

Analysis of Operations System

How?

PRODUCTIVITY , SYSTEM AND PROCESS

WHAT IS PRODUCTIVITY...

“...productivity is making the most of one’s time and talent, and energizing the whole surrounding environment so that men and women are inspired and motivated: that is make the most of themselves, both as individuals and as member of society on all planes of living, thinking and acting: whether it is politics or economics or home, village or factory, life at the ground level or life of the spirit..”

-Gandhiji

MEASURE OF PRODUCTIVITY..

- Partial measures $\frac{\text{Output}}{\text{Labor}}$ $\frac{\text{Output}}{\text{Machine}}$ $\frac{\text{Output}}{\text{Capital}}$ $\frac{\text{Output}}{\text{Energy}}$
- Multifactor measures $\frac{\text{Output}}{\text{Labor} + \text{Machine}}$ $\frac{\text{Output}}{\text{Labor} + \text{Capital} + \text{Energy}}$
- Total measure $\frac{\text{Goods or Services Produced}}{\text{All inputs used to produce them}}$

Example :

Windals Precision is compiling the monthly productivity report for its review meeting. From the following data, calculate (a) labor productivity, (b) machine productivity, and (c) the multifactor productivity of rupees spent on labor, machine, materials, and energy.

The average labor rate is Rs.30 per an hour, and the average machine usage rate is Rs.100 per hour.

- Units produced 100,000
- Labor hours 10,000
- Machine hours 5,000
- Cost of materials Rs.450,000
- Cost of energy Rs.150,000

Calculate the (a) labour productivity, (b) machine productivity (c) Multifactor productivity

PROCESS MANAGEMENT

WHAT IS SYSTEM AND PROCESS

*Knowledge is derived from the understanding of
the whole and not that of the single parts :
Aristotle's Holism*

System and Process..

Optimizing each part of a firm doesn't optimize the whole firm ([Harvard Business Review, January 2016](#))

Toyota is becoming more efficient by replacing robots with humans. (<http://qz.com/196200/toyota-is-becoming-more-efficient-by-replacing-robots-with-humans/> Dated. April 7, 2014)

A recent study indicates that increased patient satisfaction in Hospitals raise healthcare costs and lead to more patient deaths. (<https://www.theatlantic.com/health/archive/2015/04/the-problem-with-satisfied-patients/390684/>)

What is System and Process...

System is a set of interrelated or interacting elements

Management System is the framework of processes used to establish policy and objectives and to achieve those objective.

Process is a set of interrelated or interacting activities, which transforms inputs into outputs

Why Process Management

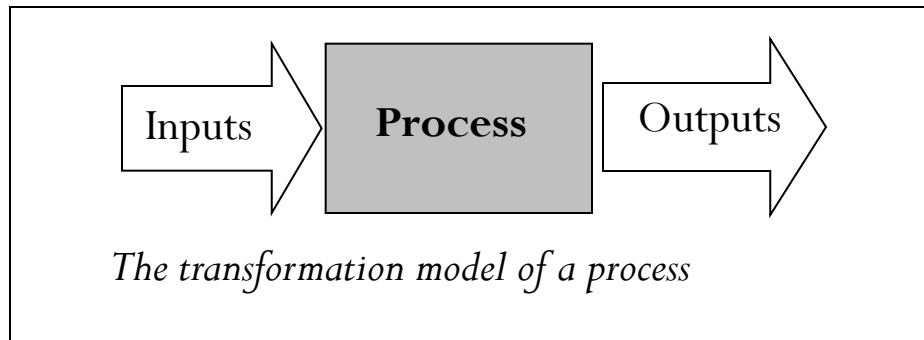
Company that managed both process and their technology deployments to support their business process experienced significant gains over those who did not

(2004 Study of London School of Economics and Mc Kinsey)

What is a Business Process?

Traditional Process definition in OM literature

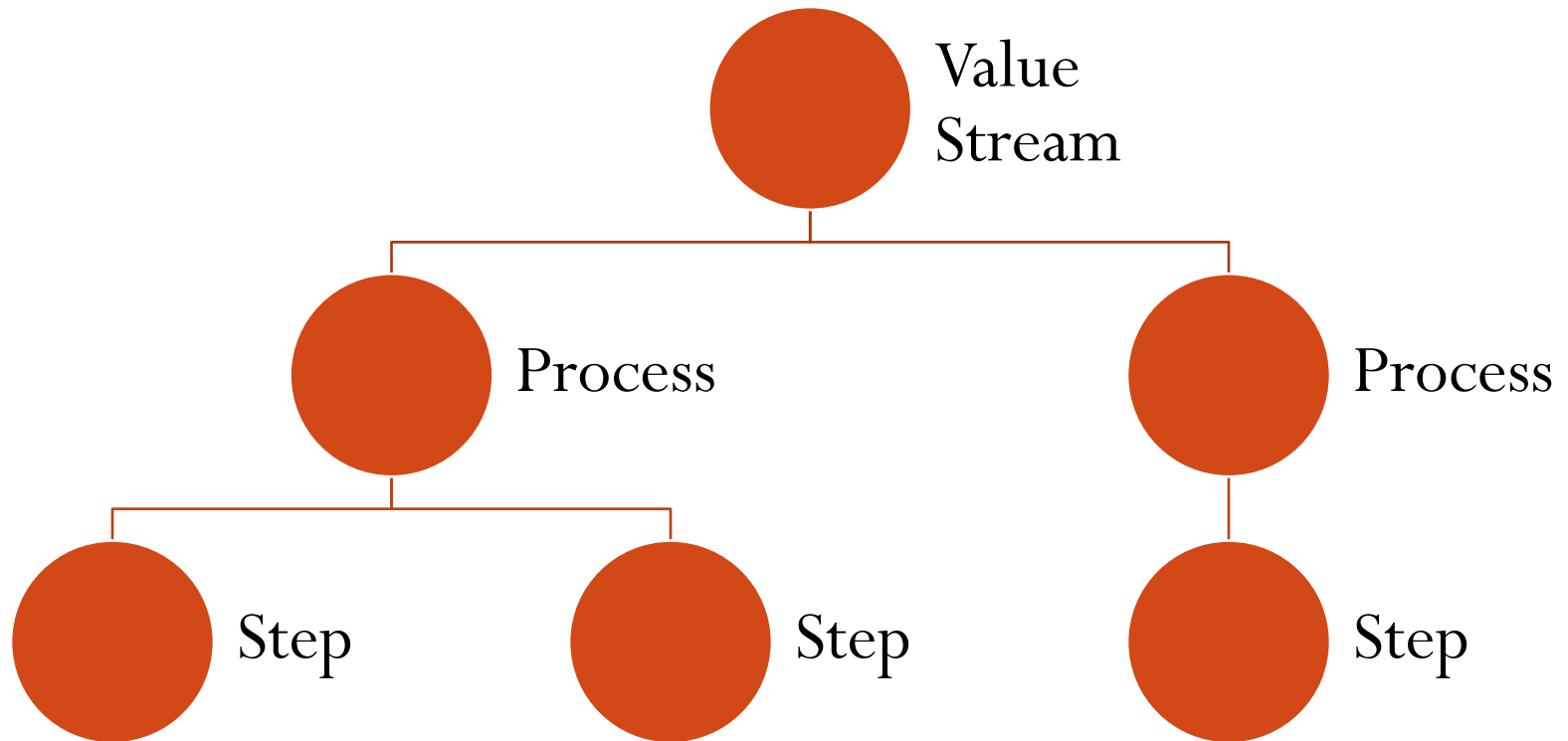
A process specifies the transformation of inputs to outputs



Different types of transformations

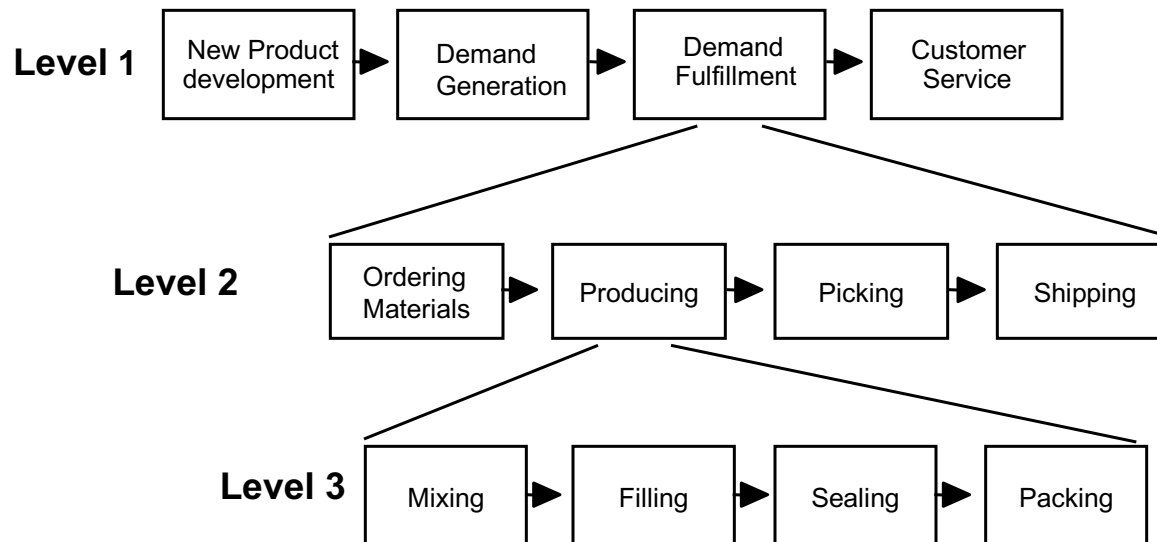
- Physical (*Ex. raw material \Rightarrow finished product*)
- Locational (*Ex. flying from Mumbai to Delhi*)
- Transactional (*Ex. depositing money in a bank*)
- Informational (*Ex. accounting data \Rightarrow financial statement*)

GRANULARITY OF WORK



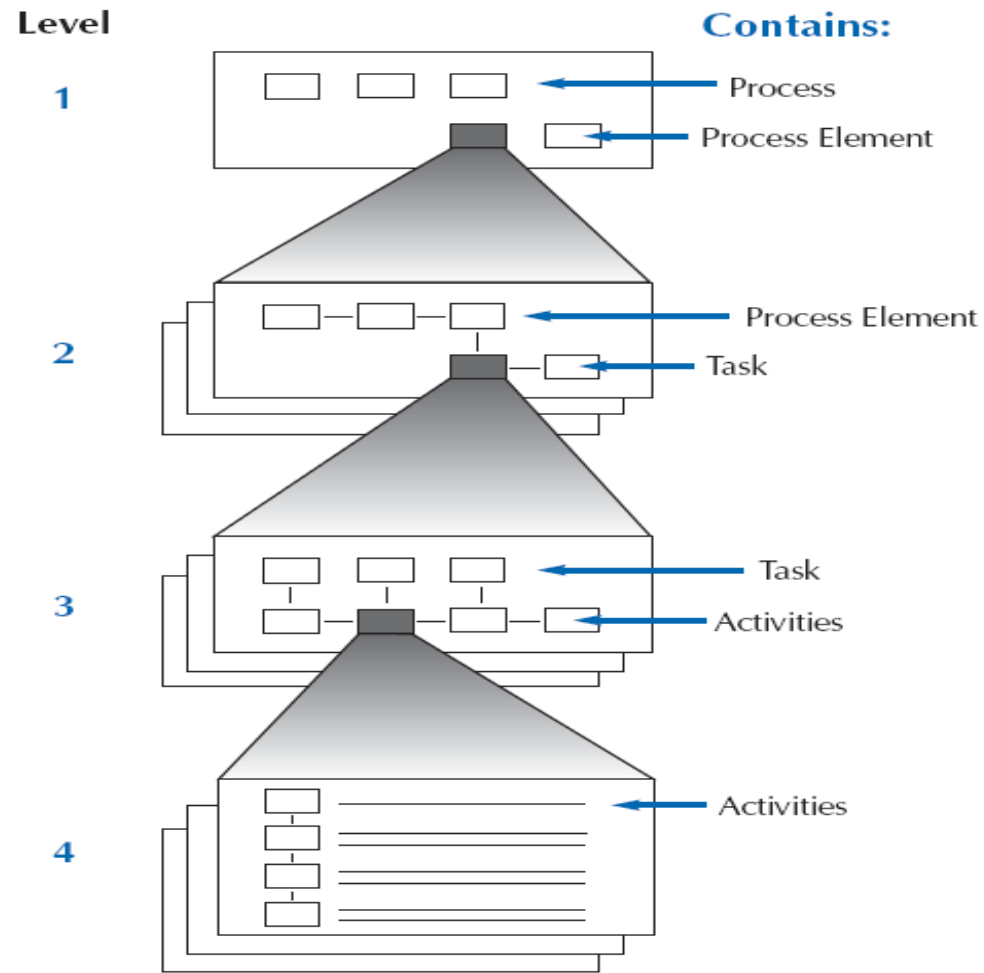
STARTING AT THE TOP

- Key business activities can be defined at different levels of the organization:



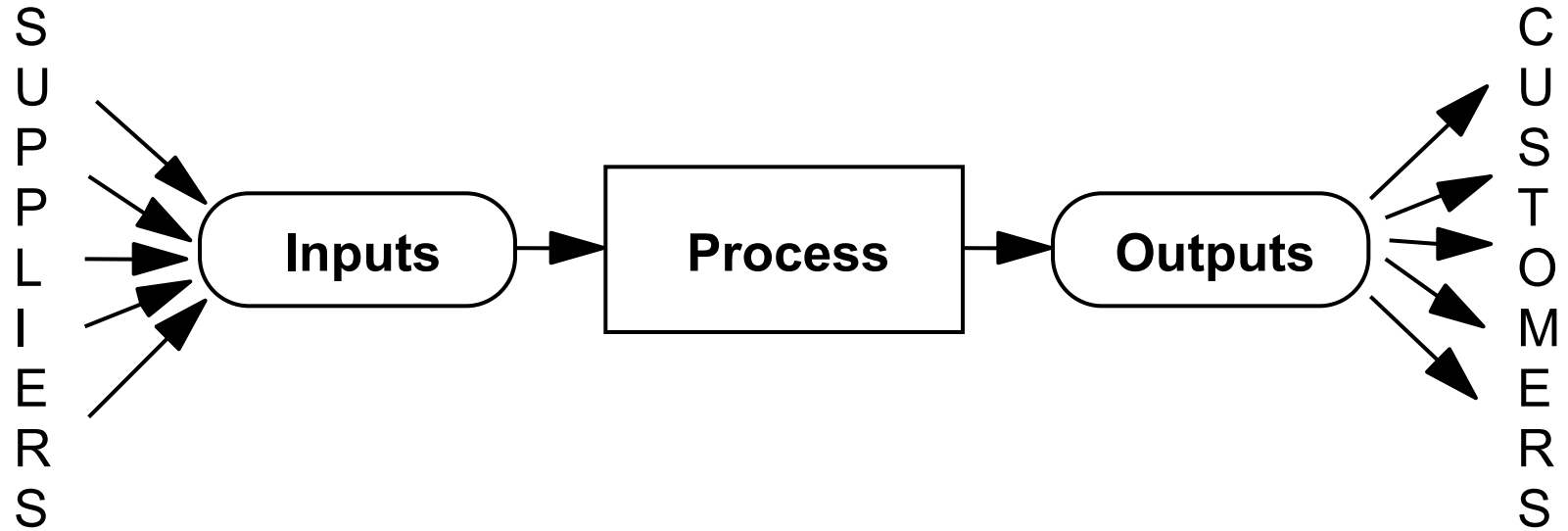
- **Level 1** = highest-level view of work in the organization
- **Level 2** = work that flows across several departments or within an entire department or work area
- **Level 3** = a detailed view of of a particular process

GRANULARITY OF WORK



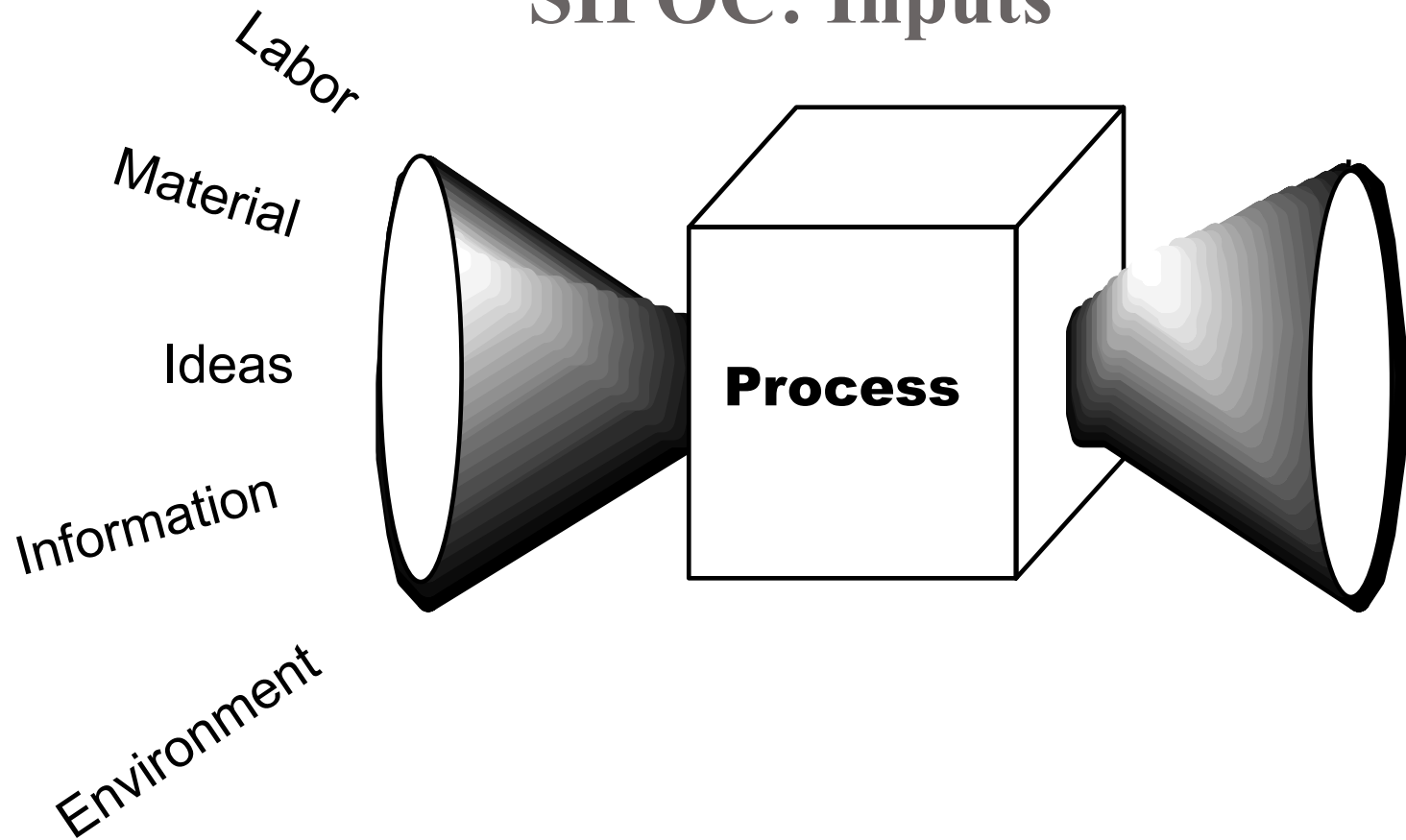
“If you cannot define what you are doing as a process, you do not understand what you are doing.” -- W. Edwards Deming ..

SIPOC

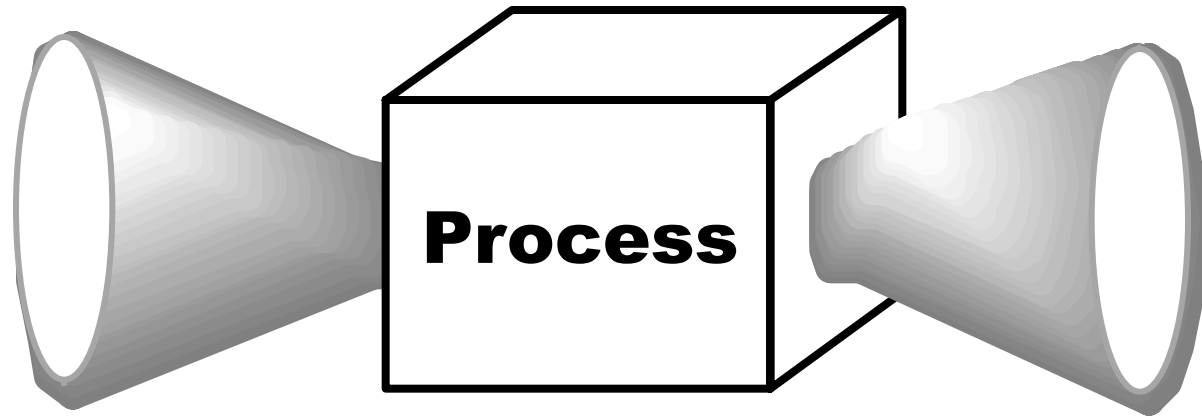


- Applies to all kinds of work, whether repetitive in nature or “one-of-a-kind.”
- Having a high-level view of a process helps to:
 - define project boundaries (starting and ending points);

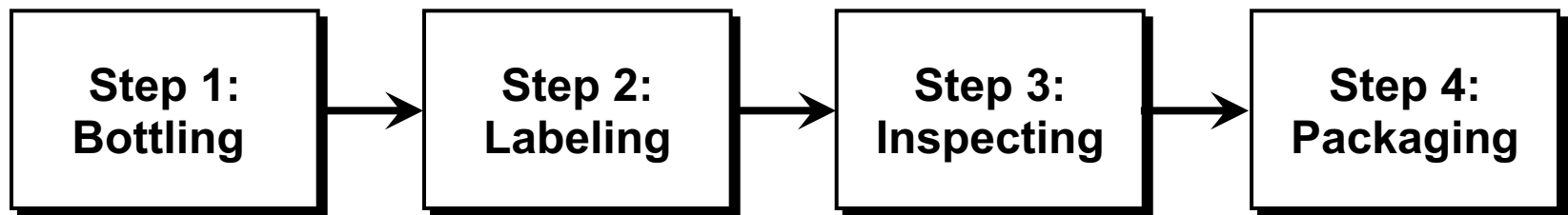
SIPOC: Inputs



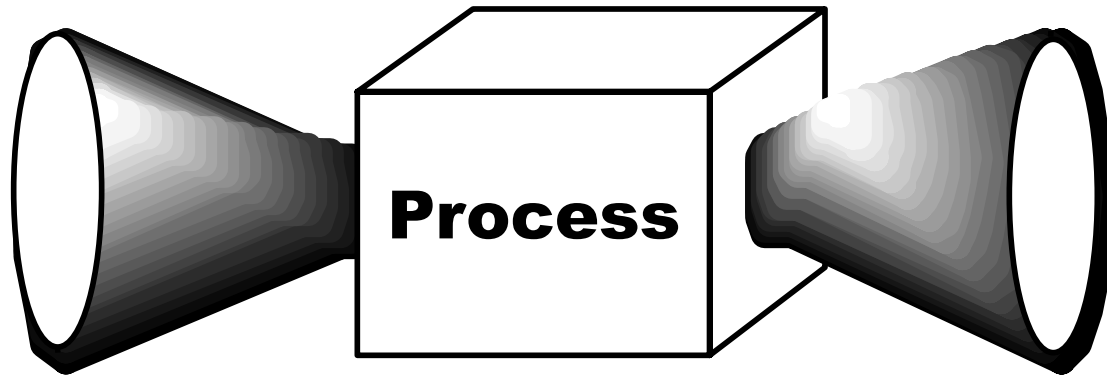
SIPOC: High-Level Process View



A high-level view is often captured as a **top-level flowchart**



SIPOC: OUTPUT



Physical products
Documents
Information
Services
Decisions

Questions to Help with SIPOC

- **Outputs**

- What product does this process make?
- What are the outputs of this process?
- At what point does this process end?

- **Customers**

- Who uses the products from this process?
- Who are the customers of this process?

- **Inputs/Suppliers**

- Where does the information or material you work on come from? Who are your suppliers?
- What do they supply?
- Where do they affect the process flow?
- What effect do they have on the process and on the outcome?

Process steps

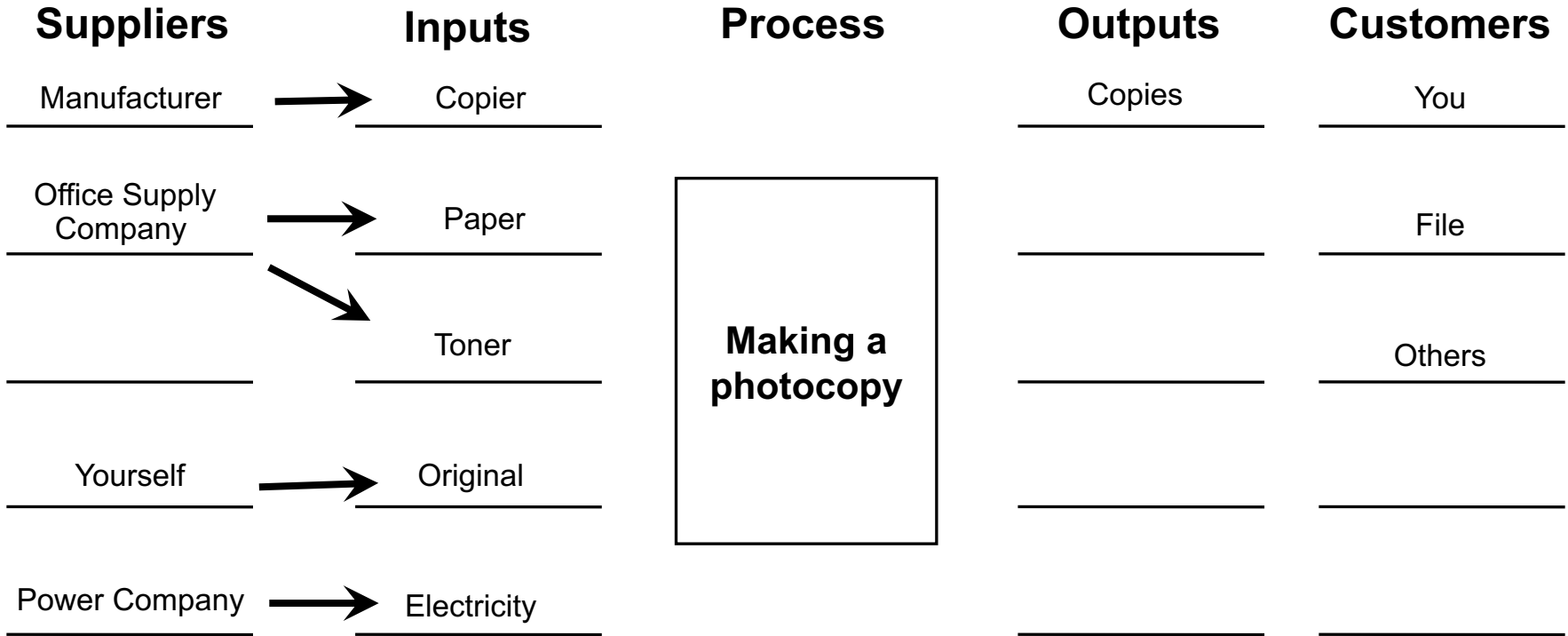
- What happens to each input?
- What conversion activities take place?

Class Exercise 1.1

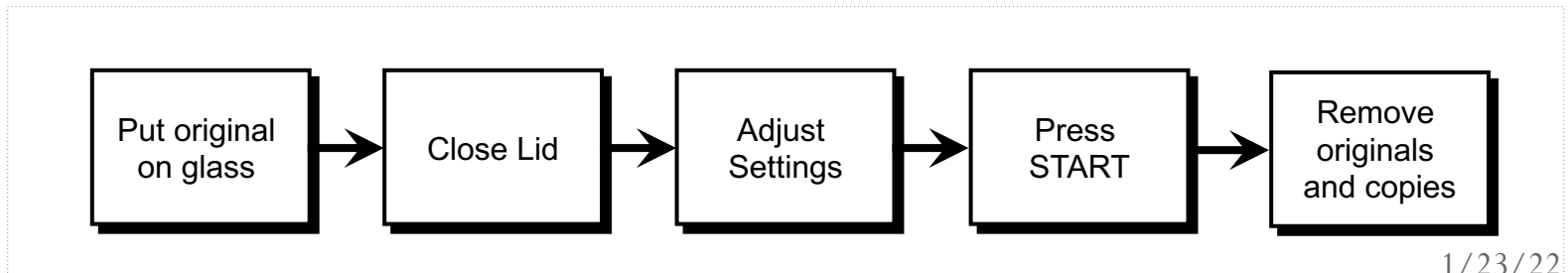
PROCESS MAP OF A PHOTOCOPYING

Time 5 minutes

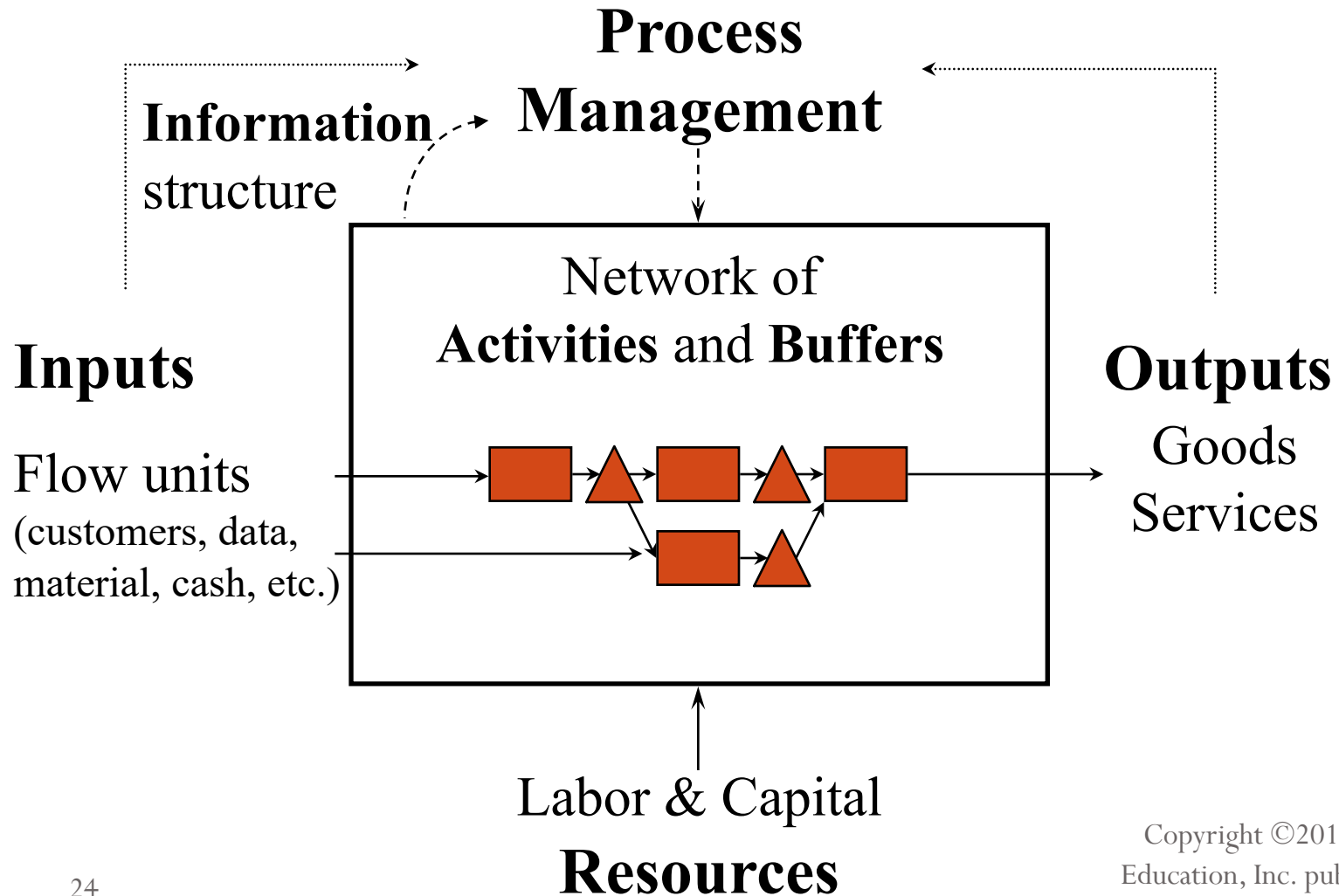
SIPOC Example



Process Steps



PROCESS VIEW OF THE ORGANISATION



PROCESS VIEW OF THE ORGANISATION

1. Inputs and output : Input is any tangible and intangible items that flow into the process from the environment and outputs is any tangible and intangible items that flow from the process back into the environment

2. Flow Units: The item being analysed

3. Network of Activities and Buffer :

Simplest form of transformation , the building block of a process and buffer stores flow units that have finished with one activity but are waiting for the next activity to start.

PROCESS VIEW OF THE ORGANISATION

- **4. Resources :** From an operations perspective, **resources** are *tangible assets that are usually divided into two categories:*

***Capital** - fixed assets such as land, buildings, facilities, equipment, machines, and information systems and **Labor**—people such as engineers, operators, customer-service representatives, and sales staff*

Resources facilitate the transformation of inputs into outputs during the process.

5. Information Structure : What information is needed and is available to whom in order to perform activities or make managerial decisions

(Reference: Ravi Anupindi et al (2012) Managing Business Process Flows, Prentice Hall, 3rd Edition)

EXERCISE

GENERIC BUSINESS PROCESS

PROCESS	FLOW UNIT	Input-Output Transformation
Order Fulfilment	Orders	
Production	Products	
Outbound Logistics	Products	
Shipping	Products/ Order	
Customer Service	Customers	
New Product Development	Projects	
Cash Cycle	Cash	

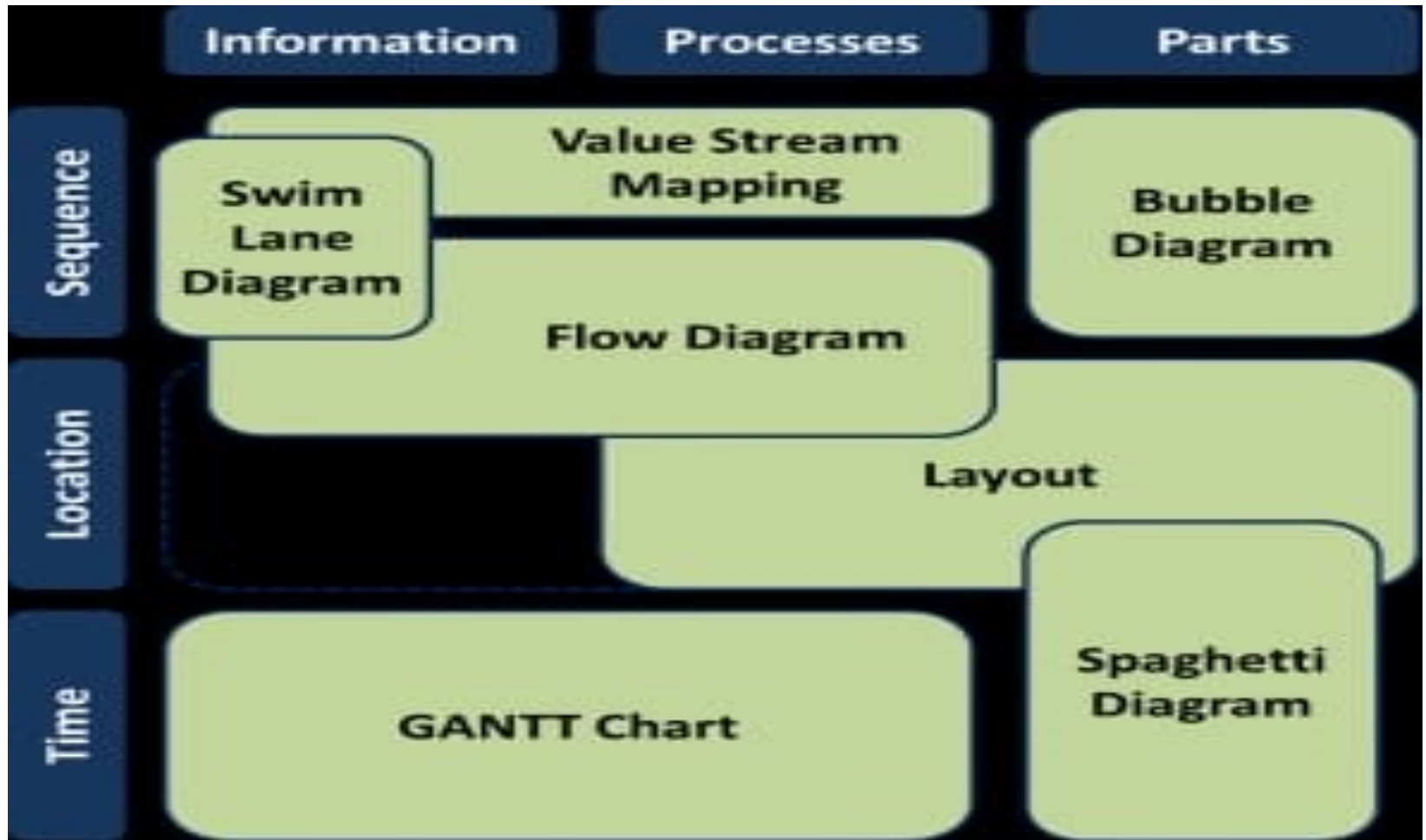
GENERIC BUSINESS PROCESS

PROCESS	FLOW UNIT	Input-Output Transformation
Order Fulfilment	Orders	From the receipt of an order to the delivery of the product
Production	Products	From the receipt of raw materials to the completion of the finished product
Outbound Logistics	Products	From the recognition of a need to the launching of a product
Shipping	Products/ Order	From the shipment of the product/order to the delivery to the customer
Customer Service	Customers	From the arrival of a customer to their departure
New Product Development	Projects	From the recognition of a need to the launching of a product
Cash Cycle	Cash	From the expenditure of funds (costs) to the collection of revenues

Why Process Mapping...

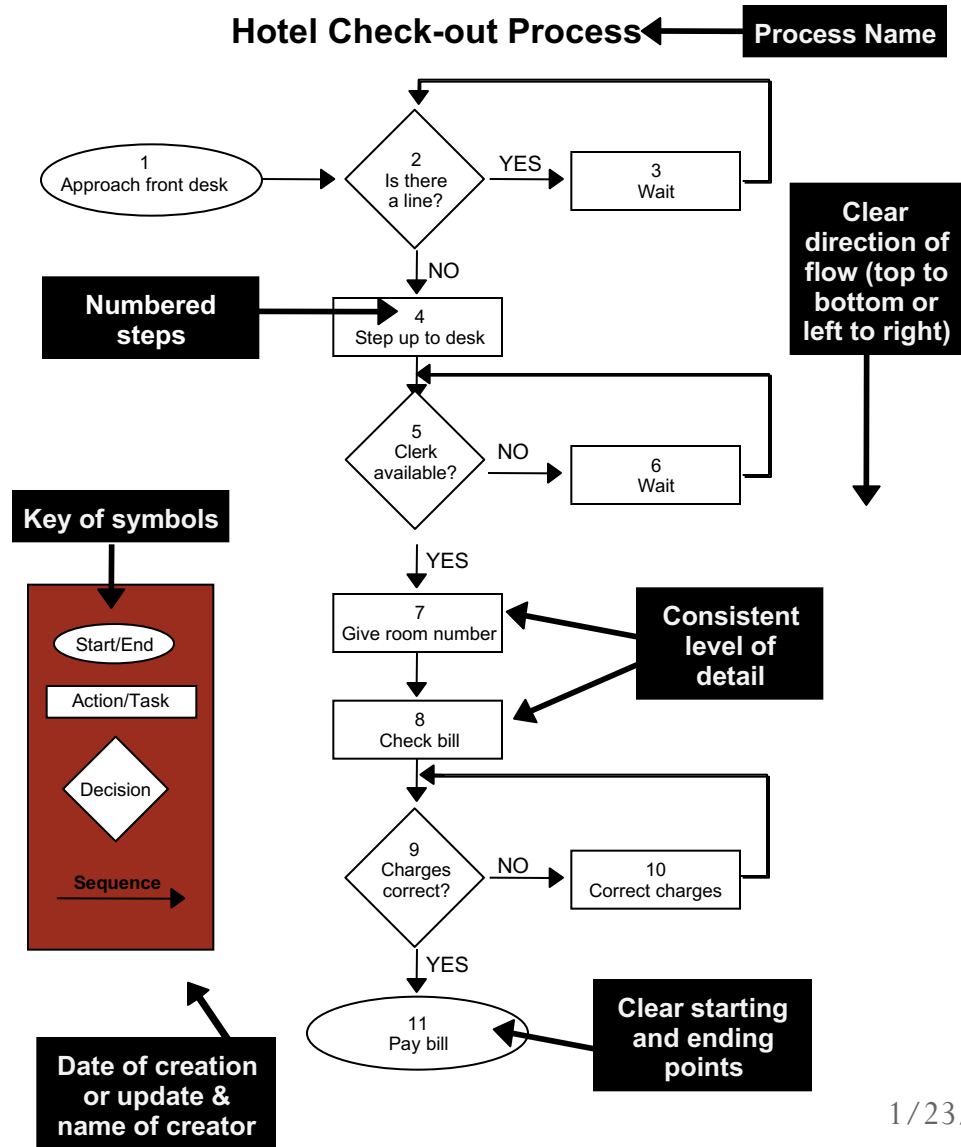
- All parties to develop a common understanding of what the actual process looks like, what the main stages are and who the main stakeholders are
- Most process improvement projects start with process map
- Three simple rules to obey when thinking about process mapping :
 - Go to Gemba (the real workplace)
 - Capture the vital few
 - Stick to the mapping methodology

PROCESS DIAGRAMS








PFD (Activity Flowcharts)

- **Activity flowcharts** are specific about what happens in a process. They often capture decision points, rework loops, complexity, etc.

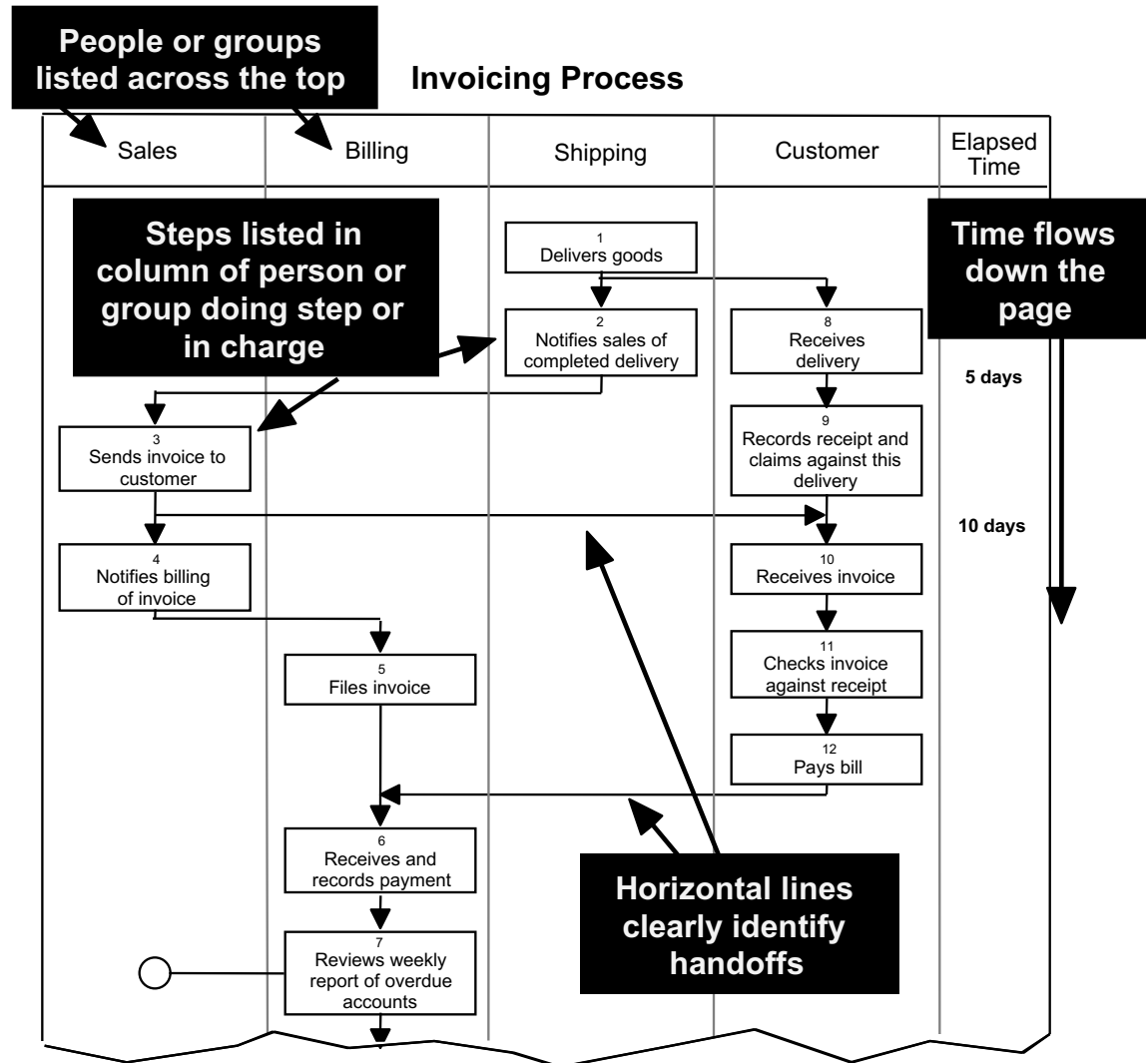


BASIC PROCESS MAPPING SYMBOLS

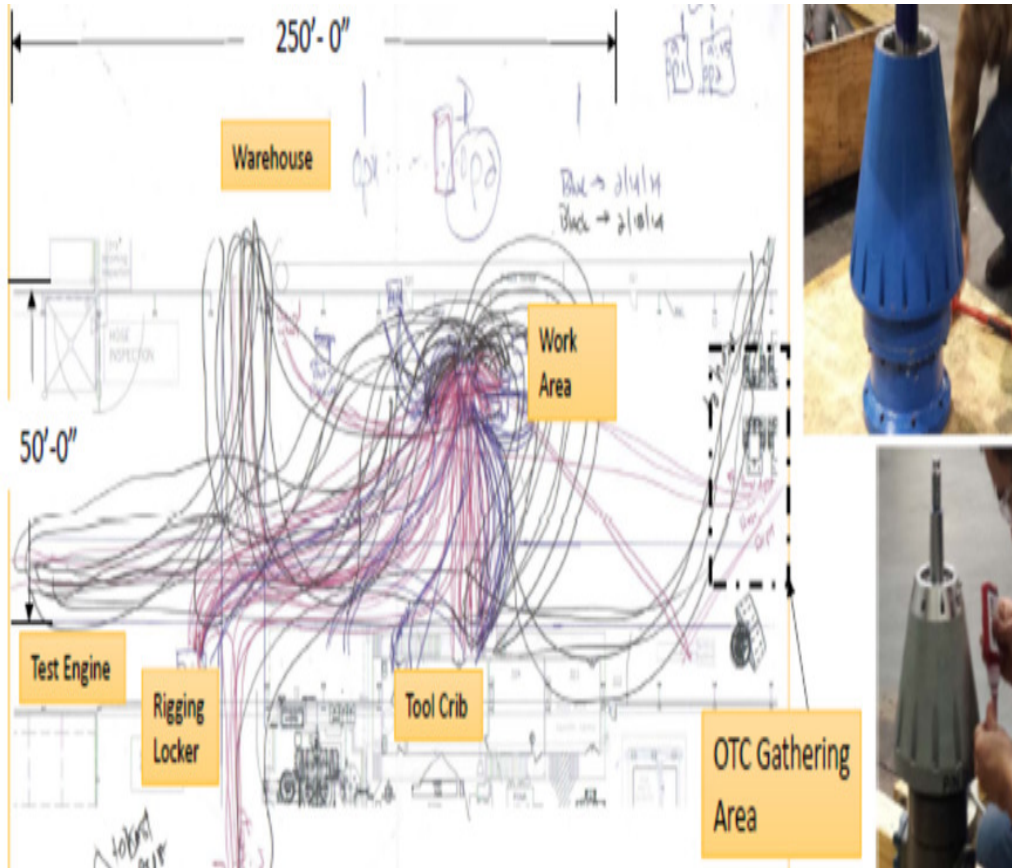
SYMBOLS	EXPLANATION
	Start or End Point
	Decision / bifurcation point
	The inventory triangle, denoting storage or delay in the process
	The process box , denoting an activity.
	Process Flow in direction of Flow

Deployment Flowcharts

- **Deployment flowcharts** show the detailed steps in a process and which people or groups are involved in each step.
- They are particularly useful in processes that involve the flow of information between people or functions, as they help highlight handoff areas.
- Information Flow Diagram/ Service System Mapping/ Swim Lane Diagram



Spaghetti Diagram (Flow Map)

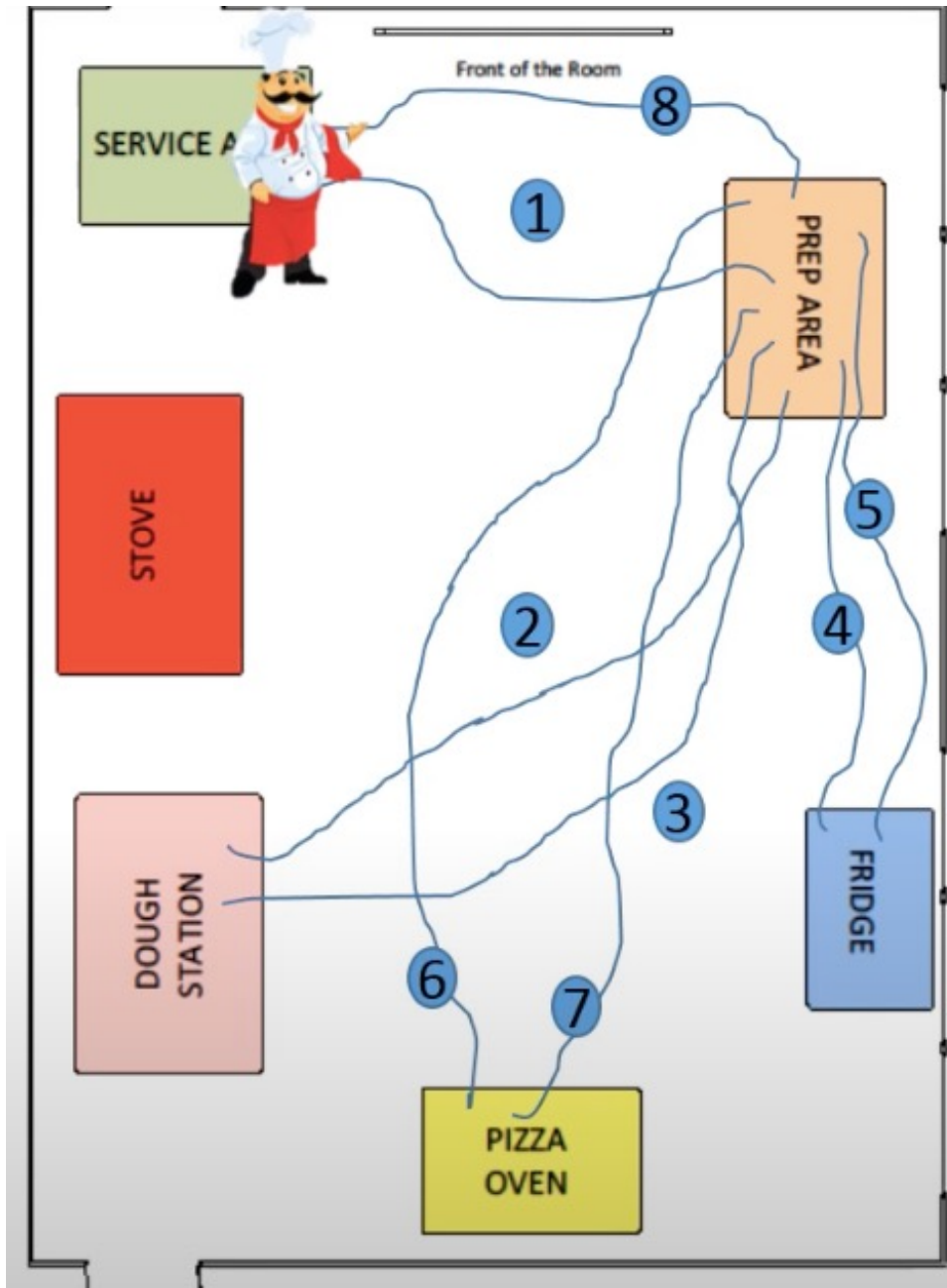


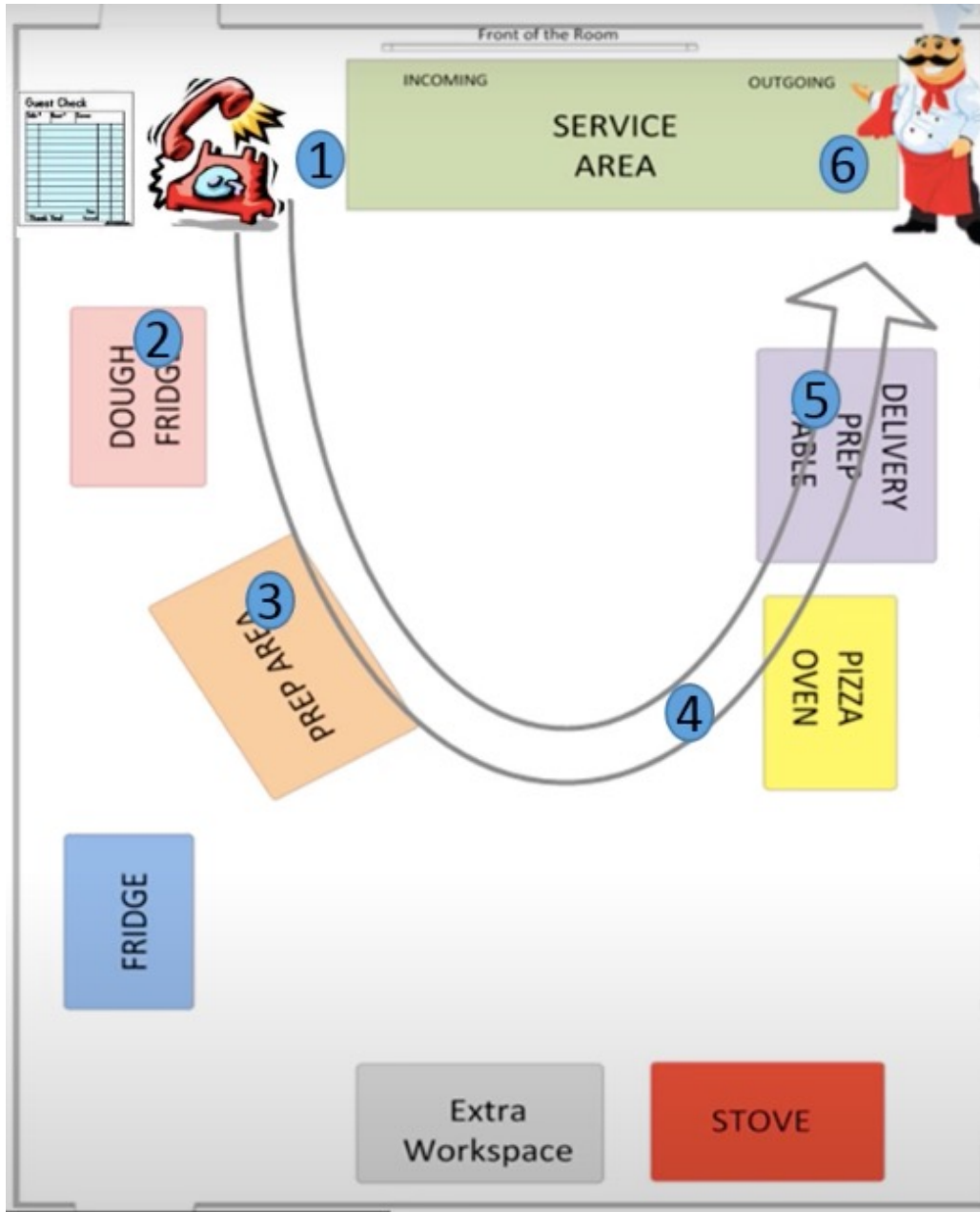
Spaghetti Diagram (Flow Map)

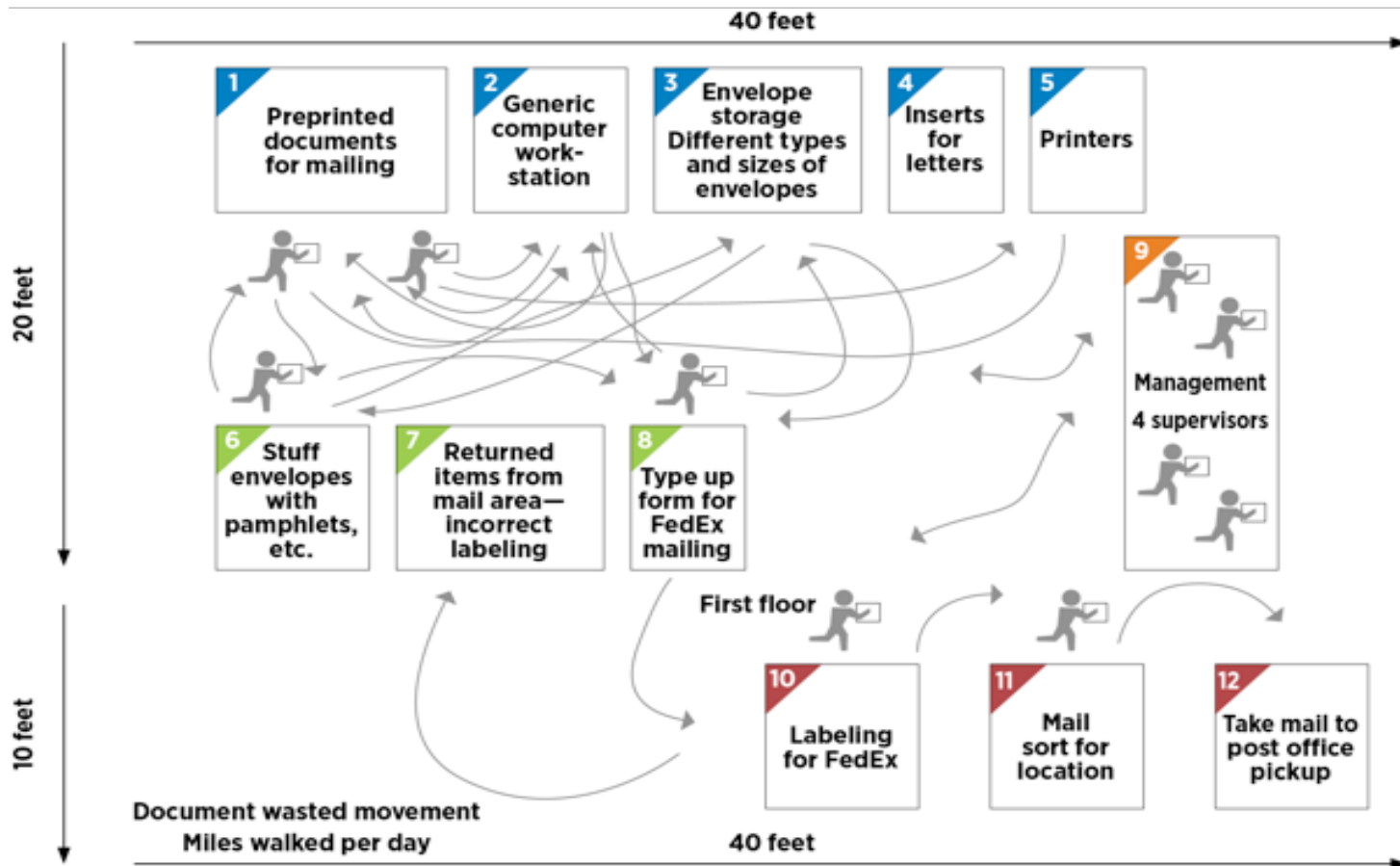
A spaghetti diagram is defined as a visual representation using a continuous flow line tracing the path of an item or activity through a process. As a process analysis tool, the continuous flow line enables process teams to identify redundancies in the work flow and opportunities to expedite process flow.

Two aspects can be captured:

1. Total Distance Travelled
2. Number of items an item is handled

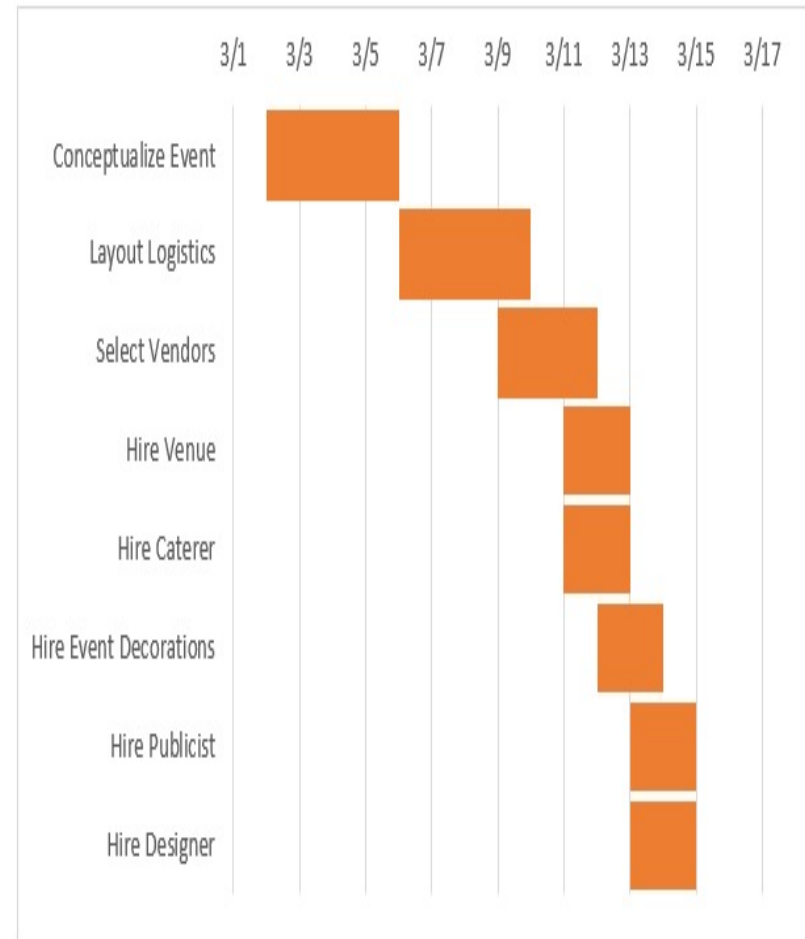






Gantt Chart

A **Gantt chart** is a horizontal bar **chart** developed as a production control tool in 1917 by Henry L. **Gantt**, an American engineer and social scientist. Frequently used in project management, a **Gantt chart** provides a graphical illustration of a schedule that helps to plan, coordinate, and track specific tasks in a project.



Value Stream Mapping

Visual Mapping technique used at the Toyota Motor Corporation known as Material and Information Flows Mapping. Mike Rother and John Shook studied Toyota's "Material and Information Flow Mapping" and recast the method as Value Stream Mapping in book *Learning To See (1999)*.

Mapping and deals with 3 things :

- Flow of Material
- Information'
- People / Process/Timeline

BASIC VSM ICON

People and Transportaion (Delivery Mode)



Operator



**Delivered
by Hand Truck**



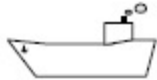
**Delivered
by Forklift**



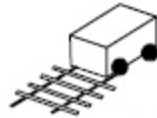
**Delivered
by Truck**



**Delivered
by Airplane**



**Delivered
by Ship or Boat**



**Delivered
by Railroad**



Mail



Fax



Telephone

Additional Diagramming Tools

- Software products for flowcharting and diagramming...
 - ✓ Micrografx
 - ✓ RFFlow
 - ✓ SmartDraw
 - ✓ Tension Software
 - ✓ PaceStar
 - ✓ Visual Thought
 - ✓ TeamFlow
 - ✓ **Visio 2013**

PROCESS ANALYSIS

"It is impossible to improve any process until it is standardized. If the process is shifting from here to there, then any improvement will just be one more variation that is occasionally used and mostly ignored. One must standardize, and thus stabilize the process, before continuous improvement can be made." ~ **Masaaki Imai**

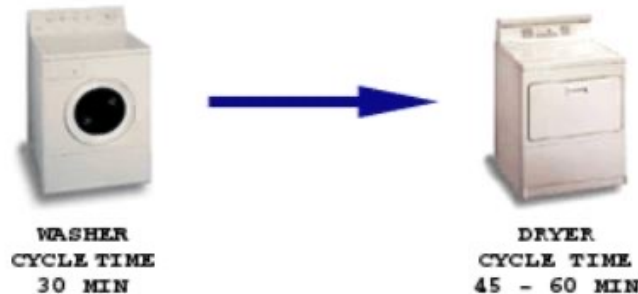
PROCESS TERMINOLOGY

- **Cycle Time**

Average time between the completion of successive units of product

or

in case of service process/ Average time between the departure of successive customers.



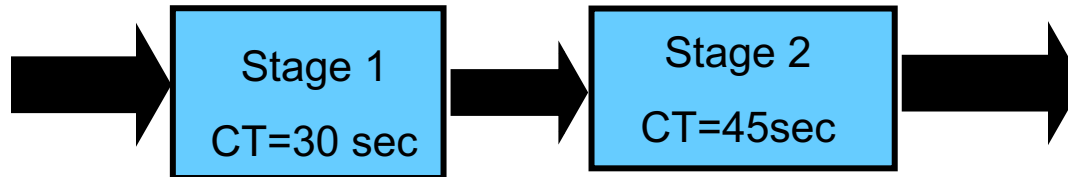
- **Bottleneck**

A resource that limits the capacity or maximum output of the process

- Within a set of dependent steps, there is generally one step that defines the speed at which the entire operation can run.



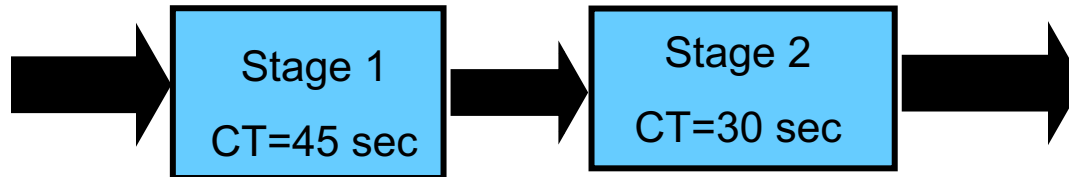
Blocking



Occurs when the activities in a stage must stop because there is no place to deposit the item just completed

(If there is no room for an employee to place a unit of work down, the employee will hold on to it not able to continue working on the next unit)

Starving

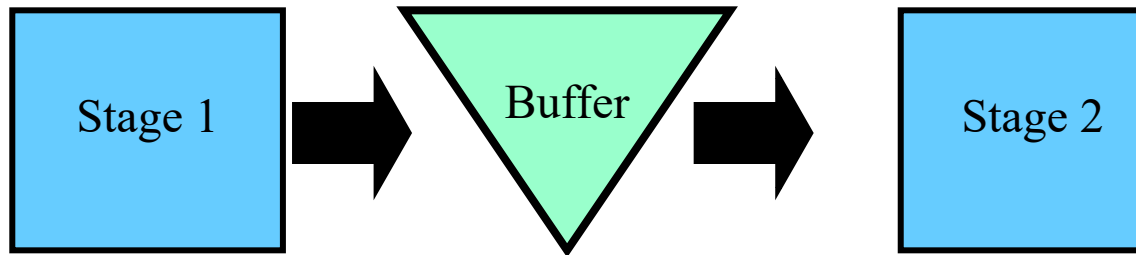


Occurs when the activities in a stage must stop because there is no work

(If an employee is waiting at a work station and no work is coming to the employee to process, the employee will remain idle until the next unit of work comes)

Buffering

Multi-stage Process with Buffer



A storage area between stages where the output of a stage is placed prior to being used in a downstream stage.

PROCESS PERFORMANCE MEASUREMENT

PROCESS TERMINOLOGY

- **Work in Process (WIP):** the number of entities in the system, which can be measured in physical units (e.g., parts, people, jobs) or financial units (e.g., dollar value of entities in system).'
- **Throughput Time:** It includes the time that the unit spends actually being worked on, together with the time spent waiting in a queue. / Sum of each of the time for each of the production steps.
- **Throughput Rate:** The rate at which entities are processed by the system

Three Key Process Measures

- **Flow Time:** It indicates the time needed to convert inputs into outputs and includes any time spent by a flow unit waiting for processing activities to be performed (cycle time/ throughput time).
- **Flow Rate:** Number of flow units that flow through a specific point in the process per units time (throughput rate)/ **Average Flowrate or Throughput Rate (R):** Average no of flow units that flow through (into or out of) the process per unit of time.
- **Inventory:** When the inflow rate exceeds the outflow rate, the number of flow units inside the process increases. Inventory is the total number of flow units present within process boundaries (WIP)

Little's Law

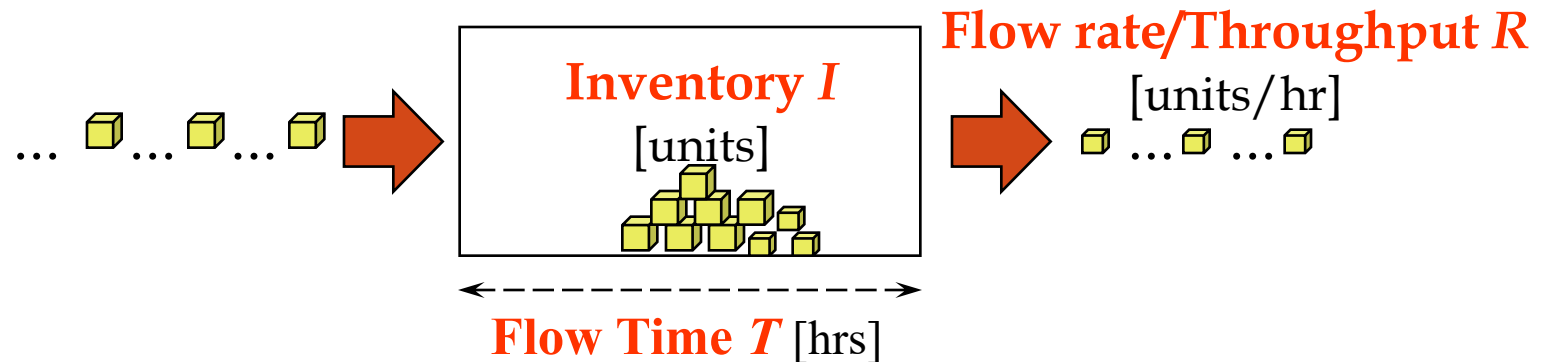
For any stable process average inventory equals throughput multiplied by average flow time

$$\text{Average Inventory (I)} = \text{Average Flow Rate (R)} \times \text{Average Flow Time (T)}$$

Answers three questions about process flows:

- 1. On average, how much time does a typical flow unit spend within process boundaries?**
- 2. On average, how many flow units pass through the process per unit time?**
- 3. On average, how many flow units are within process boundaries at any point in time?**

Linking operational measures: Little's Law



- Inventory = Throughput \times Flow Time
$$I = R \times T$$
- Inventory Turnover = Throughput / Inventory
$$= 1 / T$$

A toy manufacturer has a throughput rate of 30 toys/hr and it takes .5 hr for a toy to go through the process. How many toys on average are in the process?

$$\begin{aligned} \text{Inventory} &= \text{Throughput} \times \text{Flow Time} \\ I &= R \times T = 30 \times .5 = 15 \text{ toys} \end{aligned}$$

Executive Shirt Company, Inc.

Executive Shirt Company

ESC was planning to expand its product line of customized shirts

Increased profit margin (75%)

Whole sale price \$10

Retail price \$20

Expected delivery time 10 days

Production Process

16,000 regular shirts per month

Computer controlled Cutting machine

- 60 layers of cloth
- 8 shirts patterns
- 1.5 minutes for each layer of cloth
- 30 minute cutting time

Sewing

Inspection

Ironing

Packaging

Laser cutting machine

Laser cutting machine

- One shirt pattern at a time
- 5 layers of cloth
- Total time 2.5 minutes
- Material costs 10% higher

Initially the quantity for production of shirts was 2,000 per month

Mike's plan

New machine for Custom shirts

Old machine for Regular shirts

Produce in a batch size of 5 shirts

After cutting, both custom shirts and regular shirts would be sewn together

Buffer inventory: 6 batches per worker

Ike's plan

Separate line for Custom-shirt

Moving one worker from each operation to the Custom line

A new worker will operate laser cutting machine

4 existing worker will operate old machine for regular shirt

Overtime if necessary

Buffer inventory: 3 shirts for each of the 15 workers

Outcome: Under Mike's plan

Increased utilization

Small WIP

Small MLT

High Indirect cost

10% addition cost of material

Reduced manufacturing cost

Suggestion:

- Go for cellular manufacturing
- Reduce transportation within facility

Outcome: Under Ike's plan

Higher ideal time

Low lead time for custom shirts

Minimum order size can be one

Go for assembly line balancing

Remaining worker can be assigned on regular line

Eliminate overtime

Thank You