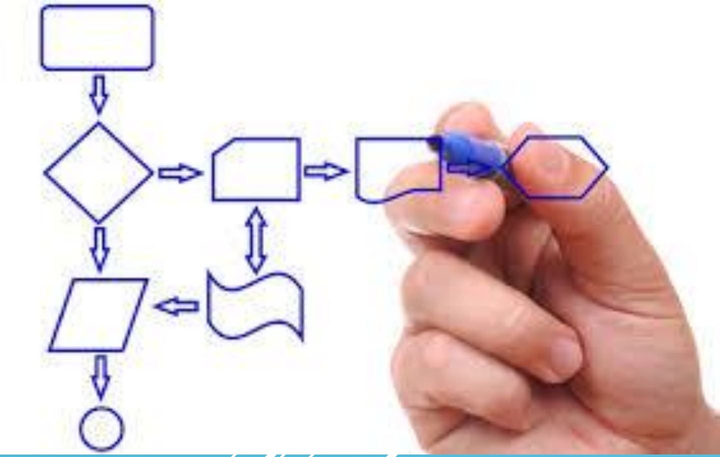
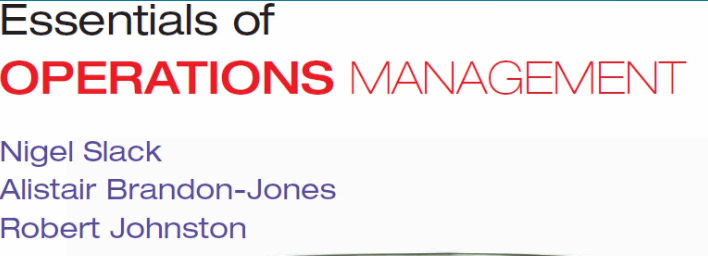


PROCESS DESIGN

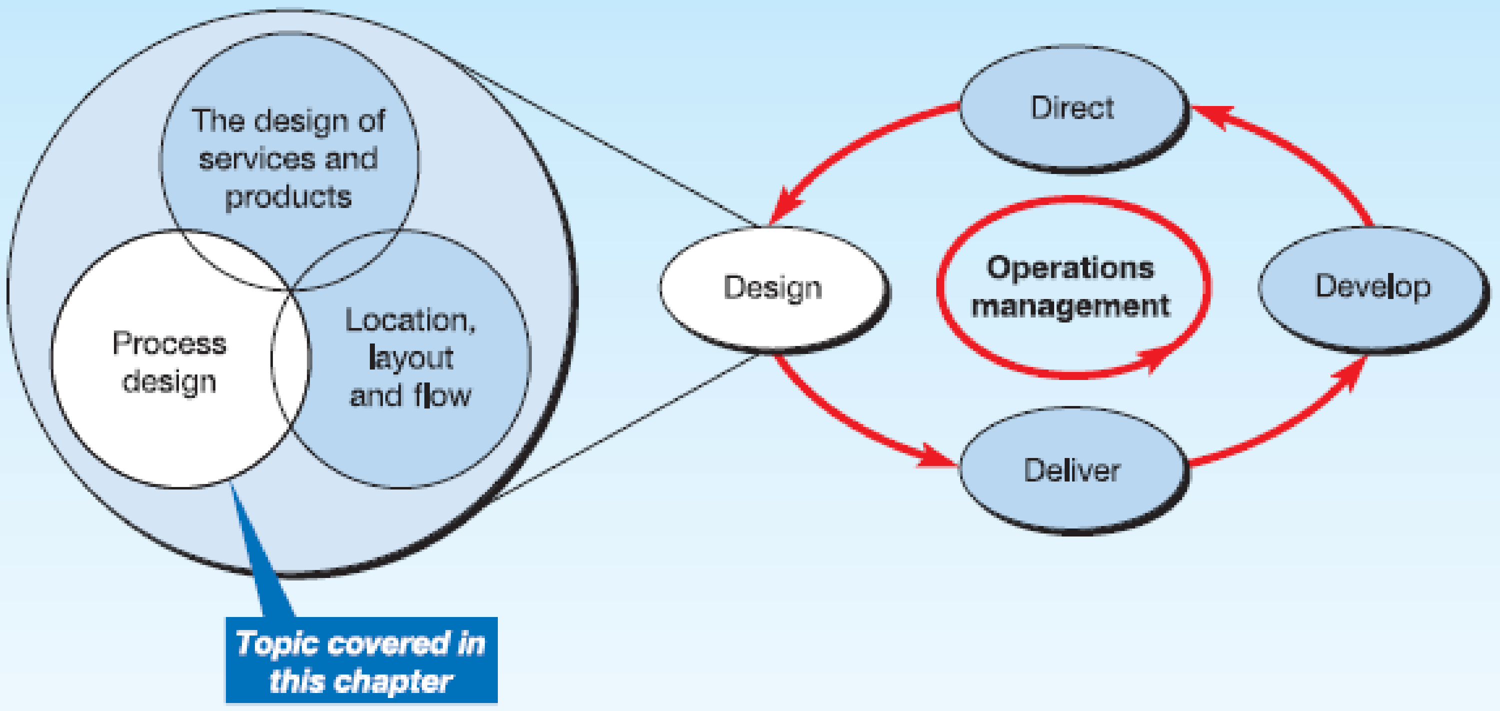
Chapter 5

Lecturer : Dr. N. Imanipour



Key questions

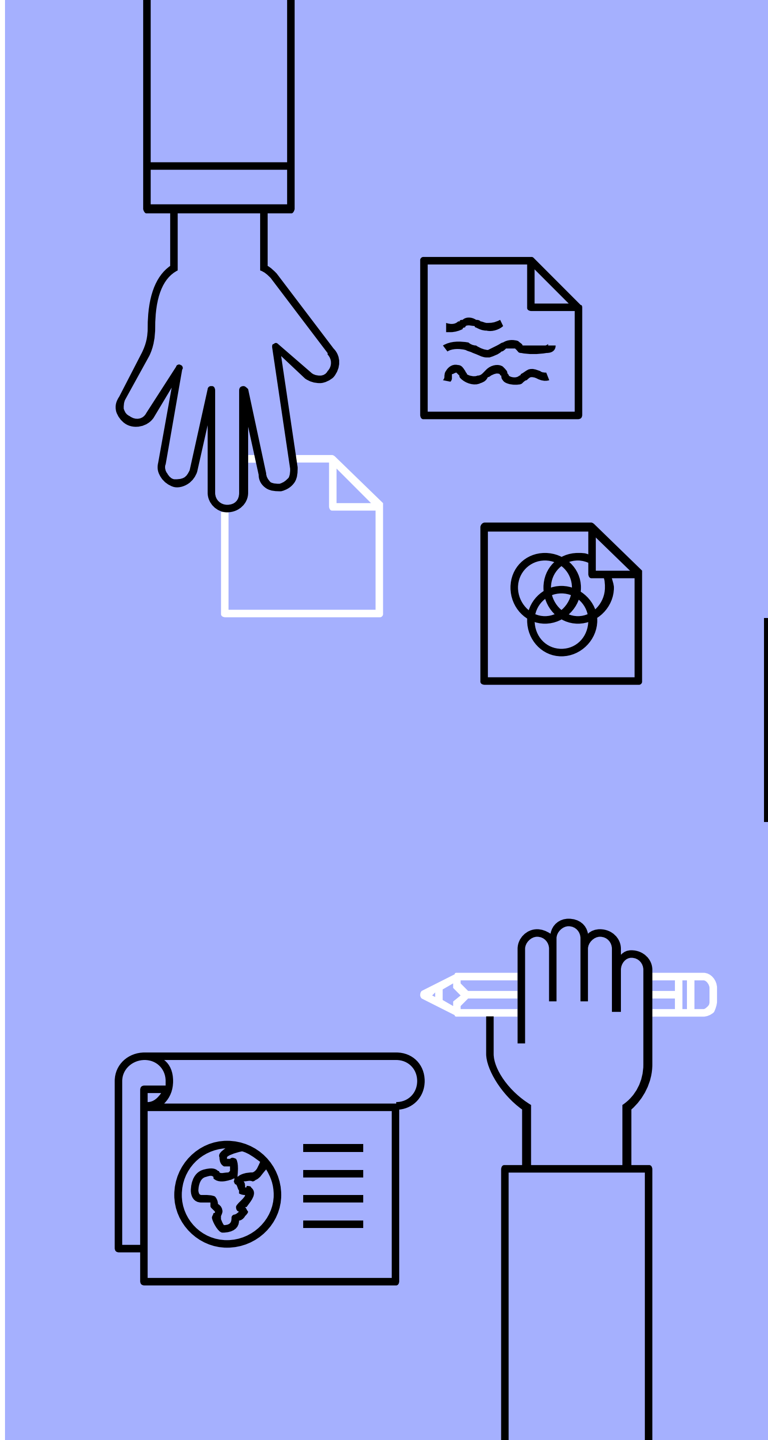
- What is process design?
- How do volume and variety affect process design?
- How are processes designed in detail?
- What are the human implications for process design?



What is process design?

Why design process?

- New product
- Change equipment
- Change methodology
- Redesign products



- To ‘design’ is to conceive the looks, arrangement, and workings of something before it is created.
- Design happens before creation

Table 5.1 The impact of strategic performance objectives on process design objectives and performance

Operations performance objective	*Typical process design objectives*	*Some benefits of good process design*
Quality	• Provide appropriate resources, capable of achieving the services or product specification • Error-free processing	• Products and services produced 'on-specification' • Less recycling and wasted effort within the process
Speed	• Minimum throughput time • Output rate appropriate for demand	• Short customer waiting time • Low in-process inventory
Dependability	• Provide dependable process resources • Reliable process output timing and volume	• On-time deliveries of products and services • Less disruption, confusion and rescheduling within the process
Flexibility	• Provide resources with an appropriate range of capabilities • Change easily between processing states (what, how, or how much is being processed)	• Ability to process a wide range of products and services • Low cost/fast product and service change • Low cost/fast volume and timing changes • Ability to cope with unexpected events (e.g. supply or a processing failure)
Cost	• Appropriate capacity to meet demand • Eliminate process waste in terms of – excess capacity – excess process capability – in-process delays – in-process errors – inappropriate process inputs	• Low processing costs • Low resource costs (capital costs) • Low delay and inventory costs (working capital costs)

Process flow performance

Throughput rate

- **Throughput rate** (or flow rate) is the rate at which units emerge from the process, i.e. the number of units passing through the process per unit of time.

Throughput time

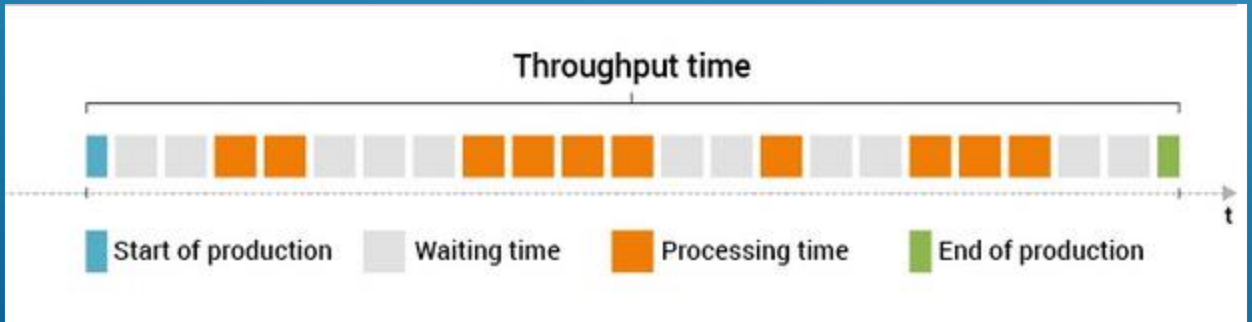
- **Throughput time** is the average elapsed time taken for inputs to move through the process and become outputs.

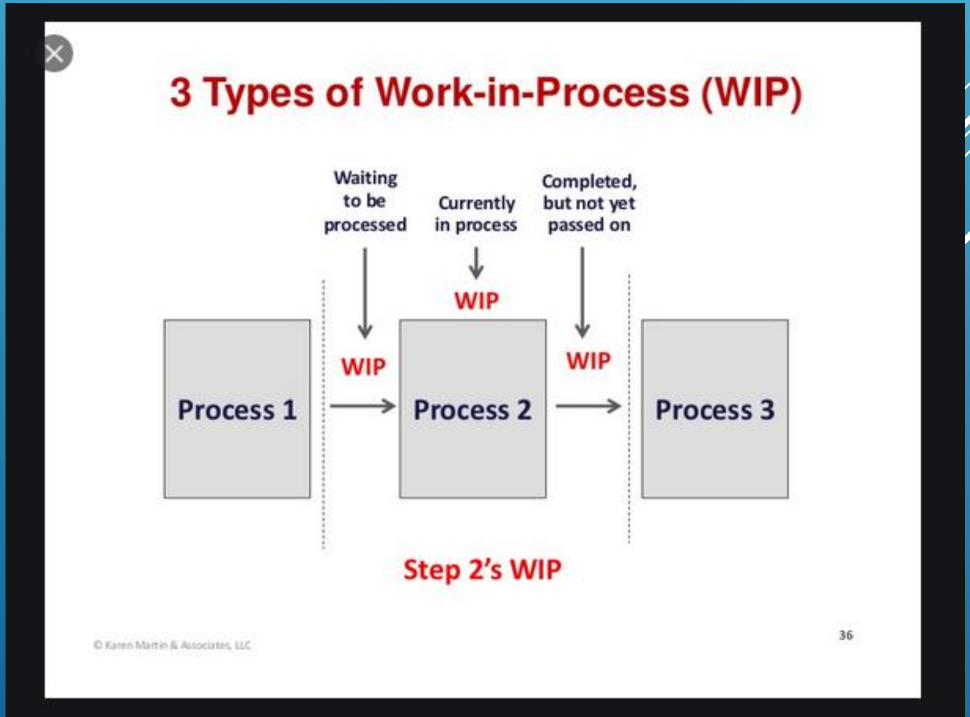
Work in process

- The number of units in the process (also called the '**work in process**' or in-process inventory), as an average over a period of time.

Utilization

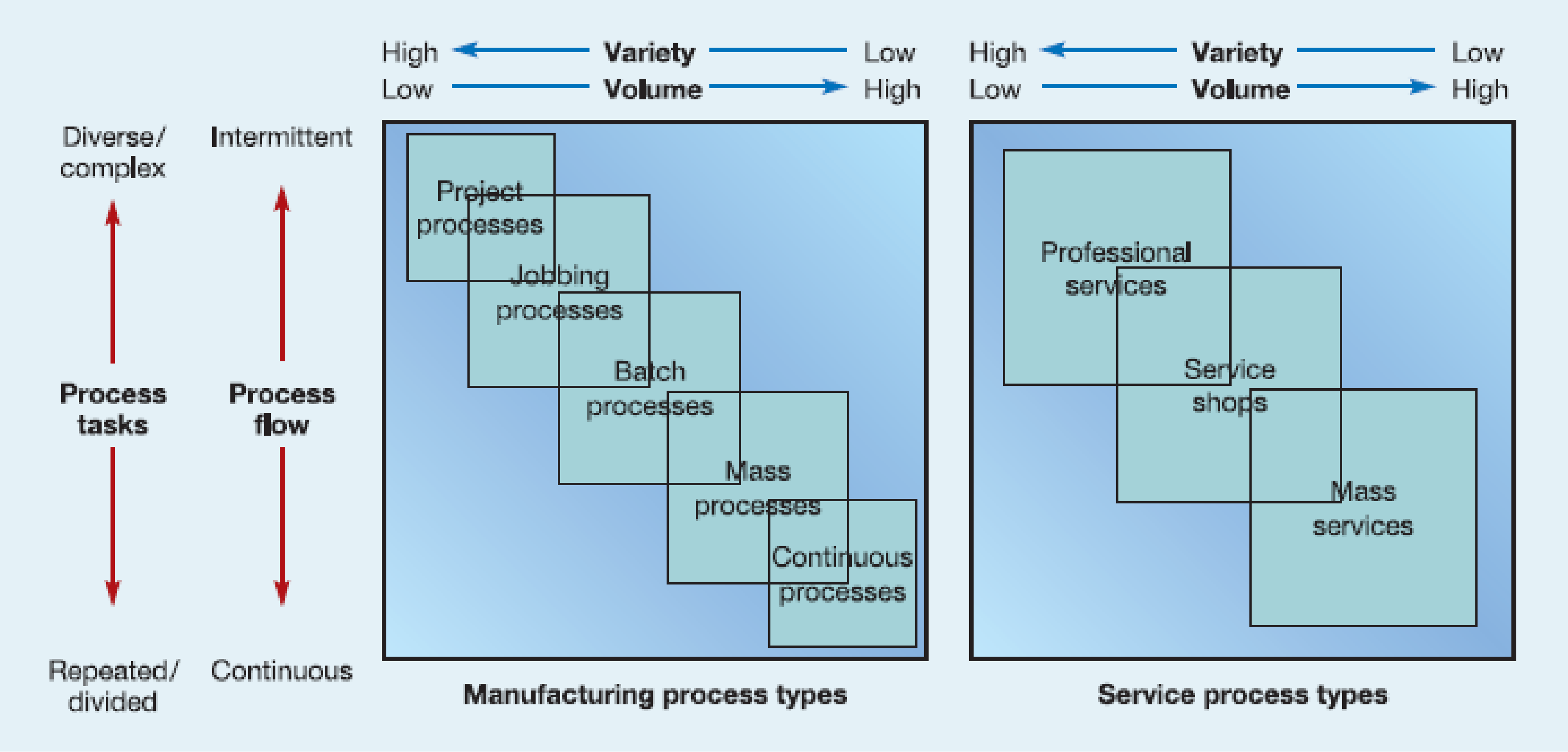
- The **utilization** of process resources is the proportion of available time that the resources within the process are performing useful work.





Environmentally sensitive design

- *The sources of inputs* to a service or product. (Will they damage rainforests? Will they use up scarce minerals? Will they exploit the poor or use child labour?)
- *Quantities and sources of energy* consumed in the process. (Do plastic beverage bottles use more energy than glass ones? Should waste heat be recovered and used in fish farming?)
- *The amounts and type of waste material* that are created in the processes. (Can this waste be recycled efficiently, or must it be burnt or buried in landfill sites? Will the waste have a long-term impact on the environment as it decomposes and escapes?)
- *The life of the product itself*. It is argued that if a product has a useful life of, say, twenty years, it will consume fewer resources than one that only lasts five years, which must therefore be replaced four times in the same period. However, the long-life product may require more initial inputs, and may prove to be inefficient in the latter part of its use, when the latest products use less energy or maintenance to run.
- *The end-of-life of the product*. (Will the redundant product be difficult to dispose of in an environmentally friendly way? Could it be recycled or used as a source of energy? Could it still be useful in third-world conditions? Could it be used to benefit the environment, such as old cars being used to make artificial reefs for sea life?)



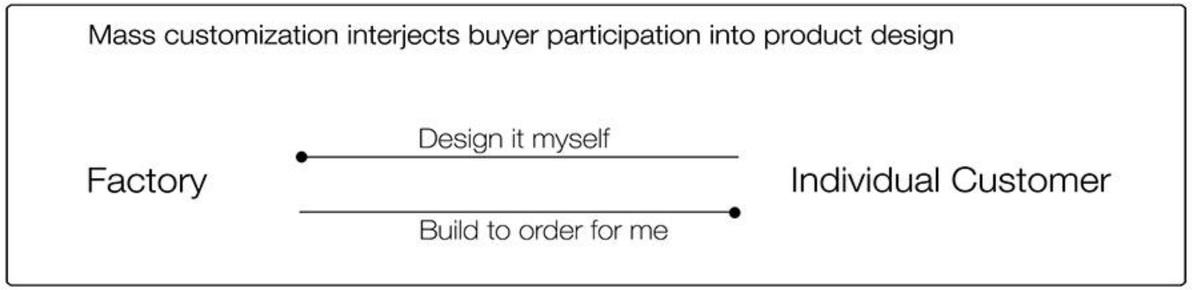
Process types – the volume–variety effect on process design

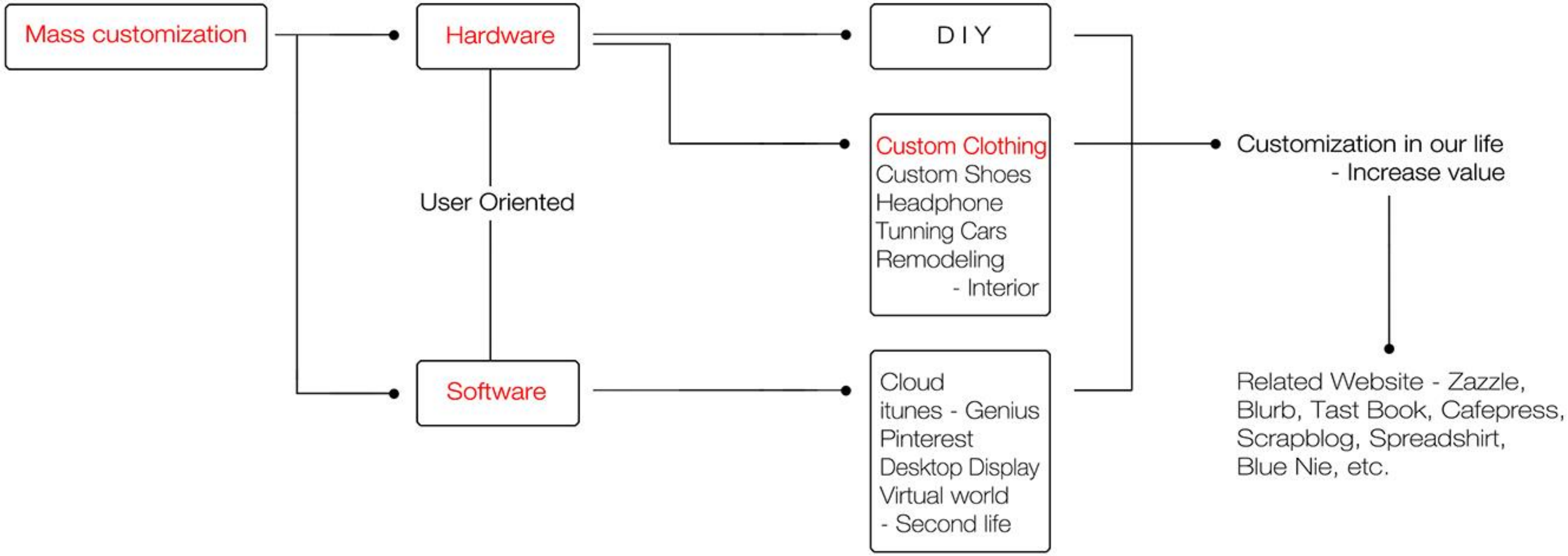
Source: Rex Features

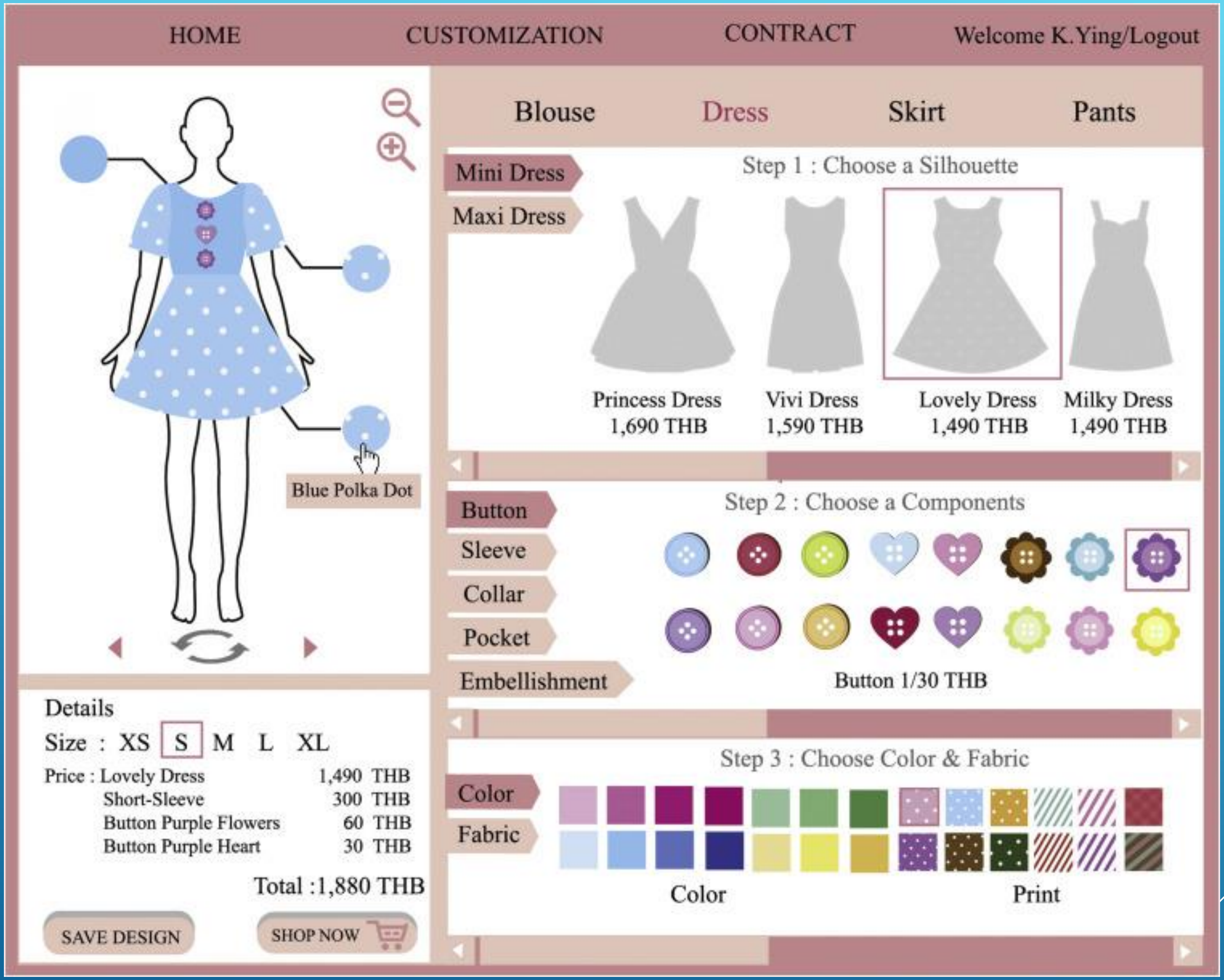
Source: Alamy Images

Mass customization

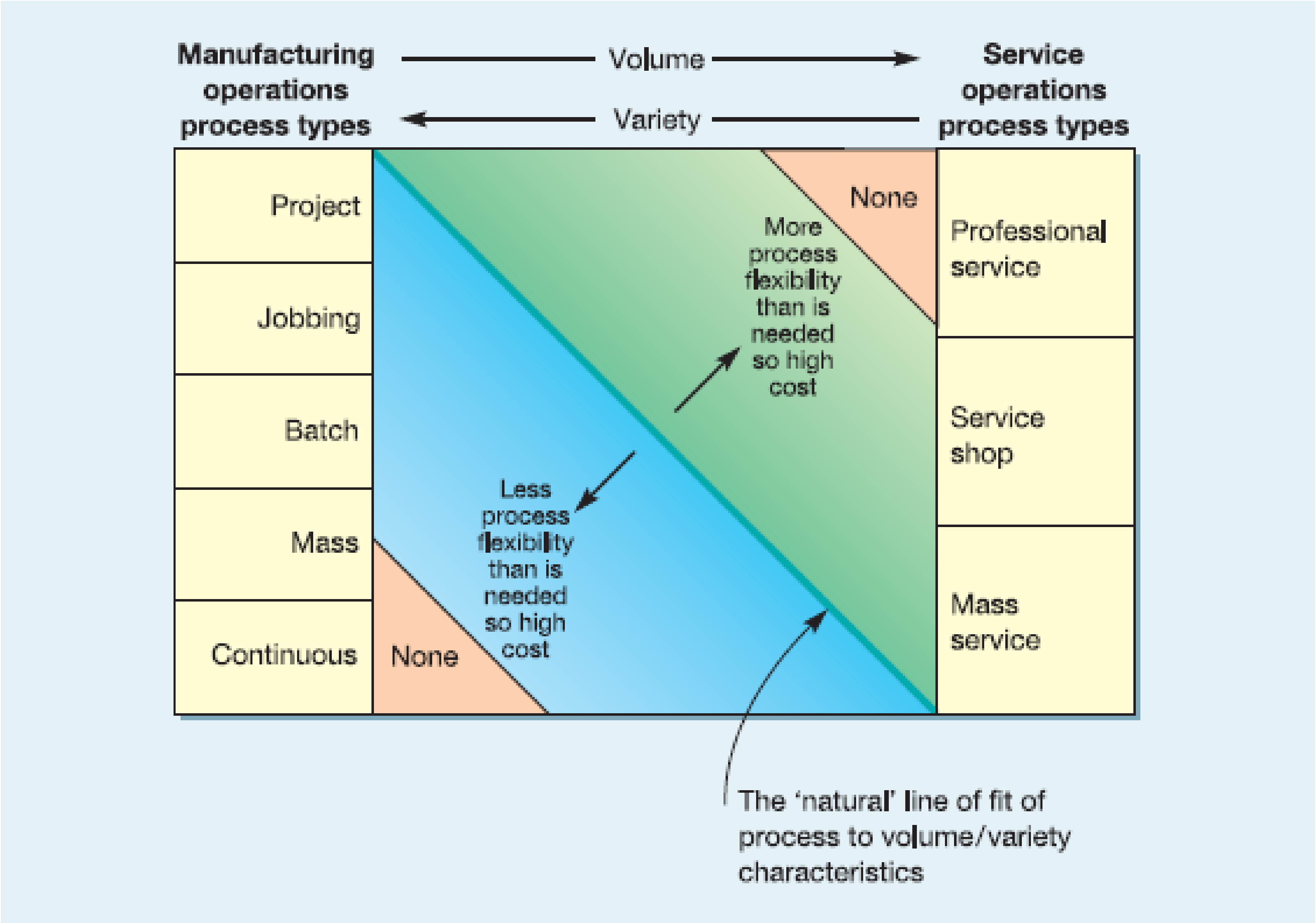
Mass customization is the next big wave after mass production.
These days, custom clothing is one of most popular fields in mass customization.
Mass customzation of clothing can possibly be the solution for excessive production of clothing without individuality.






HOME
CUSTOMIZATION
CONTRACT
Welcome K.Ying/Logout
Blouse
Dress
Skirt
Pants
Mini Dress
Maxi Dress
Step 1 : Choose a Silhouette
Princess Dress 1,690 THB
Vivi Dress 1,590 THB
Lovely Dress 1,490 THB
Milky Dress 1,490 THB
Blue Polka Dot
Step 2 : Choose a Components
Button
Sleeve
Collar
Pocket
Embellishment
Button 1/30 THB
Step 3 : Choose Color & Fabric
Color
Fabric
Color
Print
Details
Size : XS S M L XL
Price : Lovely Dress 1,490 THB
Short-Sleeve 300 THB
Button Purple Flowers 60 THB
Button Purple Heart 30 THB
Total :1,880 THB
SAVE DESIGN
SHOP NOW


HOME
CUSTOMIZATION
CONTRACT
Welcome K.Ying/Logout
Product
Details
Item
Total
Size : S
- 1 +
1,880 THB
Fabric : Top Cotton Blue
Skirt Blue Polka Dot
Short-Sleeve Blue Polka Dot
Price : Lovely Dress 1,490 THB
Short-Sleeve 300 THB
Button Purple Flowers 60 THB
Button Purple Heart 30 THB
1,880 THB
SELECT SHIPPING METOD
Registered +35
Express +50
Total 1,930 THB
MORE PAYMENT OPTION
Credit card
Debit card
Choose a Bank
Net Banking
Choose a Bank
Cancel
OK
SHIPPING TIME
10-15 Working days
Customization Your Own Design
Order
Shipping

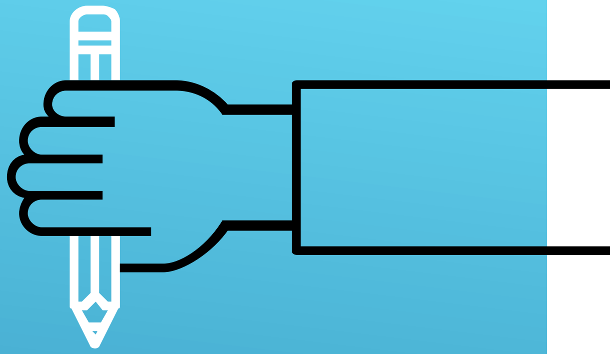

Manufacturing operations process types
Volume
Variety
Service operations process types
Project
Jobbing
Batch
Mass
Continuous
None
More process flexibility than is needed so high cost
Less process flexibility than is needed so high cost
None
Professional service
Service shop
Mass service
The 'natural' line of fit of process to volume/variety characteristics

Jobbing Processes

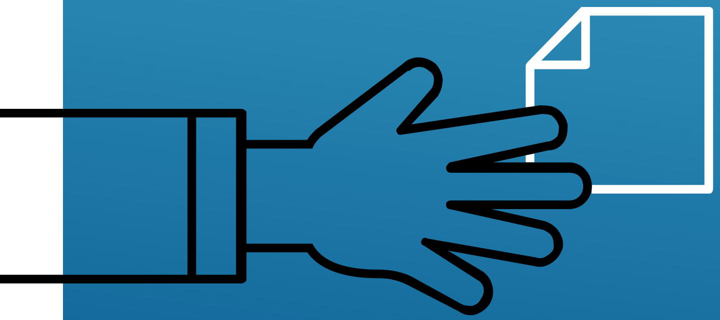
- Very small quantities: “one-offs”, or only a few required
- Specially made. High variety, low repetition.
- Skill requirements are usually very broad
- Skilled jobber, or team of jobbers complete whole product
- Fixed position or process layout (routing decided by jobbers)

Batch Processes

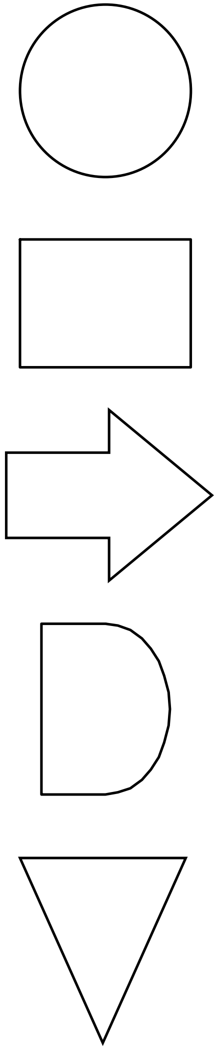
- Higher volumes and lower variety than for jobbing
- Standard products, repeating demand. But can make specials
- Specialized, narrower skills
- Set-ups (changeovers) at each stage of production
- Process or cellular layout



PROCESS FLOWCHART SYMBOLS



Process Flowchart Symbols



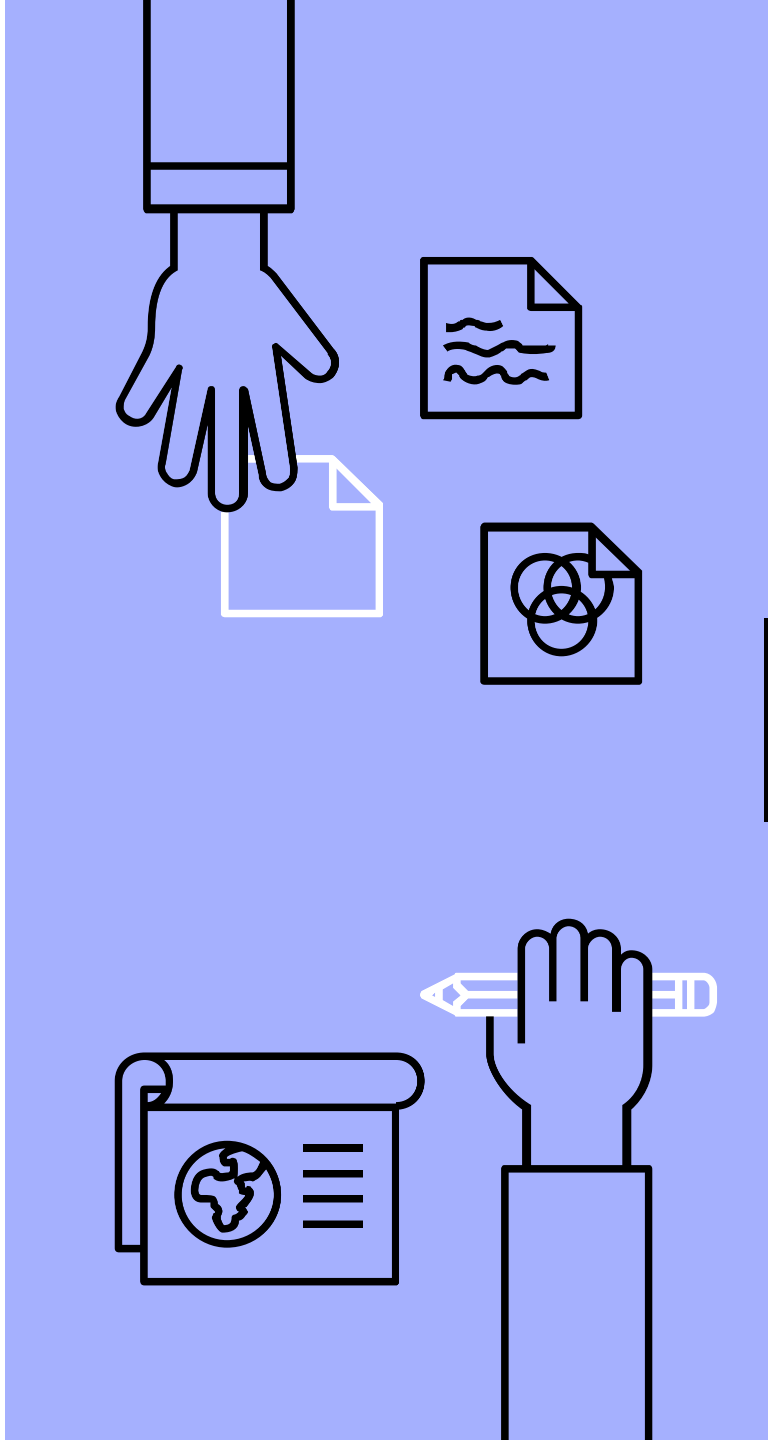
Operations

Inspection

Transportation

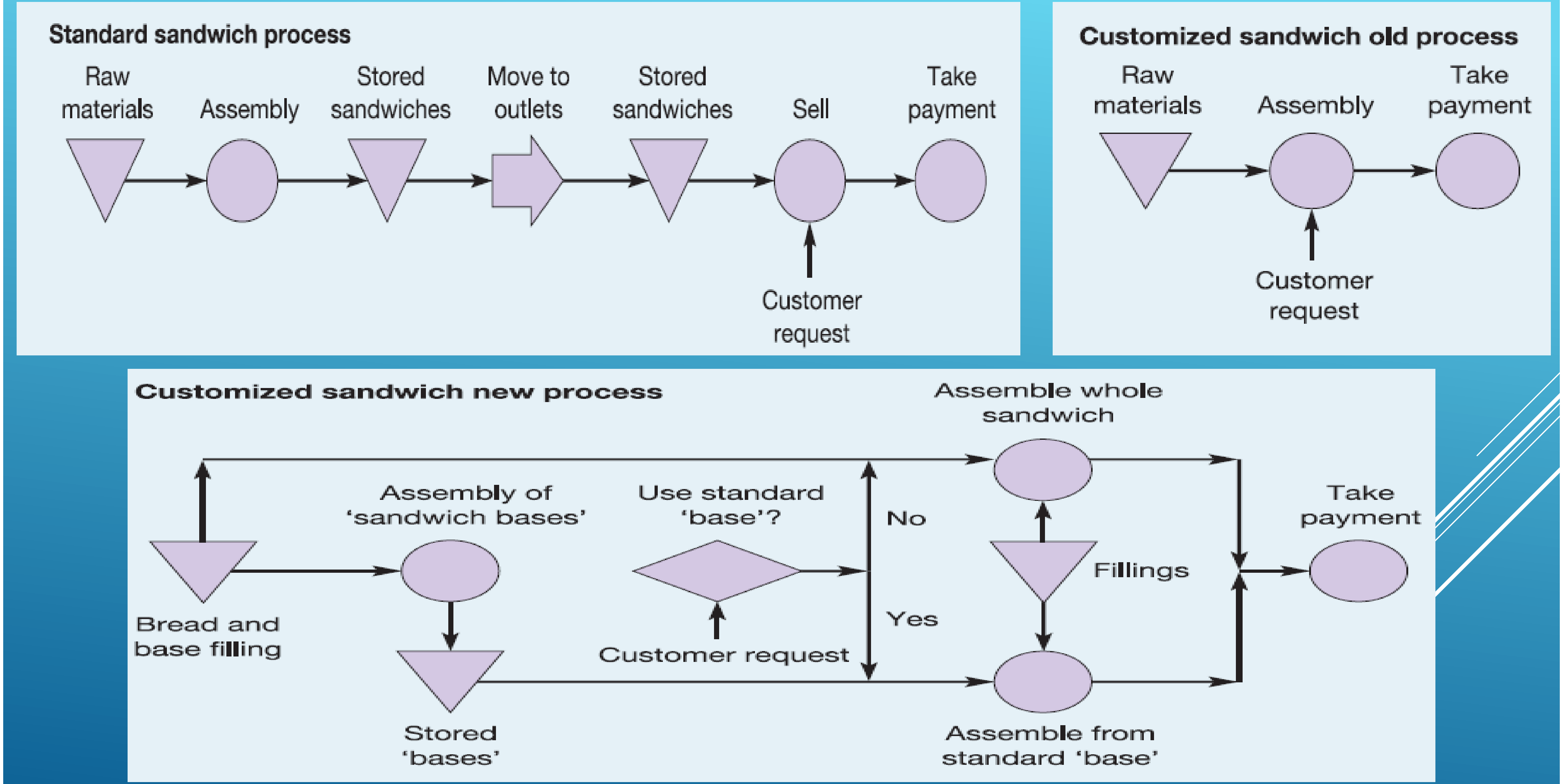
Delay

Storage



Process Chart Symbols

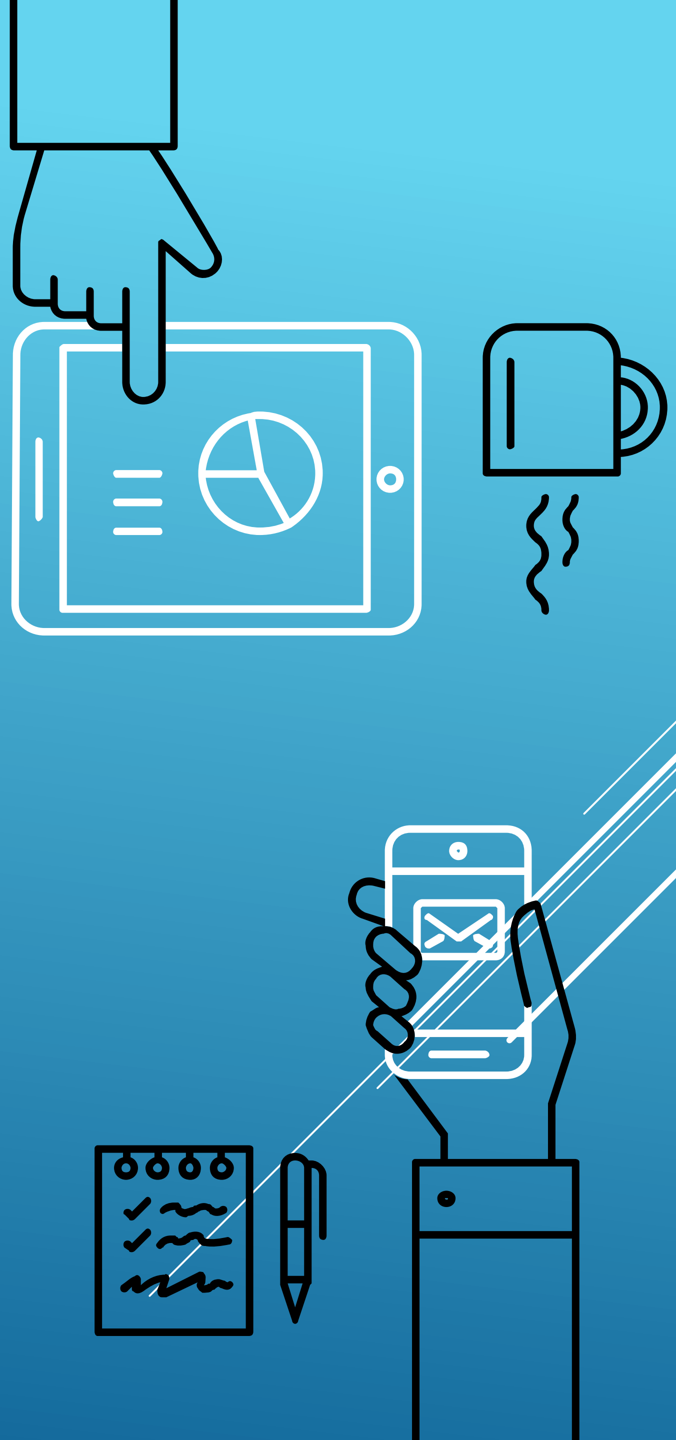
Sym	Name	Action		Examples
	Operation	Adds Value		Saw, Cut, Paint, Solder, Package
	Transport	Moves Some Distance		Convey, Fork Truck, OTR Truck
	Inspect	Check For Defects		Visual Inspect, Dimension Inspect
	Delay	Temporary Delay/Hold	STOP	WIP Hold, Queue
	Storage	Formal Warehousing		Warehouse or Tracked Storage Location
	Handle	Transfer Or Sort		Re-Package, Transfer To Conveyor
	Decide	Make A Decision		Approve/Deny Purchase

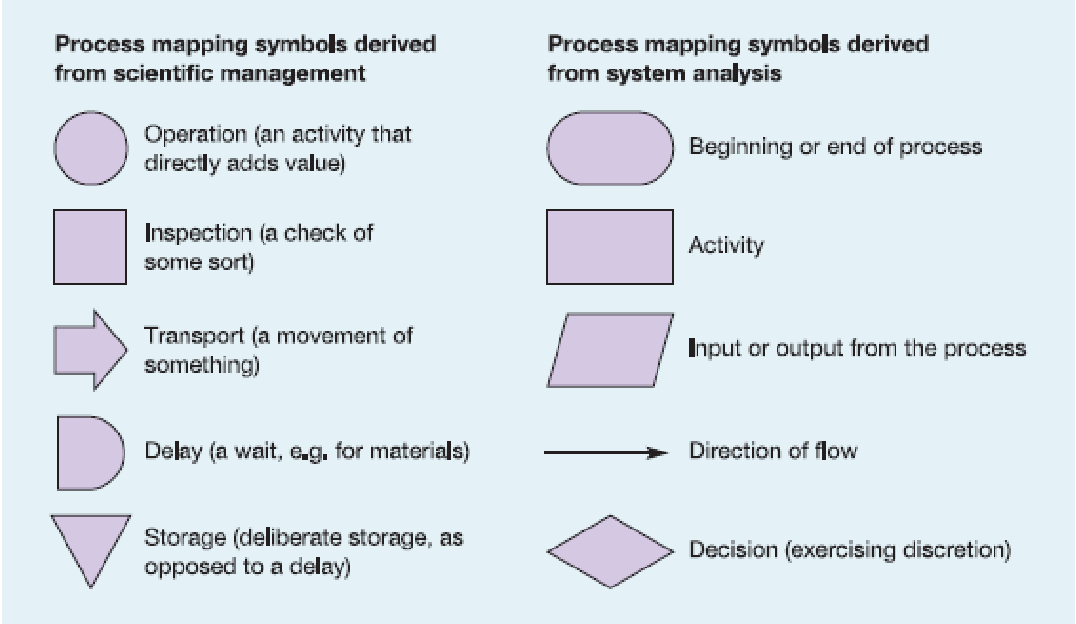

Standard sandwich process
Raw materials
Assembly
Stored sandwiches
Move to outlets
Stored sandwiches
Sell
Take payment
Customer request
Customized sandwich old process
Raw materials
Assembly
Take payment
Customer request
Customized sandwich new process
Assemble whole sandwich
Assembly of 'sandwich bases'
Use standard 'base'?
No
Yes
Take payment
Fillings
Bread and base filling
Customer request
Stored 'bases'
Assemble from standard 'base'

Date: 9-30-00 Location: Graves Mountain

Analyst: TLR Process: Apple Sauce

Step	Operation	Transport	Inspect	Delay	Storage	Description of process	Time (min)	Distance (feet)
1	●	⇨	□	D	▽	Unload apples from truck	20	
2	○	➡	□	D	▽	Move to inspection station		100 ft
3	○	⇨	■	D	▽	Weigh, inspect, sort	30	
4	○	➡	□	D	▽	Move to storage		50 ft
5	○	⇨	□	D	▼	Wait until needed	360	
6	○	➡	□	D	▽	Move to peeler		20 ft
7	●	⇨	□	D	▽	Apples peeled and cored	15	
8	○	⇨	□	D	▼	Soak in water until needed	20	
9	●	⇨	□	D	▽	Place in conveyor	5	
10	○	➡	□	D	▽	Move to mixing area		20 ft
11	○	⇨	■	D	▽	Weigh, inspect, sort	30	
	Page 1 0f 3					Total	480	190 ft





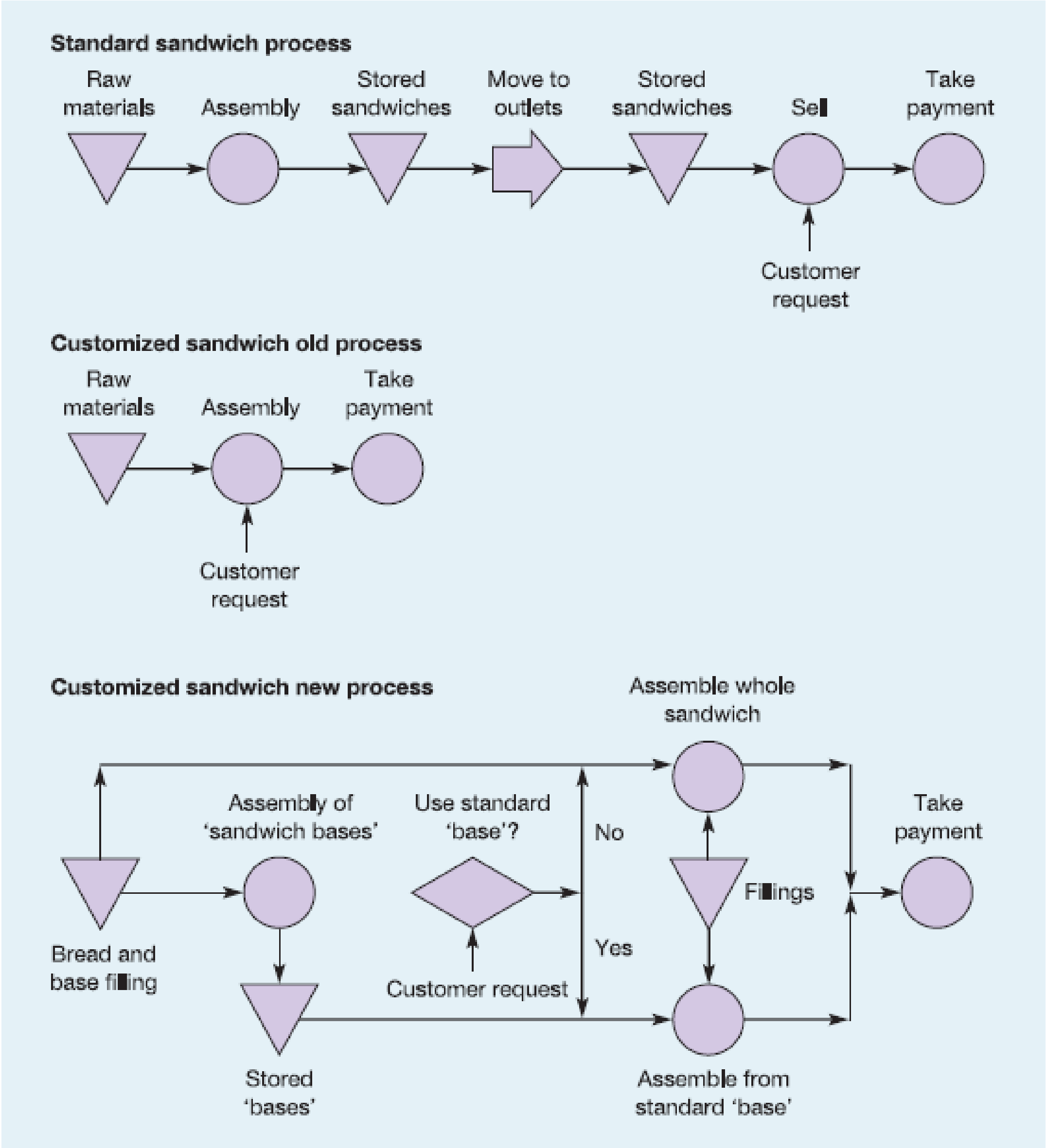
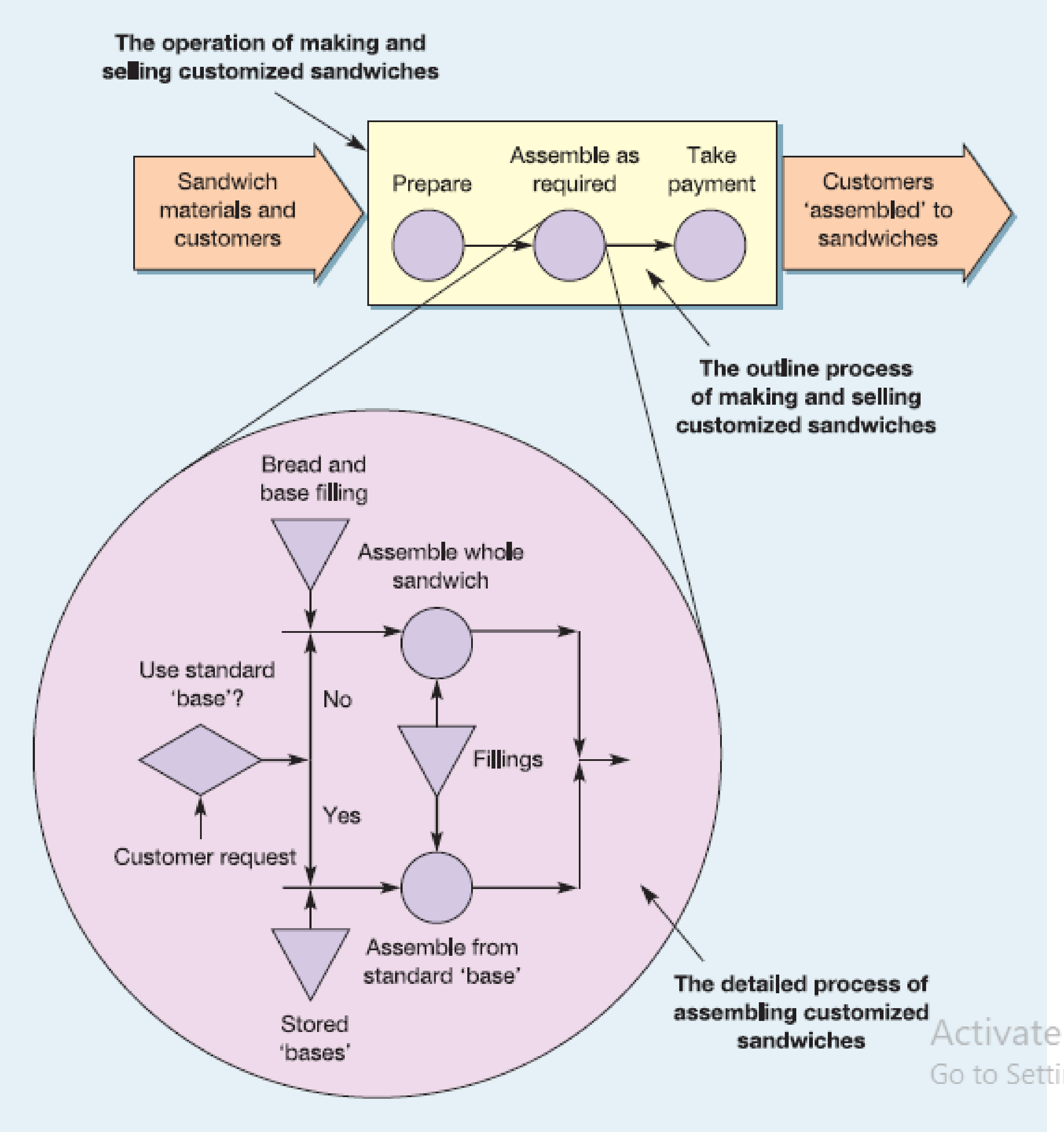


Figure 5.5 Process maps for three sandwich making and selling processes

	Description of activity	●	➡	D	■	▼
1	*Report arrives*					
2	*Wait for processing*					
3	*Check expenses report*					
4	*Stamp and date report*					
5	*Send cash to receipt desk*					
6	*Wait for processing*					
7	*Check advance payment*					
8	*Send to accounts receivable*					
9	*Wait for processing*					
10	*Check employee record*					
11	*Send to accounts payable*					
12	*Attach payment voucher*					
13	*Log report*					
14	*Check against rules*					
15	*Wait for batching*					
16	*Collect reports into batch*					
17	*Batch to audit desk*					
18	*Wait for processing*					
19	*Batch of reports logged*					
20	*Check payment voucher*					
21	*Reports to batch control*					
22	*Batch control number*					
23	*Copies of reports to filing*					
24	*Reports filed*					
25	*Payment voucher to keying*					
26	*Confirm payment*					
	Totals	7	8	5	5	1

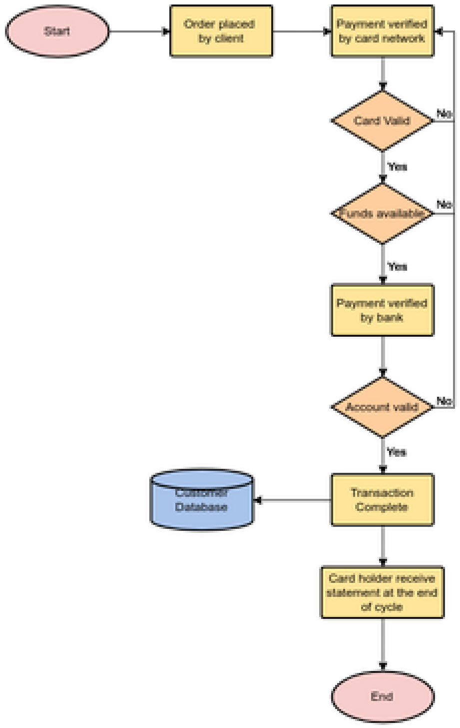
	Description of activity	●	➡	D	■	▼
1	*Report arrives*					
2	*Stamp and date report*					
3	*Check expenses report*					
4	*Attach payment voucher*					
5	*Wait for batching*					
6	*Collect reports into batch*					
7	*Batch to audit desk*					
8	*Wait for processing*					
9	*Check reports and vouchers*					
10	*Reports to batch control*					
11	*Batch control number*					
12	*Copy of reports to filing*					
13	*Reports filed*					
14	*Payment voucher to keying*					
15	*Confirm payment*					
	Totals	5	5	2	2	1

Figure 5.7 Flow process charts for processing expense reports at Intel before and after improving the process



The operation of making and selling customized sandwiches
Sandwich materials and customers
Prepare
Assemble as required
Take payment
Customers 'assembled' to sandwiches
The outline process of making and selling customized sandwiches
Bread and base filling
Assemble whole sandwich
Use standard 'base'?
No
Yes
Fillings
Customer request
Assemble from standard 'base'
Stored 'bases'
The detailed process of assembling customized sandwiches

Flowchart Example: Credit Card Payment Process



Credit Card Payment Process

Description:

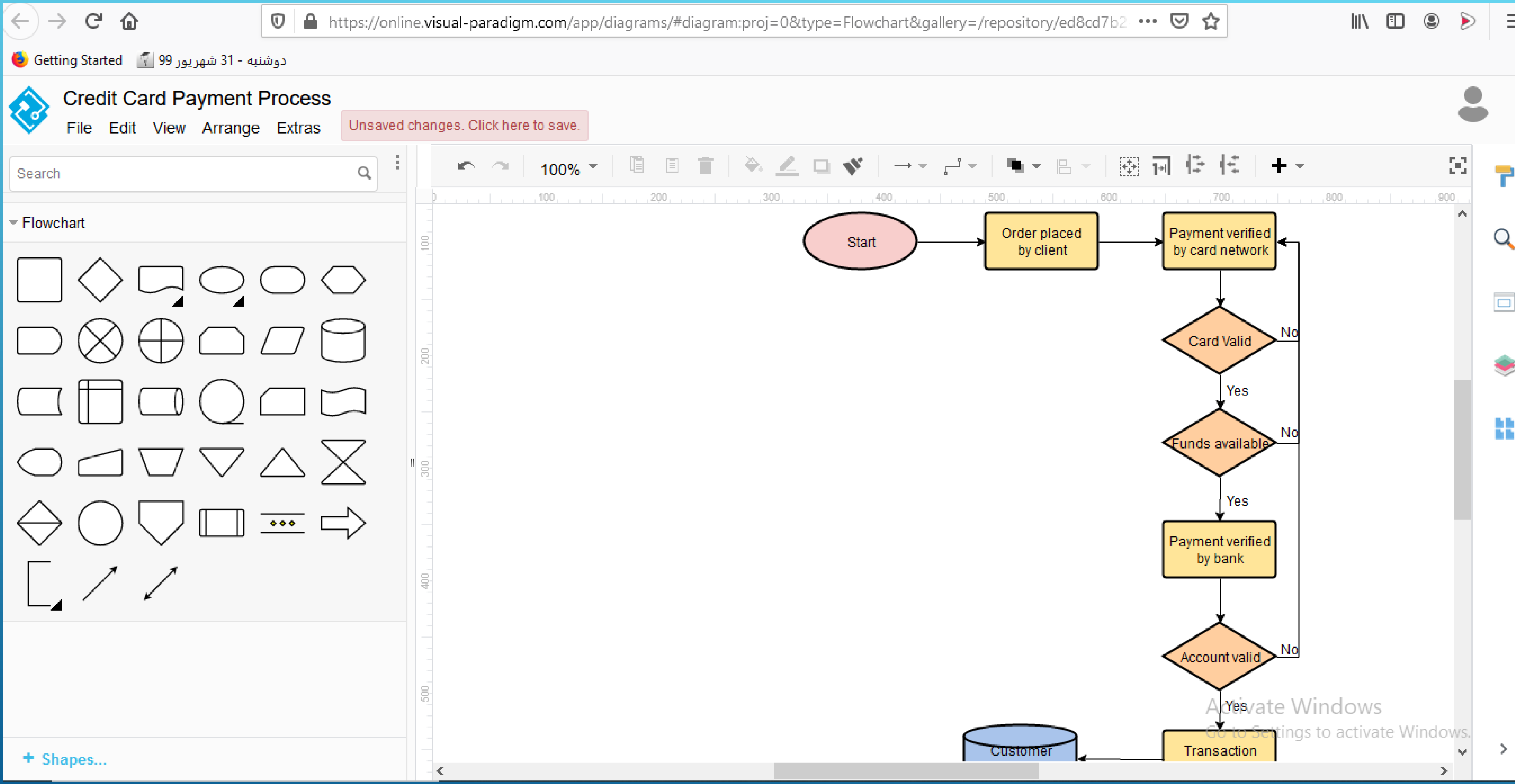
The flowchart shows the process when paying with credit cards in a shop, using process, decision and database.

Start creating your own flow chart from scratch by clicking Create Blank, or customize this example by clicking **Use This Template**.

Draw Diagram

Use This Template   Create New

Other Examples


https://online.visual-paradigm.com/app/diagrams/#diagram:proj=0&type=Flowchart&gallery=/repository/ed8cd7b2
Getting Started
دوشنبه - 31 شهریور 99
Credit Card Payment Process
File
Edit
View
Arrange
Extras
Unsaved changes. Click here to save.
Search
Flowchart
100%
+ Shapes...
Start
Order placed by client
Payment verified by card network
Card Valid
No
Yes
Funds available
No
Yes
Payment verified by bank
Account valid
No
Yes
Customer
Transaction
Activate Windows
Go to Settings to activate Windows.

Cycle time	
Throughput time	The time for unit to move trough the process
Work in process	The average time between units of output emerging from the process

$$\text{Throughput time} = \text{Work-in-process} \times \text{Cycle time}$$

In this case,

$$10 \text{ minutes wait} = 10 \text{ people in the system} \times 1 \text{ minute per person}$$

Worked example

Suppose the regional back-office operation of a large bank is designing an operation which will process its mortgage applications. The number of applications to be processed is 160 per week and the time available to process the applications is 40 hours per week.

$$\text{Cycle time for the process} = \frac{\text{time available}}{\text{number to be processed}} = \frac{40}{160} = \frac{1}{4} \text{ hour}$$

$$= 15 \text{ minutes}$$

So the bank's layout must be capable of processing a completed application once every 15 minutes.

Little's law

This mathematical relationship (throughput time = work-in-process × cycle time) is called **Little's law.** It is simple but very useful, and it works for any stable process. For example, suppose it is decided that, when the new process is introduced, the average number of customers in the process should be limited to around ten and the maximum time a customer is in the process should be on average four minutes. If the time to assemble and sell a sandwich (from customer request to the customer leaving the process) in the new process has reduced to 1.2 minutes, how many staff should be serving?

Putting this into Little's law:

$$\text{Throughput time} = 4 \text{ minutes}$$

and

$$\text{Work-in-progress, WIP} = 10$$

So, since

$$\text{Throughput time} = \text{WIP} \times \text{Cycle time}$$

$$\text{Cycle time} = \frac{\text{Throughput time}}{\text{WIP}}$$

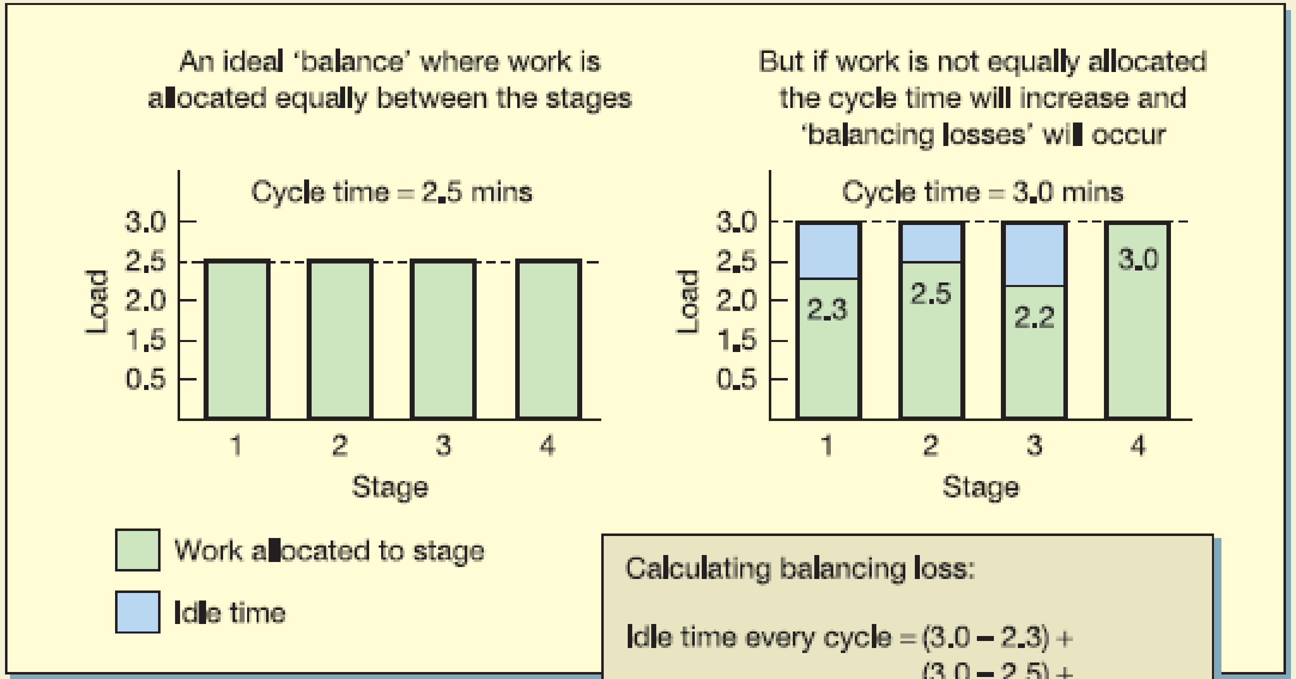
$$\text{Cycle time for the process} = \frac{4}{10} = 0.4 \text{ minute}$$

That is, a customer should emerge from the process every 0.4 minute, on average.

Given that an individual can be served in 1.2 minutes,

$$\text{Number of servers required} = \frac{1.2}{0.4} = 3$$

In other words, three servers would serve three customers in 1.2 minutes. Or one customer in 0.4 minute.



Calculating balancing loss:

Idle time every cycle $= (3.0 - 2.3) + (3.0 - 2.5) + (3.0 - 2.2) = 2.0$ mins

Balancing loss $= \dfrac{2.0}{4 \times 3.0} = 0.1667 = 16.67\%$

Figure 5.8 Balancing loss is that proportion of the time invested in processing the product or service which is not used productively

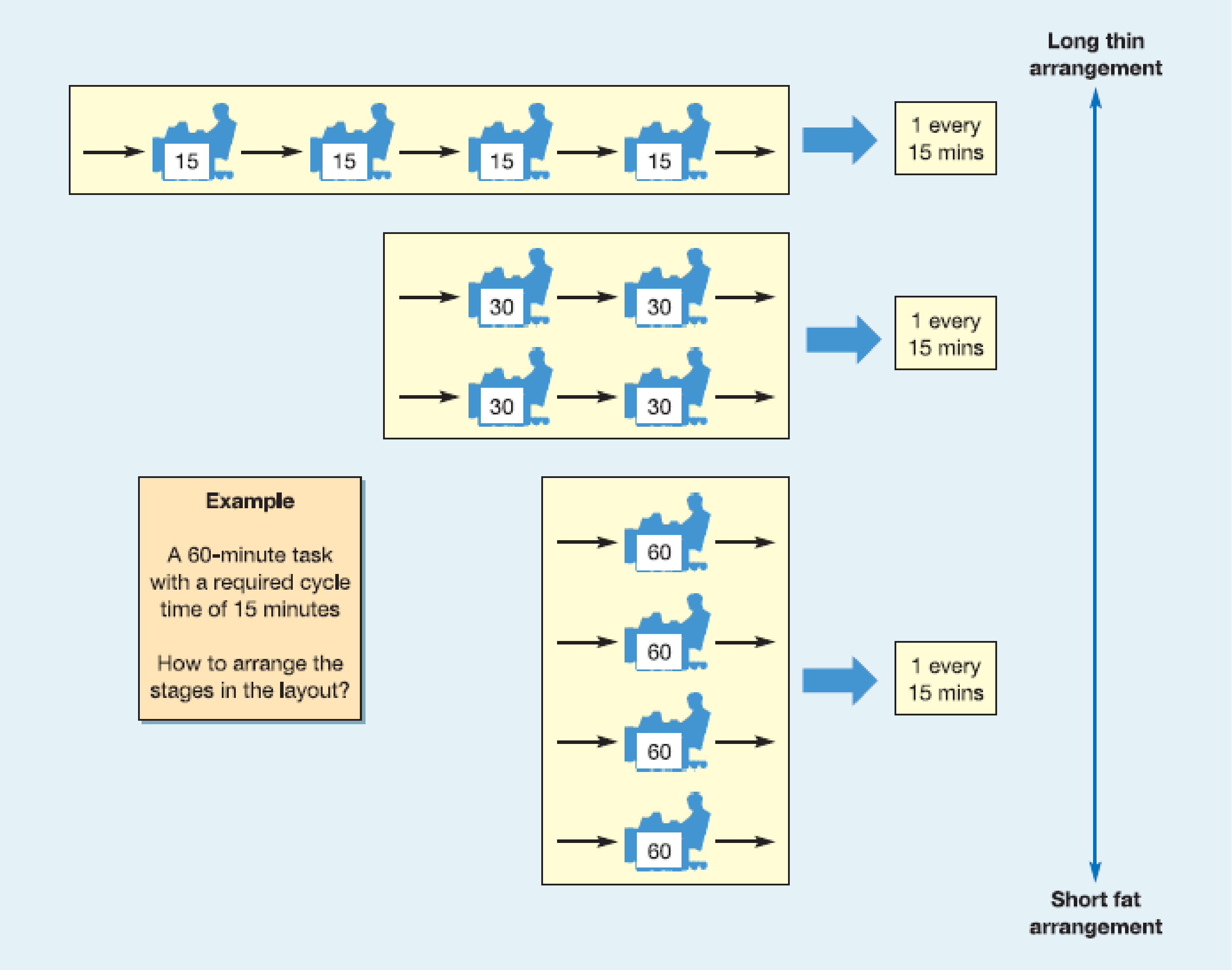


Figure 5.9 The arrangement of stages in product layout can be described on a spectrum from 'long thin' to 'short fat'

Advantages of long thin management	Advantages of short fat management
• Controlled flow of materials or customers • Simple materials handling • Lower capital requirements • More efficient operation	• Higher mix flexibility • Higher volume flexibility • Higher robustness • Less monotonous work

$$\text{Percentage throughput efficiency} = \frac{\text{Work content}}{\text{Throughput time}} \times 100$$

Worked example

A vehicle licensing centre receives application documents, keys in details, checks the information provided on the application, classifies the application according to the type of licence required, confirms payment and then issues and mails the licence. It is currently processing an average of 5,000 licences every 8-hour day. A recent spot check found 15,000 applications that were 'in progress' or waiting to be processed. The sum of all activities that are required to process an application is 25 minutes. What is the throughput efficiency of the process?

$$\text{Work-in-progress} = 15{,}000 \text{ applications}$$

$$\text{Cycle time} =$$

$$\frac{\text{Time producing}}{\text{Number produced}} = \frac{8 \text{ hours}}{5{,}000} = \frac{480 \text{ minutes}}{5{,}000} = 0.096 \text{ minute}$$

From Little's law,

$$\text{Throughput time} = \text{WIP} \times \text{Cycle time}$$

$$\text{Throughput time} = 15{,}000 \times 0.096$$

$$= 1{,}440 \text{ minutes}$$

$$\text{Throughput efficiency} = \frac{\text{Work content}}{\text{Throughput time}} = \frac{25}{1{,}440} = 1.74 \text{ per cent}$$

Although the process is achieving a throughput time of 24 hours (which seems reasonable for this kind of process) the applications are only being worked on for 1.74 per cent of the time they are in the process.

Workflow management : the automation of procedures where documents, information or tasks are passed between participants according to a defined set of rules to achieve or contribute to, an overall business goals . workflow is concerned with the following.

- analysis, modelling, definition and subsequent operational implementation of business processes;
- the technology that supports the processes;
- the procedural (decision) rules that move information or documents through processes;
- defining the process in terms of the sequence of work activities, the human skills needed to perform each activity and the appropriate IT resources.

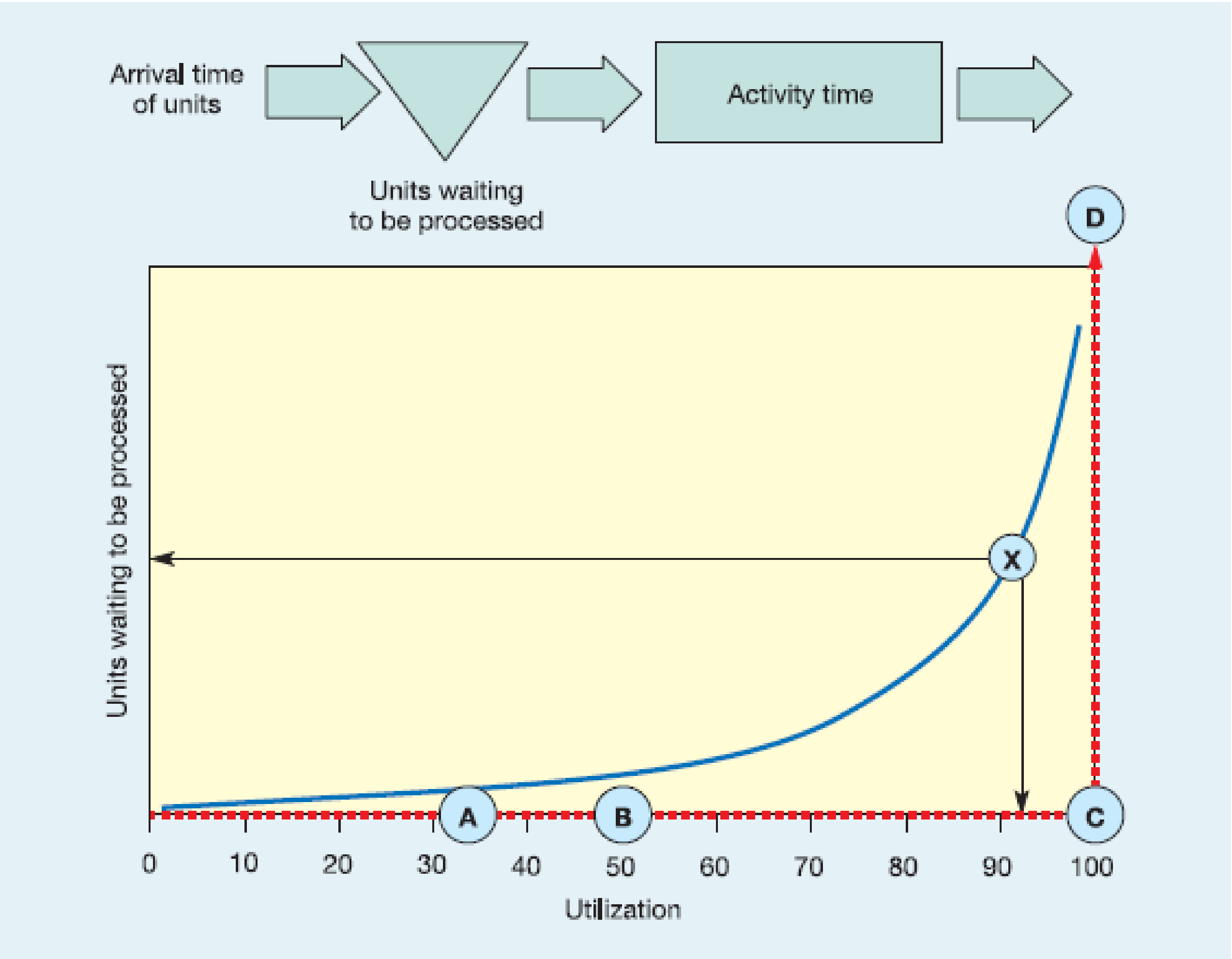


Figure 5.10 The relationship between process utilization and number of units waiting to be processed for constant, and variable, arrival and process times

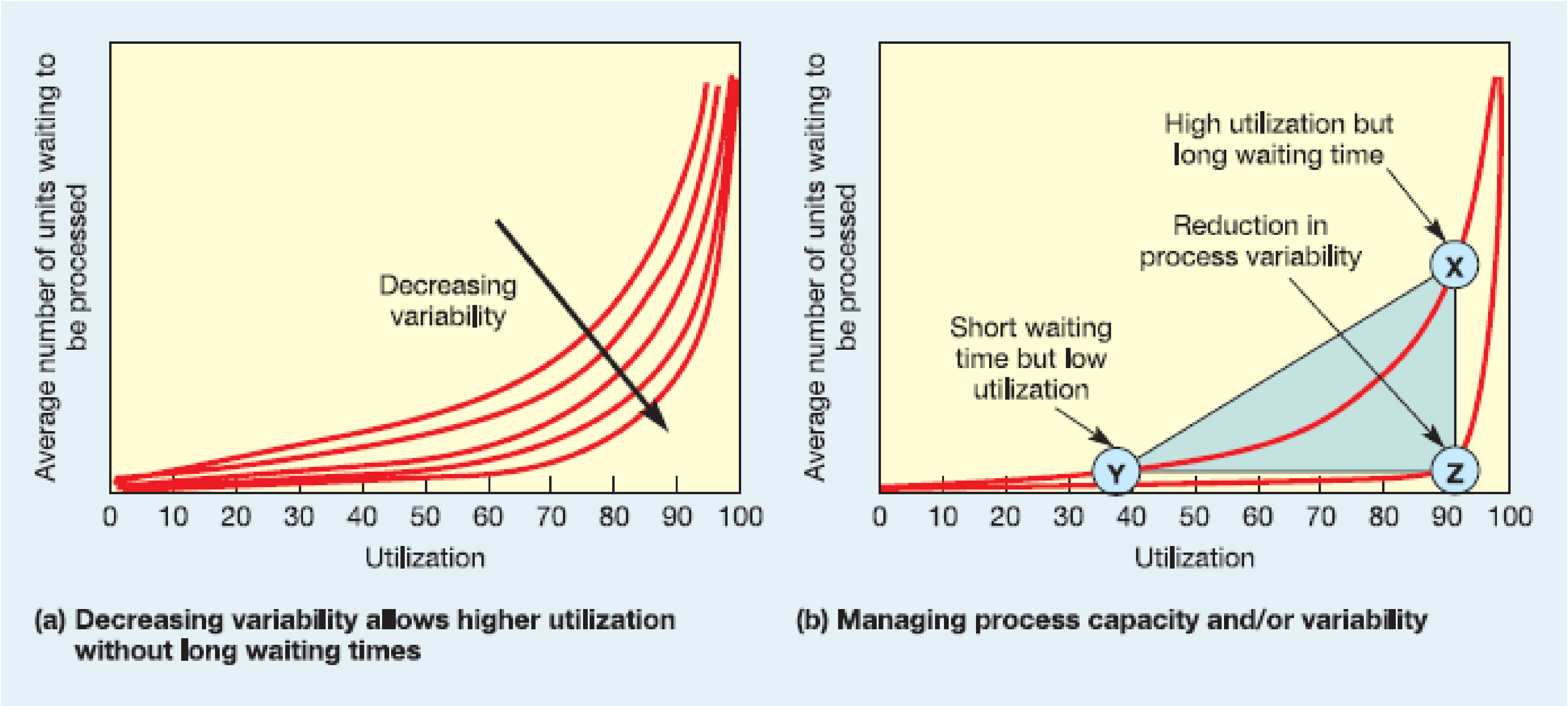
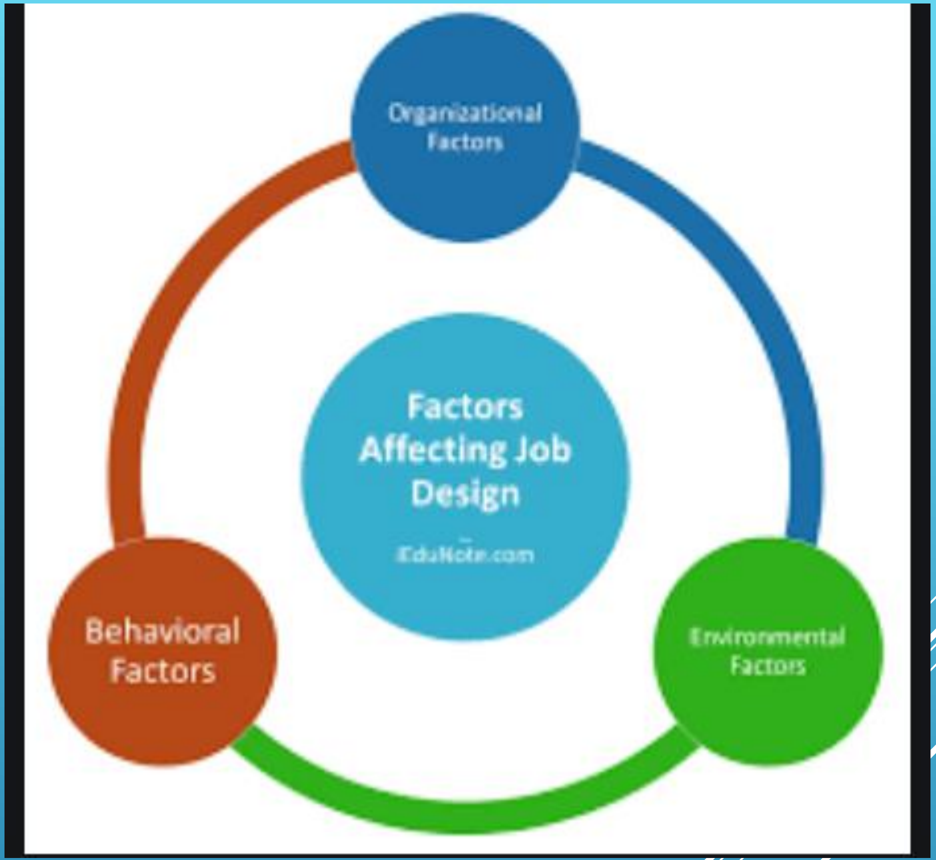


Figure 5.11 The relationship between process utilization and number of units waiting to be processed for variable arrival and activity times

Definition of Job Design

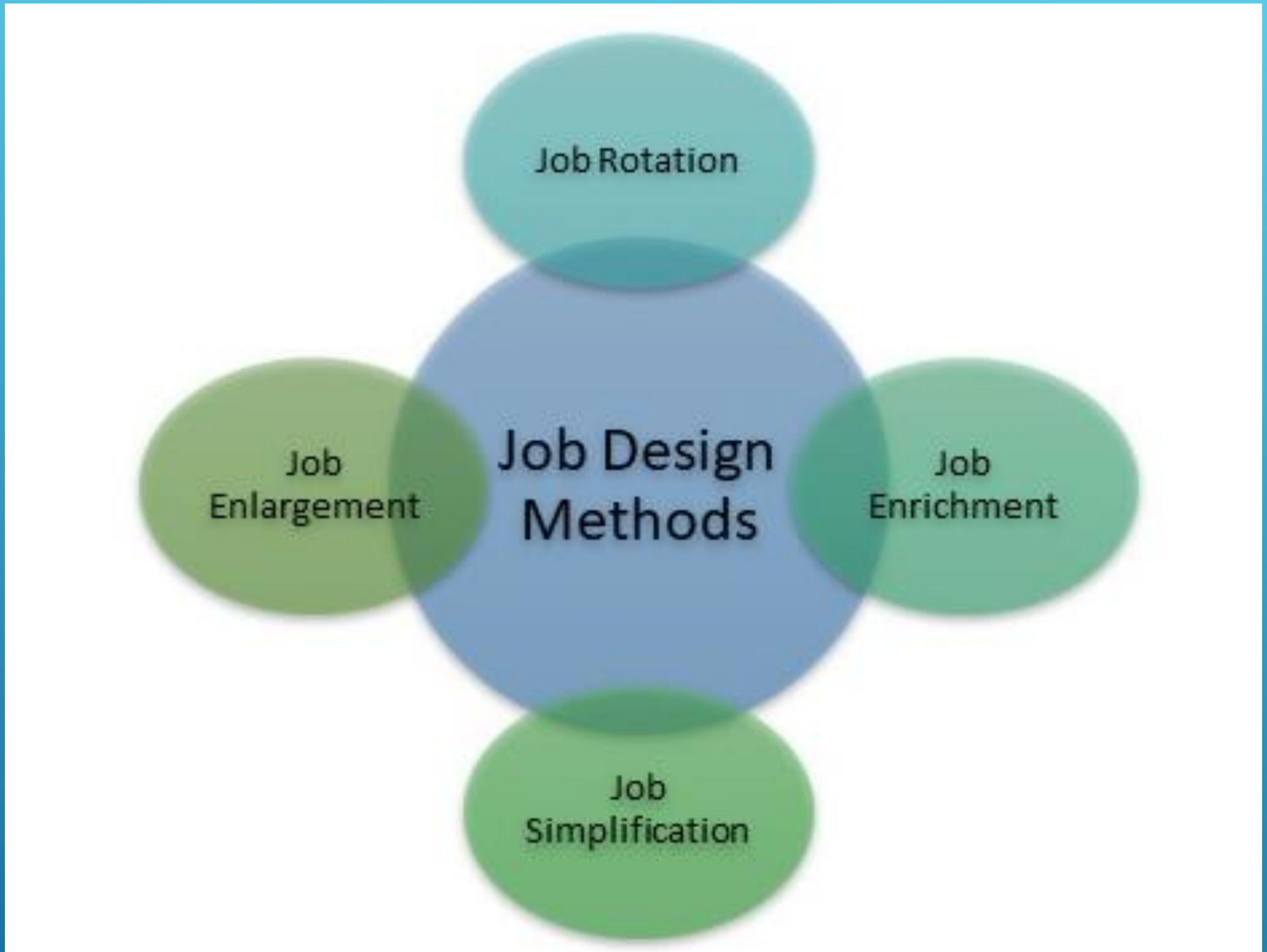
Job design refers to the way that a set of tasks, or an entire job, is organized. Job design helps to determine:

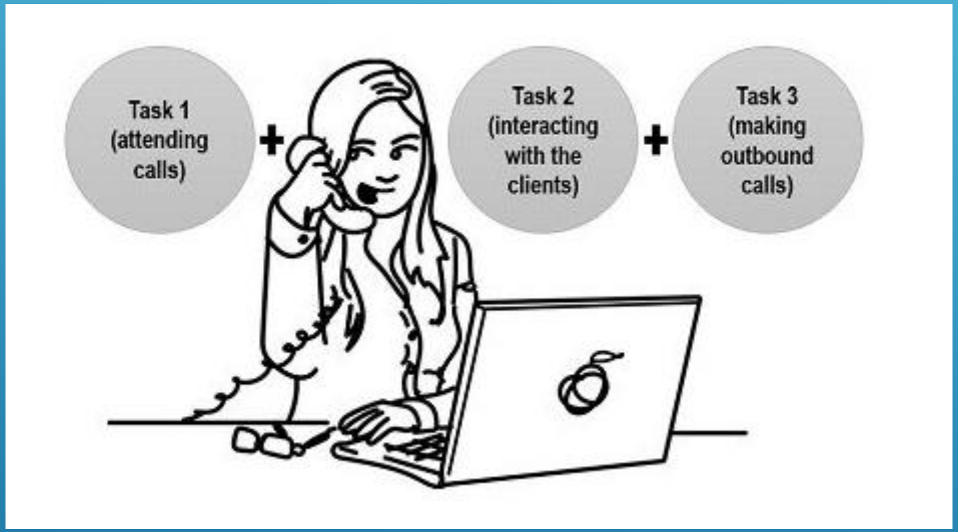
- what tasks are done,
- how the tasks are done,
- how many tasks are done and
- In what order the tasks are done.



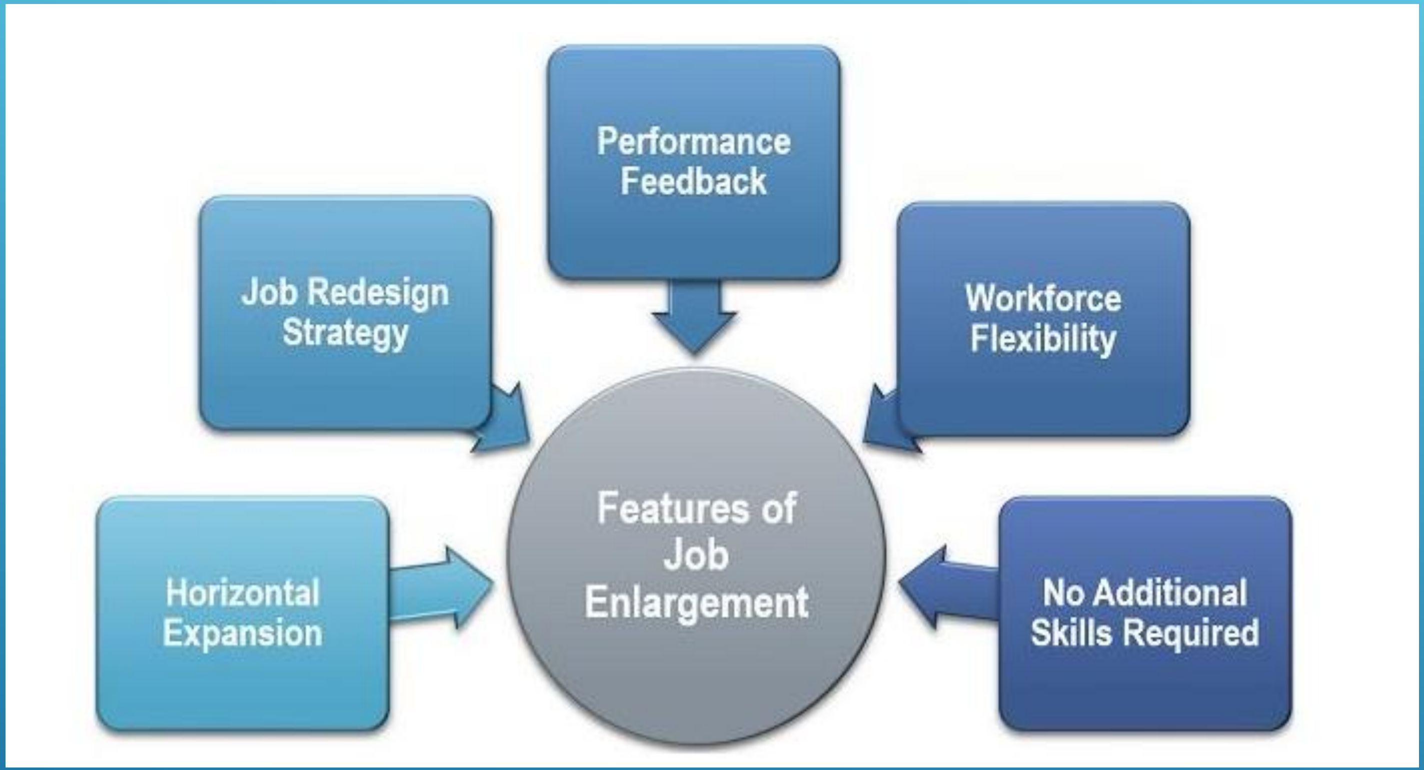
Task allocation- division of labor

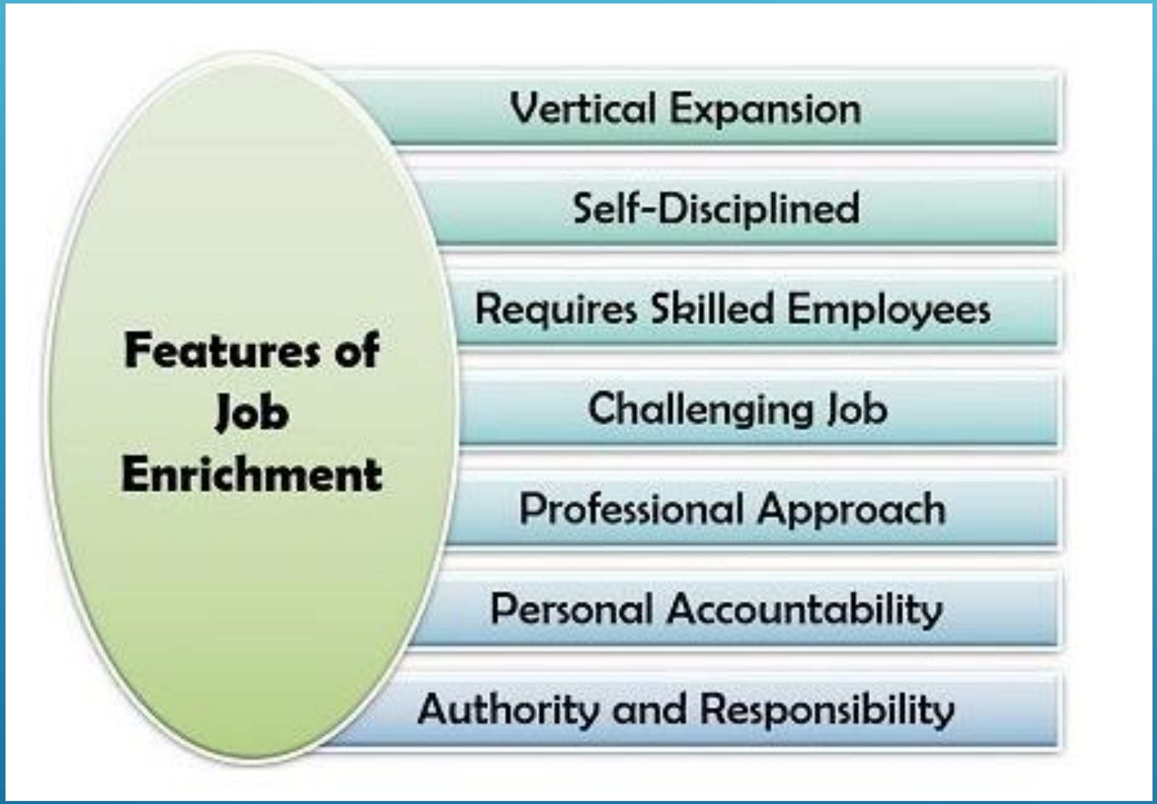
Advantages of division of labor	Disadvantages of highly divided jobs
It promote faster learning Automation becomes easier Reduced non productive works	Monotony Physical injury Low flexibility Poor robustness


Job Rotation
Job Enlargement
Job Design Methods
Job Enrichment
Job Simplification


Task 1
(attending
calls)
+
Task 2
(interacting
with the
clients)
+
Task 3
(making
outbound
calls)


Task 3 (keeping contact with the provident fund office and initial scrutinizing of the candidates for the interviews)
+
Task 2 (providing the employees' provident fund details to the accounts department)
+
Task 1 (maintaining the employees' record and calling the candidates for interviews)


Performance Feedback
Job Redesign Strategy
Workforce Flexibility
Features of Job Enlargement
Horizontal Expansion
No Additional Skills Required


Features of Job Enrichment
Vertical Expansion
Self-Disciplined
Requires Skilled Employees
Challenging Job
Professional Approach
Personal Accountability
Authority and Responsibility

Difference and Comparison

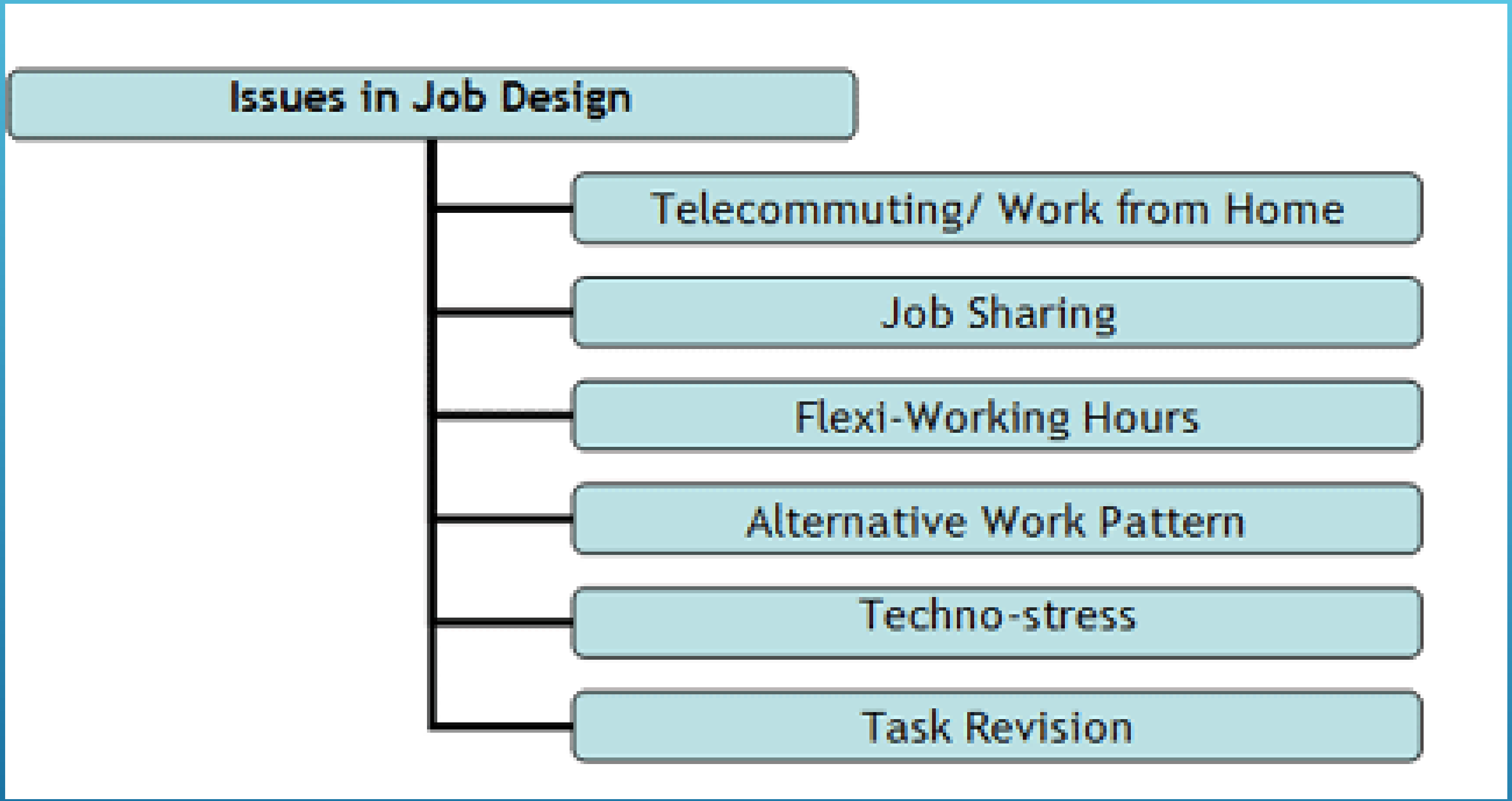
BASIS	JOB ENLARGEMENT	JOB ENRICHMENT
Meaning	Job enlargement refers to increasing the number of tasks to be performed by an employee to reduce work related boredom.	Job enrichment is that motivational tool which allows more decision making power and work related authority to the employees.
Tool or Technique	Job Design Technique	Management Tool
Objective/Purpose	Reduce Boredom and Monotony	Make Job Challenging
Skills Requirement	No	Yes
Expansion	Horizontal	Vertical

Difference and Comparison

BASIS	JOB ENLARGEMENT	JOB ENRICHMENT
Level of Responsibility	Remains the Same	Increases
Level of Authority	Remains the Same	Increases
Directions	Supervisor's Direction	Self-Directed
Dependency on Each Other	Independent	Dependent
Supervisory Control	More	Comparatively Less
Result	Positive or Negative	Usually Positive

Job commitment –behavioral approach to job design

- Job rotation
- Job enlargement
- Job enrichment
- Empowerment
- Team working


Issues in Job Design
Telecommuting/ Work from Home
Job Sharing
Flexi-Working Hours
Alternative Work Pattern
Techno-stress
Task Revision