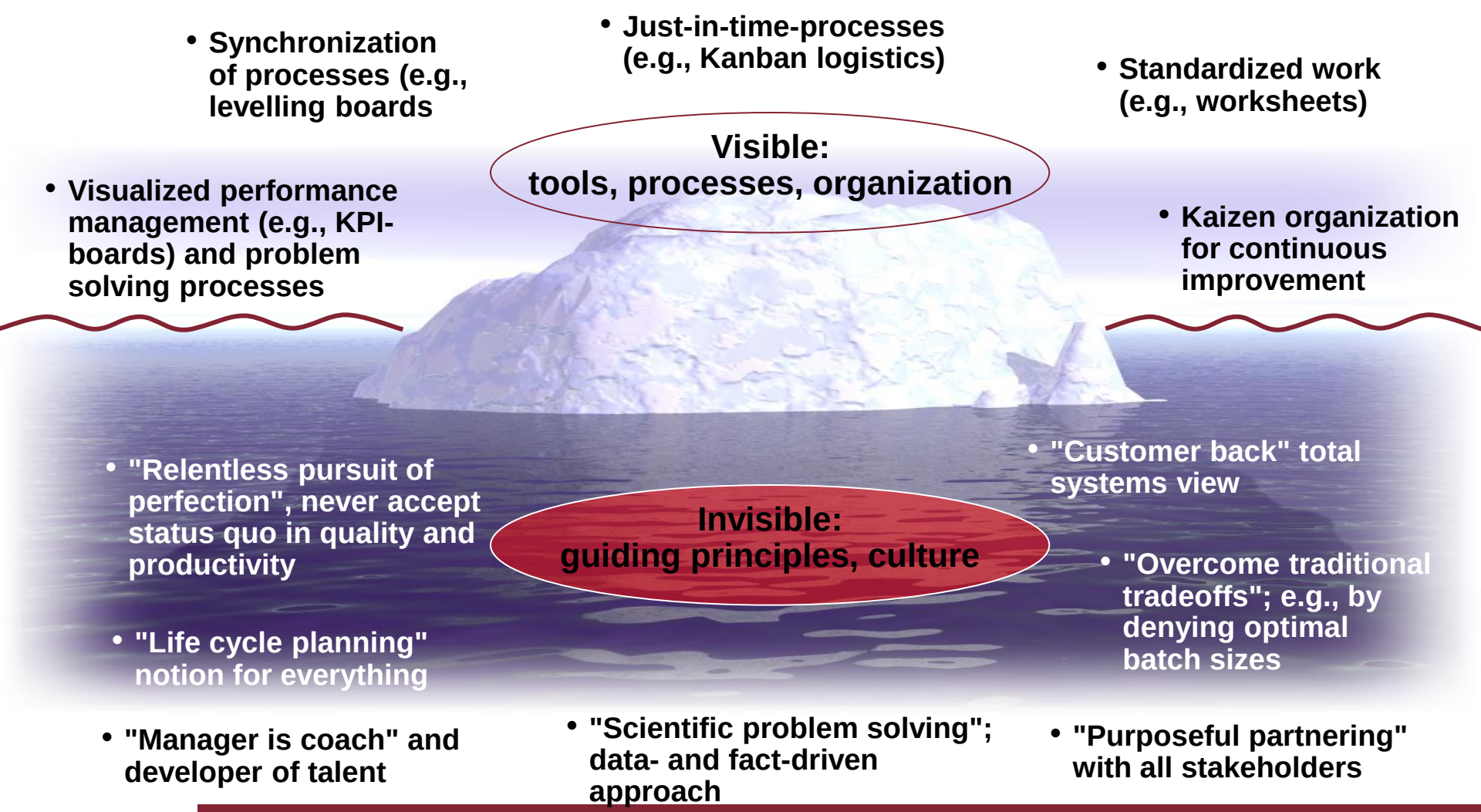
- Japanese economy is depressed with low productivity (MacArthur said Japan was 1/9th of USA)
- Toyota is a dwarf compared to American car companies – export is impossible (In 1950, GM 3,656,000, Toyota 11,000)
- Taiichi Ohno, chief engineer at Toyota, invents an alternative: the Toyota Production System (TPS)

- Toyota Motor Company achieved mass production efficiency in a low volume, high diversity environment
- Toyota introduces TPS into the supply base
- Japanese companies in the US and Europe obtain similar results to those in Asia.
- European and US companies realise their success is due to a systematic approach to operations

Toyota Remains World's Top Automaker Despite Selling Fewer Cars in 2024



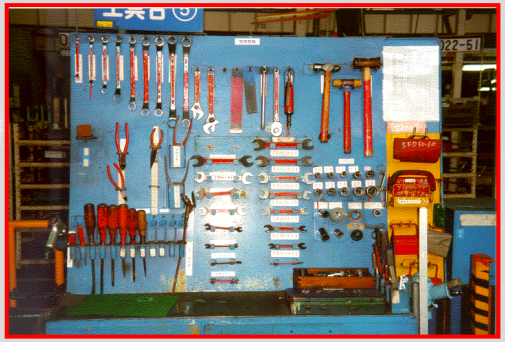
THE ESSENCE OF TPS: WHAT PEOPLE SEE AND WHAT PEOPLE DON'T SEE



EXAMPLES OF WHAT YOU SEE

Production planning following customer needs

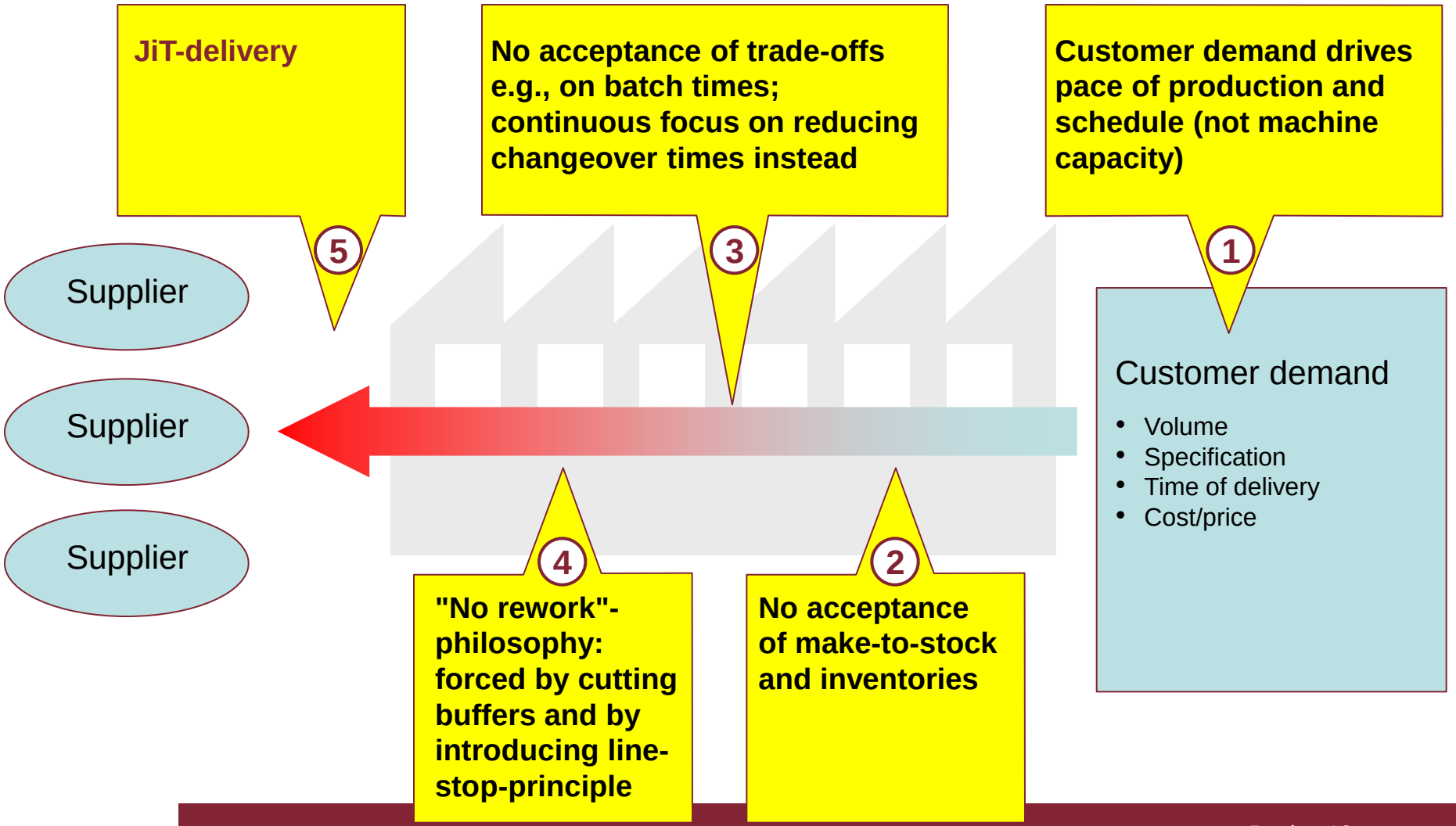
Standardization of material, tools, work procedures



Levelling of work to improve manpower and machine loading

Visualization of performance

WHAT LIES BEHIND WHAT YOU SEE: CUSTOMER DEMAND AS STARTING POINT OF ALL OPTIMIZATION EFFORTS



THE PURE ESSENCE OF TPS CAN BE TRANSLATED TO OTHER INDUSTRIES

TOYOTA

Passenger cars

Toyota Home

DELL™

JEFFERSON PILOT FINANCIAL

ALCOA

BOEING

What is Lean? – The original definition

“Lean production is ‘lean’ because it uses less of everything compared with Mass Production – *half* the human effort, *half* the manufacturing space, *half* the investment in tools ….

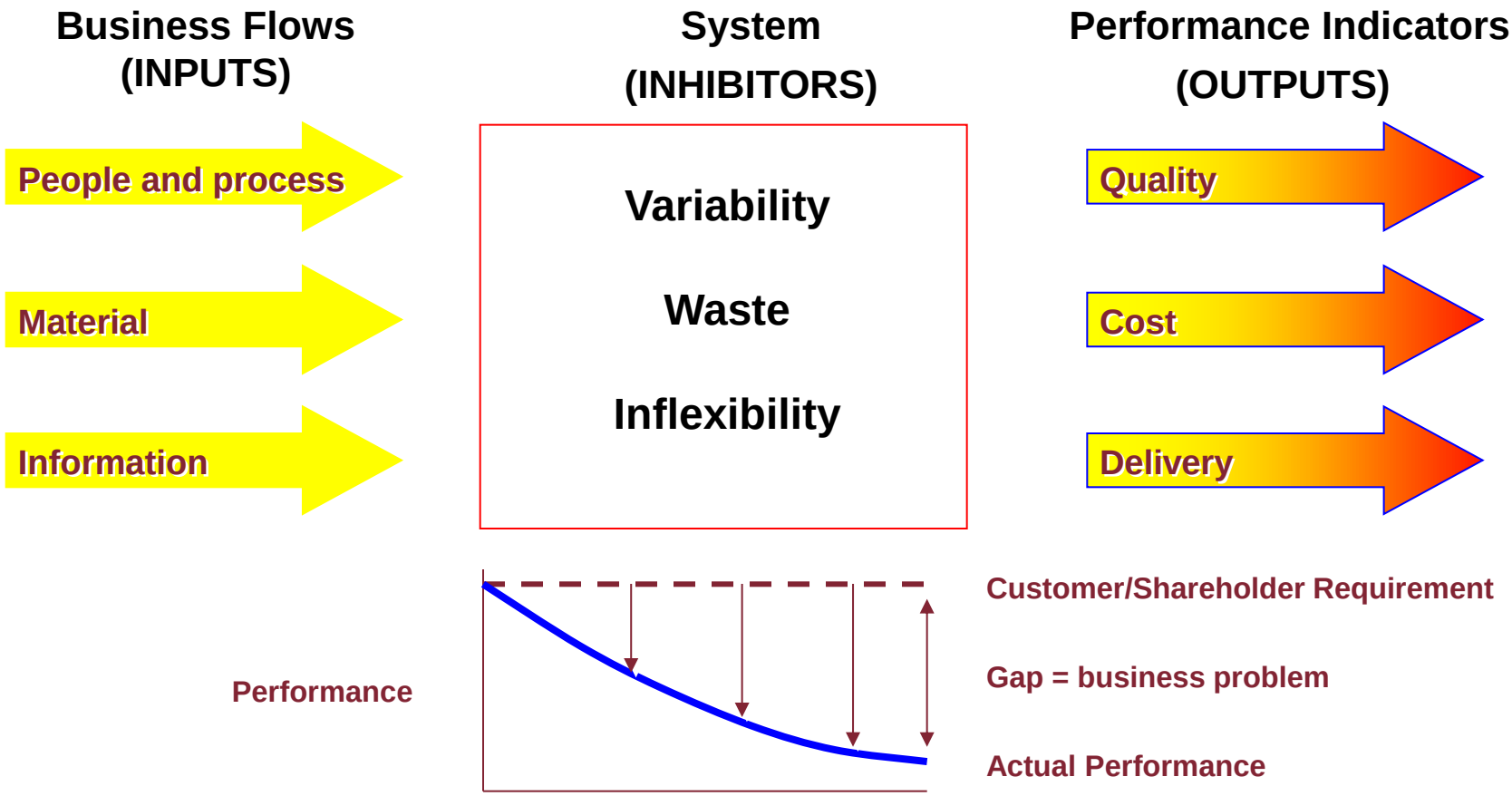
Also, it requires keeping far less than *half* the needed inventory on site, results in many fewer defects ….”

What is Lean?

Lean is a customer focused approach which eradicates operational business problems.

It ensures that customers receive their required level of quality, price and delivery whilst maximising an organisation's competitive advantage and shareholder value.

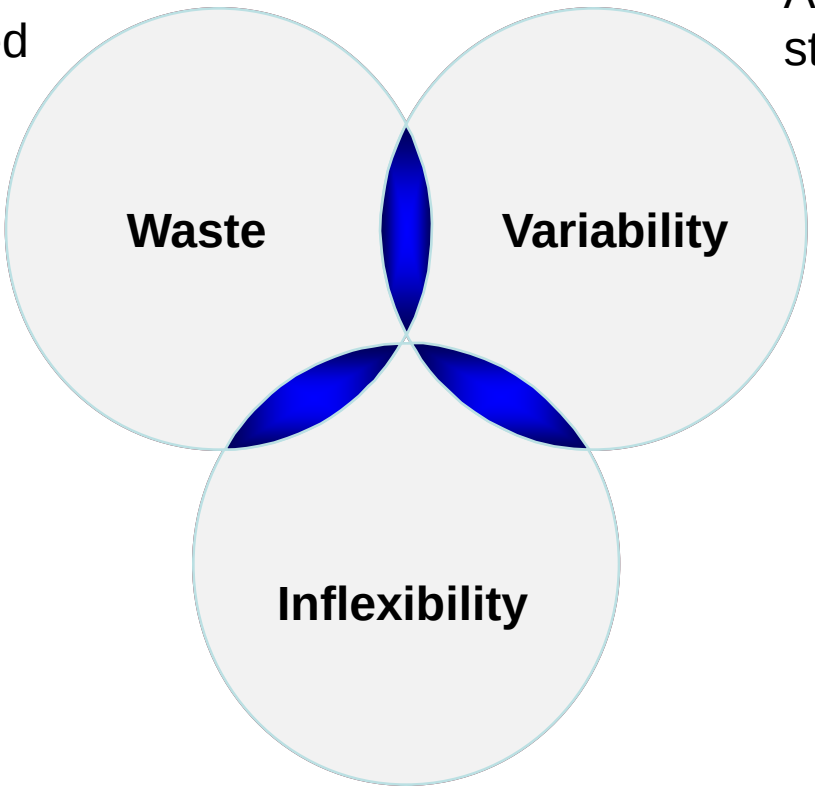
It can only be achieved by reducing the system inhibitors



To improve performance the inhibitors should be understood and continually reduced

Use of resources beyond what is needed to meet customer requirements

Any deviation from standard



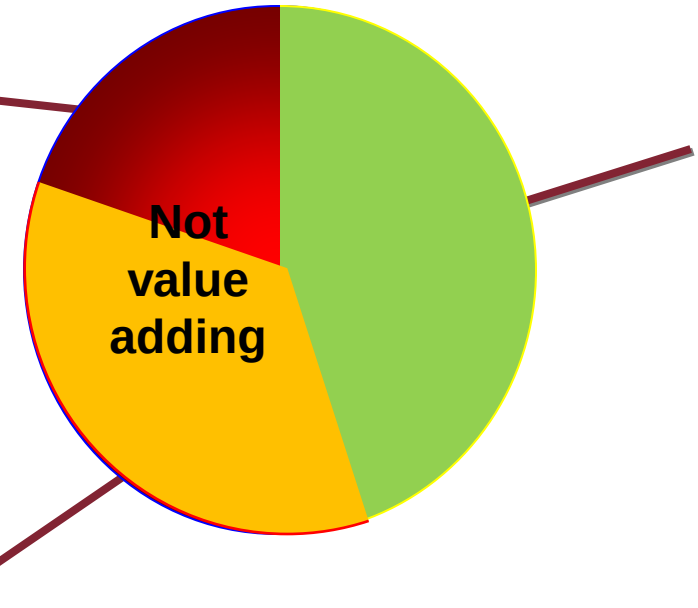
The additional costs incurred by the current system in giving the customer exactly what they want

Waste adds cost, but doesn't add value

Waste

Job elements that don't add value to the product

(e.g. waiting for a machine cycle to finish)



Value-adding processes

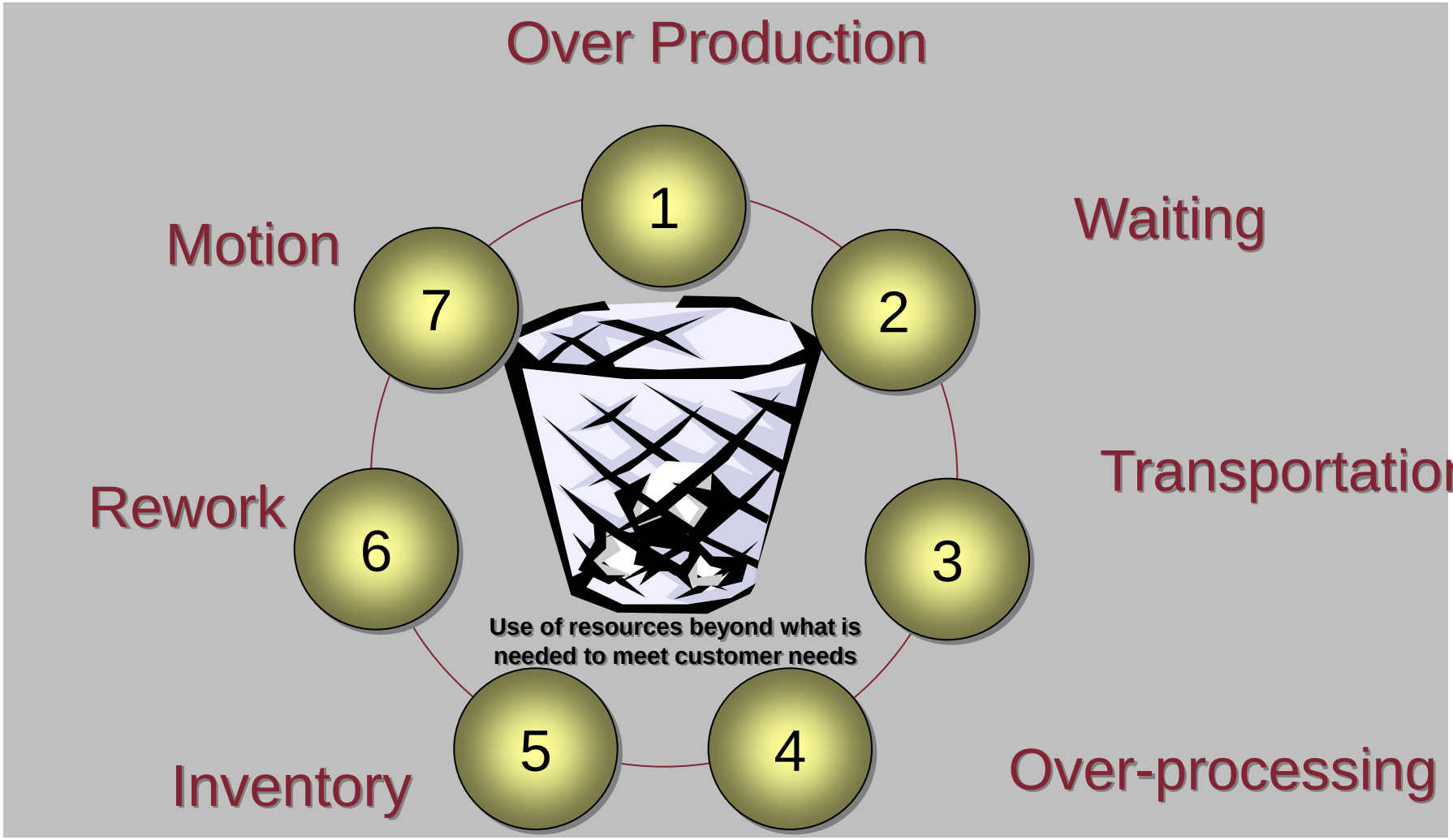
Job elements that directly add value to the product

(e.g. processing parts on a machines)

Incidental work

Job elements that don't add value but must be done, currently, to accomplish value-added work in the current system (e.g. walking the width of the machines)

There are 7 types of waste



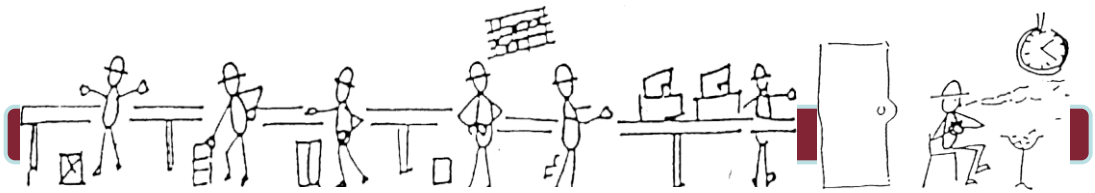
Over production is producing sooner, faster or in greater quantities than customer's demand

- **Over Production can prevent other essential activities from taking place**
- **Over-produced items end up as inventory or scrap, therefore creating other waste**

Produce only what the customer wants, when he wants it

Waiting is people or machines which wait for the completion of a another work cycle

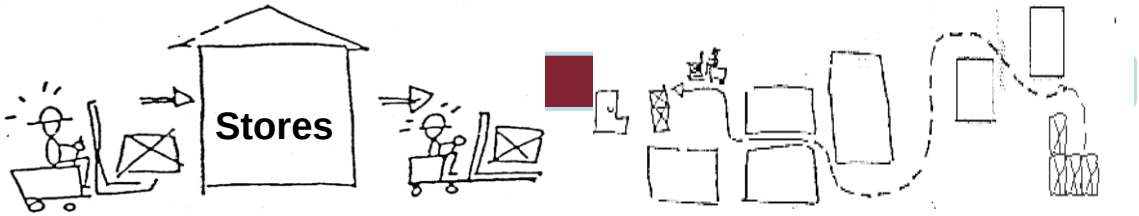
- **Waiting can often be avoided - most machines do not have to be supervised**
- **Essential waiting time can be filled productively (e.g. sub-assembly, quality checks, material handling, etc)**



Rebalance operations and use standardised in-process stock and autonomation to remove waiting

Transportation is the unnecessary movement of people between processes

- Can create handling damage and causes production delays
- Misuse of operators' and management's time



Minimise the transportation steps by gathering the work content using continuous flow processing

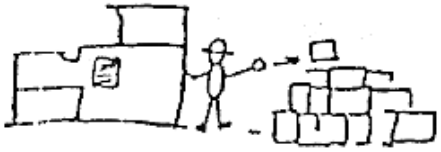
Over-processing is processing beyond the standard required by the customer

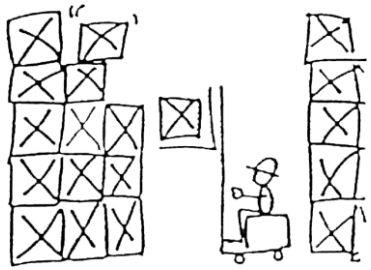
- **May be an undesirable effect of an operator's pride in his work**
- **Often arises where standards are difficult to define (e.g. polishing, finishing, painting)**

Provide clear, customer driven standards for every process

Inventory is raw material, work-in-progress or finished goods not having value added

- Often is a symptom of other problems in the system that are hidden behind rising stock levels
- Increases operational costs (conveyance, storage, risk of obsolescence) and manufacturing lead-time

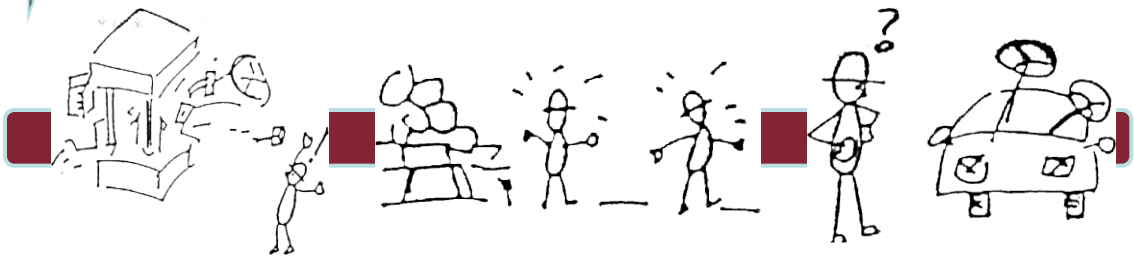




Define necessary inventory level and minimise by reducing batch sizes and improving process reliability

Rework is repetition or correction of a process

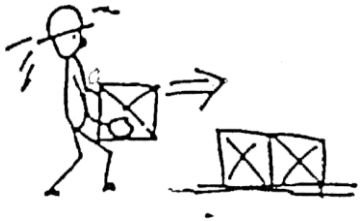
- **Rework is failure to meet the Right First Time expectation**
- **Can be caused by Methods, Materials, Machines or Manpower**
- **Requires additional resource to prevent disruption of production**

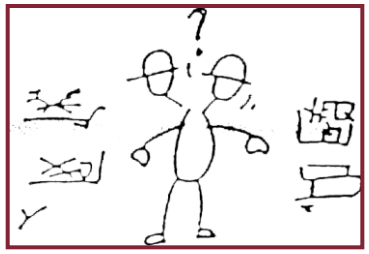


Improve process capability by analysing and solving the root causes of rework

Motion is the unnecessary movement of people or machines within a process

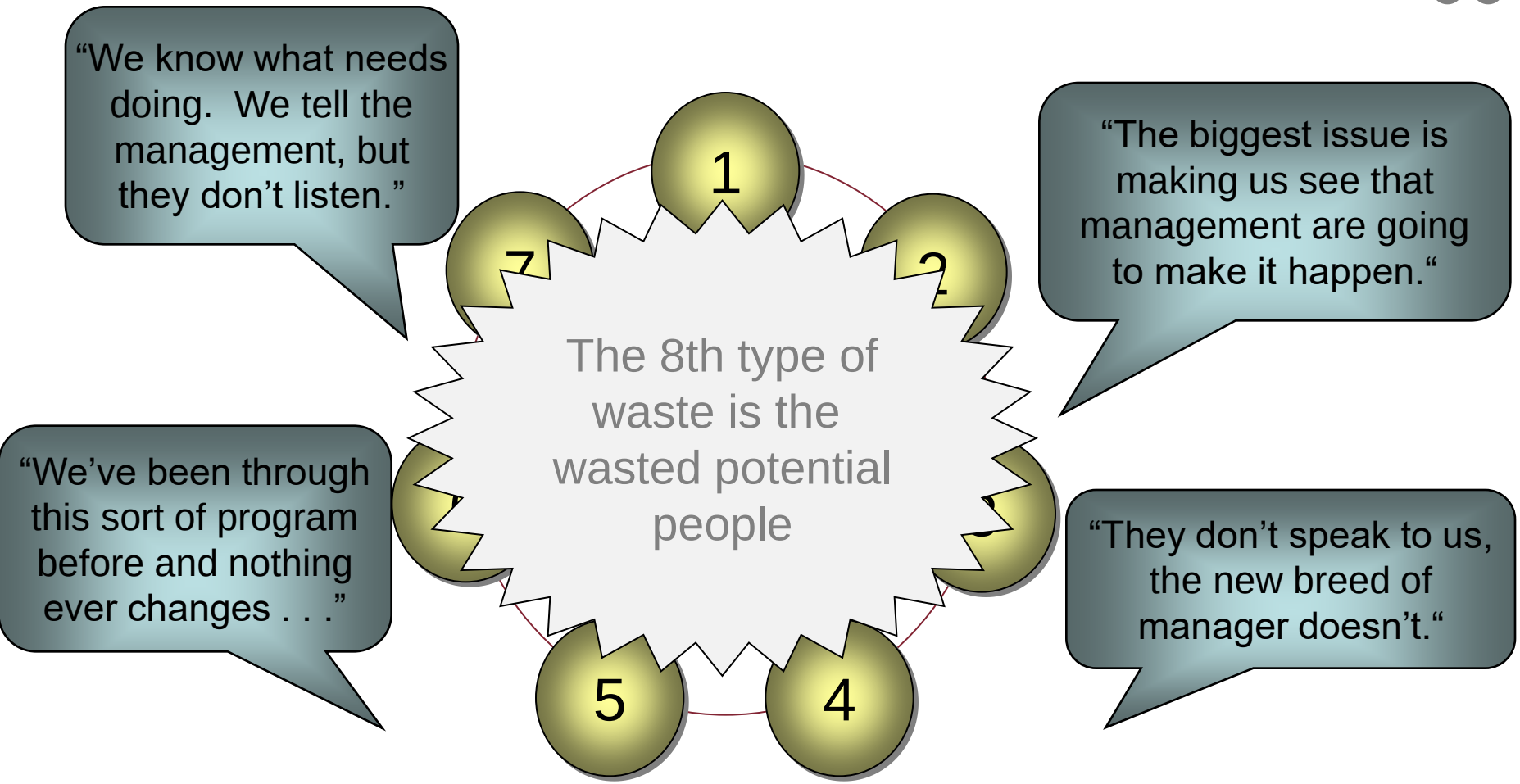
- Manual and machine work cycles both often comprise unnecessary motion elements
- Unnecessary motion can also be caused by a layout not being optimised for varying customer demands



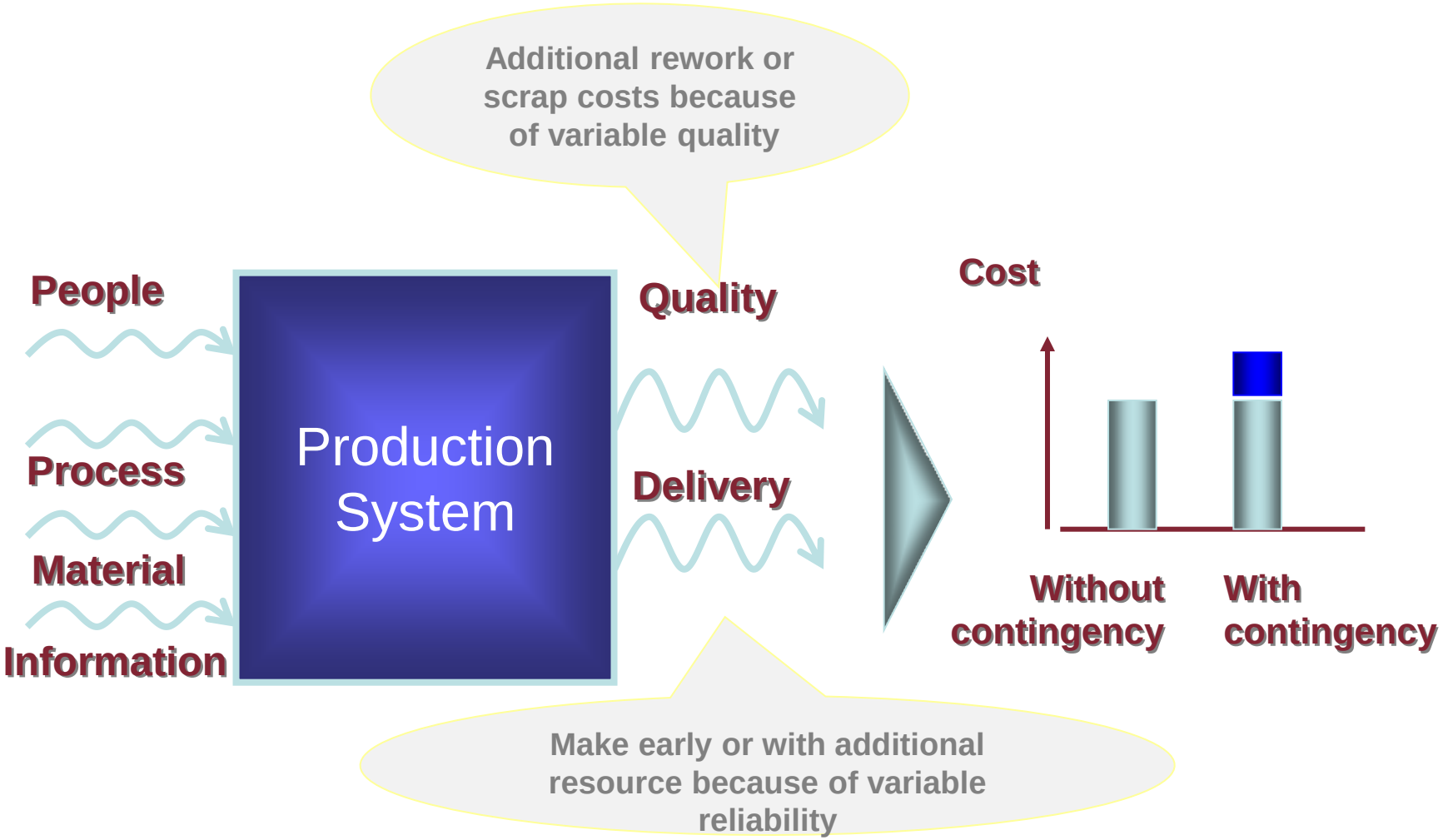


Arrange tooling, equipment and parts around work stations and use standardised work to minimise motion

The 8th type of waste

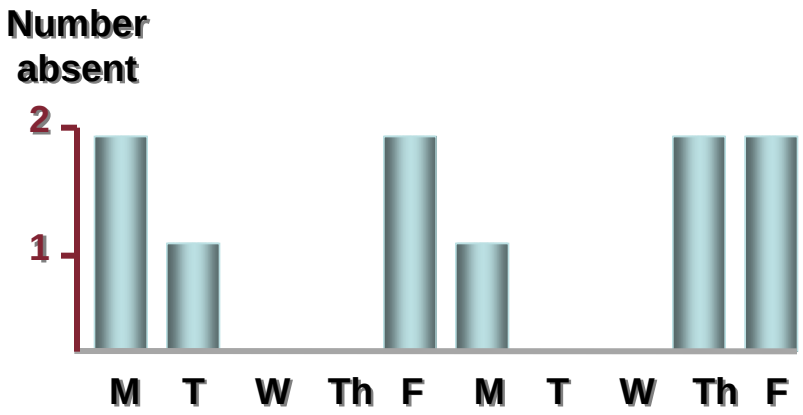


Variability increases cost due to the contingencies required for poor quality & delivery



People variability is caused by skill and attendance issues

Attendance

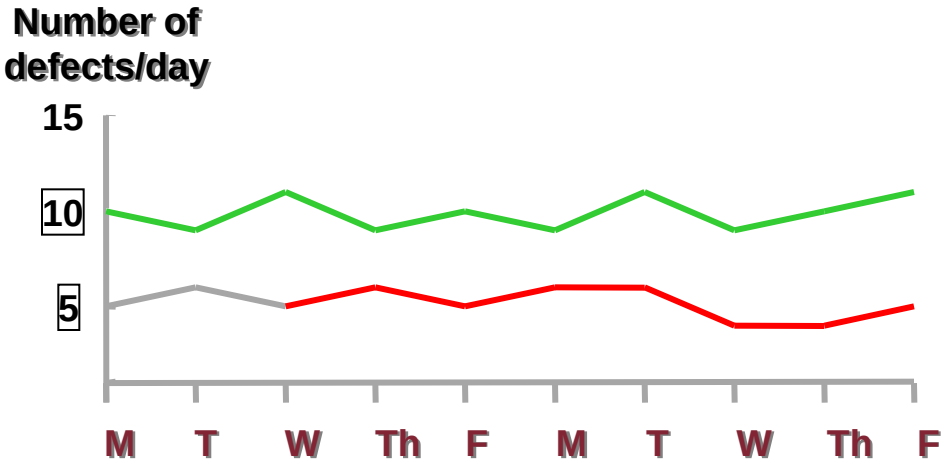


Average absence = 1 person/day

Absence cover = 2 person/day

Wasted manpower = 1 person/day

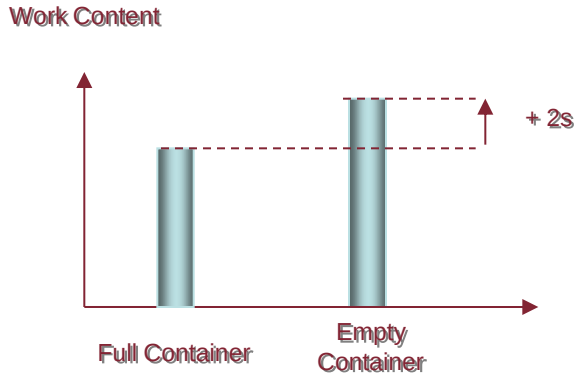
Skill



Operator A creates more rework than operator B

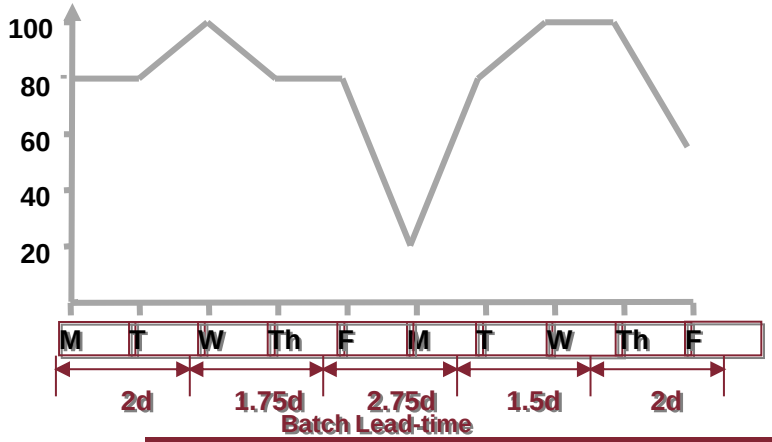
Process variability is caused by Operator and Machine issues

Operator Motion



Machine Performance

% OEE



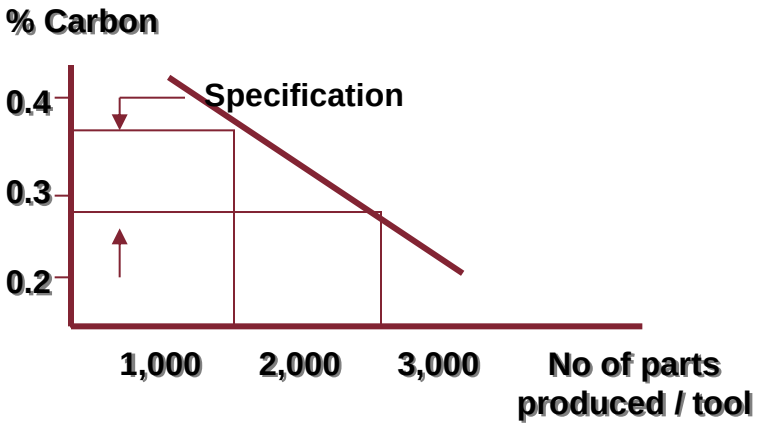
Lead-time Max = 2.75 days

Lead-time Min = 1.5 days

Set lead-time as 2.75 days & have 0 – 1.25 days of stock

Material variability is caused by quality and delivery of material arriving at a process

Quality

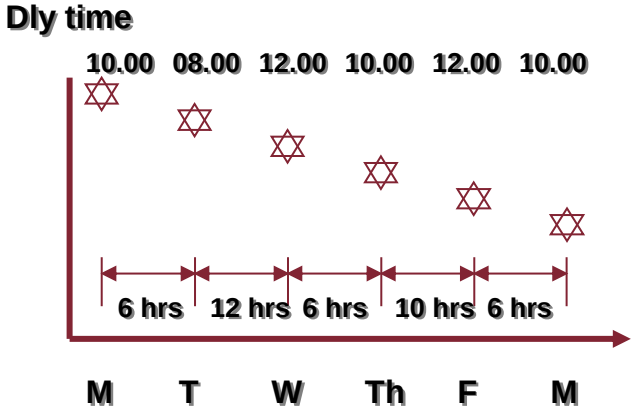


Average tool life = 2,000 parts

Minimum tool life = 1,500 parts

Average wasted tool life = 500 parts

Delivery



Average time between deliveries = 8 hrs

Maximum time between deliveries = 12 hrs

Safety stock = 4 hrs

Variability is caused by quality and release of information

Quality

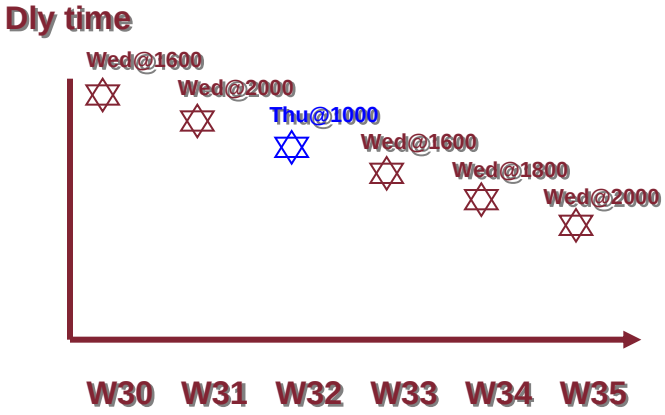
W33 Req't	F'cast	Firm	Order
	W30	W31	W32
ABC	500	500	200
XYZ	500	500	800

300 ABC's found labelled as XYZ

Too much raw material for ABC

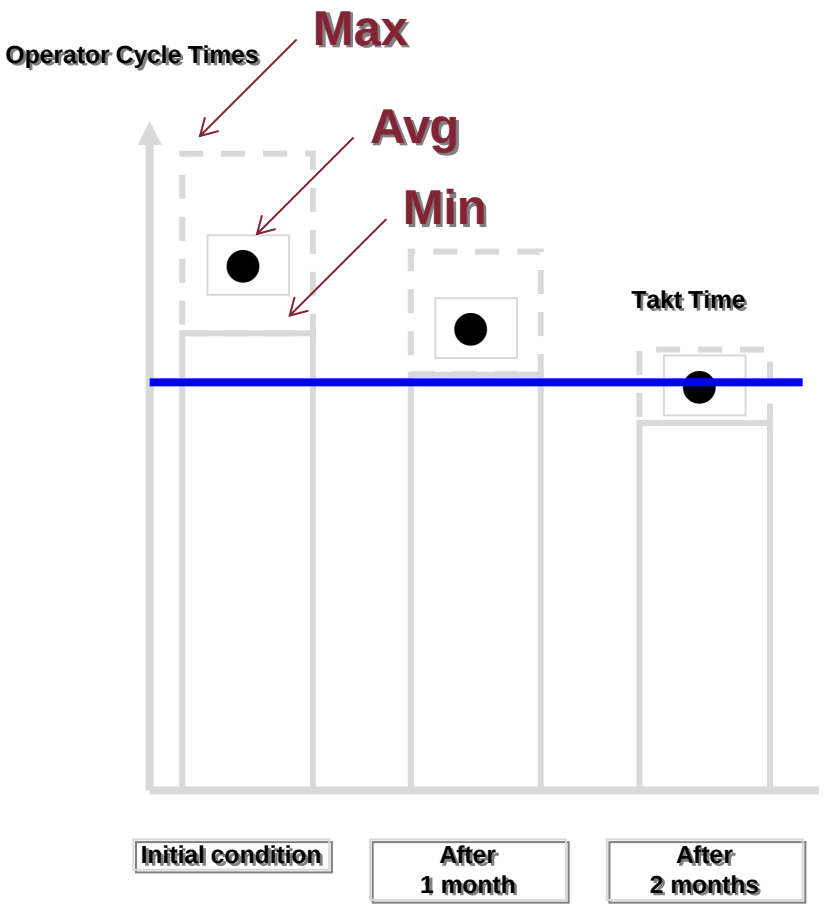
Too little raw material for XYZ; leading to a short shipment

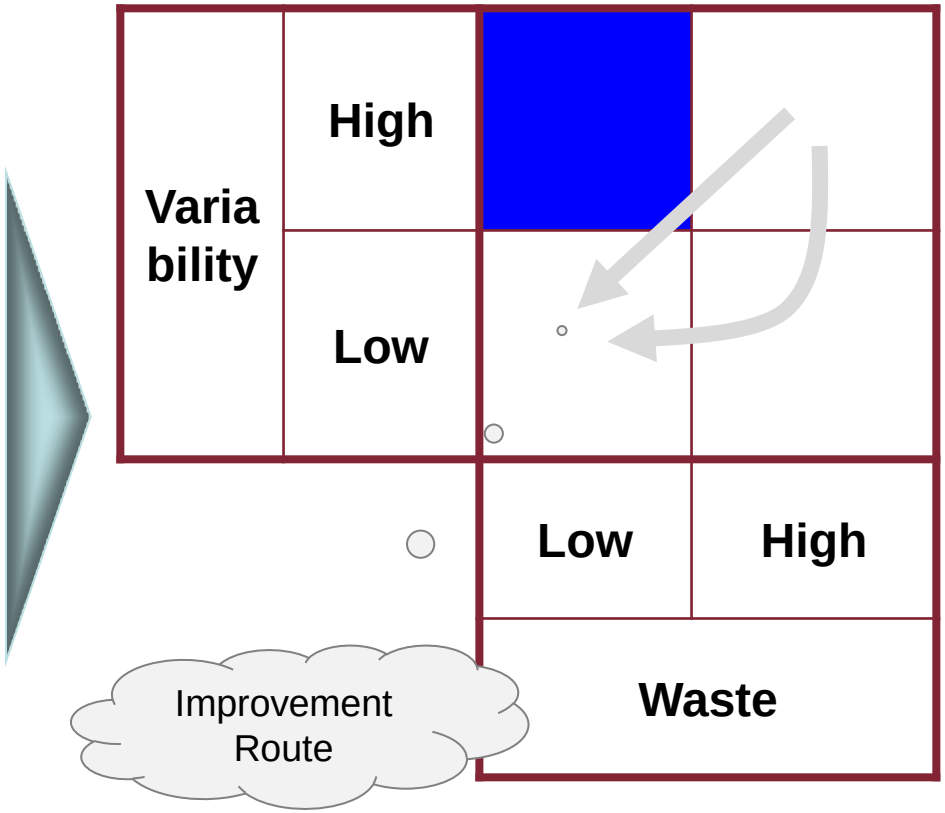
Release



No production from 06.00–10.00 on Thursday in W32

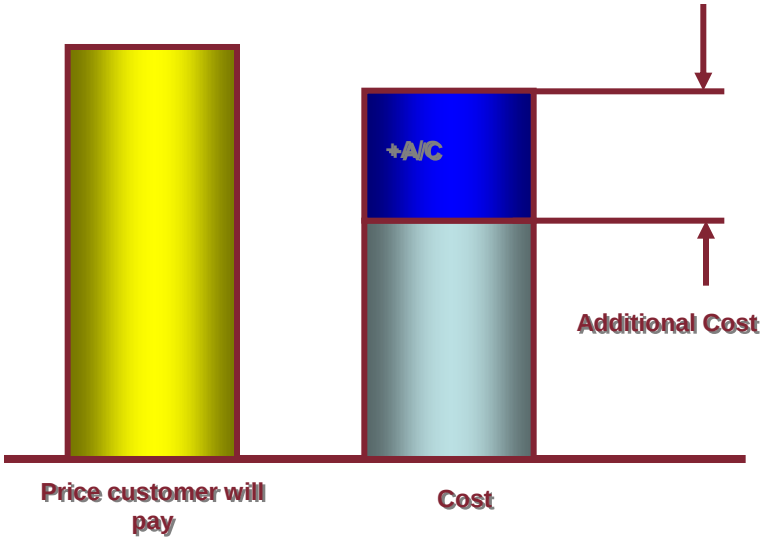
Variability and Waste are inextricably linked; reducing waste requires variability to be reduced





Inflexibility is the additional cost incurred by the current system in giving the customer exactly what they want

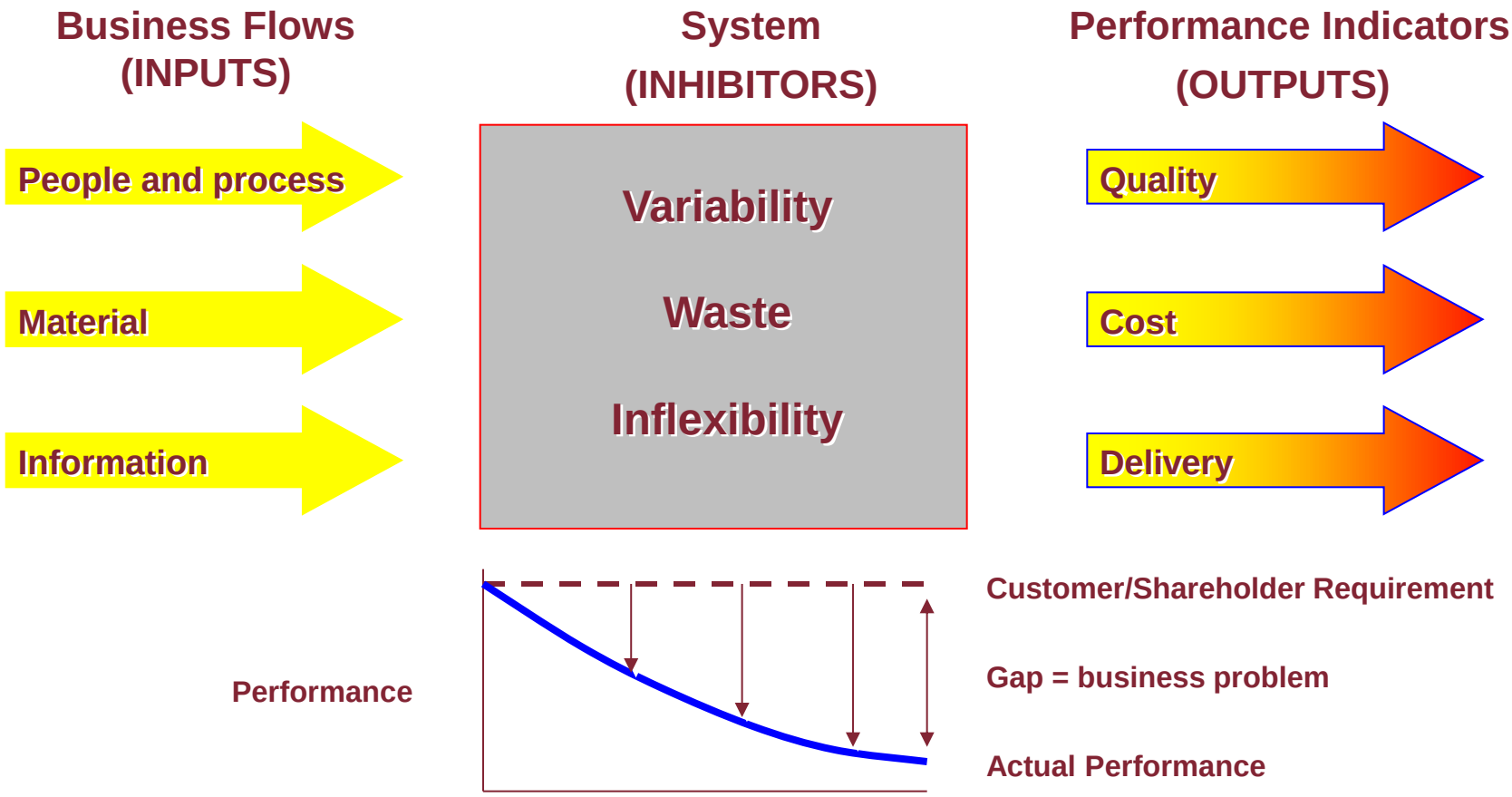
Exceeding the customer's requirement
(Providing a Car with Air Conditioning that was not required)



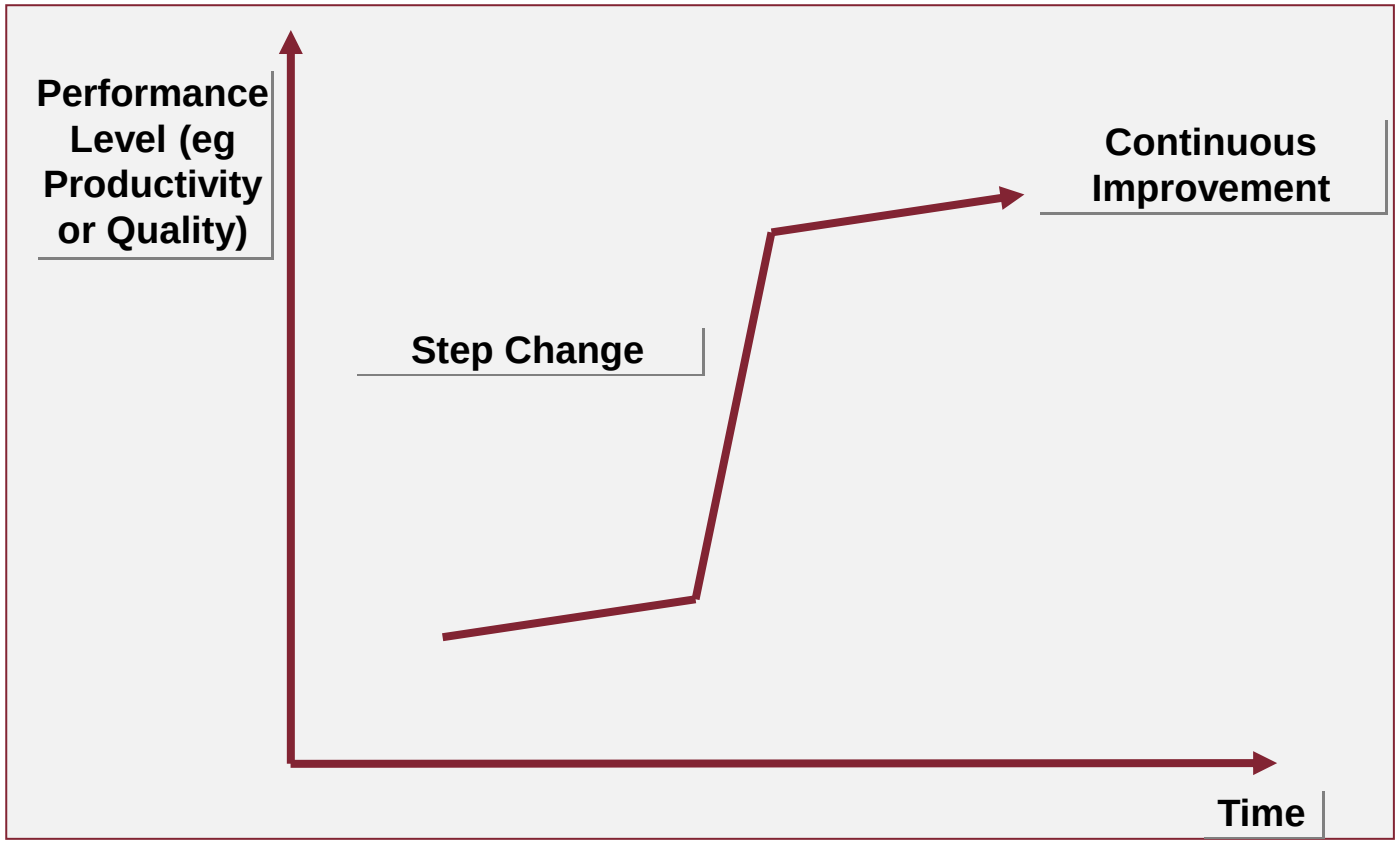
Inflexibility can reveal itself in many forms

Characteristic	What the customer wants	What the producer can make/supply	Additional cost
Quantity	1 pine conference room table	100 pine conference tables	Cost of storage and obsolescence risk for 99 tables
Quality	Fast, healthy hotel food (Regular Business Traveller)	Slow, rich food	Loss of business to fast food chains
People	Mon-7Hrs; Tues-8Hrs; Wed-10Hrs; Thurs-8Hrs; Fri-7Hrs	Mon / Tues / Wed / Thurs / Fri – 8 Hrs	Building up stock from Fri & Mon to meet Weds demand
Delivery	A new bed, next week	A new bed in 6 weeks	Loss of price premium that could be charged

Reducing the system inhibitors will improve the business performance and close the gap



But lean requires a sustainable step change as a foundation for continuous improvement



Recap, Q&A and Homework Assignment

Recap of Key Points

- Lean production focuses on eliminating waste and improving efficiency.
- Minimizes inventory and reduces production timelines by producing only what is needed.
- Emphasizes continuous improvement and customer satisfaction to enhance product quality.

Homework Assignment

- **Task:** Research a company that has successfully implemented Lean production methodologies
- **Deliverable**: Write a 1-page report describing the company's approach, the benefits achieved, and the challenges faced.