204 GC OSCM

Operations & Supply Chain Management

Semester II

DIMR

Unit : I

- Introduction to Operations and Supply Chain Management: Definition, Concept, Significance and Functions of Operations and SCM.
- Evolution from manufacturing to operations management, Physical distribution to Logistics to SCM, Physical Goods and Services Perspectives.
- Quality: Definitions from various Perspectives, Customers view and Manufacturer's view, Concept of Internal Customer, Overview of TQM and LEAN Management,
- Impact of Global Competition, Technological Change, Ethical and Environmental Issues on Operations and Supply Chain functions.

Operations Management

What is operations?

- The part of a business organization that is responsible for producing goods or services

How can we define operations management?

- The management of systems or processes that create goods and/or provide services

Operations Management

The planning, scheduling, and control of the activities that transform inputs into finished goods and services.

Decision Making

Most operations decisions involve many alternatives that can have quite different impacts on costs or profits. Typical operations decisions include:

- What: What resources are needed, and in what amounts?
- When: When will each resource be needed? When should the work be scheduled? When should materials and other supplies be ordered?
- Where: Where will the work be done?
- How: How will he product or service be designed? How will the work be done? How will resources be allocated?
- *Who:* Who will do the work?

Scope of Operations Management

The scope of operations management ranges across the organization.

The operations function includes many interrelated activities such as:

- Forecasting
- Capacity planning
- Facilities and layout
- Scheduling
- Managing inventories
- Assuring quality
- Motivating employees
- Deciding where to locate facilities
- And more . . .

Operations Function

The collection of people, technology, and systems within a company ...

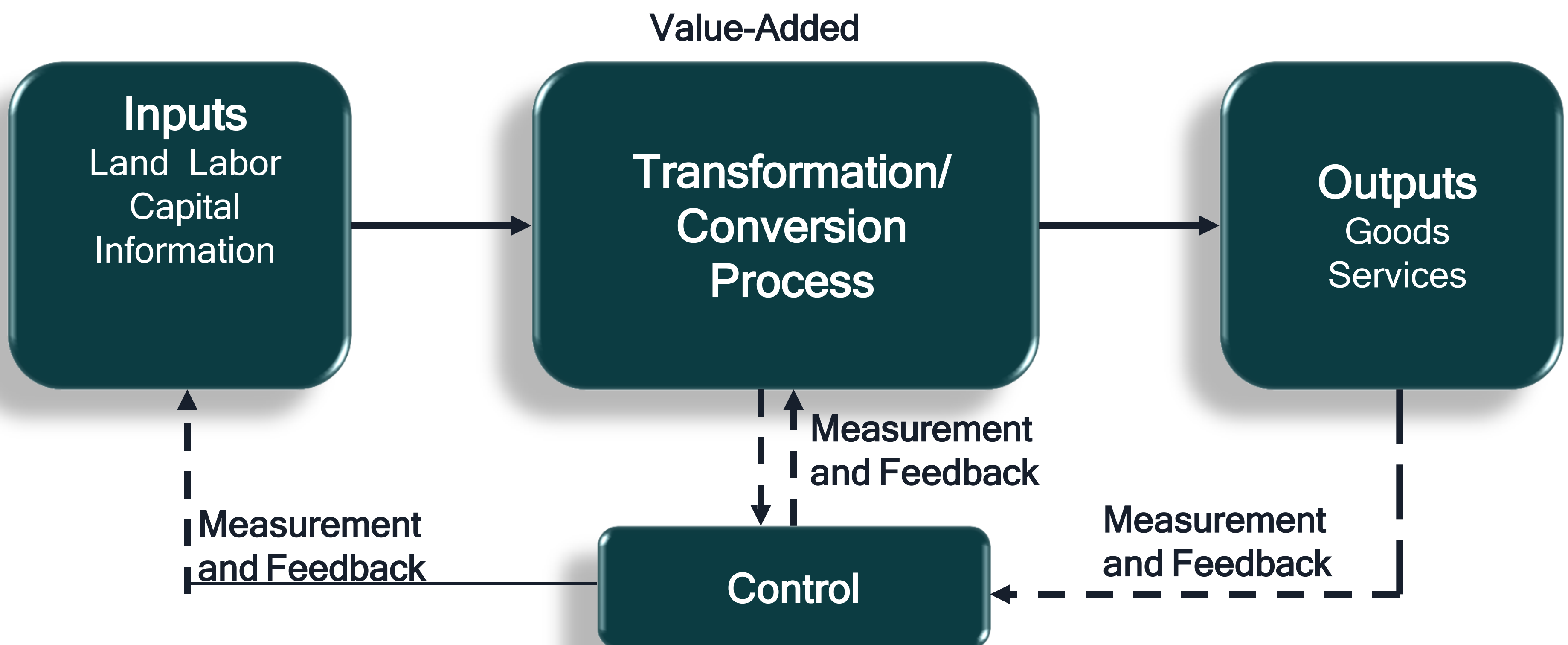
... that has primary responsibility ...

... for providing the organization's products and/or services.

7'Ms of Operations

M
- anpower
- aterial
- achine
- oney
- easurement
- ovement
- ethods

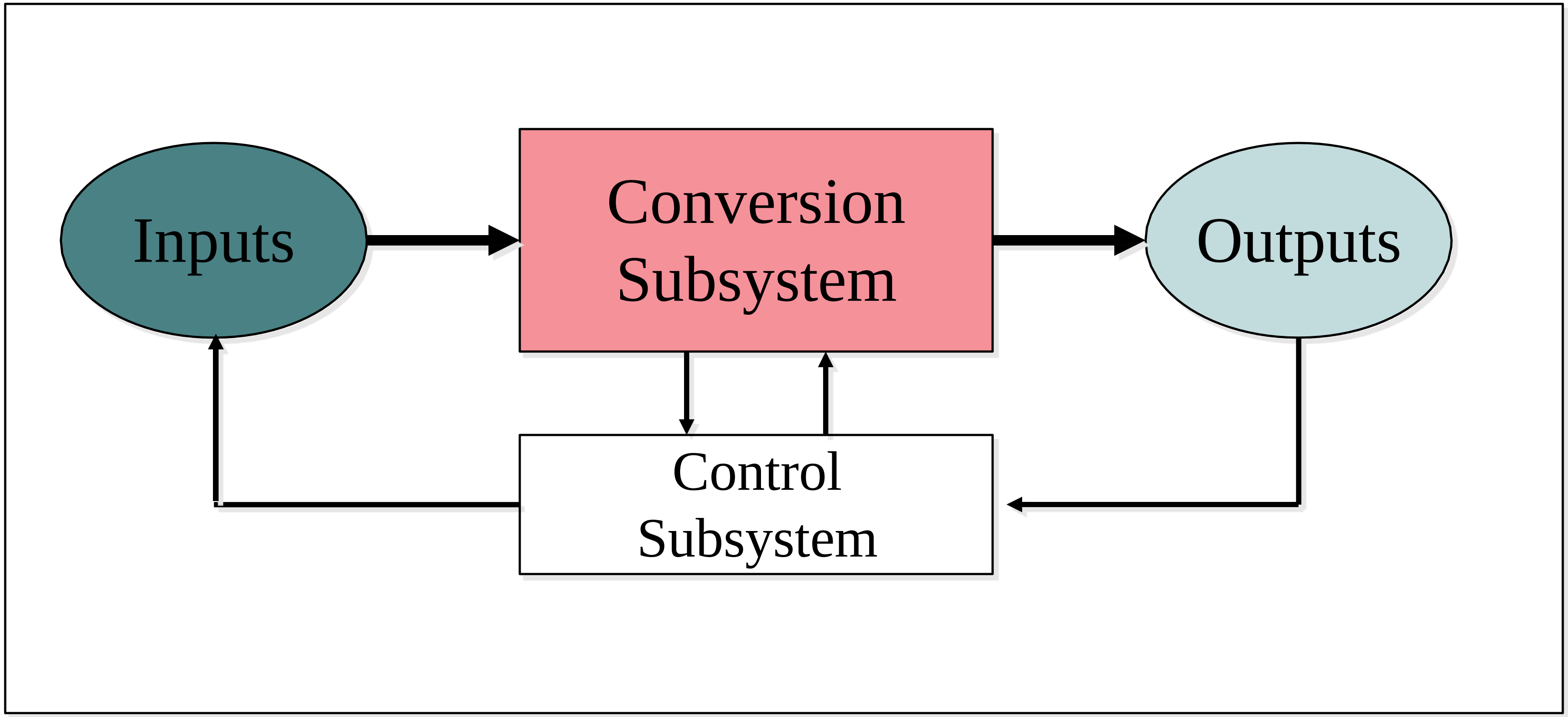
The Transformation Process



Feedback = measurements taken at various points in the transformation process

Control = The comparison of feedback against previously established standards to determine if corrective action is needed.

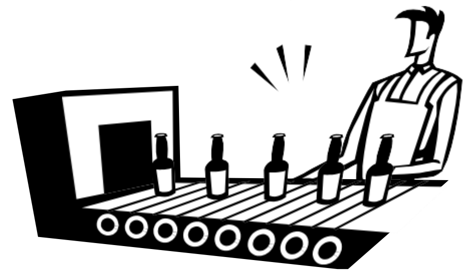
Production System



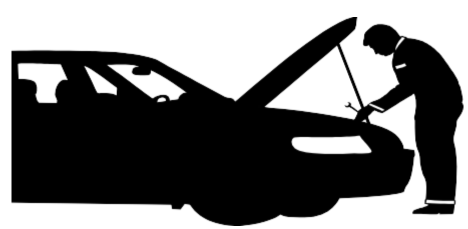
Viewing Operations as a *Transformation* Process

Transformation Process

Manufactu ring operations



Service operations



Inputs

- ✓Materials
- ✓People
- ✓Equipment
- ✓Intangible needs
- ✓Information

Outputs

- ✓Tangible goods
- ✓Fulfil ledrequests
- ✓Information
- ✓*Satisfied Customers*

DIMR


Bisleri
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Bisleri

Good or Service?

Goods are physical items that include raw materials, parts, subassemblies, and final products.

- Automobile
- Computer
- Oven
- Shampoo

Services are activities that provide some combination of time, location, form or psychological value.

- Air travel
- Education
- Haircut
- Legal counsel

Manufacturing Vs. Services

Location, Exchange, Storage, Physiological, Information

Manufacturing

Tangible product

Key decisions driven by physical characteristics of the product:

- How is the product made?
- How do we store it?
- How do we move it?

Services

Intangible "Product" or Service

Key decisions:

- How much customer involvement?
- How much customization?

Manufacturing vs. Service

Factors	Manufacturing	Services
Degree of customer contact	LOW	HIGH
Uniformity of input	HIGH	LOW
Labor content of jobs	LOW	HIGH
Uniformity of output	HIGH	LOW
Measurement of productivity	LOW	HIGH
Production and delivery	HIGH	LOW
Quality assurance	HIGH	LOW
Amount of inventory	HIGH	LOW
Evaluation of work	HIGH	LOW
Ability to patent design	HIGH	LOW

Supply Chain Management

<u>Active</u> management of supply chain activities and relationships to maximize customer value and achieve a sustainable competitive advantage

Supply Chain

Supply Chain – a sequence of activities and organizations involved in producing and delivering a good or service

The Need for Supply Chain Management

In the past, organizations did little to manage the supply chain beyond their own operations and immediate suppliers which led to numerous problems:

- Oscillating inventory levels
- Inventory stock outs
- Late deliveries
- Quality problems

Physical Distribution

"The activities associated with the movement of material, usually finished goods or service parts, from the manufacturer to the customer"

- *APICS 11th Edition Dictionary*

Physical Distribution

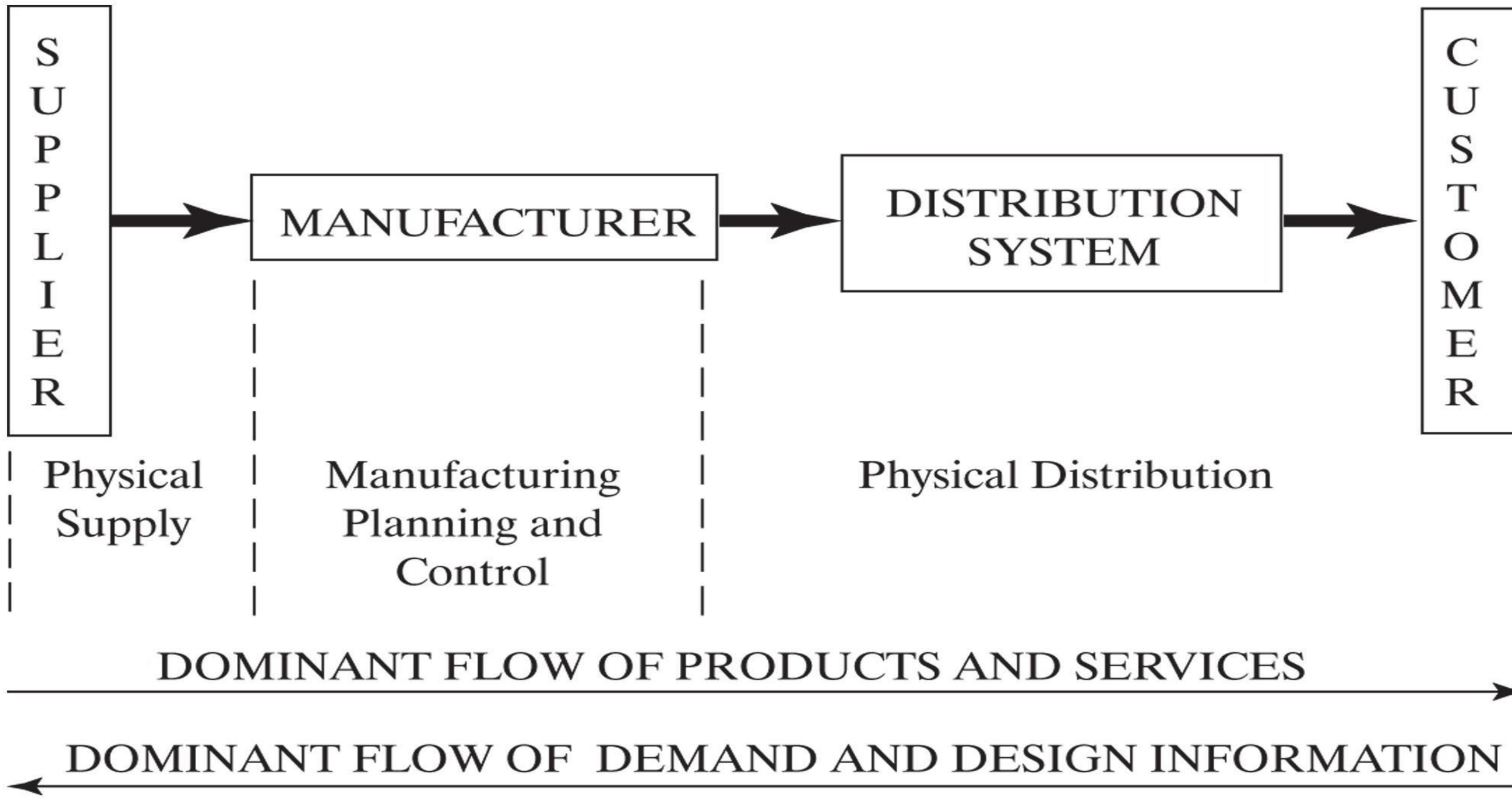
Physical Supply

- goods moving from supplier to manufacturer
- “inbound”

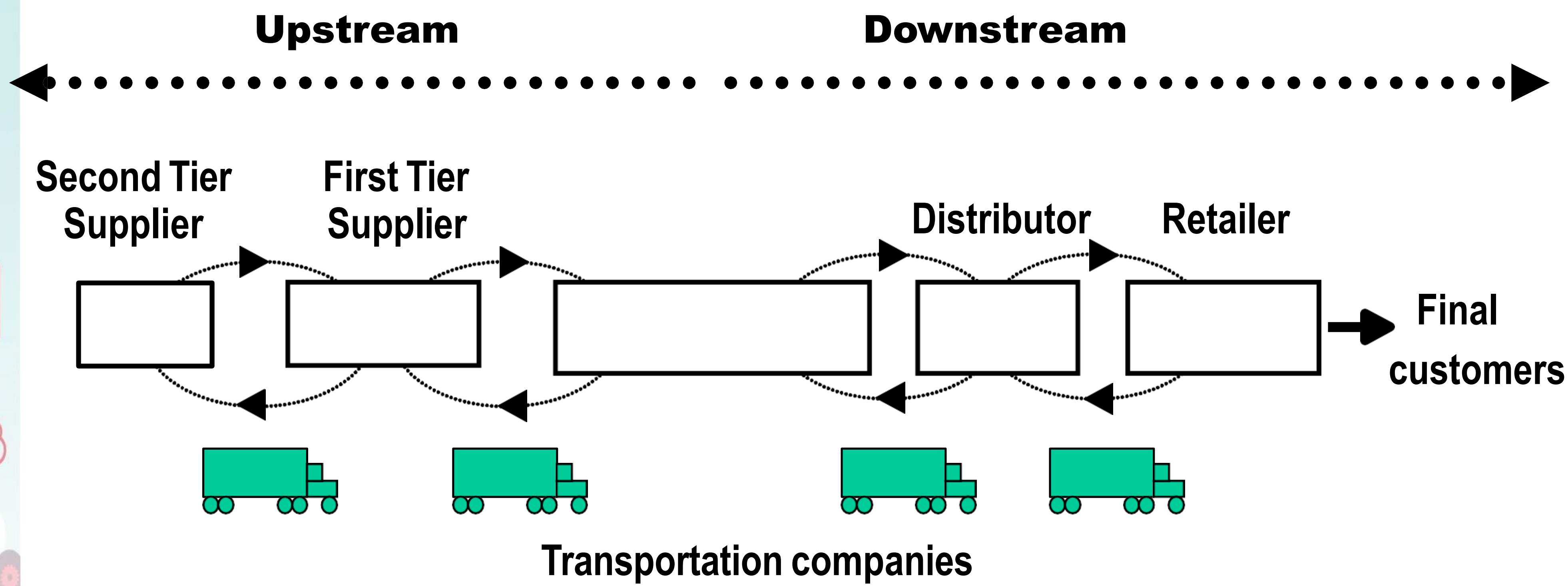
Physical Distribution

- goods moving from manufacturer to customers
- “outbound”

Physical Distribution



Material Flows



Channels of Distribution

Any series of firms or individuals that participates in the flow of goods and services from the raw material supplier and producer to the final user or consumer.”

Channels of Distribution

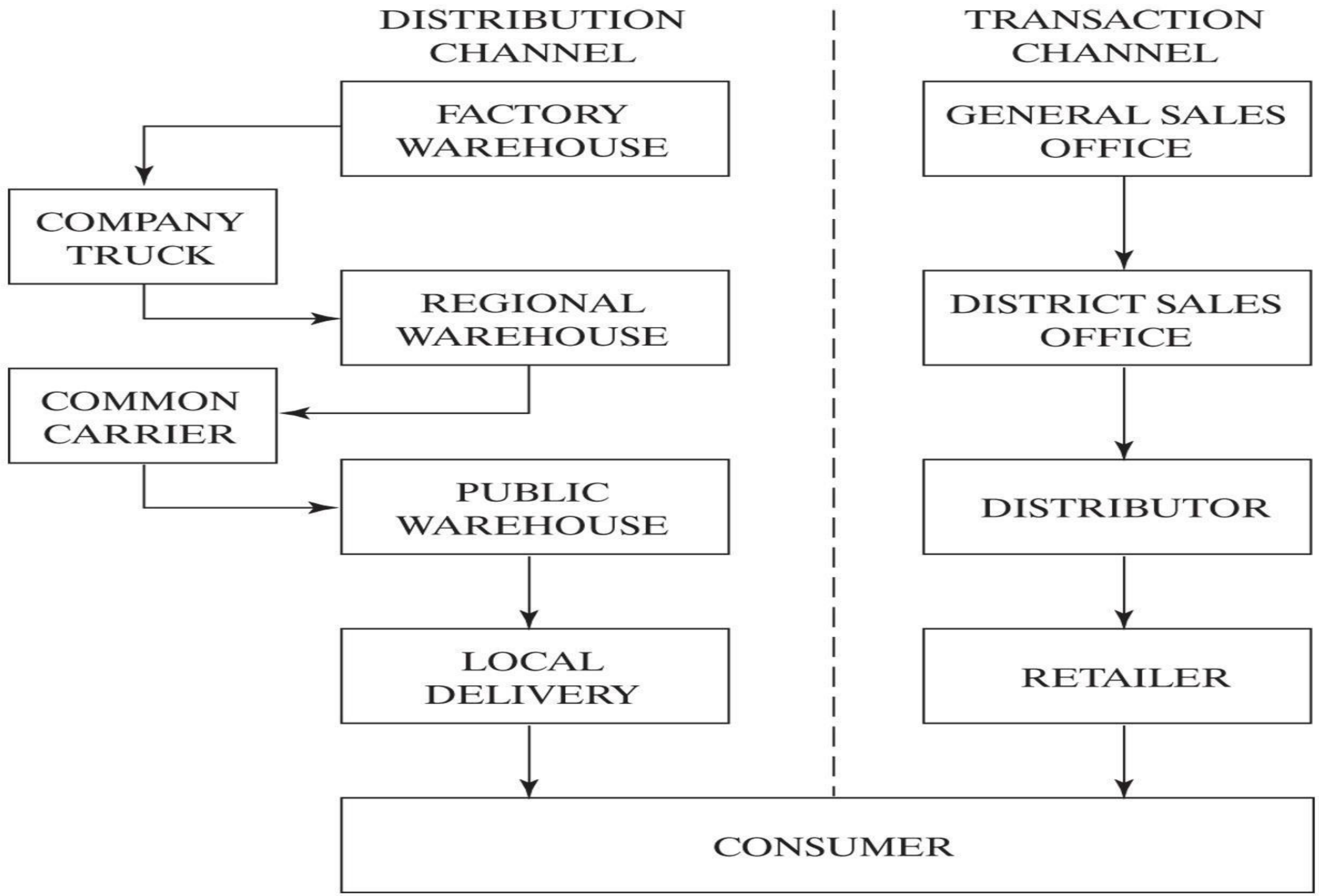
Company may deliver directly to customers

Use other companies or individuals to deliver goods

Intermediaries

- wholesalers - agents
- transportation companies - warehouses

Channels of Distribution



Supply Chain Issues

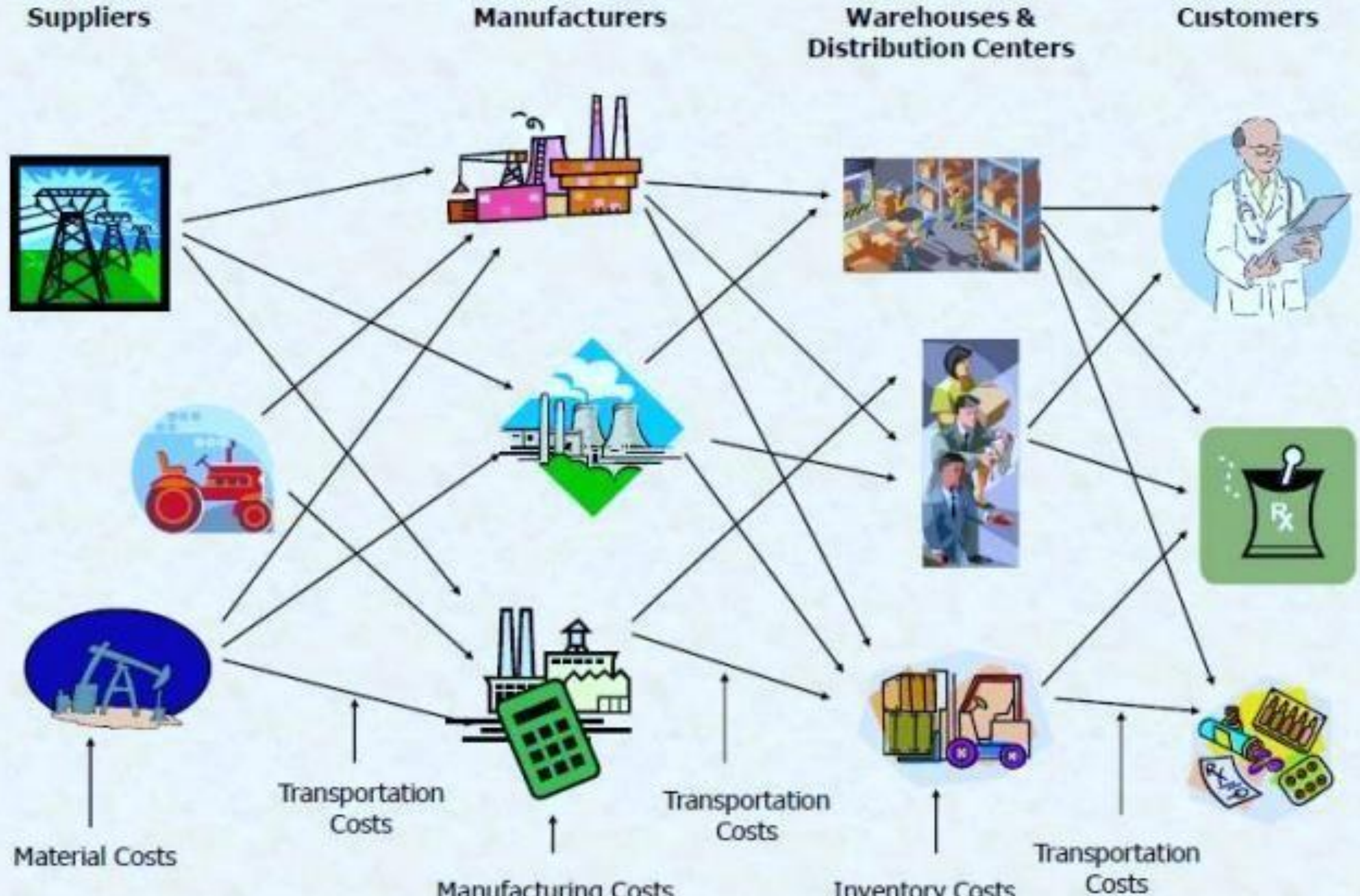
Length of the chain

Complexity

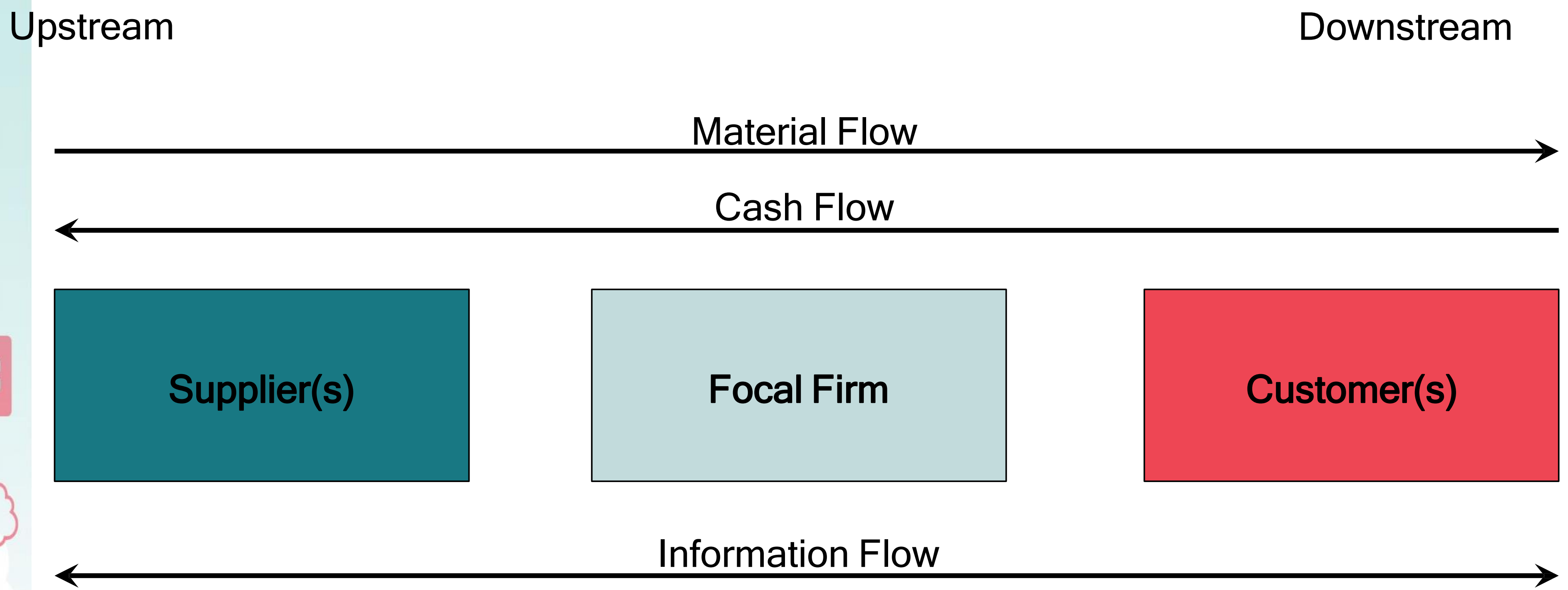
Stability

Physical, informational, and monetary flows

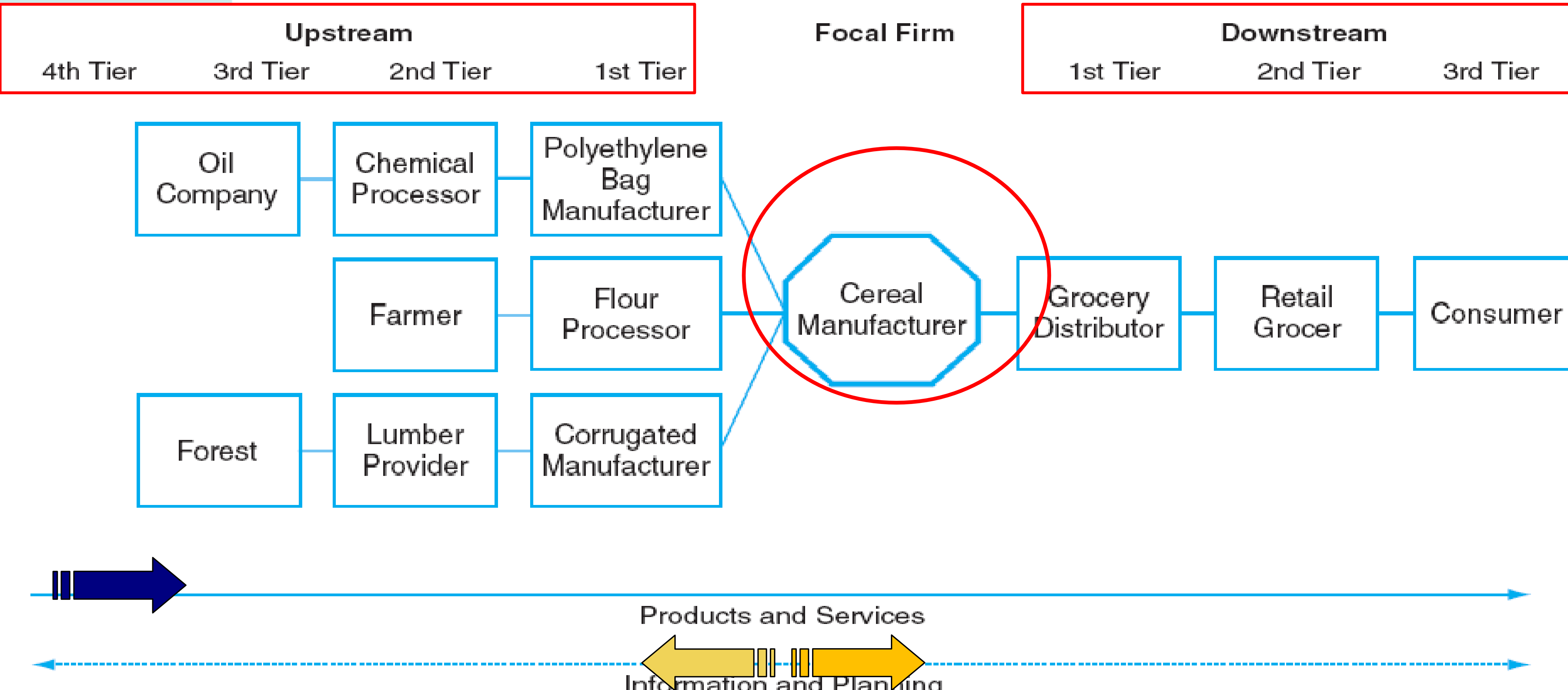
The Supply Chain



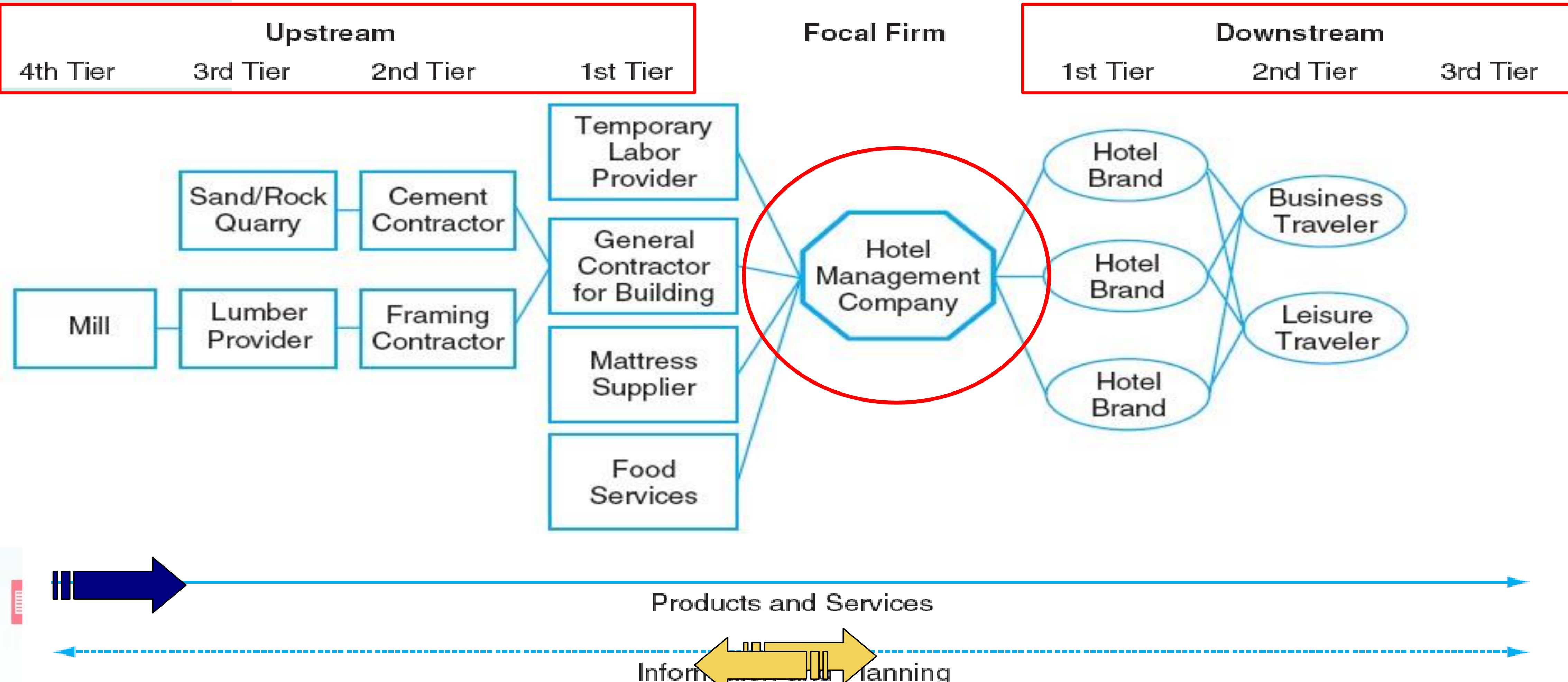
Basic SC structure



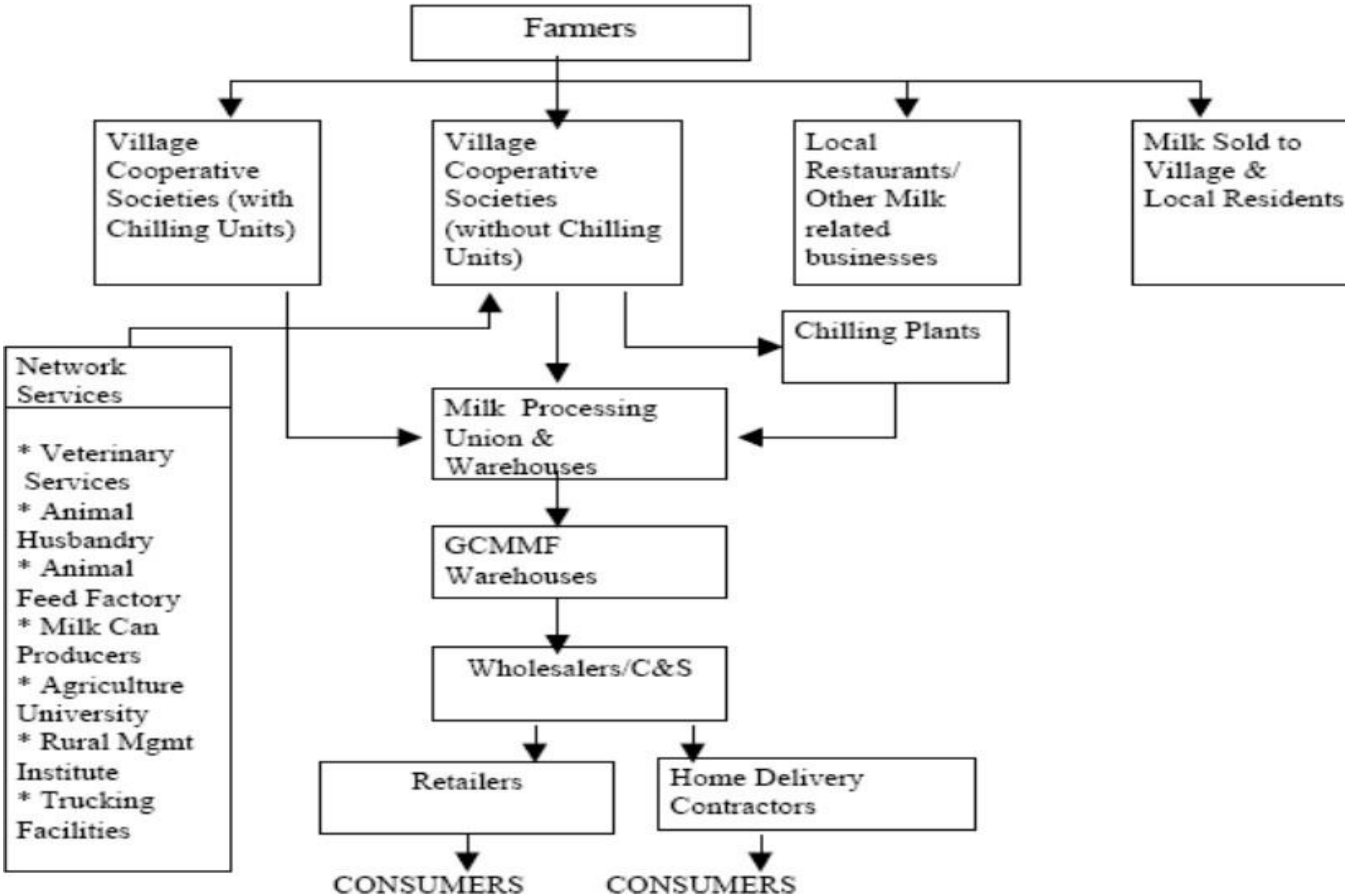
Supply Chain: Manufacturing Example



Supply Chain: Service Example



SCM for Milk


Farmers
Village Cooperative Societies (with Chilling Units)
Village Cooperative Societies (without Chilling Units)
Local Restaurants/ Other Milk related businesses
Milk Sold to Village & Local Residents
Network Services
* Veterinary Services
* Animal Husbandry
* Animal Feed Factory
* Milk Can Producers
* Agriculture University
* Rural Mgmt Institute
* Trucking Facilities
Chilling Plants
Milk Processing Union & Warehouses
GCMMF Warehouses
Wholesalers/C&S
Retailers
Home Delivery Contractors
CONSUMERS
CONSUMERS

Cross-Functional Linkages

Finance
Budgeting.
Analysis.
Funds.

MIS
What IT solutions to make it all work together?

Human Resources
Skills? Training?
# of Employees?

Design
Sustainability.
Quality.
Manufacturability.

Operations & Supply Chain

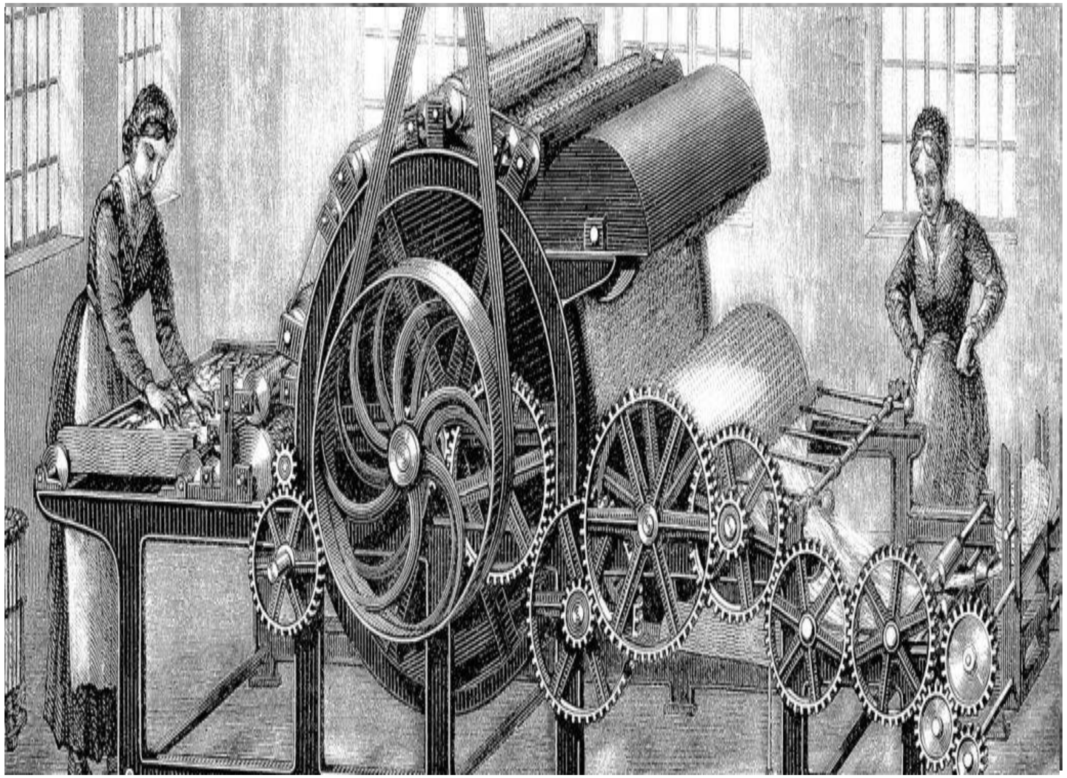
Marketing
What products?
What volumes?
Costs? Quality?
Delivery?

Accounting
Performance measurement systems.
Planning and control.

Historical Milestones in OM

- The Industrial Revolution
- Post-Civil War Period
- Scientific Management
- Human Relations and Behaviorism
- Operations Research
- The Service Revolution

The Industrial Revolution



1700's Cottage Industry....

Machine power for human power....

Factory system which resulted in greater productivity.

The Industrial Revolution…Contd.

The industrial revolution developed in England in the 1700s.

The steam engine, invented by James Watt in 1764, largely replaced human and water power for factories.

Adam Smith's *The Wealth of Nations* in 1776 touted the economic benefits of the specialization of labor.

Thus the late-1700s factories had not only machine power but also ways of planning and controlling the tasks of workers.

The Industrial Revolution

The industrial revolution spread from England to other European countries and to the United Sates.

In 1790 an American, Eli Whitney, developed the concept of interchangeable parts.

The first great industry in the US was the textile industry.

In the 1800s the development of the gasoline engine and electricity further advanced the revolution.

By the mid-1800s, the old cottage system of production had been replaced by the factory system.

Post-Civil War Period

During the post-Civil War period great expansion of production capacity occurred.

By post-Civil War the following developments set the stage for the great production explosion of the 20th century:

- increased capital and production capacity
- the expanded urban workforce
- new Western US markets
- an effective national transportation system

Scientific Management

Frederick Taylor is known as the father of scientific management. His shop system employed these steps:

- Each worker's skill, strength, and learning ability were determined.
- Stopwatch studies were conducted to precisely set standard output per worker on each task.
- Material specifications, work methods, and routing sequences were used to organize the shop.
- Supervisors were carefully selected and trained.
- Incentive pay systems were initiated.

Scientific Management

In the 1920s, Ford Motor Company's operation embodied the key elements of scientific management:

- standardized product designs
- mass production
- low manufacturing costs
- mechanized assembly lines
- specialization of labor
- interchangeable parts

Human Relations and Behavioralism

In the 1927-1932 period, researchers in the Hawthorne Studies realized that human factors were affecting production.

Researchers and managers alike were recognizing that psychological and sociological factors affected production.

From the work of behavioralists came a gradual change in the way managers thought about and treated workers.

Operations Research

During World War II, enormous quantities of resources (personnel, supplies, equipment, …) had to be deployed.

Military operations research (OR) teams were formed to deal with the complexity of the deployment.

After the war, operations researchers found their way back to universities, industry, government, and consulting firms.

OR helps operations managers make decisions when problems are complex and wrong decisions are costly.

The Service Revolution

The creation of services organizations accelerated sharply after World War II.

Today, more than two-thirds of the US workforce is employed in services.

About two-thirds of the US GDP is from services.

There is a huge trade surplus in services.

Investment per office worker now exceeds the investment per factory worker.

Thus there is a growing need for service operations management.

The Computer Revolution

Explosive growth of computer and communication technologies

Easy access to information and the availability of more information

Advances in software applications such as Enterprise Resource Planning (ERP) software

Widespread use of email

More and more firms becoming involved in E-Business using the Internet

faster, better decisions over greater distances

Today's Factors Affecting OM

Global Competition

Quality, Customer Service, and Cost Challenges

Rapid Expansion of Advanced Technologies

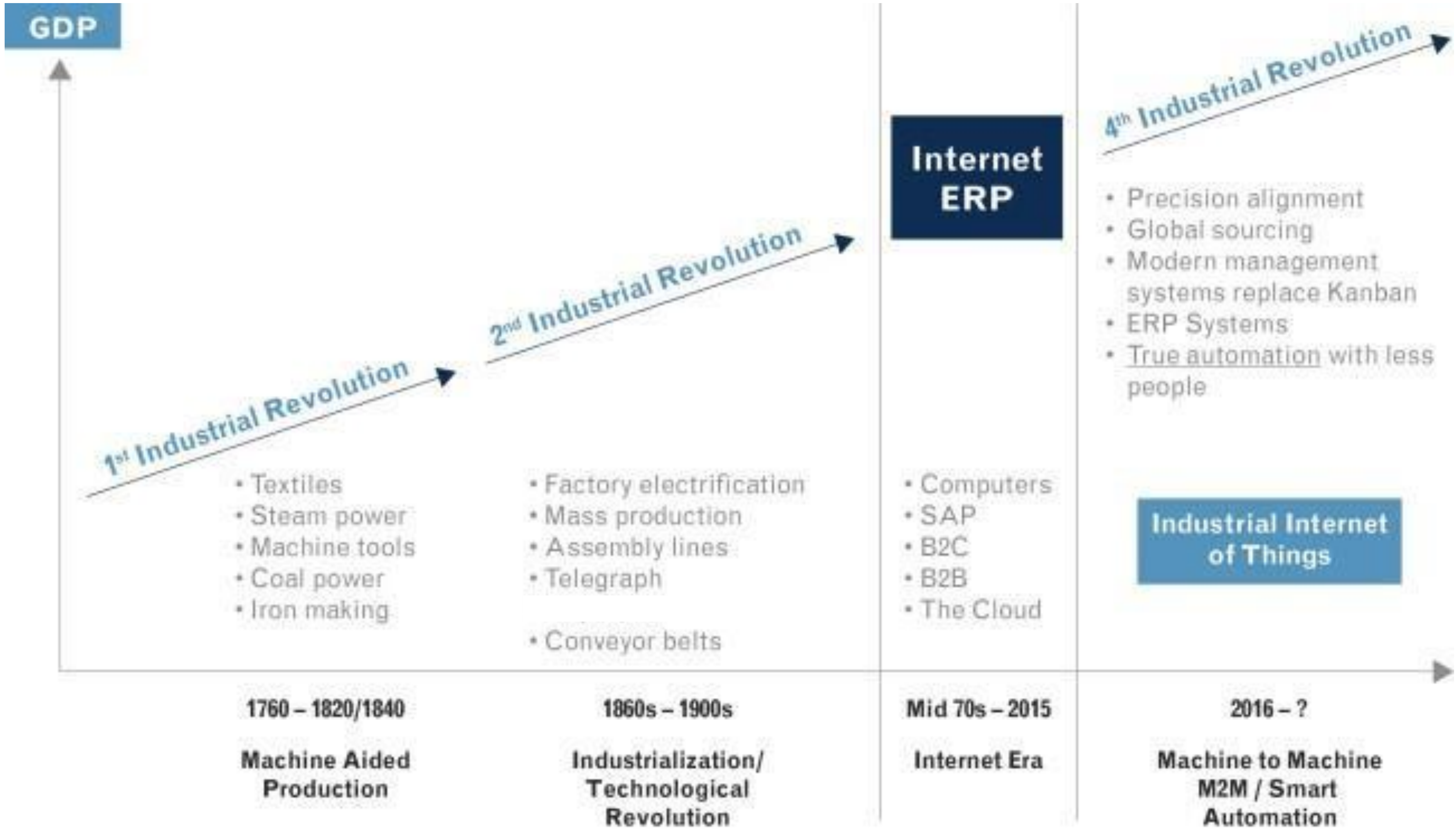
Continued Growth of the Service Sector

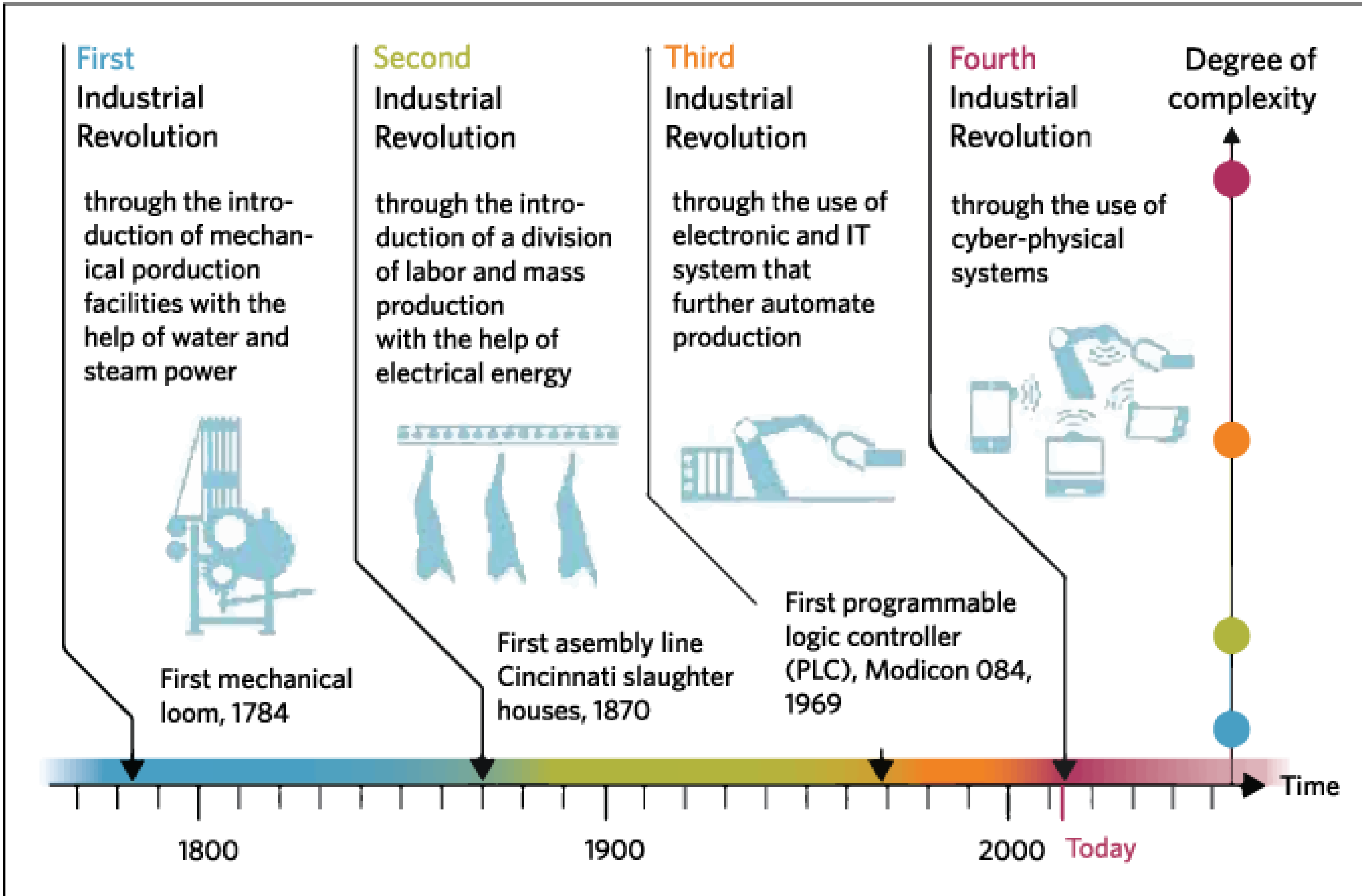
Scarcity of Operations Resources

Social-Responsibility Issues

Comparison

Period		Key Points to Remember
1760-1820	The Industrial Revolution	Cottage Industry.to Factory System, Steam Engine, Specialization of Labor, Interchangeable Parts
1865-1877	Post-Civil War Period	increased capital & production capacity, urban workforce, new Western US markets, national transportation system
1880-1900	Scientific Management	standardized product designs, mass production, low manufacturing costs, mechanized assembly lines
1900-1920	Human Relations and Behaviorism	psychological and sociological factors affected production
1945-1960	Operations Research	OR – LPP, Transportation, Assignment
1070-1980	The Service Revolution	Investment per office worker now exceeds the investment per factory worker.
	Today's	Global competition , Social Responsibility, AI & IOT


GDP
1st Industrial Revolution
2nd Industrial Revolution
Internet ERP
4th Industrial Revolution
• Textiles
• Steam power
• Machine tools
• Coal power
• Iron making
• Factory electrification
• Mass production
• Assembly lines
• Telegraph
• Conveyor belts
• Computers
• SAP
• B2C
• B2B
• The Cloud
• Precision alignment
• Global sourcing
• Modern management systems replace Kanban
• ERP Systems
• True automation with less people
Industrial Internet of Things
1760 – 1820/1840
Machine Aided Production
1860s – 1900s
Industrialization/ Technological Revolution
Mid 70s – 2015
Internet Era
2016 – ?
Machine to Machine M2M / Smart Automation


First
Industrial
Revolution
through the introduction of mechanical porduction facilities with the help of water and steam power
First mechanical loom, 1784
Second
Industrial
Revolution
through the introduction of a division of labor and mass production with the help of electrical energy
First asembly line Cincinnati slaughter houses, 1870
Third
Industrial
Revolution
through the use of electronic and IT system that further automate production
First programmable logic controller (PLC), Modicon 084, 1969
Fourth
Industrial
Revolution
through the use of cyber-physical systems
Degree of complexity
Time
1800
1900
2000
Today

Quality

Quality is conformance to specifications. Assuring manufacturing quality entails three principal functions:

1. Quality design and engineering,
2. Quality control, and
3. Quality management.

DIMR

The Three Quality Gurus

1. Deming
2. Juran,
3. Philip Crosby:

Quality is defined as conformance to requirements, not “goodness”.

The system for achieving quality is prevention, not appraisal.

.

The performance standard is zero defects, not “that’s close enough”

The measurement of quality is the price of non-conformance. The cost of poor manufacturing quality is high. Rework, scrap, product failures and recalls can severely damage a manufacturer through inefficiencies, delays, direct costs, customer dissatisfaction and low shareholder confidence.

QMS is a set of policies, processes and procedures required for planning and execution in the core business area of an organization.

Q A is aimed to avoid the defect, QA provides **assurance** that **quality** requested will be achieved

QC is aimed to identify and fix the defects. **It** is a procedure that focuses on fulfilling the **quality** requested

Dimensions of Quality: Manufactured Products

Performance

- Basic operating characteristics of a product; *how well a car is handled or its gas mileage.*

Features

- "Extra" items added to basic features, such as a stereo CD or a leather interior in a car

Reliability

- probability that a product will operate properly within an expected time frame; that is, a TV will work without repair for about seven years

Dimensions of Quality: Manufactured Products (cont.)

- Conformance
  - degree to which a product meets pre-established standards
- Durability
  - how long product lasts before replacement
- Serviceability
  - ease of getting repairs, speed of repairs, courtesy and competence of repair person

Dimensions of Quality: Manufactured Products (cont.)

- Aesthetics
  - how a product looks, feels, sounds, smells, or tastes
- Safety
  - assurance that customer will not suffer injury or harm from a product; an especially important consideration for automobiles
- Perceptions
  - subjective perceptions based on brand name, advertising, and the like

Dimensions of Quality: Service

- Time and Timeliness
  - How long must a customer wait for service, and is it completed on time?
  - Is an overnight package delivered overnight?
- Completeness:
  - Is everything customer asked for provided?
  - Is a mail order from a catalogue company complete when delivered?

Dimensions of Quality: Service (cont.)

- Courtesy:
  - How are customers treated by employees?
  - Are catalogue phone operators nice and are their voices pleasant?
- Consistency
  - Is the same level of service provided to each customer each time?
  - Is your newspaper delivered on time every morning?

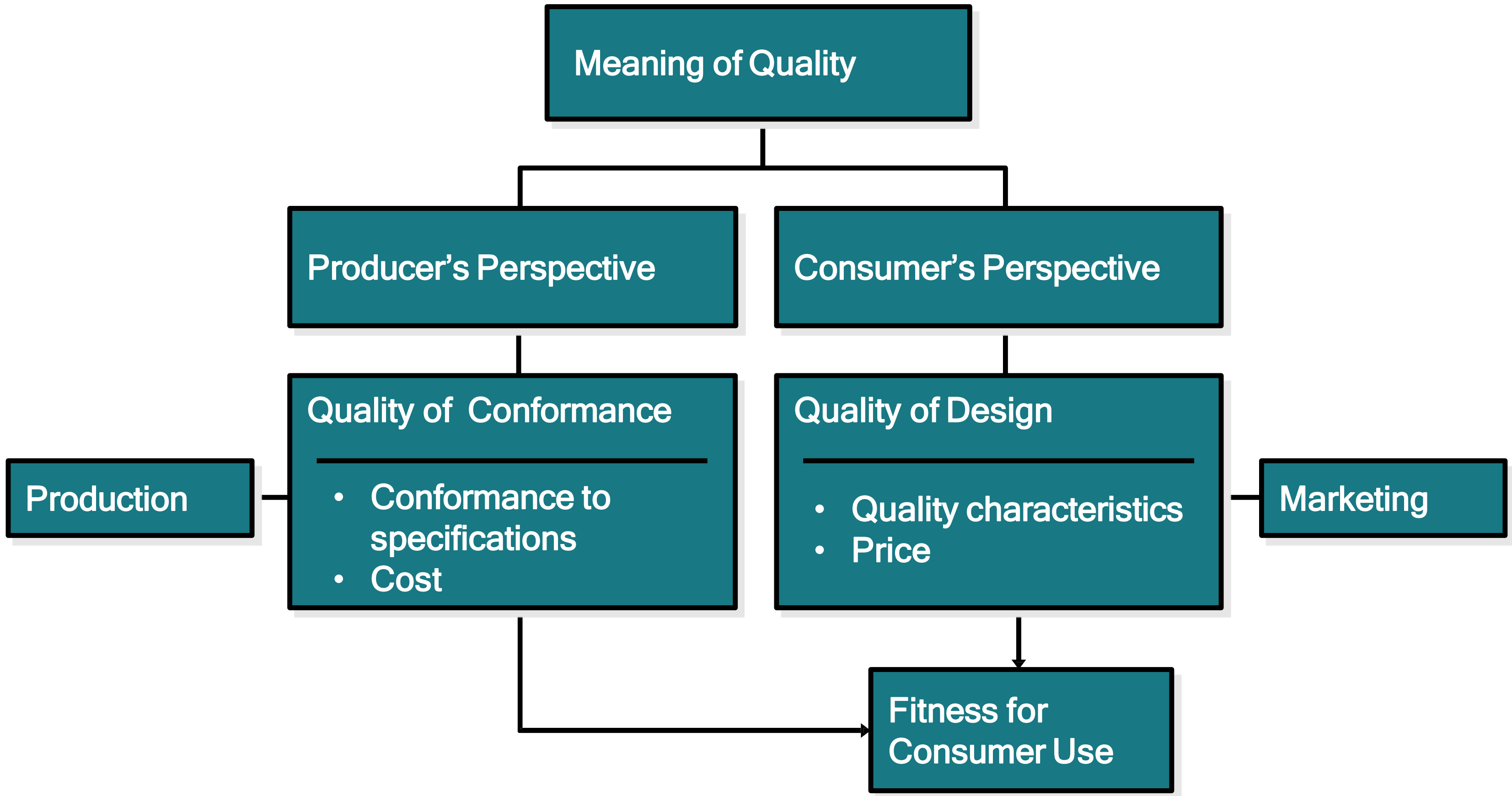
Meaning of Quality: Producer's Perspective

- Quality of Conformance
  - Making sure a product or service is produced according to design
    - if new tires do not conform to specifications, they wobble
    - if a hotel room is not clean when a guest checks in, the hotel is not functioning according to specifications of its design

Meaning of Quality: Customer's Perspective

- Quality of Design
  - Degree to which it matches to the expectation of customer
  - if a hotel room is not clean when a guest checks in, the hotel is not functioning according to customers expectation

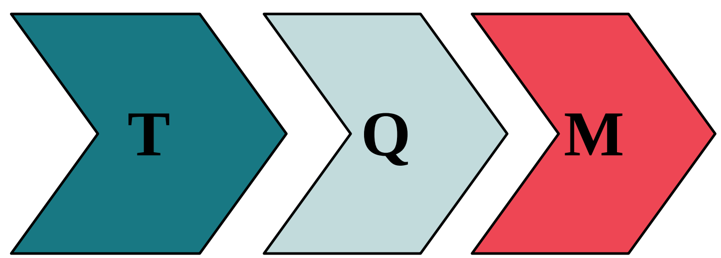
Meaning of Quality



Total Quality Management

What is TQM?

TQM is the integration of all functions and processes within an organization in order to achieve continuous improvement of the quality of goods and services. The goal is customer satisfaction.



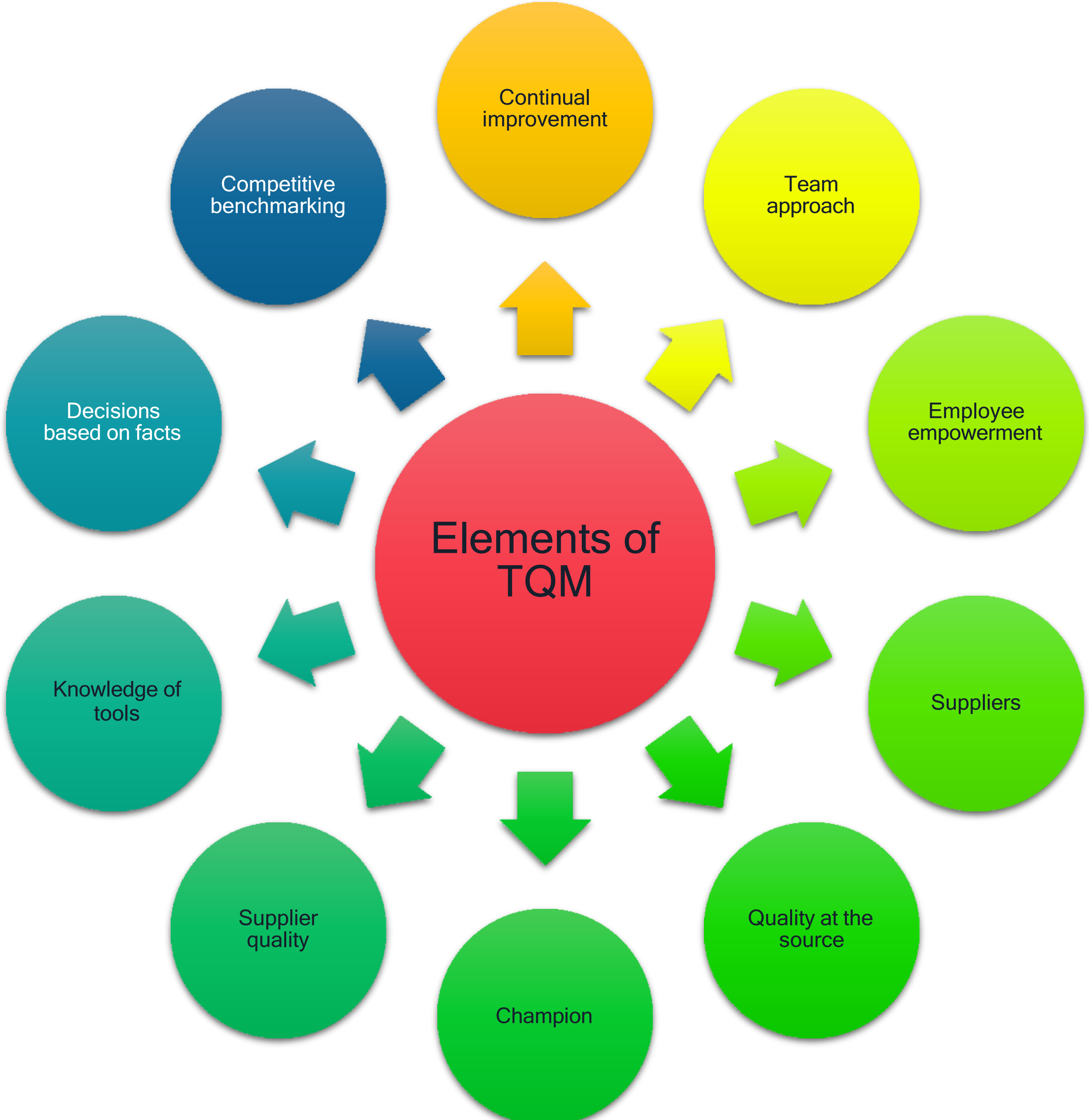
TQM

Focus on the customer and their requirements
Right first time
Competitive benchmarking
Minimisation of cost of quality

- Prevention costs
- Appraisal costs
- Internal / external failure costs
- Cost of exceeding customer requirements

The TQM Approach

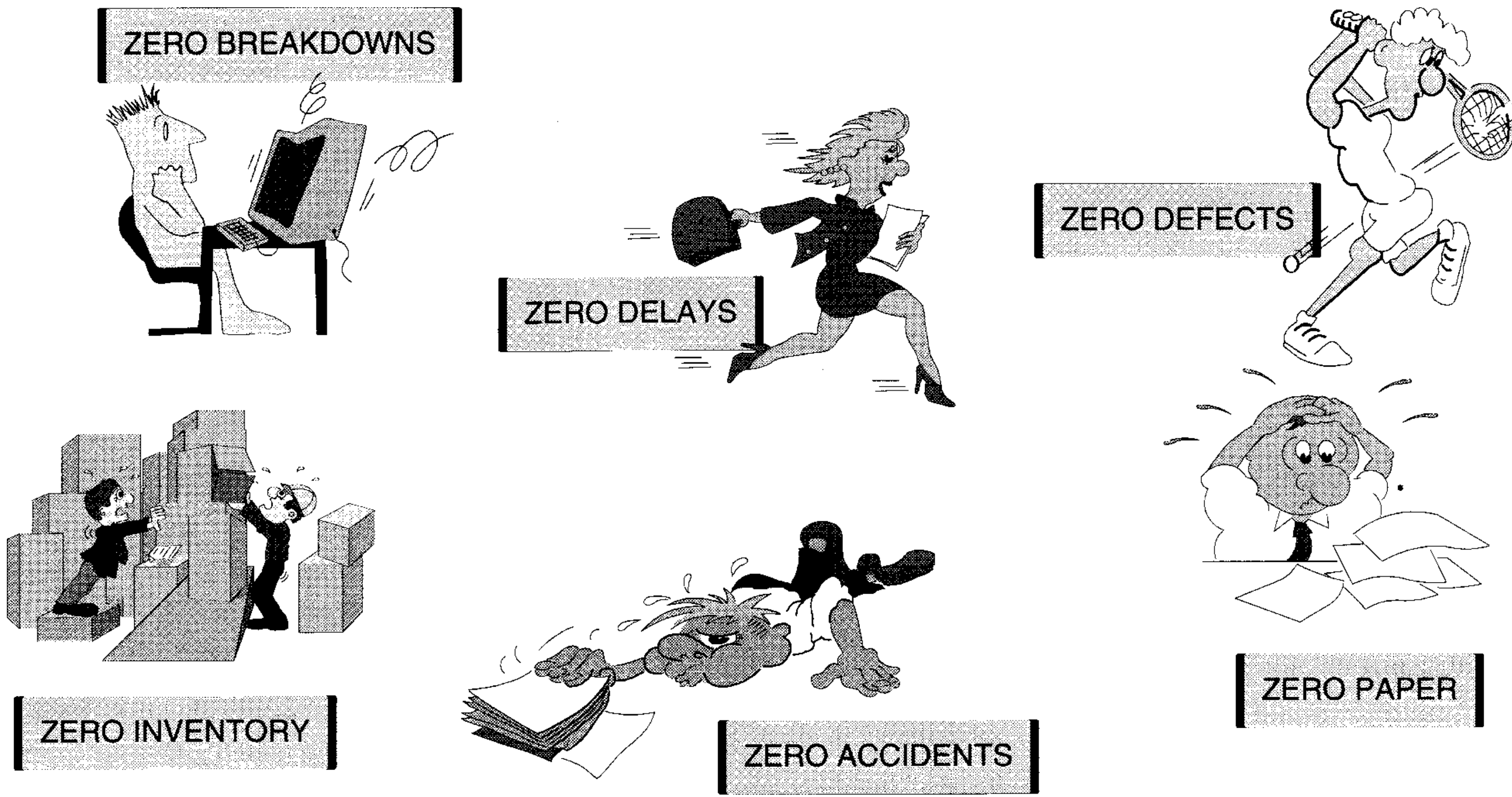
1. Find out what the customer wants
2. Design a product or service that meets or exceeds customer wants
3. Design processes that facilitates doing the job right the first time
4. Keep track of results
5. Extend these concepts to suppliers


Elements of TQM
Continual improvement
Team approach
Employee empowerment
Suppliers
Quality at the source
Champion
Supplier quality
Knowledge of tools
Decisions based on facts
Competitive benchmarking

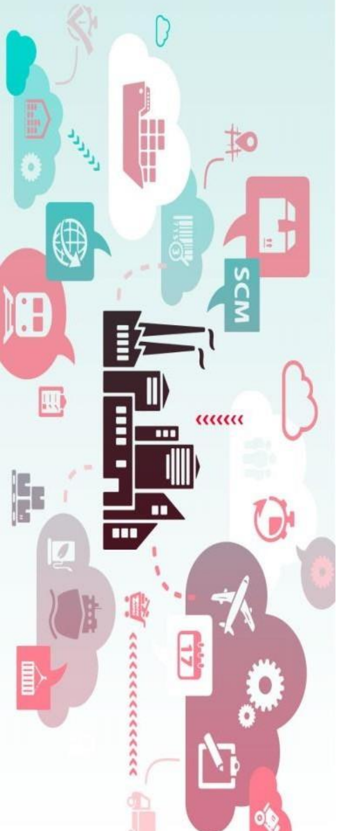
Lean management

Lean management is an approach to managing an organization that supports the concept of *continuous improvement,* a long-term approach to work that systematically seeks to achieve small, incremental changes in processes in order to improve efficiency and quality.

Lean Manufacturing goals



IDENTIFY
operational challenges and opportunities for improvement
1
PLAN
rollouts based on top supply chain needs
2
EXECUTE
implementation by balancing priorities and resources
3
REVIEW
feedback from your users
4
CONTINUOUS PROCESS IMPROVEMENT



Impact of global competition

Primary Factors

Availability of raw materials

Nearness to the market

Availability of labor

Transport facilities

Availability of fuel and power

Availability of water

Secondary factors

Suitability of climate

Government policies

Availability of finance

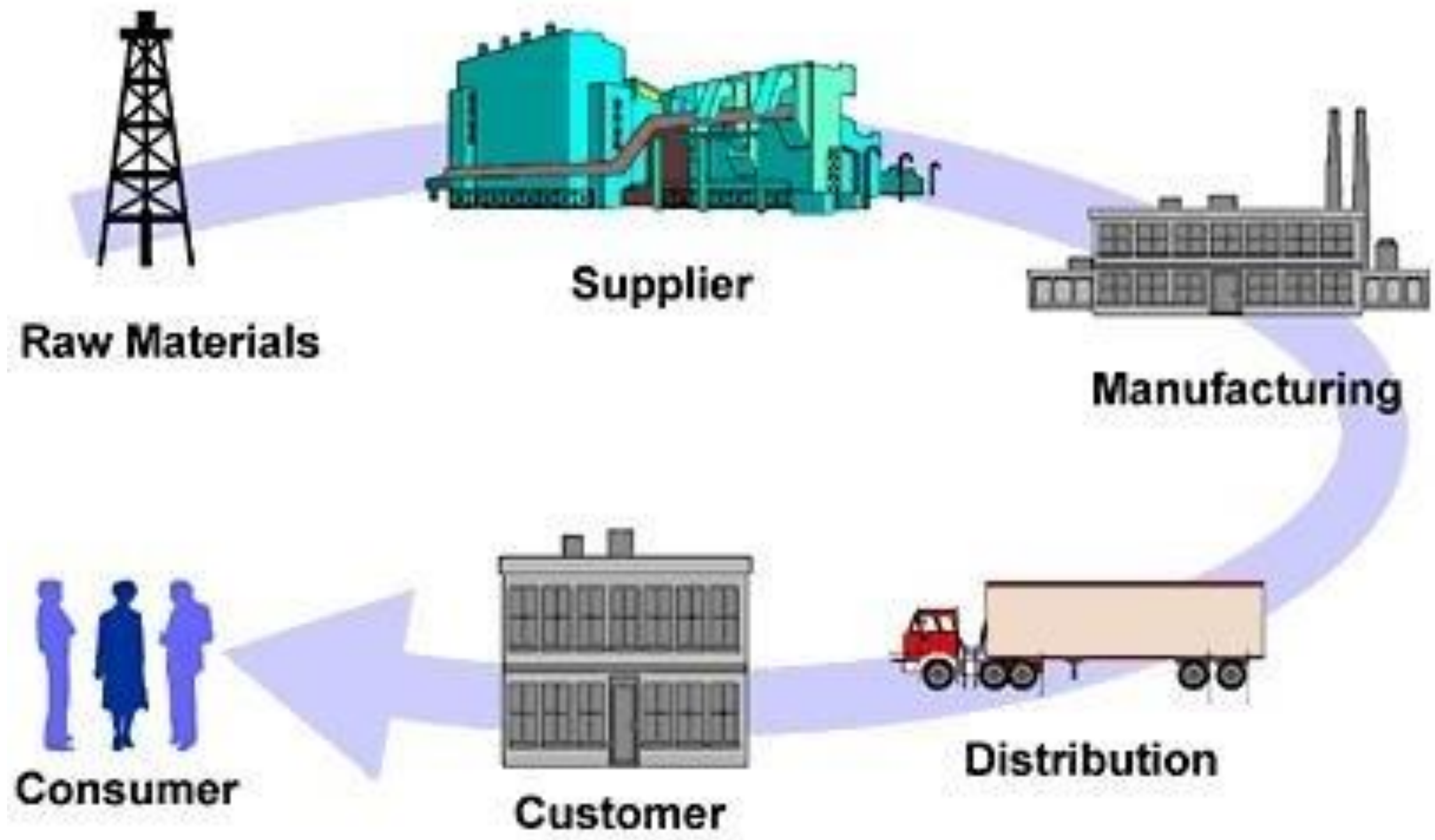
Competition between states

Availability of facilities

Disposal of waste

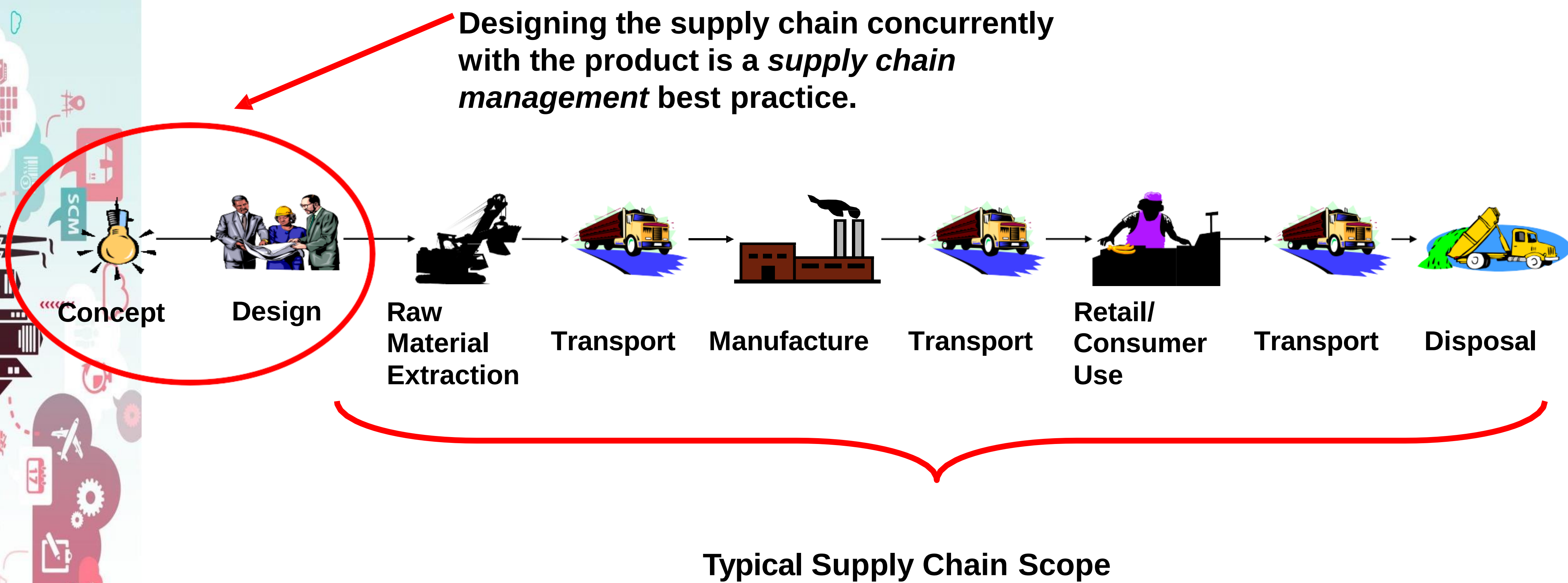
Technological Changes

Ethical and Environmental Issues on Operations and Supply Chain functions

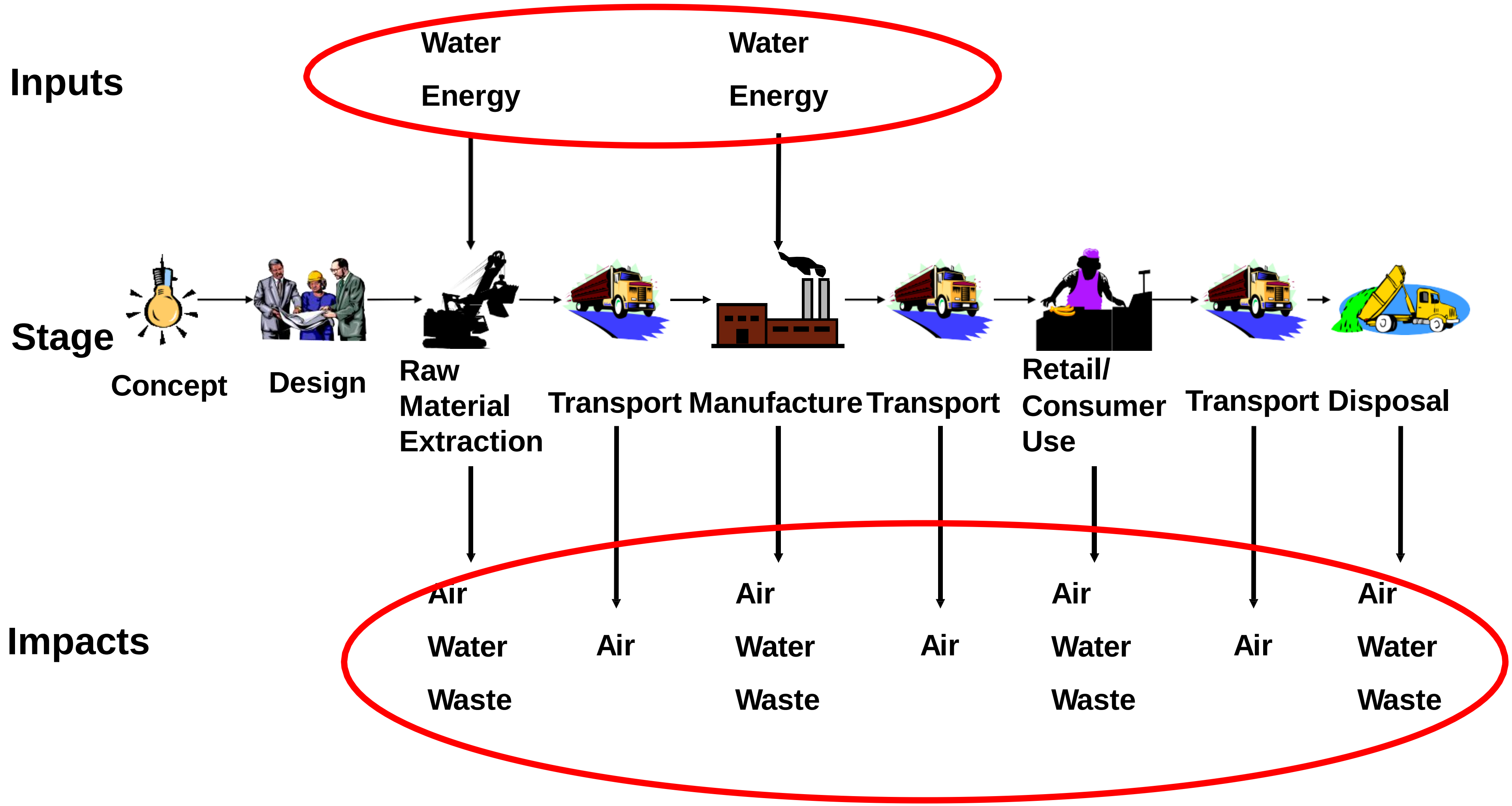


The product life cycle is the basis of green supply chain management.

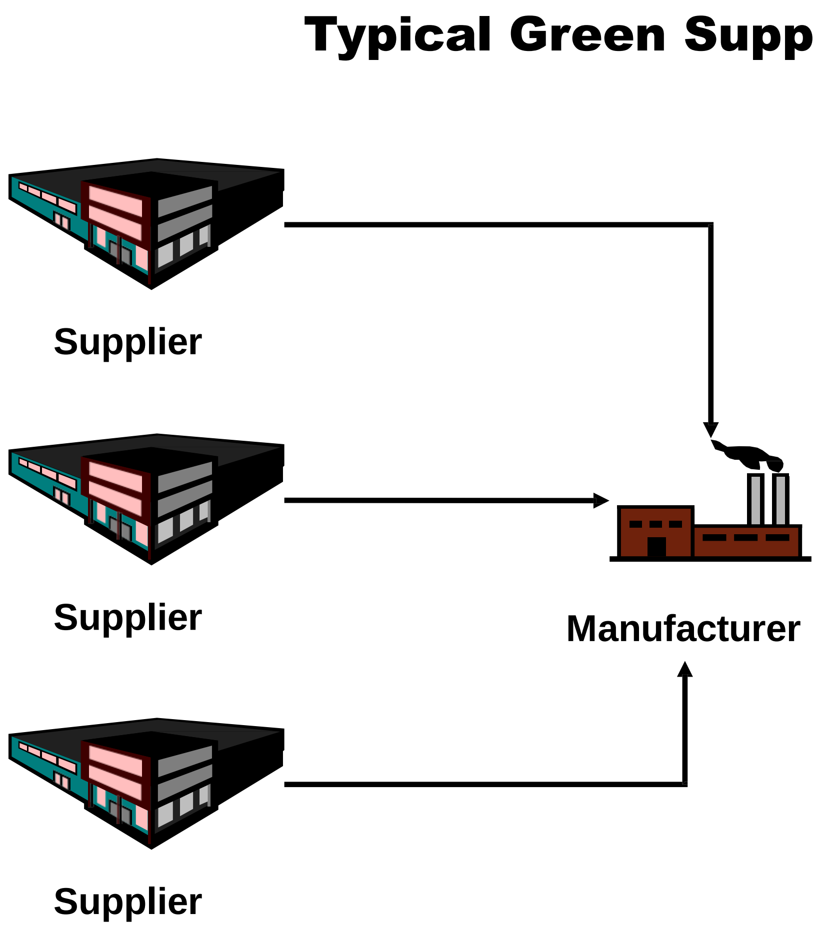
Supply Chain in the Environmental Life Cycle



The environmental impacts of each LC stage are examined for reduction.



Historically, GSC management focused on the upstream supply chain.

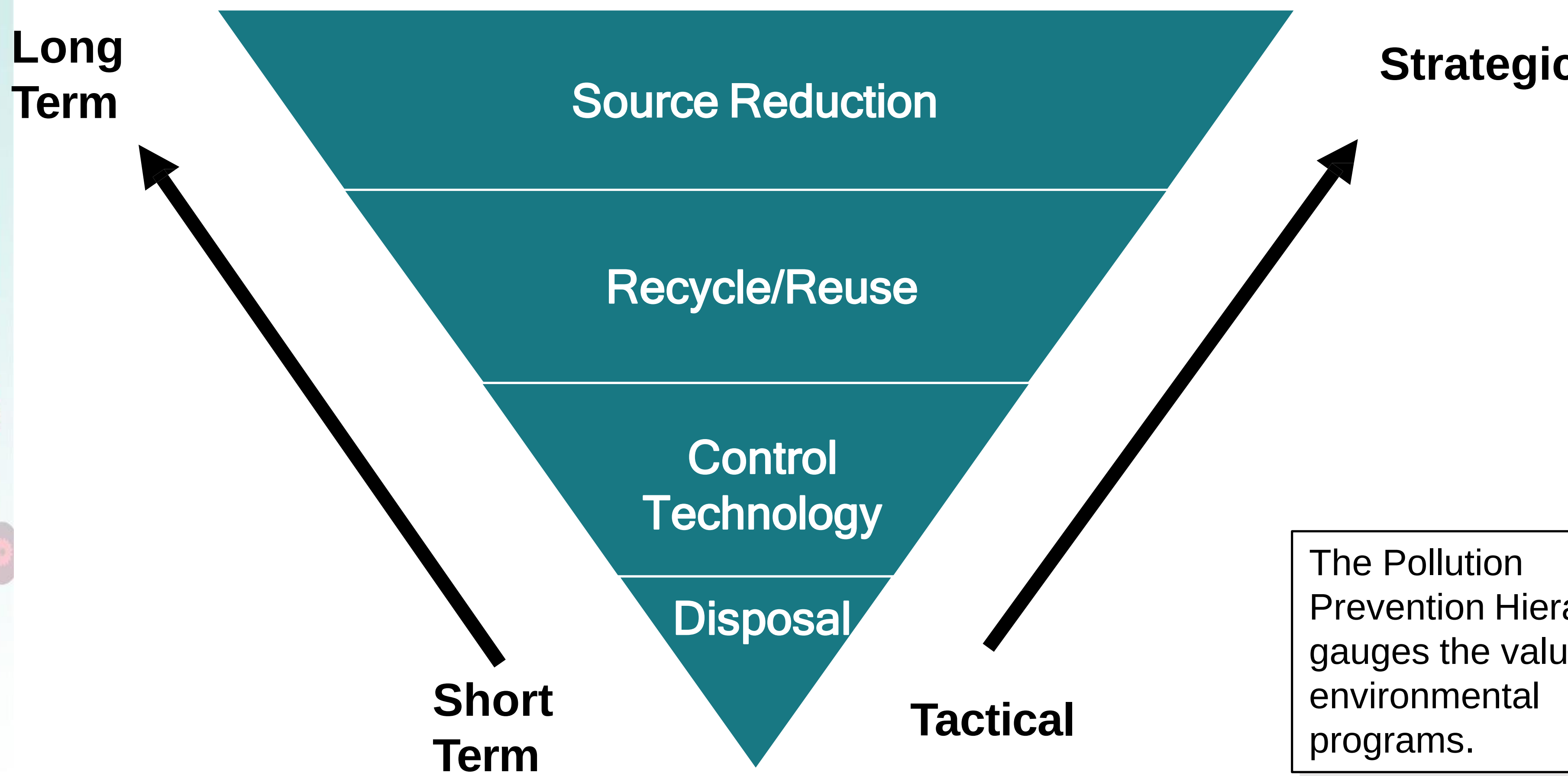


Manufacturer encourages suppliers to adopt green practices, environmental management systems, etc.

Focus is on the material content and environmental practices of suppliers.

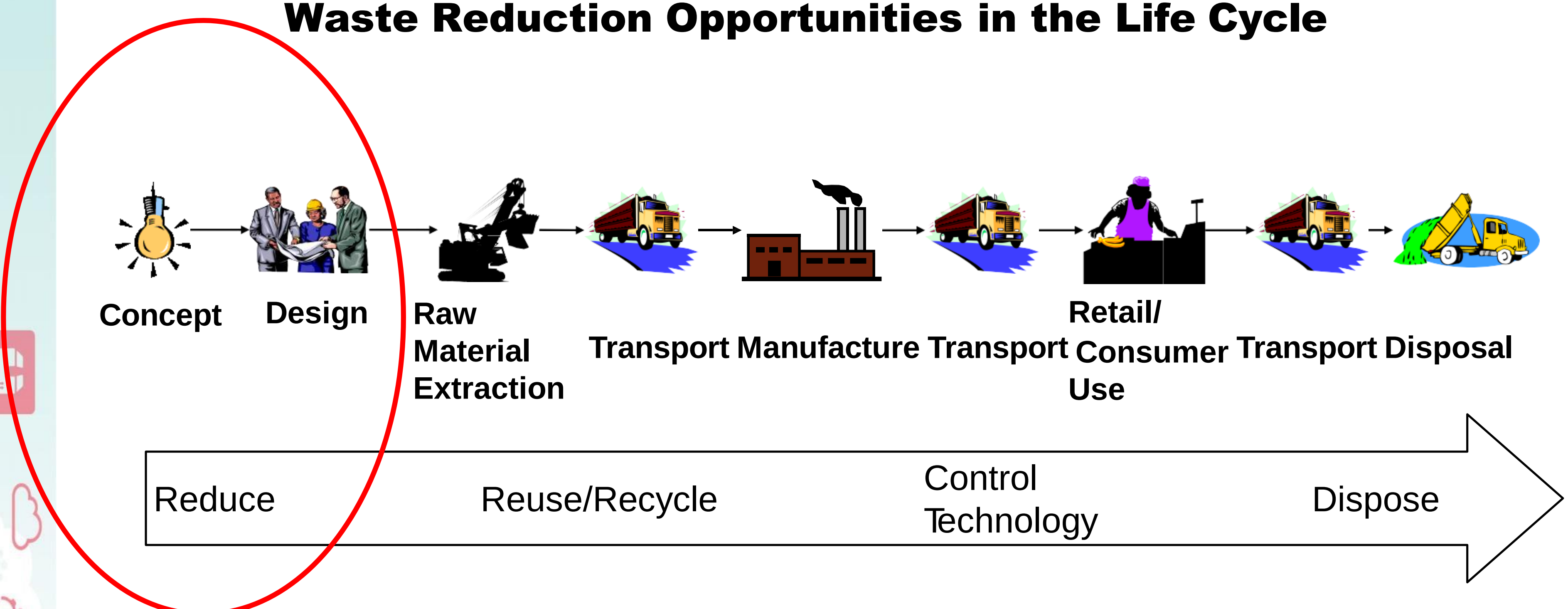
Companies are starting to view GSC as a strategic analysis tool.

Pollution Prevention Hierarchy



The Pollution Prevention Hierarchy gauges the value of environmental programs.

Waste Reduction Opportunities in the Life Cycle



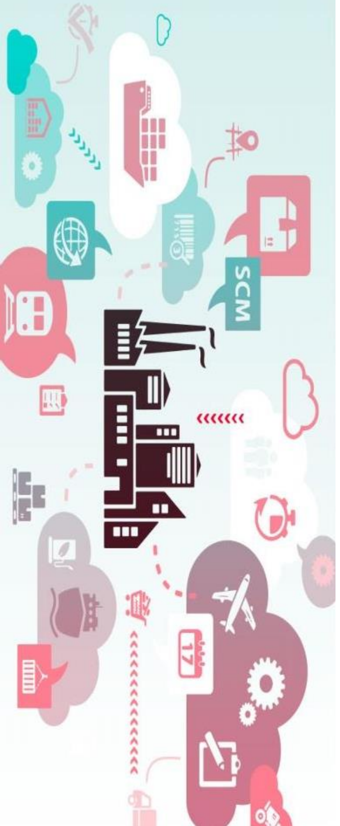
What benefits Working with environmental supply chain management ?

- Improved business & public image
- Reduced risk of legal non-compliance
- Attraction of environmentally aware customers
- Improved productivity and efficiencies
- Improved quality
- Reduced number of defaults
- Improved environmental management
- More sustainable products

End of Unit 1

Operations Processes

Unit 2



Unit 2

Operations Processes: Process Characteristics in Operations: Volume Variety and Flow.

Types of Processes and Operations Systems - Continuous Flow system and intermittent flow systems.

Process Product Matrix: Job Production, Batch Production, Assembly line and Continuous Flow, Process and Product Layout.

Service System Design Matrix : Design of Service Systems, Service Blueprinting.

INPUTS
People
Energy
materials
information
fixed assets

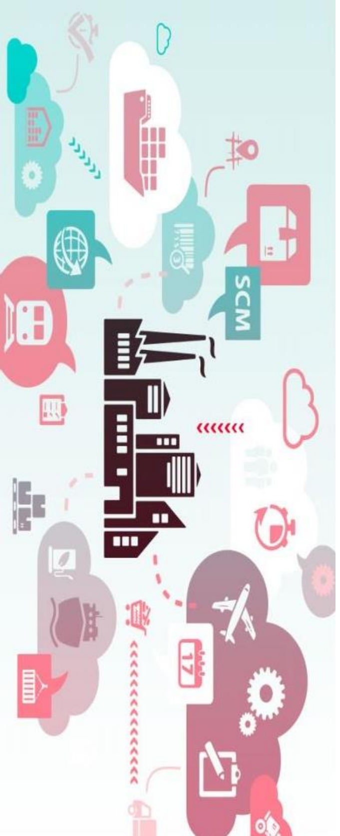
Transformation process

- Method(s) of conversion.
- Support function to provide controls and feedback and to improve the process

OUTPUTS

Goods
services

Learning Objectives



Explain the strategic importance of process selection.

Explain the influence that process selection has on an organization.

Describe the basic processing types.

Discuss automated approaches to processing.

Explain the need for management of Technology.

Learning Objectives

List some reasons for redesign of layouts. Describe the basic layout types.

List the main advantages and disadvantages of product layouts and process layouts.

Solve simple line-balancing problems. Develop simple process layouts.

Factors Affecting The Choice Of Manufacturing Process

Following factors need to be considered before making a choice of manufacturing process:

1. Effect of volume/variety
2. Capacity of the plant
3. Lead time
4. Flexibility and efficiency

Four V’s

All operations processes have one thing in common, they all take their „inputs‟ like, raw materials, knowledge, capital, equipment and time and transform them into outputs (goods and services). \They do this is different ways and the main four are known as the **Four V‟s,,**

V

olume
ariety,
ariation
isibility.

The Volume Dimension

A great example of this is **McDonalds**, they are a well known example of high volume low cost hamburger and fast food production.

repeatability of the tasks, **systemization** of the work, where **standards** and procedures drive the way in which each part of the job is carried out. ...

The Variety Dimension

A common example used to describe the variety dimension is the contrast between a taxi and a bus service.

Both offer hired transportation services but a taxi service has a much higher variety dimension as they will basically pick you up and drop you off wherever it is you need to go. ...

The Variation Dimension

Consider two home building companies. One offers prefabricated homes that you choose from a catalogue or online. It is transferred to site and erected over the course of a few days.

The second building company offers customized homes they have display homes they have built that you can walk through. ...

The Visibility Dimension

This dimension refers to a customers ability to see, track their experience or order through the operations process. A high visibility dimension includes courier companies where you can track your package online or a retail store where you pick up the goods and purchase them over the counter. ...

Facility layout

Process & Product Layout

Facility layout

Facility layout refers to the arrangement of

- machines,
- departments,
- workstations,
- storage areas,
- aisles, and
- common areas within an existing or proposed facility.

Implications

- Layouts have far-reaching implications for
  - the quality,
  - productivity, and
  - competitiveness of a firm.
- Layout decisions significantly affect how efficiently workers can do their jobs,
- how fast goods can be produced,
- how difficult it is to automate a system, and
- how responsive the system can be to changes in
  - product or service design,
  - product mix, and
  - demand volume

Objective of the layout decision

Ensure a smooth flow of work, material, people, and information through the system

Effective layouts also:

- Minimize material handling costs;
- Utilize space efficiently;
- Utilize labor efficiently;
- Eliminate bottlenecks;
- Facilitate communication and interaction between workers, between workers and their supervisors, or between workers and customers;
- Reduce manufacturing cycle time and customer service time;
- Eliminate wasted or redundant movement;
- Facilitate the entry, exit, and placement of material, products, and people;
- Incorporate safety and security measures;
- Promote product and service quality;
- Encourage proper maintenance activities;
- Provide a visual control of operations or activities;
- Provide flexibility to adapt to changing conditions.

Basic Layouts

Process,

Product, and

Fixed-position

Three hybrid layouts:

- cellular layouts,
- flexible manufacturing systems, and
- mixed-model assembly lines

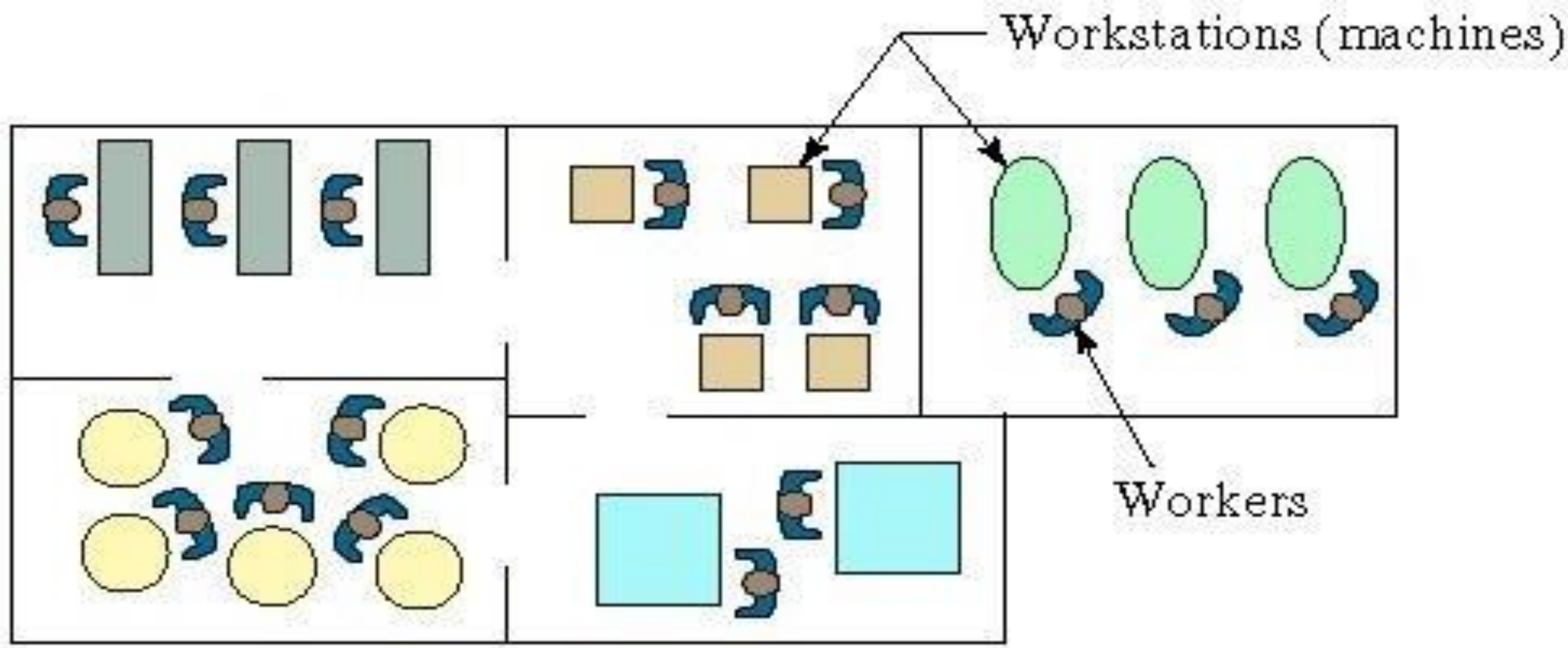
Process Layout

Process Layout
(functional)

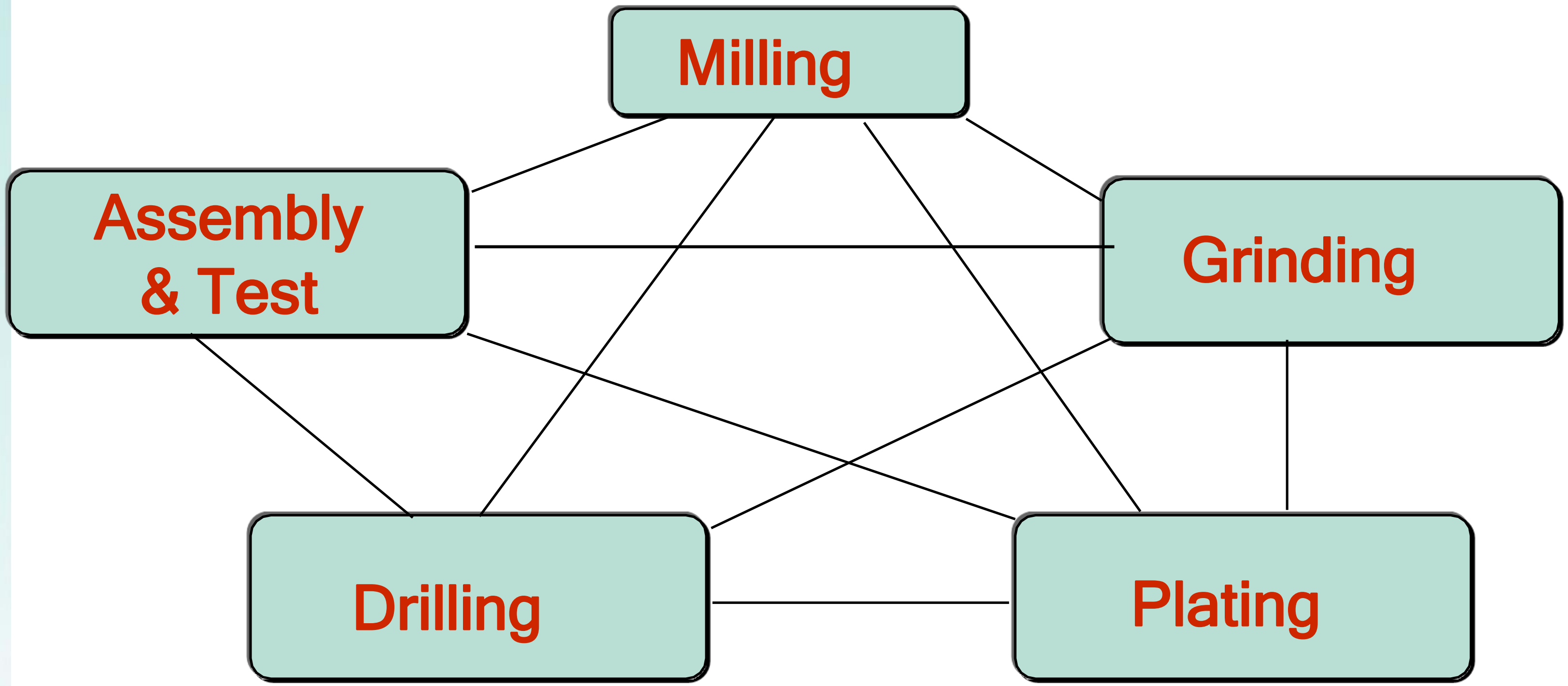
Dept. A	Dept. C	Dept. E
Dept. B	Dept. D	Dept. F

Used for Intermittent processing
Job Shop or Batch Processes

Process layouts



Process Layout



Process Layout - work travels to dedicated process centers

Advantages of Process Layouts

Can handle a variety of processing requirements

Not particularly vulnerable to equipment failures

Equipment used is less costly

Possible to use individual incentive plans

Disadvantages of Process Layouts

In-process inventory costs can be high

Challenging routing and scheduling

Equipment utilization rates are low

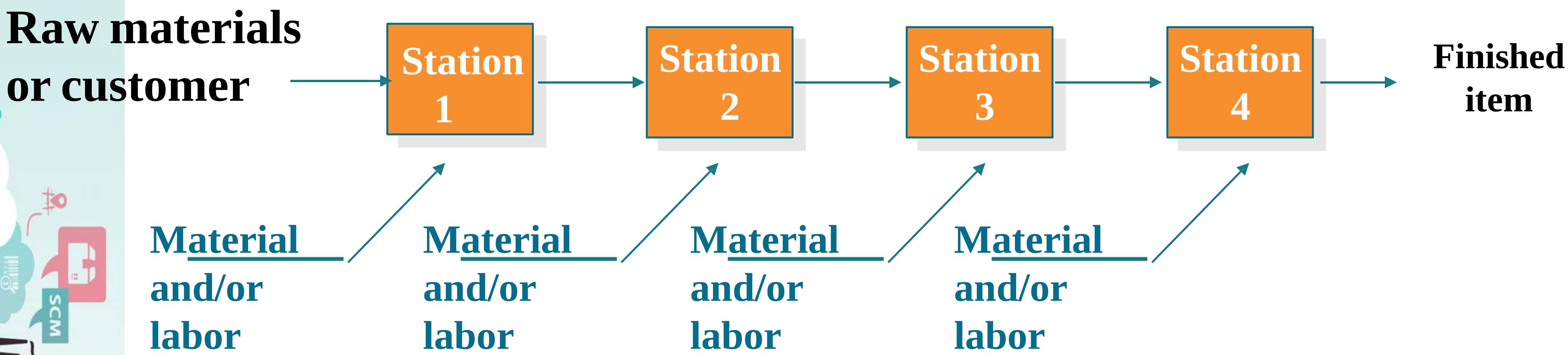
Material handling slow and inefficient

Complexities often reduce span of supervision

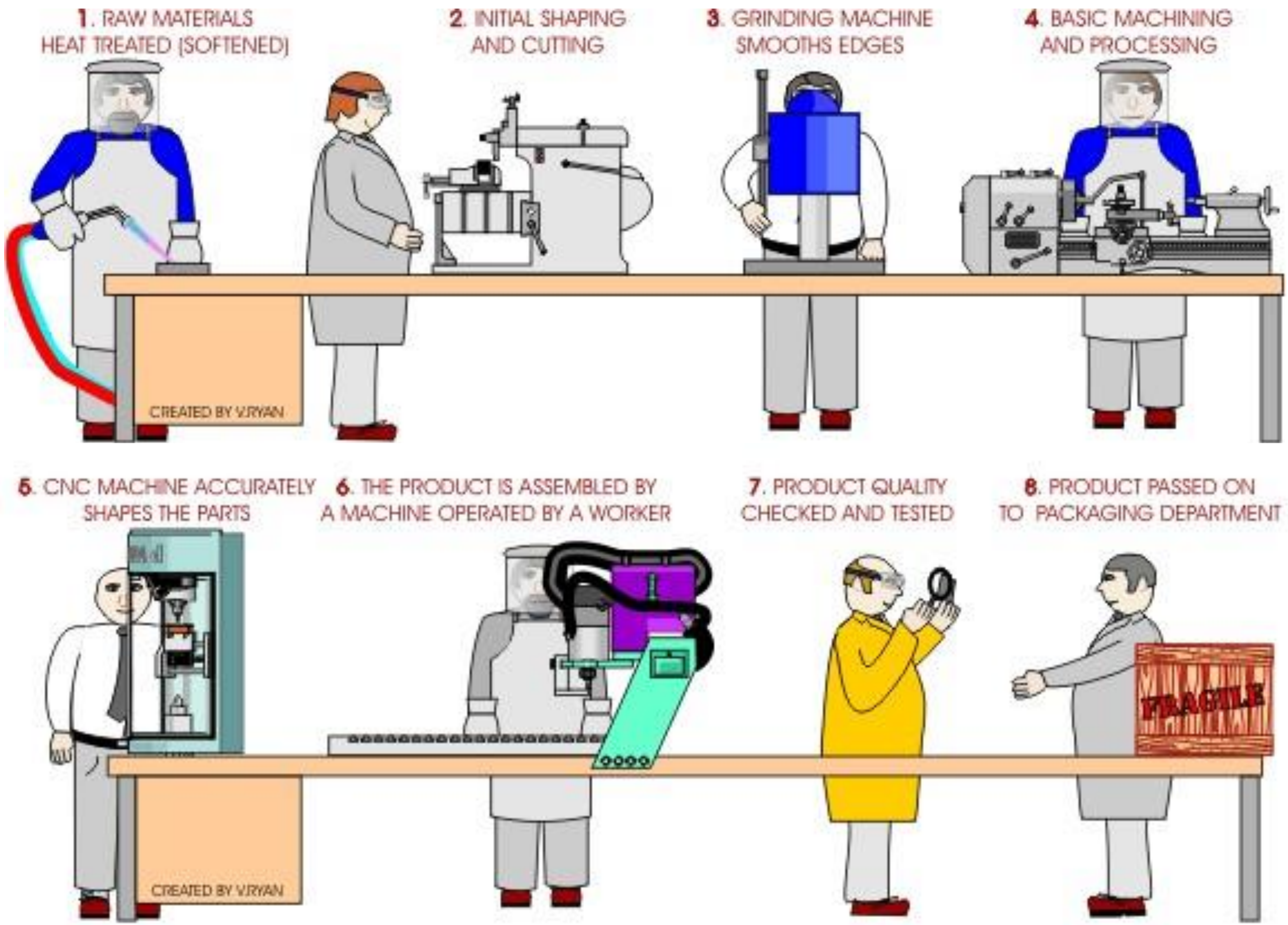
Special attention for each product or customer

Accounting and purchasing are more involved

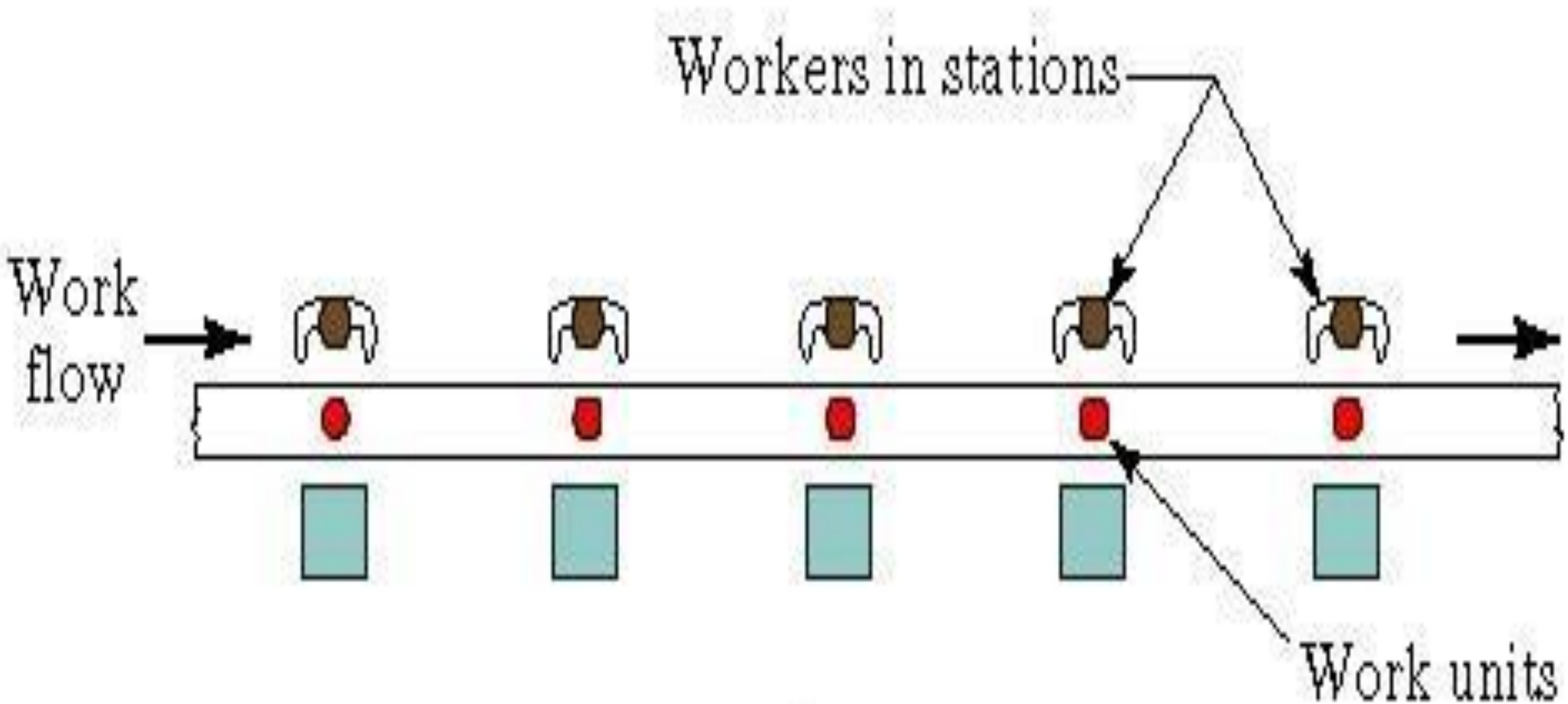
Product Layout



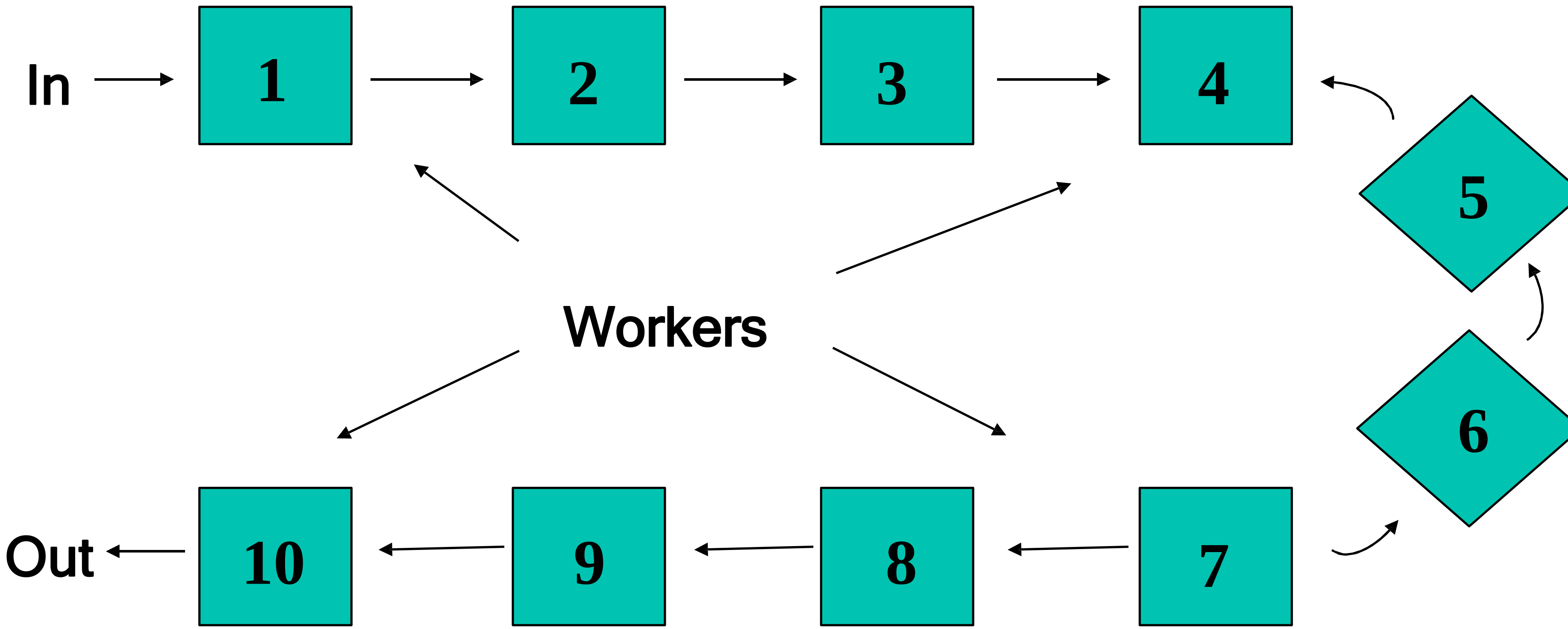
Used for Repetitive or Continuous Processing

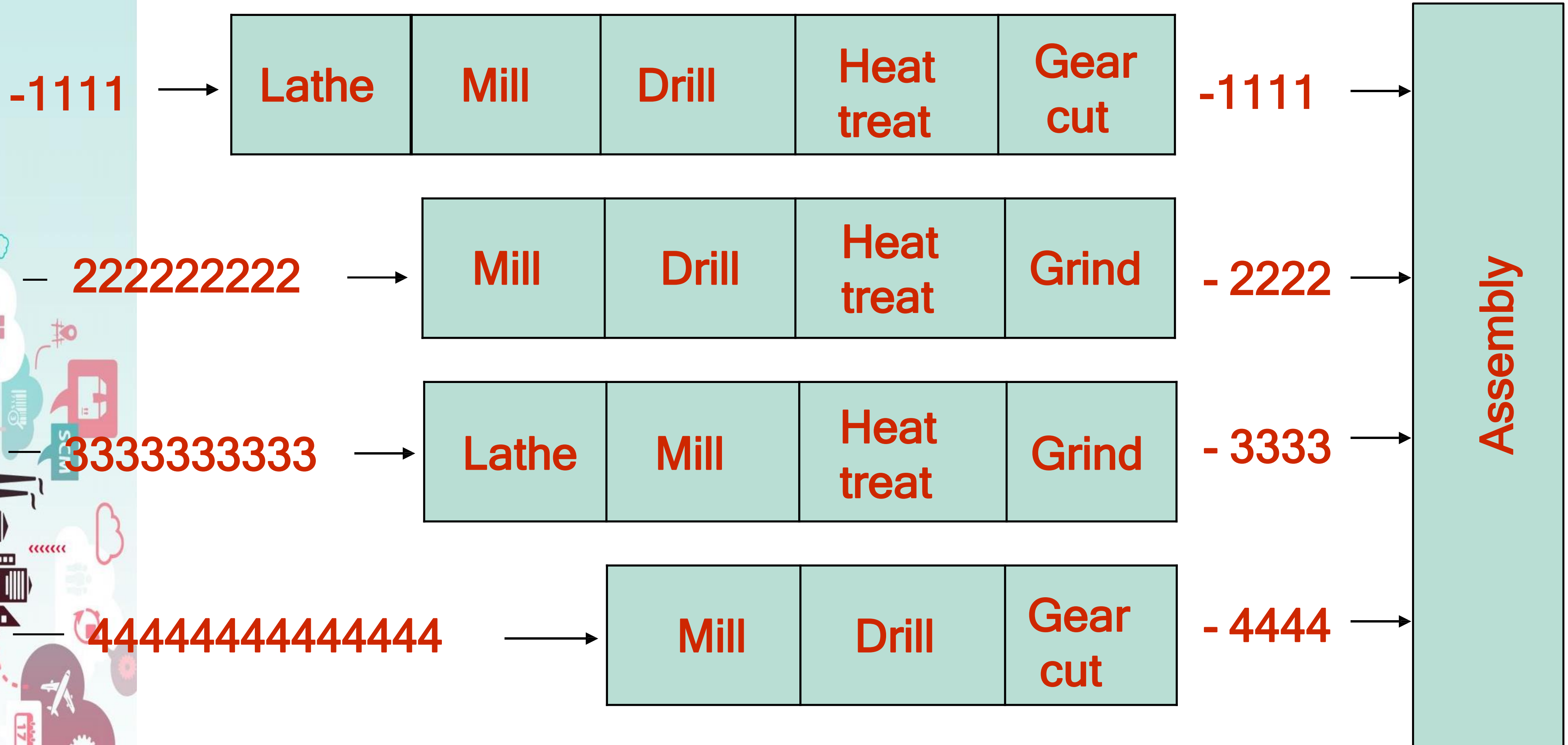

1. RAW MATERIALS HEAT TREATED (SOFTENED)
2. INITIAL SHAPING AND CUTTING
3. GRINDING MACHINE SMOOTHS EDGES
4. BASIC MACHINING AND PROCESSING
CREATED BY V.RYAN
5. CNC MACHINE ACCURATELY SHAPES THE PARTS
6. THE PRODUCT IS ASSEMBLED BY A MACHINE OPERATED BY A WORKER
7. PRODUCT QUALITY CHECKED AND TESTED
8. PRODUCT PASSED ON TO PACKAGING DEPARTMENT
FRAGILE
CREATED BY V.RYAN

Product layouts



A U-Shaped Production Line





-1111
Lathe
Mill
Drill
Heat treat
Gear cut
-1111
222222222
Mill
Drill
Heat treat
Grind
- 2222
3333333333
Lathe
Mill
Heat treat
Grind
- 3333
4444444444444
Mill
Drill
Gear cut
- 4444
Assembly

Advantages of Product Layout

High rate of output

Low unit cost

Labor specialization

Low material handling cost

High utilization of labor and equipment

Established routing and scheduling

Routing accounting and purchasing

Disadvantages of Product Layout

Creates dull, repetitive jobs

Poorly skilled workers may not maintain equipment or quality of output

Fairly inflexible to changes in volume

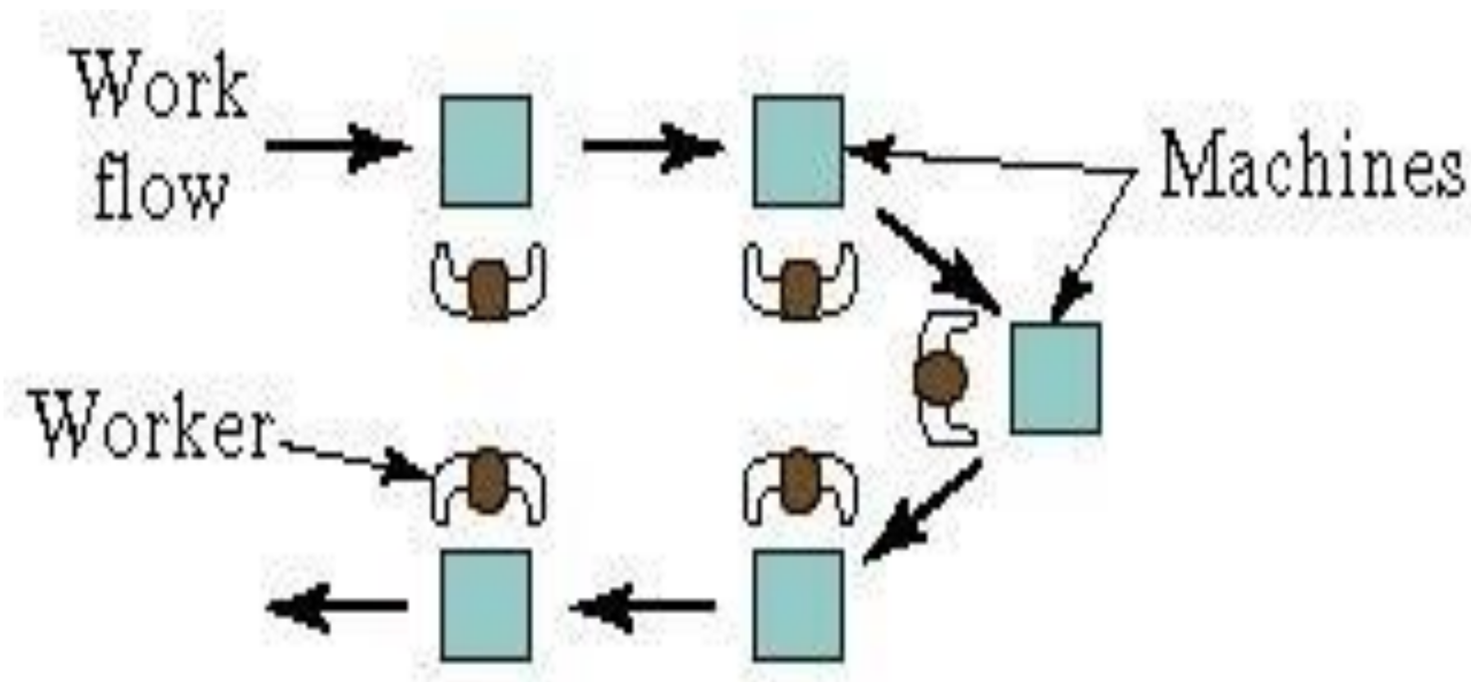
Highly susceptible to shutdowns

Needs preventive maintenance

Individual incentive plans are impractical

Fixed-position layouts

Hybrid - Cellular Layout



What is Process Selection?

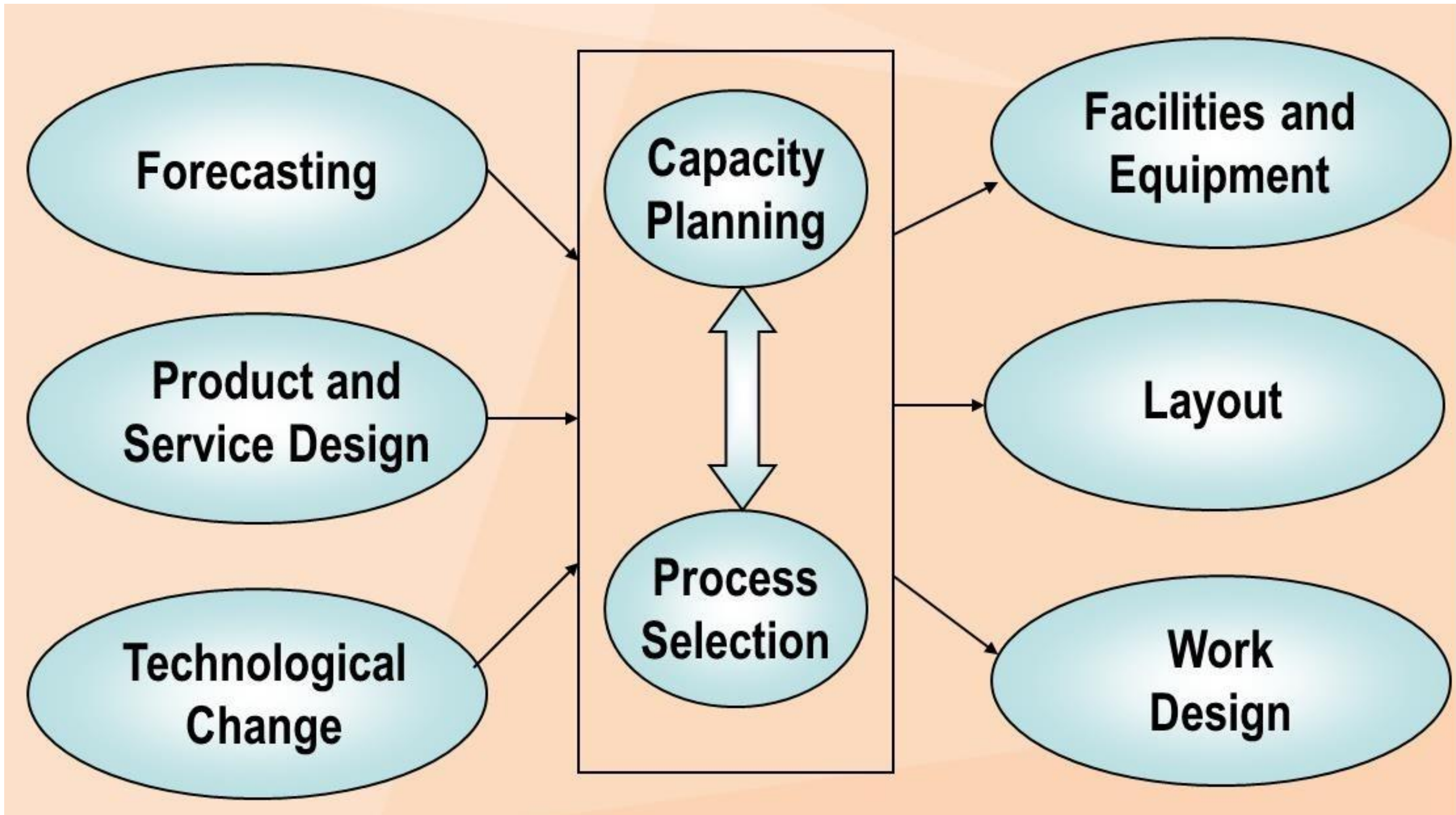
Process selection

- Deciding on the way production of goods or services will be organized

Major implications

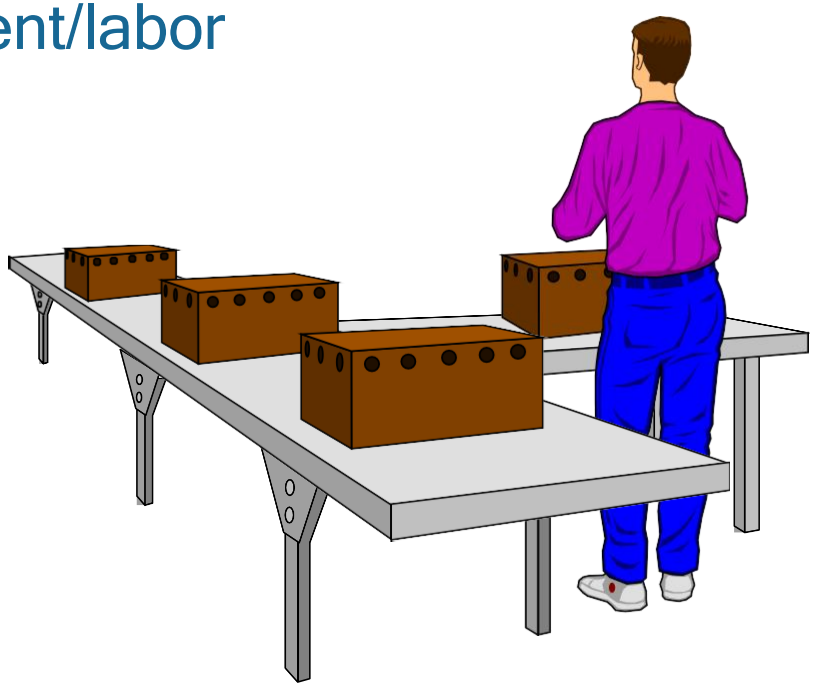
- Capacity planning
- Layout of facilities
- Equipment
- Design of work systems

Process Selection and System Design



Process Strategy

- Key aspects of process strategy
  - Capital intensive - equipment/labor
  - Process flexibility
  - Technology
  - Adjust to changes
    - Design
    - Volume
    - technology



Technology

Technology: The application of scientific discoveries to the development and improvement of products and services and operations processes.

Technology innovation: The discovery and development of new or improved products, services, or processes for producing or providing them.

Kinds of Technology

Operations management is primarily concerned with three kinds of technology:

- Product and service technology
- Process technology
- Information technology

All three have a major impact on:

- Costs
- Productivity
- Competitiveness

2010s

DRIVER ASSIST FEATURES

This includes driver safety features like traffic alerts and lane departure warnings

2014

TESLA AUTOPILOT

Elon Musk's autopilot technology can steer the car and even change lanes on the motorway

2014

4G WI-FI HOTSPOTS

2020

SELF-DRIVING CAR

2020 is the projected release date of Google's self-driving car, the Waymo

Car Technology in the Future

GESTURE CONTROLS

Forget touchscreen – car makers are already working on making displays that respond to gesture control

BIOMETRIC ACCESS

Car makers are working on technology to let you unlock and start your car with your fingerprint

WINDSCREEN DISPLAYS

Soon, all the information you need about the car could be displayed on smart glass in the windscreen

Technology Acquisition

Technology can have benefits but …

Technology risks include:

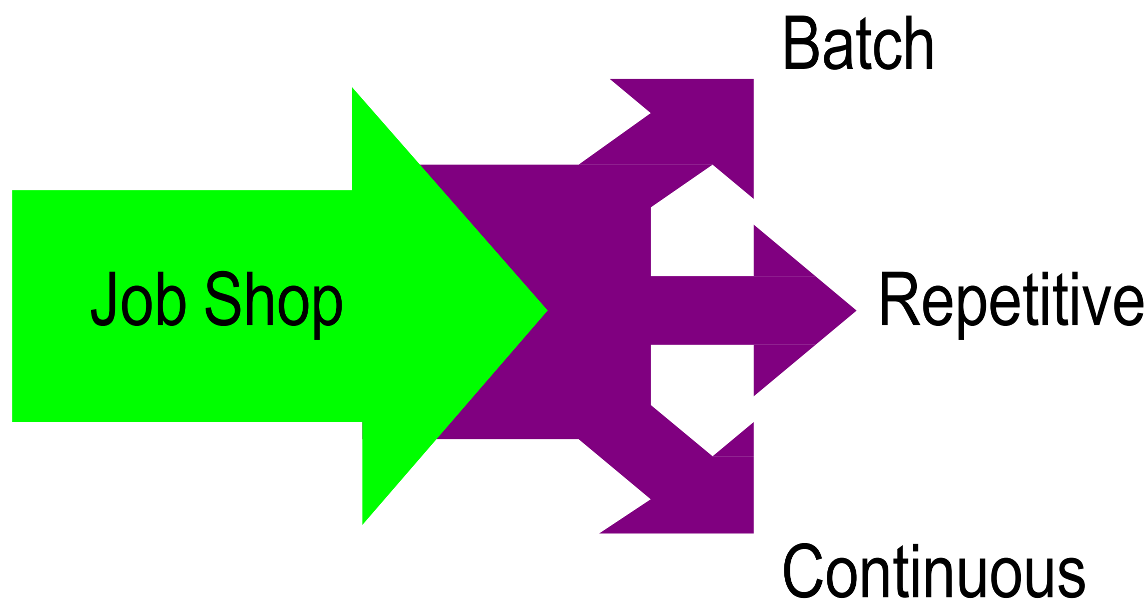
- What technology will and will not do
- Technical issues
- Economic issues
  - Initial costs, space, cash flow, maintenance
  - Consultants and/or skilled employees
  - Integration cost, time resources
  - Training, safety, job loss

Process Selection

Variety
- How much

Flexibility
- What degree

Volume
- Expected output



Process Types

Job shop

- Small scale

Batch

- Moderate volume

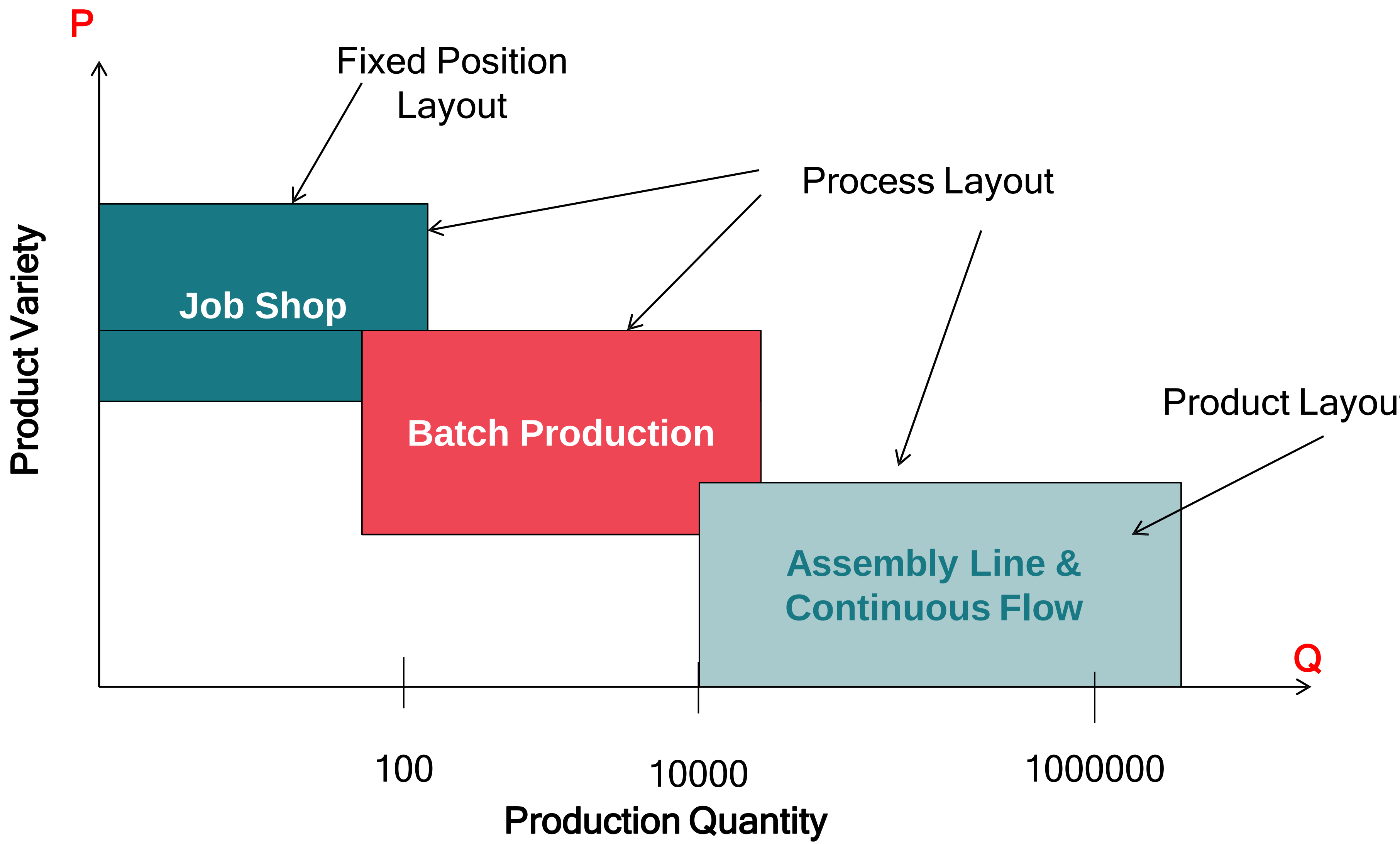
Repetitive/assembly line

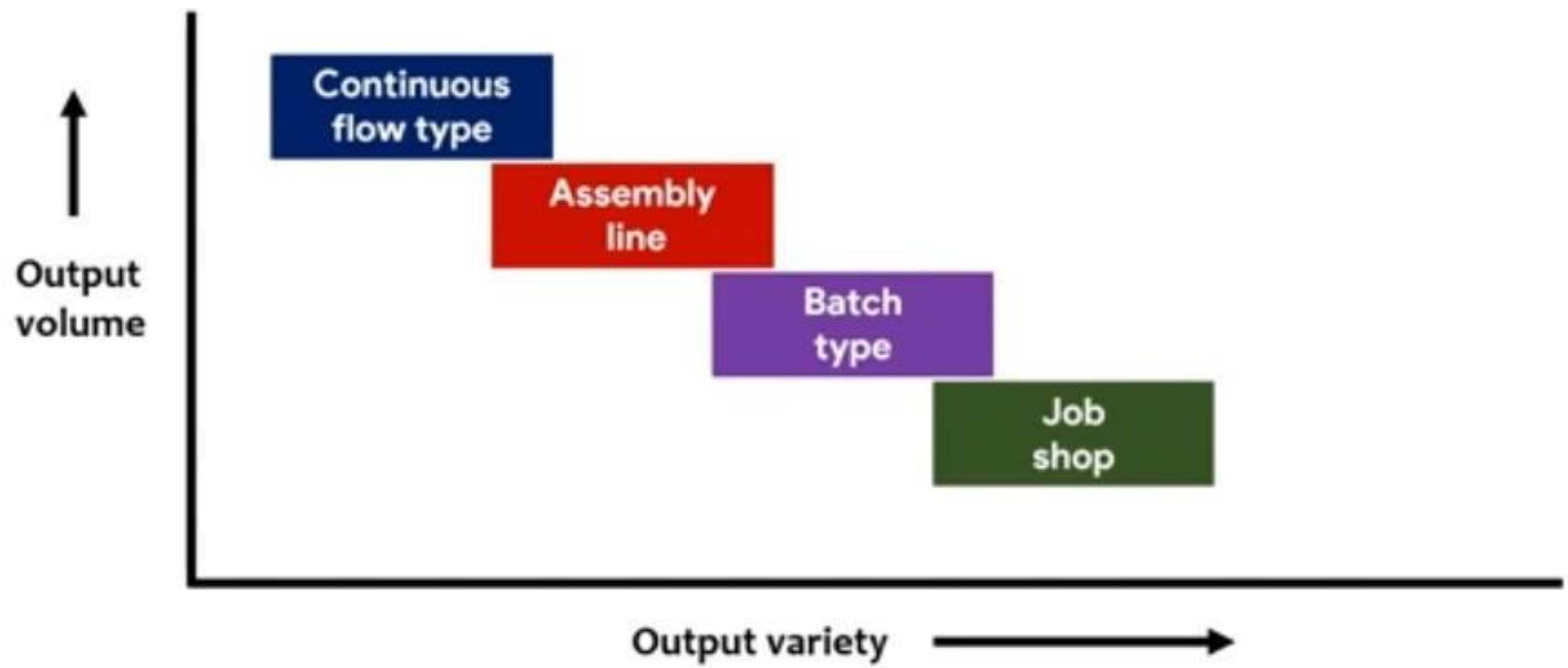
- High volumes of standardized goods or services

Continuous

- Very high volumes of non-discrete goods

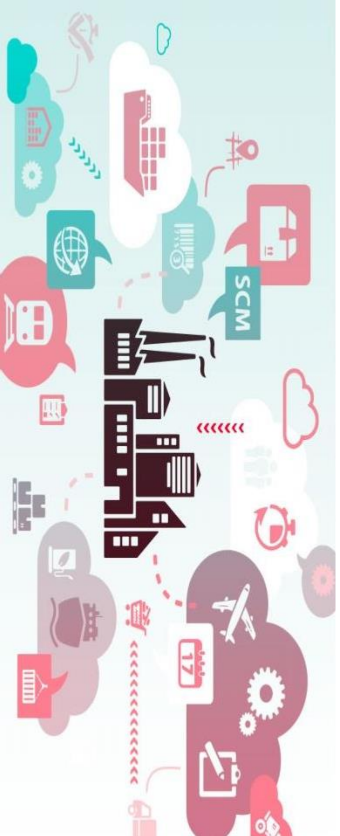
PQ Relationships




Continuous flow type
Assembly line
Batch type
Job shop
Output volume
Output variety

Product and Service Processes

Process Type				
Job Shop	Appliance repair Emergency room			
Batch	Commercial baking Classroom Lecture			
Repetitive	Automotive assembly Automatic carwash			
Continuous (flow)	Steel Production Water purification			



- Agriculture And Allied Industries
- Auto Components
- Automobiles
- Aviation
- Banking
- Cement
- Consumer Durables
- Ecommerce
- Education And Training
- Engineering And Capital Goods
- Financial Services
- FMCG
- Gems And Jewellery
- Healthcare
- Infrastructure
- Insurance
- IT & ITeS
- Manufacturing
- Media And Entertainment
- Metals And Mining
- Oil And Gas
- Pharmaceuticals
- Ports
- Power
- Railways
- Real Estate
- Renewable Energy
- Retail
- Roads
- Science And Technology
- Services
- Steel
- Telecommunications
- Textiles
- Tourism And Hospitality

Product and Service Processes

Process Type	Job variety	Process flexibility	Unit cost	Volume of output
Job Shop	Very High	Very High	Very High	Very low
Batch	Moderate	Moderate	Moderate to High	Moderate
Repetitive	Low	Low	Low	Moderate to High
Continuous (flow)	Very low	Very low	Very low	Very High

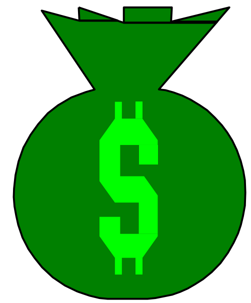
The Need for Layout Decisions

Inefficient operations

For Example:

High Cost

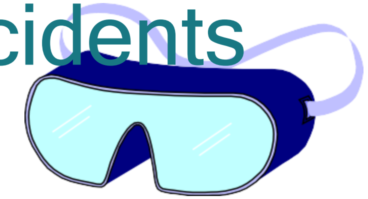
Bottlenecks



Changes in the design of products or services

The introduction of new products or services

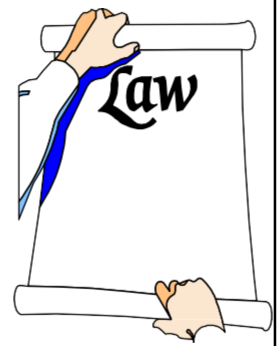
Accidents



Safety hazards

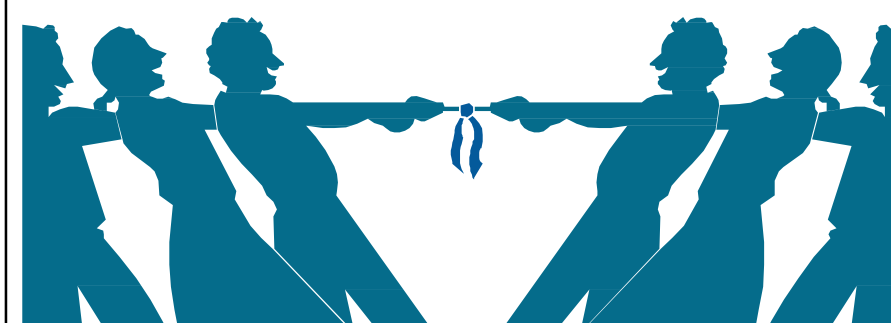
The Need for Layout Design (Cont'd)

Changes in environmental or other legal requirements



Changes in volume of output or mix of products

Morale problems



Changes in methods and equipment

Service Layouts

- Warehouse and storage layouts
- Retail layouts
- Office layouts
- Service layouts must be aesthetically pleasing as well as functional

How are Services Different?

- Everyone is an expert on services
- What works well for one service provider doesn"t necessarily carry over to another
- Quality of work is not quality of service
- "Service package" consists of tangible and intangible components
- Services are experienced, goods are consumed
- Mgmt of service involves mktg, personnel
- Service encounters mail, phone, F2F

Degree of Customer Contact

More customer contact, harder to standardize and control

Customer influences:

- Time of demand
- Exact nature of service
- Quality (or perceived quality) of service

What do People Want?

Amount of friendliness and helpfulness

Speed and convenience of delivery

Price of the service

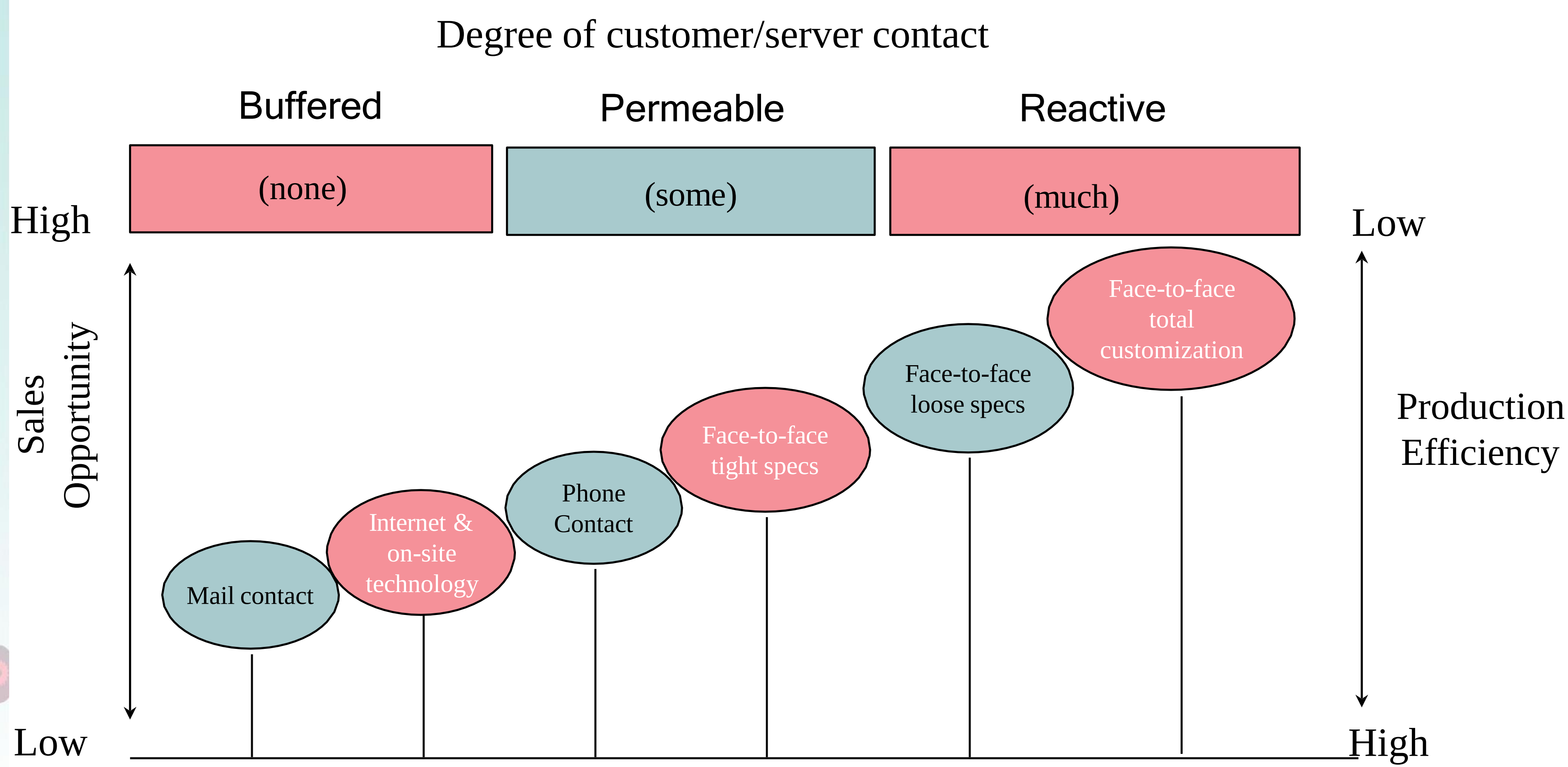
Variety of services

Quality of tangible goods involved

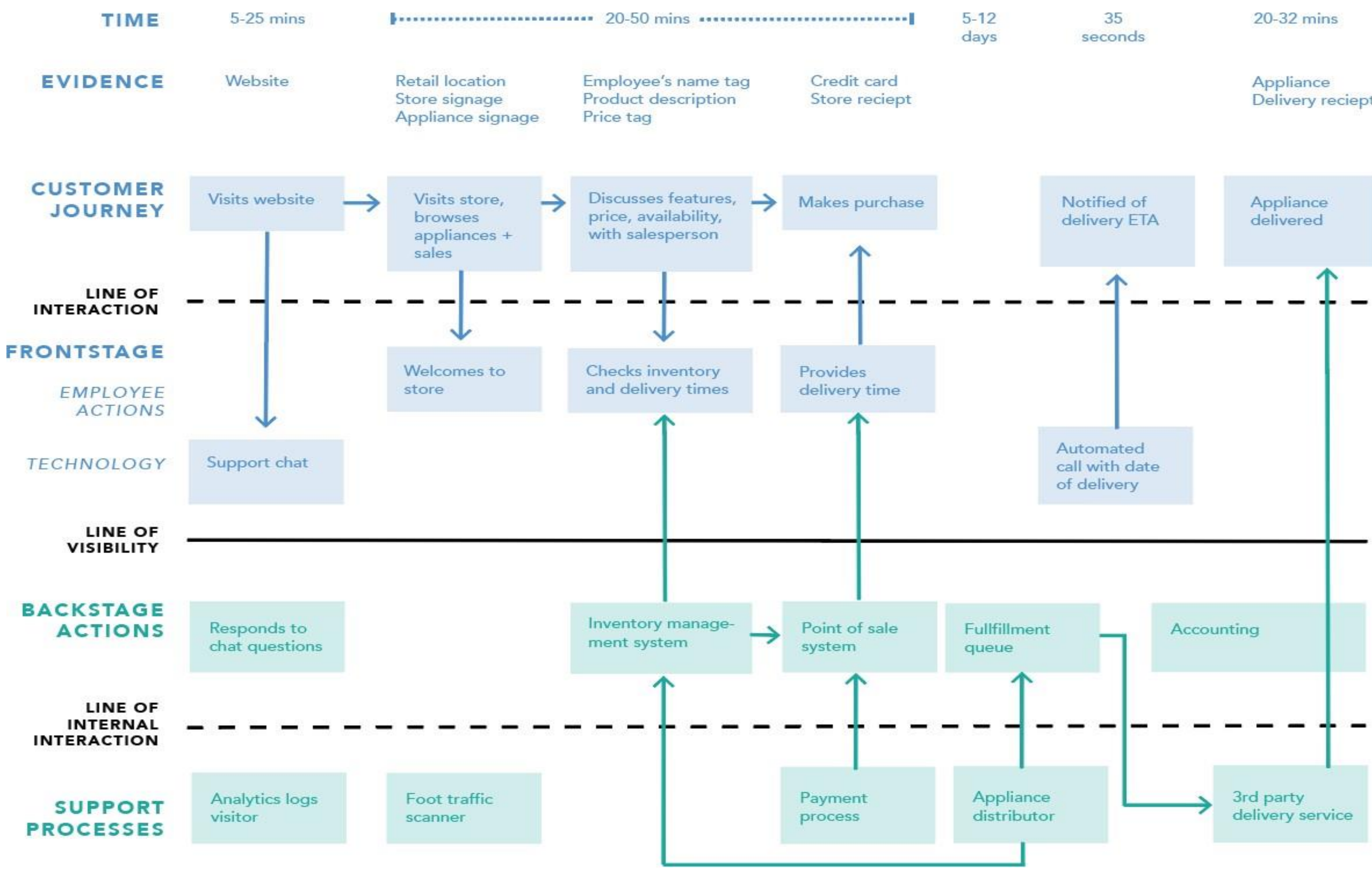
Unique skills required to provide service

Level of customization

Service-System Design Matrix

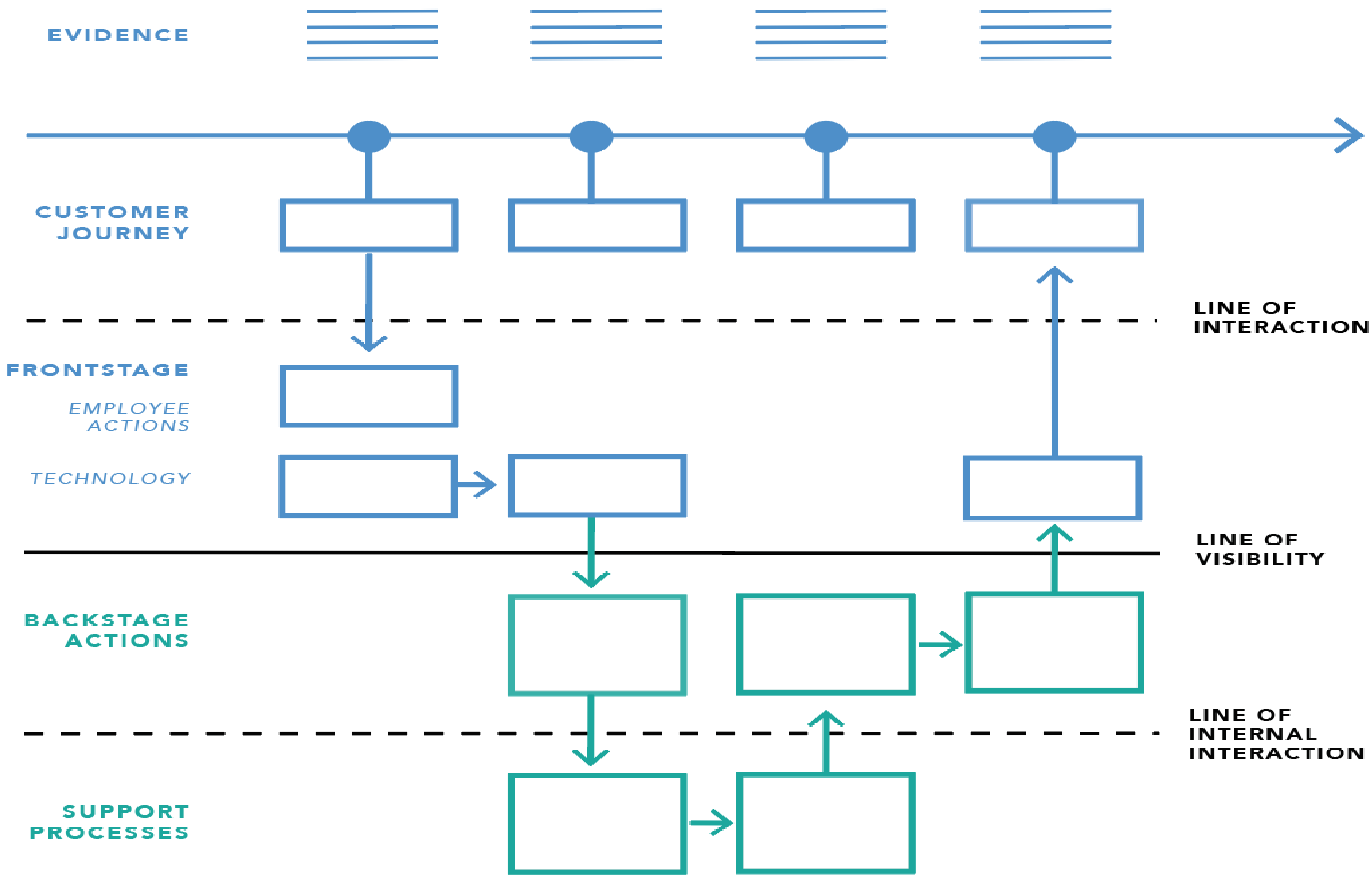


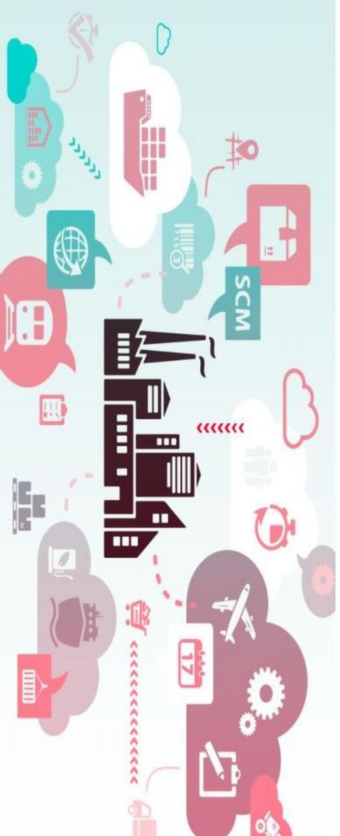
SERVICE BLUEPRINT *Example*

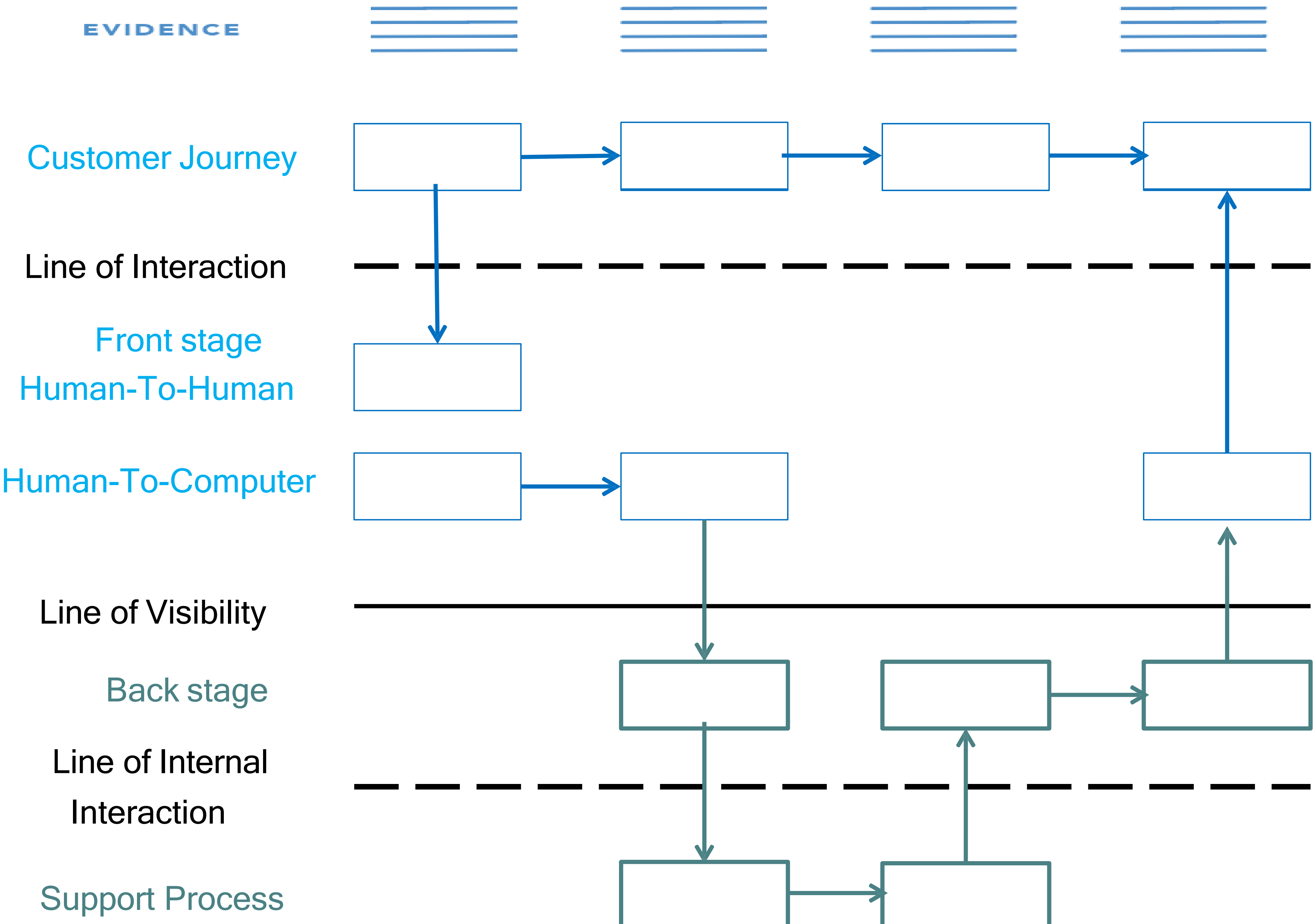


SERVICE BLUEPRINT *101*

A diagram that visualizes the relationships between different service components (people, props, and processes) that are directly tied to the touchpoints throughout the customer's journey.






EVIDENCE
Customer Journey
Line of Interaction
Front stage
Human-To-Human
Human-To-Computer
Line of Visibility
Back stage
Line of Internal
Interaction
Support Process

UNIT 3

UNIT 3

1. Produ (PPC):
2. Demand Forecasting
   Time
   Forec
3. Production Planning:
   fo
4. Master Production
5. Production Control

PRODUCTION PLANNING &CONTROL (PPC)

Learning Objectives

Session should help us to understand following

Part I

1. Production Planning and control
2. Objectives of PPC
3. The factors determining production planning procedures.
4. The scope of PPC

Part II

5. Phases in PPC functions
6. Benefit of PPC function
7. Limitations of PPC function
8. PPC in Different Production systems

Session outline

Session Outline

Introduction Production Planning and control

- Definition
- 3 phases of PPC
- Production (Transformation)

Factors determining production planning procedures.

Role & scope

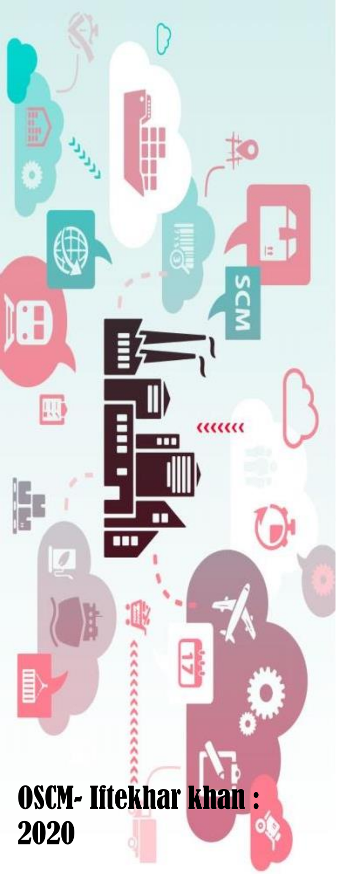
Benefit & Limitations of PPC function

PPC in Different Production systems

DIMR

Introduction to PPC

Production Planning and Control



Designing Product	**Determining Eqpmnts.**	**Determining Capacity rqmnt.**	**Designing layout**

Planning, direction and co-ordination of the firm's facilities to achieve the predetermined Production objectives in the most economical manner.

Determining Material Handling Eqpmnt.	**Time Management**	**Specifying quality & quantity level**

Three Stages Of PPC

Planning	Utilization of resources available from the best possible alternatives
Operation	Performance in accordance with the details set out in the production plan
Control	Monitoring of Performance and comparing with planned

Objectives of PPC

1. Deliver Quality goods in required Quantity to the customer in the required Delivery Schedule to achieve maximum Customer Satisfaction and Minimum Possible Cost
2. Ensure maximum Utilization of Recourses
3. Minimize product Through Put Time (Mfg. cycle time)
4. Maintain Optimum Inventory levels
5. Coordination between labour and machines and various supporting departments

Objectives of PPC …contd. …contd.

6. **Remove bottle neck** at all stages of production and to solve problems related to production

7. Ensure effective **cost reduction** and cost control

8. **Plan for plant capacity** for future requirements

Production Planning *is to provide* ***a physical system*** *with a* ***set of operating guidelines*** *for efficient conversion of raw materials, human skills and other inputs into finished products*

Factors Determining Production Planning Procedures

1. Volume of Production-

2. Nature of Production Processes-

3. Nature of Operations

Factors Determining Production Planning Procedures

1. Volume of Production-

Intensity of Production planning varies and depend upon volume of production

i. Custom order Job shop- Air Buses,
ii. High volume operations- fasteners

Factors Determining Production Planning Procedures…Contd.

2. Nature of Production Processes-

i. Continues
ii. Intermittent (batch wise)
iii. Job Production

Factors Determining Production Planning Procedures…Contd.

3. Nature of Operations

i. Manufacturing to order (may or may not be repeated)
ii. Stock and sell (Batch or mass production- automobile, watches, TV etc.)
iii. Stock and sell (Continues production- sugar, chemicals, yarn etc.)

Scope of Production Planning

Materials	Raw Material, Spare parts , Components
Methods	Best sequence of operations with in the limitations of existing layout
Machines & Equipments	selection of m/c, tools, maintenance policy , replacement policy etc.
Routing	Flow of work, layout, temporary storage of raw materials, material handling systems
Estimating	Process time (set up & Opn time), standard time (Labour & m.c time)

Scope of Production Planning…(contd.)

Loading & Scheduling	Capacity & Capability of m/c. Starting & Completion time of each and every operations
Dispatching	execution of planning functions. Orders, instruction, release of material and tools to instruction, release of material and tools to operators
Progressing , Evaluating or Controlling	Feed back, follow up Evaluation for improvement

What to produce ?	Product planning and development including product design.
How to produce ?	Process planning, material planning, tool planning etc.
Where to produce ?	Facilities planning, capacity planning and sub-contracting planning.
When to produce ?	Production scheduling and machine loading
Who will produce ?	Man power planning
How much to produce ?	Planning for quantity, Economic batch size etc.

Role of PPC-

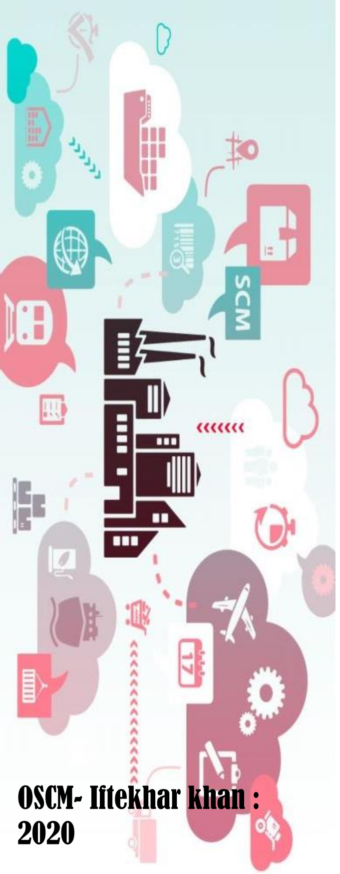
- Product design
- Job design & process design
- Equipment selection and replacement
- Labour skills and training programs
- Raw material selection and sub contracting
- Plant selection and layout
- Scheduling steps of the plan
- Implementing and controlling the schedule
- Operating the production system

Benefit of PPC function function

Efficient PPC results in

- high quality production
- Better utilization of resources
- Reduced inventories
- Reduced through put time
- Better customer service

Lower production cost and lower capital investment



Benefit of PPC function…contd.

Limitations of PPC function

PPC function is based on certain **assumptions** or forecasts of customer's demand, plant capacity , availability of materials , power etc. If these assumptions go wrong , PPC becomes ineffective.

Employee may **resist changes** is production levels set per production plans if such plans are rigid.

The production planning process is **time consuming** when it is necessary to carry out routing and scheduling functions for and complex production consisting of a large no of parts going into the product.

Limitations of PPC function…contd.
function…contd.

PPC function becomes extremely difficult when the **environmental factors changes** very rapidly such as

- Technology,
- Customer’s taste regarding fashion or style of product needed,
- Government policy and control change frequently,
- Stoppage of power supply by electricity board due to power cuts ,
- Break in supply chain due to natural calamities such as floods earthquakes wars etc.

PPC in Different Production systems

PPC in Job Production

- Mfg. of products to meet specific customer requirements of special orders
- Qty. is usually small
- Examples: large turbo generators, boilers, steam engines, processing equipments , material handling equipments, ship building etc.
- Types
  - Small no. of products produced only once
  - Small no. of products intermittently when the need arises
  - Small no. of products produced periodically at known interval of time

PPC in Job Production…contd.
Production…contd.

PPC function is relatively difficult

- Every job order is of different nature and has different sequence of operations. There is no standardization routing for job orders.
- Specific job orders are assigned to different workstations as per availability of capacity.
- Production schedules drawn depend on the relative priority assigned to several job orders.
- Scheduling is dependent on assessment of production times and estimating is based on judgment

PPC in Batch Production

- Mfg. no. of identical articles either to meet a specific order or satisfy continuous demand
- Decision regarding tooling and jigs and fixtures are dependant on the quantities involved in production batch
- Type
  - Batch produced only once
  - At repeatedly at irregular interval, when the arises
  - Periodically at known intervals, to satisfy continuous demand

PPC in Batch Production…contd.

Production…contd.

Here PPC is more simplified as quantities increase and as manufacture becomes more regular.

Two problems that may arise in batch production are due to size of batch and due to scheduling of production

Solutions:

- External customer orders only
- Whether the plant is producing for internal consumption i.e. subassembly used in the final product

PPC in Continuous Production

It is normally associated with large no. of quantities of production and with high rate of demand.

Types

- Mass Production –
- Flow Production-

Production Planning is the key activity for the organization's

efficiency,
effectiveness,
timely delivery,
quality product and
customer satisfaction.

This is just like the steering wheel of running vehicle, which drives you destination.

Demand Forecasting

1.

2.

3.

4.

5.

An estimate of future demand.

A forecast can be determined by mathematical means using historical, it can be created subjectively by using estimates from informal sources, or it can represent a combination of both techniques.

Why Forecast ?

- To plan for the future by reducing uncertainty.
- To anticipate and manage change.
- To increase communication and integration of planning teams.
- To anticipate inventory and capacity demands and manage lead times.
- To project costs of operations into budgeting processes.
- To improve competitiveness and productivity through decreased costs and improved delivery and responsiveness to customer needs.

Decisions that Need Forecasts

Which markets to pursue?

What products to produce?

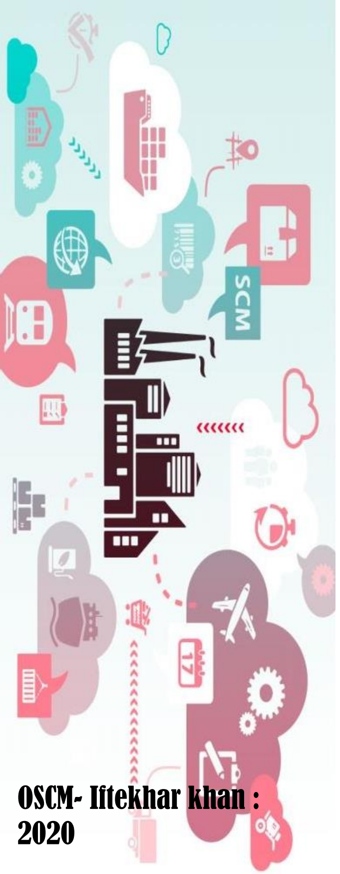
How many people to hire?

How many units to purchase?

How many units to produce?

And so on……

Common Characteristics of Forecasting



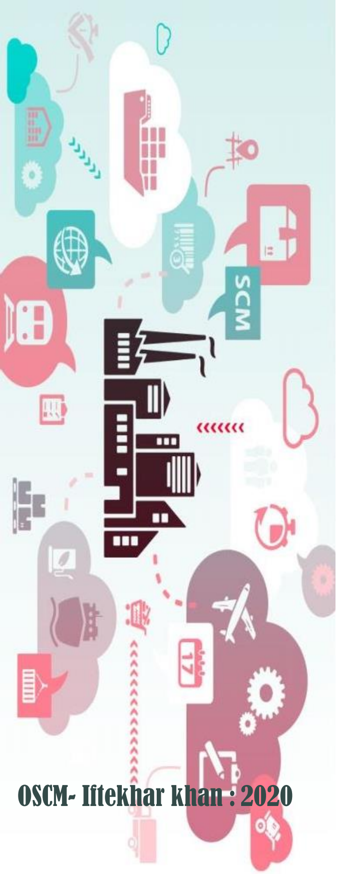
Forecasts are rarely perfect

Forecasts are more accurate for aggregated data than for individual items

Forecast are more accurate for shorter than longer time periods

Constructing Demand Forecasting System.

1. Determine the information that needs to be forecasted.
   1. This includes defining the source of the historical data to be provided and the periods over which the data will be collected.
2. Assign responsibility for the forecast to a person which performance will be measured on the accuracy of actual sales to the forecast.
3. Setup forecast system parameters :
   1. Forecast horizon.
   2. Forecast level : Business unit, Product family, Model and brand, or SKU.
   3. Forecast period and frequency.
   4. Forecast revision : The way in which changes to the forecast will be recorded, such as original forecast, revised forecast, subsequently revised forecast, current forecast.



Demand Forecasting System

4. Select appropriate forecasting models and techniques.
5. Collect data for input to forecasting models and test models for forecast accuracy.
6. Run the forecasting model and generating forecasts.
7. Record actual demand information against forecast.
8. Report forecast accuracy and determine the root cause for variance between forecast and actual data. Periodically assess the forecast system for performance, so that changes can be made to the forecasting approach where necessary.

Types of Forecasting Models

- Forecasts generated subjectively by the forecaster

- Forecasts generated through mathematical modeling

General Methods of Forecasting

1. Qualitative Techniques.
   - They are based on expert or informed opinion regarding future product demands.
   - This information is intuitive and based on subjective judgment.
   - Qualitative techniques include gathering information from customer focus groups, groups of experts, think tanks, research groups, etc.

DIMR

Qualitative Methods

Market R

Market research is used mostly for product research in the sense of looking for new product ideas, like and dislikes about existing products, which competitive products within a particular class are preferred, and so on.

Pane .

In a panel consensus, the idea that two heads are better than one is extrapolated to the idea that a panel of people from a variety of positions can develop a more reliable forecast that a narrow group. Panel forecasts are developed through open meetings with free exchange of idea from all levels of management and individuals.

Historic

In trying to forecast demand for a new product, an ideal situation would be where an existing product or generic product could be used as a model. There are many ways to classify such analogies - for example, complementary products, substitute or competitive products, and products as a function of income.

Delph .

The Delphi method conceals the identity of the individuals participating in the forecasting. Everyone has the same weight. Procedurally, a moderate creates a questionnaire and distributes it to participants. Their response are summed and given back to the entire group along with a new set of questions.

DIMR

DELPHI FORECASTING METHOD

Round 1	Round 2	Round 3
Analysis of results	Analysis of results	Analysis of results
Feedback	Feedback	Feedback

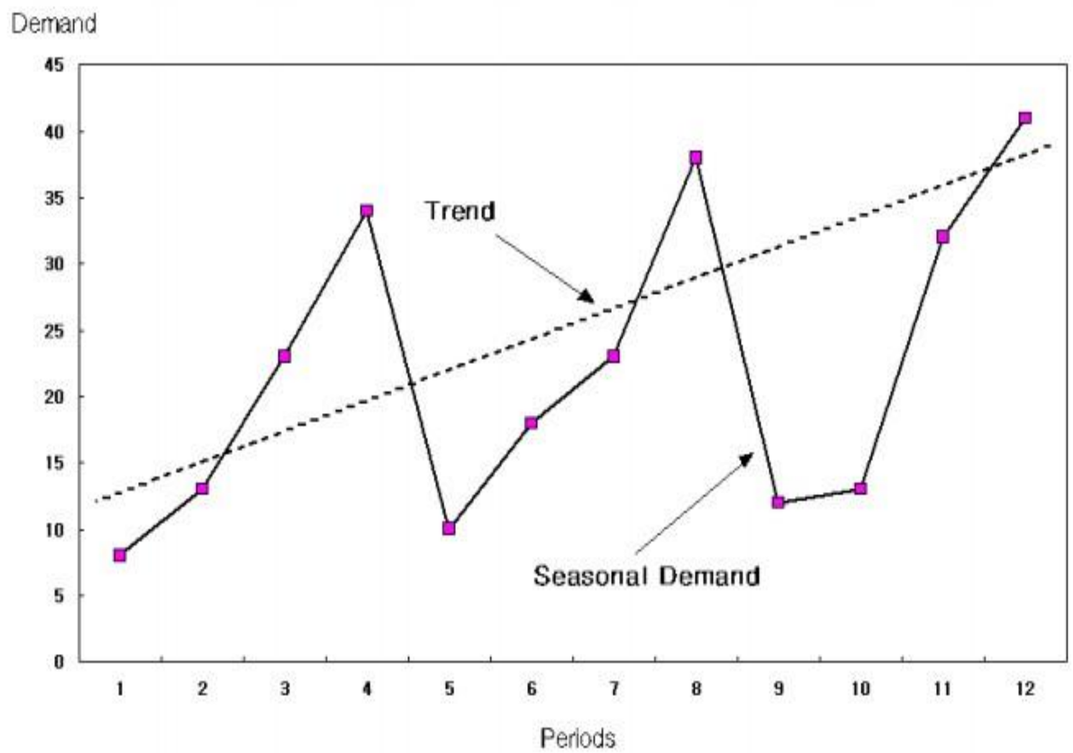
Statistical Forecasting

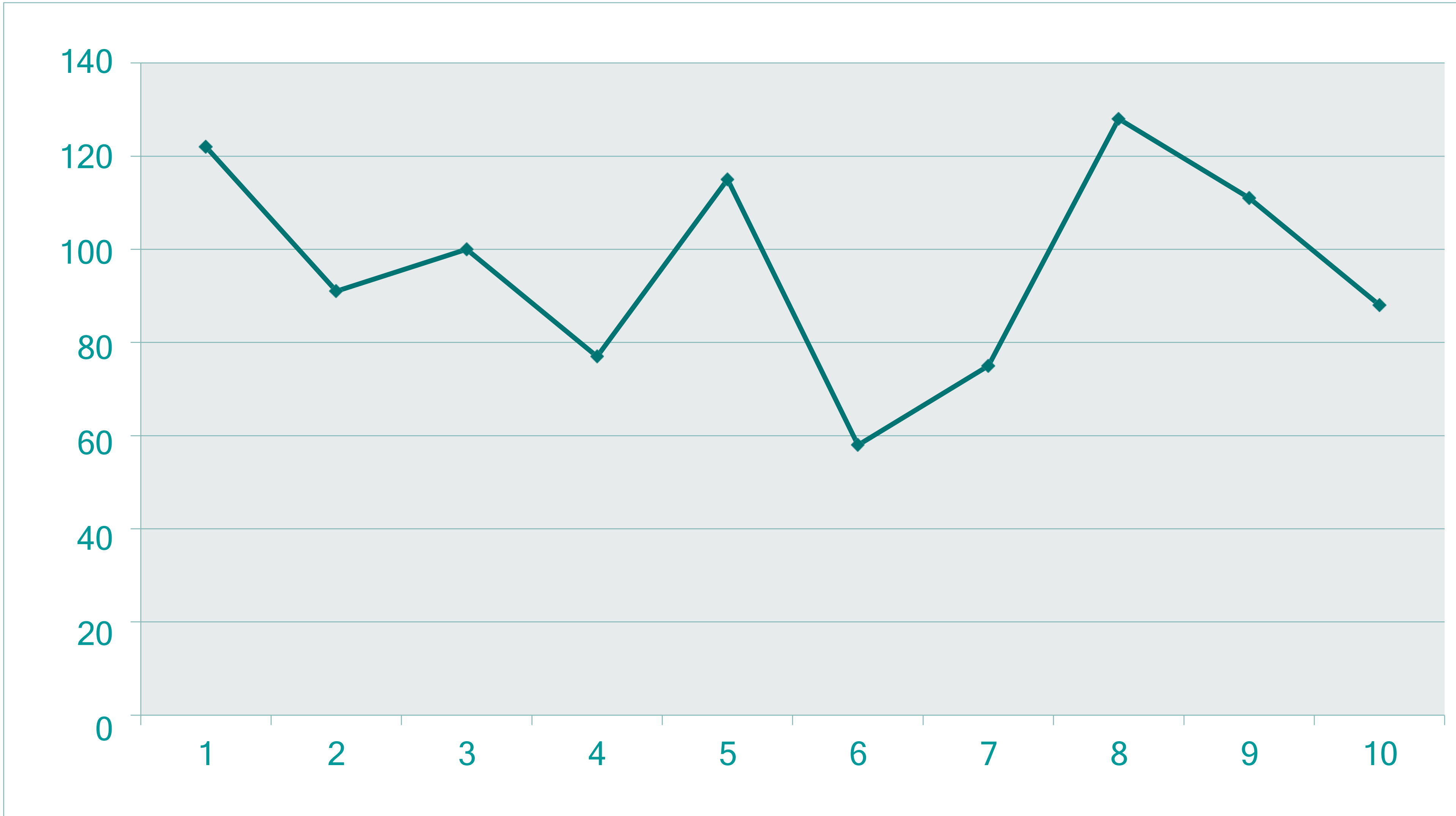
- **Time Series Models:**
  - Assumes the future will follow same patterns as the past

- **Causal Models:**
  - Explores cause-and-effect relationships
  - Uses leading indicators to predict the future
  - E.g. housing starts and appliance sales

Time Series Analysis.

Time series analysis is based on the idea that data relating to past demand can be used to predict future demand. Past data may include several components, such as trend, seasonal, or cyclical influences




140
120
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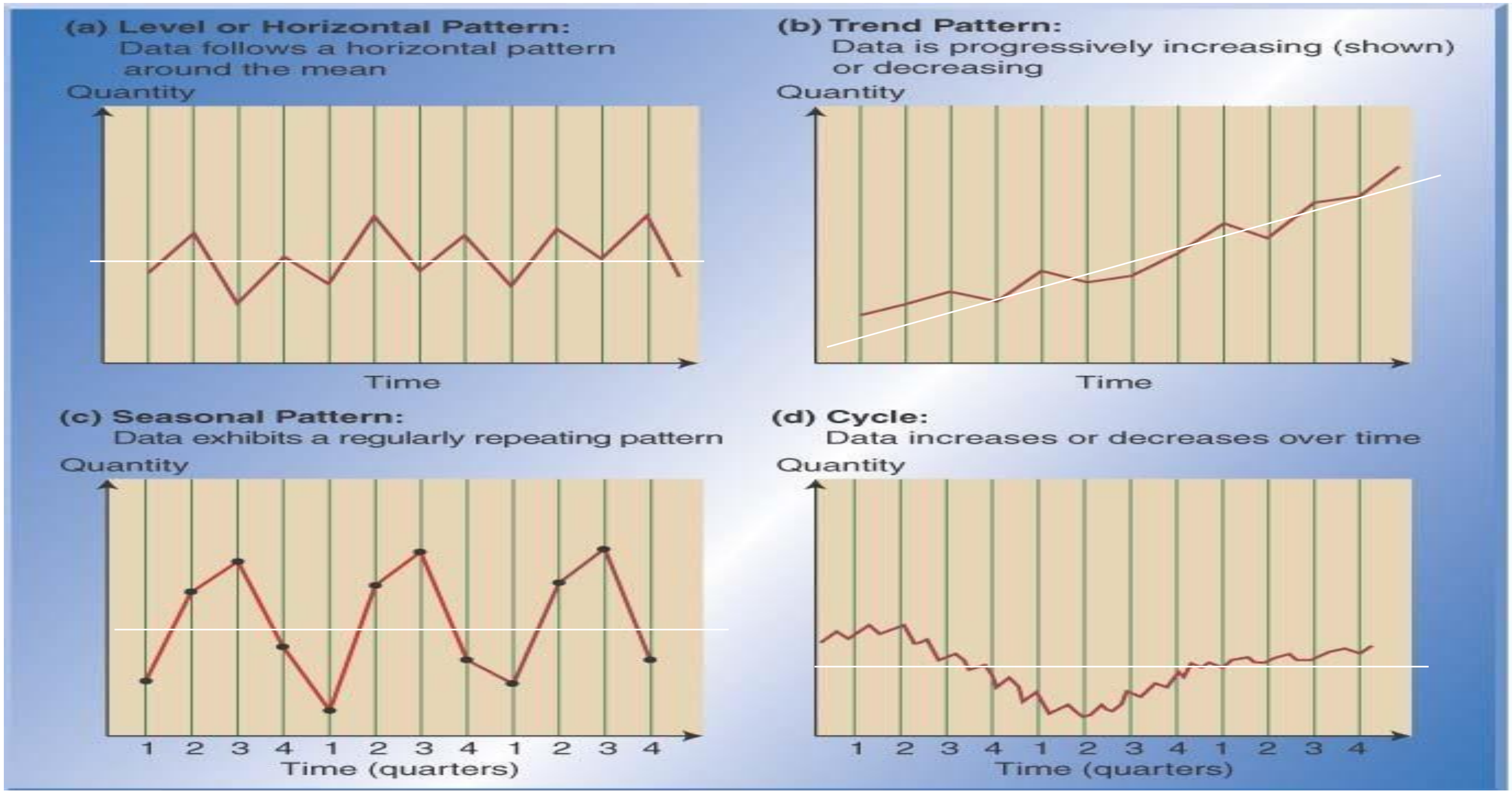
Composition of Time Series Data

Data = historic pattern + random variation

Historic pattern may include:

- Level (long-term average)
- Trend
- Seasonality
- Cycle

Time Series



(a) Level or Horizontal Pattern:
Data follows a horizontal pattern around the mean
Quantity
Time
(b) Trend Pattern:
Data is progressively increasing (shown) or decreasing
Quantity
Time
(c) Seasonal Pattern:
Data exhibits a regularly repeating pattern
Quantity
1 2 3 4 1 2 3 4 1 2 3 4
Time (quarters)
(d) Cycle:
Data increases or decreases over time
Quantity
1 2 3 4 1 2 3 4 1 2 3 4
Time (quarters)

Methods of Forecasting the Level

Naïve Forecasting

Simple Mean

Moving Average

Weighted Moving Average

Exponential Smoothing

Naïve Forecasting

Next period forecast = Last Period's actual:

$$\boxed{F_{t+1} = A_t}$$

Month	Period	Orders (A)	Naïve Forecast
January	1	122	
February	2	91	122
March	3	100	91
April	4	77	100
May	5	115	77
June	6	58	115
July	7	75	58
August	8	128	75
September	9	111	128
October	10	88	111
November	11		88

Simple Average (Mean)

Next period's forecast = average of all historical data

$$F_{t+1} = \frac{A_t + A_{t-1} + A_{t-2} + \ldots\ldots\ldots\ldots}{n}$$

Month	Period	Orders (A)	Simple Avg Forecast
January	1	122	
February	2	91	122
March	3	100	107
April	4	77	104
May	5	115	98
June	6	58	101
July	7	75	94
August	8	128	91
September	9	111	96
October	10	88	97
November	11		97

An arithmetic average of a certain number n of the most recent observations. As each new observation is added, the oldest observation is dropped. The value of n (the number of periods to use for the average) reflects responsiveness versus stability in the same way that the choice of smoothing constant does in exponential smoothing.

Moving Average

Next period's forecast = simple average of the last N periods

$$F_{t+1} = \frac{A_t + A_{t-1} + \dots\dots\dots + A_{t-N+1}}{N}$$

			Moving Avg. (N=3)
Month	Period	Orders (A)	Forecast
January	1	122	
February	2	91	
March	3	100	
April	4	77	104
May	5	115	89
June	6	58	97
July	7	75	83
August	8	128	83
September	9	111	87
October	10	88	105
November	11		109

			Moving Avg. (N=5)
Month	Period	Orders (A)	Forecast
January	1	122	
February	2	91	
March	3	100	
April	4	77	
May	5	115	
June	6	58	101
July	7	75	88
August	8	128	85
September	9	111	91
October	10	88	97
November	11		92

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Weighted Moving Average

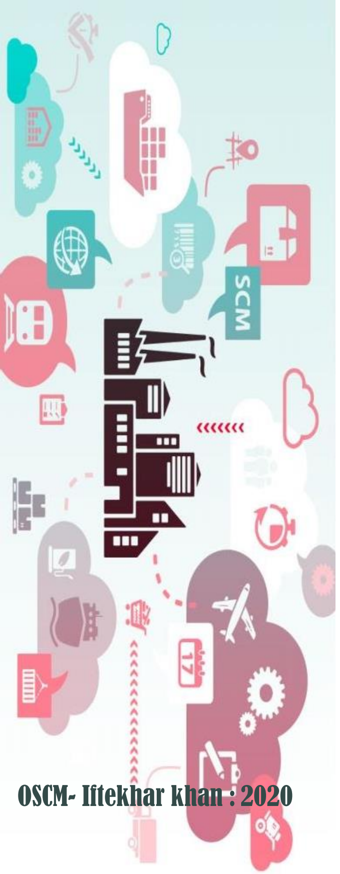
Whereas the simple moving average gives equal weight to each component of moving average database, a weighted moving average allows any weights to be placed on each element, providing, of course, that the sum of all weights equals 1.

$$F_t = w_1 A_{t-1} + w_2 A_{t-2} + ... + w_n A_{t-n}$$

where w_i = Weight to be given to the actual occurrence for the period (t - n)

n = Total number of periods in the forecast.

$\sum n_{i=1} = 1$, The sum of all the weight must equal 1.



			Weighted Moving Avg. (N=3), .2,.3,.5
Month	Period	Orders (A)	Forecast
January	1	122	
February	2	91	
March	3	100	
April	4	77	102
May	5	115	87
June	6	58	101
July	7	75	79
August	8	128	78
September	9	111	98
October	10	88	109
November	11		103

Exponential Smoothing

A type of weighted moving average forecasting techniques in which past observations are geometrically discounted according to their age. The heaviest weight is assigned to the most recent data.

The techniques makes use of a smoothing constant to apply the difference between the most recent forecast and the critical sales data.

$F_t = \alpha A_{t-1} + (1 - \alpha) F_{t-1}$

where F_t = New forecast.

A_{t-1} = Latest demand.

F_{t-1} = Previous forecast.

α = Smoothing factor. $(0 \le \alpha \le 1)$

			Exponential Smoothing
Month	Period	Orders (A)	(α= 0.2) Forecast
January	1	122	122
February	2	91	122
March	3	100	116
April	4	77	113
May	5	115	106
June	6	58	108
July	7	75	98
August	8	128	93
September	9	111	100
October	10	88	102
November	11		99

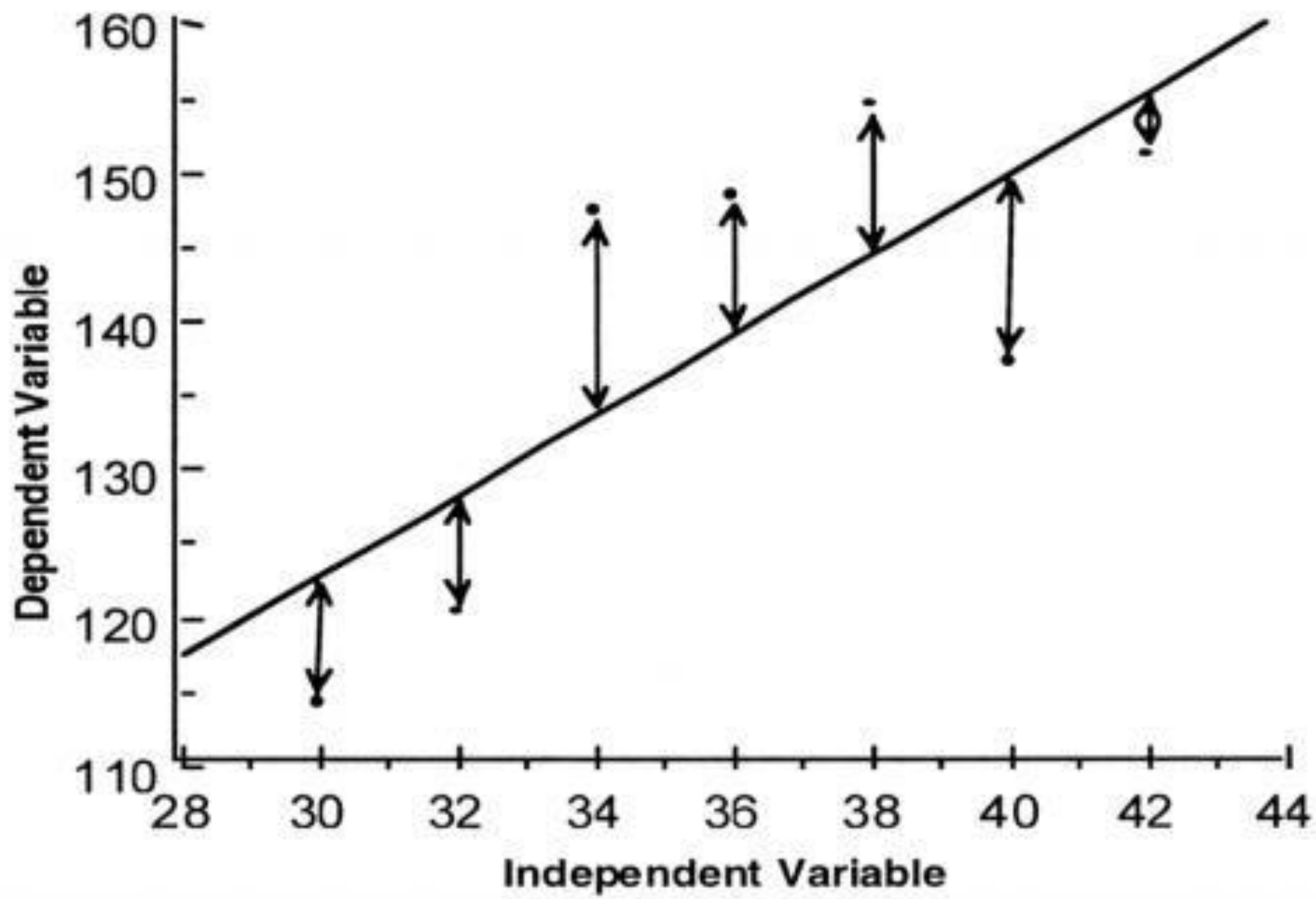
Time Series Problem Solution

Period	Orders (A)	Naïve Forecast	Simple Average	Simple Moving Average (N=3)	Simple Moving Average(N=5)	Weighted Moving Average (N=3)	Exponential Smoothing (α=0.2)	Exponential Smoothing (α=0.5)
1	122						122	122
2	91	122	122				122	122
3	100	91	107				116	107
4	77	100	104	104		102	113	104
5	115	77	98	89		87	106	91
6	58	115	101	97	101	101	108	103
7	75	58	94	83	88	79	98	81
8	128	75	91	83	85	78	93	78
9	111	128	96	87	91	98	100	103
10	88	111	97	105	97	109	102	107
11		88	97	109	92	103	99	98

Causal Forecasting

Causal forecasting assumes that demand is related to some underlying factor for factors in the environment.

Causal forecasting methods develop forecasts after establishing and measuring an association between the dependent variable and one or more independent variables.


160
150
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130
120
110
28
30
32
34
36
38
40
42
44
Dependent Variable
Independent Variable

Casual Models

Often, leading indicators hint can help predict changes in demand

Causal models build on these cause-and-effect relationships

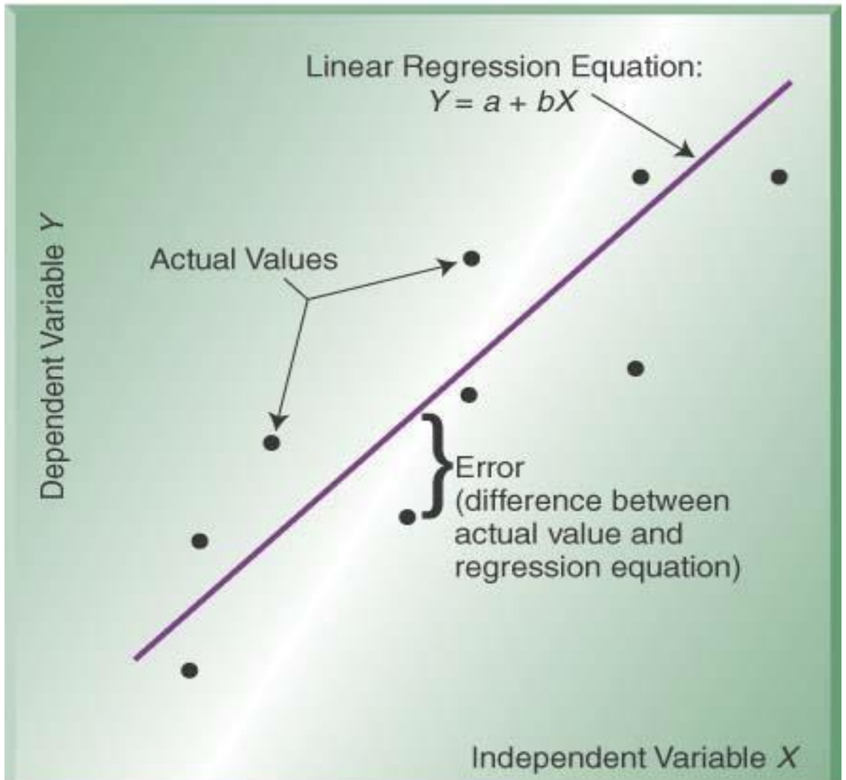
A common tool of causal modeling is linear regression:

$$Y = a + bx$$

Re
n

A method of fitting an equation to a data set. Simple regression involves one independent variable and one dependent variable. Least squares is the most common method of regression.

Linear Regression



- Identify dependent (y) and independent (x) variables
- Solve for the slope of the line

$$b = \frac{\sum XY - n\bar{X}\bar{Y}}{\sum X^2 - n\bar{X}^2}$$

- Solve for the y intercept

$$\mathbf{a = \bar{Y} - b\bar{X}}$$

- Develop your equation for the trend line

  Y=a + bX

Linear Regression Problem: A maker of golf shirts has been tracking the relationship between sales and advertising dollars. Use linear regression to find out what sales might be if the company invested $53,000 in advertising next year.

	Adv.$ (X)	Sales $ (Y)	XY	X^2	Y^2
1	48	130	4240	2304	16,900
2	52	151	7852	2704	22,801
3	50	150	7500	2500	22,500
4	55	158	8690	3025	24964
	53	**153.85**			
Tot	205	589	30282	10533	87165
Avg	**51.25**	**147.25**			

$$b = \frac{\sum XY - n\overline{X}\,\overline{Y}}{\sum X^2 - n\overline{X}^2}$$

$$b = \frac{30282 - 4(51.25)(147.25)}{10533 - 4(51.25)^2} = 3.58$$

$$a = \overline{Y} - b\overline{X} = 147.25 - 3.58(51.25)$$

$$a = -36.20$$

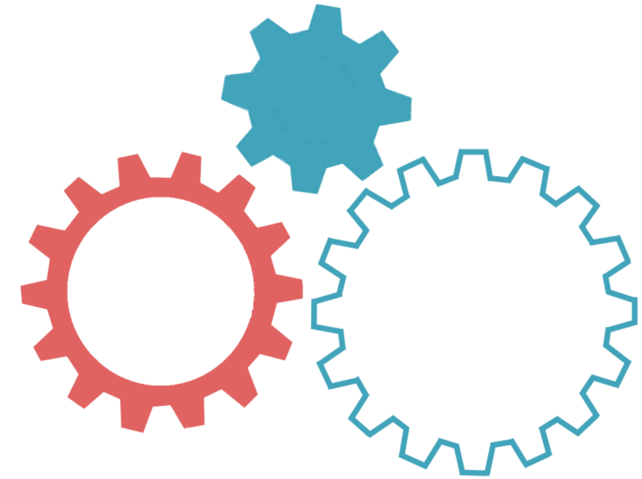
$$Y = a + bX = -36.20 + 3.58x$$

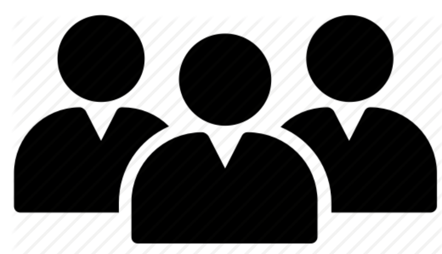
$$Y_5 = -36.20 + 3.58(53) = 153.54$$

Qualitative (technological) methods:

Quantitative (statistical) methods:

Capacity Planning





What is Capacity?

- The upp
capacity
- Capacity
- The ope
- The loa

A machine is able to process 120 Kgs. of raw materials in every hour it works, so its input capacity is 120-Kgs/hour.

A machine can produce 20 units of finished goods in every hour it works, so its output capacity is 20 units/hour

Do you think in the operations management should measure the human capacity and the machine capacity with the same measurement?

Measuring Capacity Examples

There is no one best way to measure capacity

Output measures like kegs per day are easier to understand

With multiple products, inputs measures work b

Business	Inputs	Outputs
Auto manufacturer	• Labor hours • Machine hours	Number of cars per shift
Steel mill	• Furnace size	Tons of steel per day
Oil refinery	• Refinery size	Gallons of fuel per day
Farming	• Number of acres • Number of cows	Bushel of grain per acre per year Gallons of milk per day
Restaurant	• Number of tables • Seating capacity	Number of meals served per day
Theater	• Number of seats	Number of tickets sold per performance
Retail sales	• Square feet of floor space	Revenue generated per day

Measuring Capacity Examples

Type of Business	Input Measures of Capacity	Output Measures of Capacity
Car manufacturer	Labor hours	Cars per shift
Hospital	Available beds	Patients per month
Pizza parlor	Labor hours	Pizzas per day
Retail store	Floor space in square feet	Revenue per foot

Measuring Available Capacity

Design capacity:

- Maximum output rate under ideal conditions
- *A bakery can make 30 custom cakes per day when pushed at holiday time*

Effective capacity:

- Maximum output rate under normal (realistic) conditions
- *On the average this bakery can make 20 custom cakes per day*

Actual Output:

- The rate of output actually achieved. It cannot exceed effective capacity and is often less than effective capacity due to breakdowns, defective outputs, shortage of materials, and similar factors.

Measuring Effectiveness of Capacity Use

Measures how much of the available capacity is actually being used:

$$\text{Utilization} = \frac{\text{actual output rate}}{\text{capacity}}(100\%)$$

- Measures effectiveness
- Use either effective or design capacity in denominator

Example of Computing Capacity Utilization: A bakery's design capacity is 30 custom cakes per day. Currently the bakery is producing 28 cakes per day. What is the bakery's capacity utilization relative to both design and effective capacity?

$$\text{Utilization}_{\text{effective}} = \frac{\text{actual output}}{\text{effective capacity}}(100\%) = \frac{28}{20}(100\%) = 140\%$$

$$\text{Utilization}_{\text{design}} = \frac{\text{actual output}}{\text{design capacity}}(100\%) = \frac{28}{30}(100\%) = 93\%$$

The current utilization is only slightly below its design capacity and considerably above its effective capacity

The bakery can only operate at this level for a short period oftime

DIMR

Efficiency = Actual output / Effective capacity

= 36 units per day/ 40 units per day

= 90%

Utilization = Actual output / Design capacity

= 36 units per day/ 50 units per day

= 72%

Thus, compared with the effective capacity of 40 units pe
units per day (90%) looks pretty good.

However, compared with design capacity of 50 units per

Why term efficiency and utilization are important to measure the capacity of any business related issue? Choose any business issue of your choice and based on that justify your argument?

Capacity Planning

Capacity Planning or Aggregate Planning is defined as the process of aggregating (i.e., consolidating or grouping) all the requirements for fulfilling capacity requirements for each period and determining the best way to provide the needed capacity.

The objectives of capacity planning are *feasibility* i.e., the internal needs must be within the capability of the operations system and o*ptimality* i.e., it is desirable to determine the least costly way to meet the capacity needs.

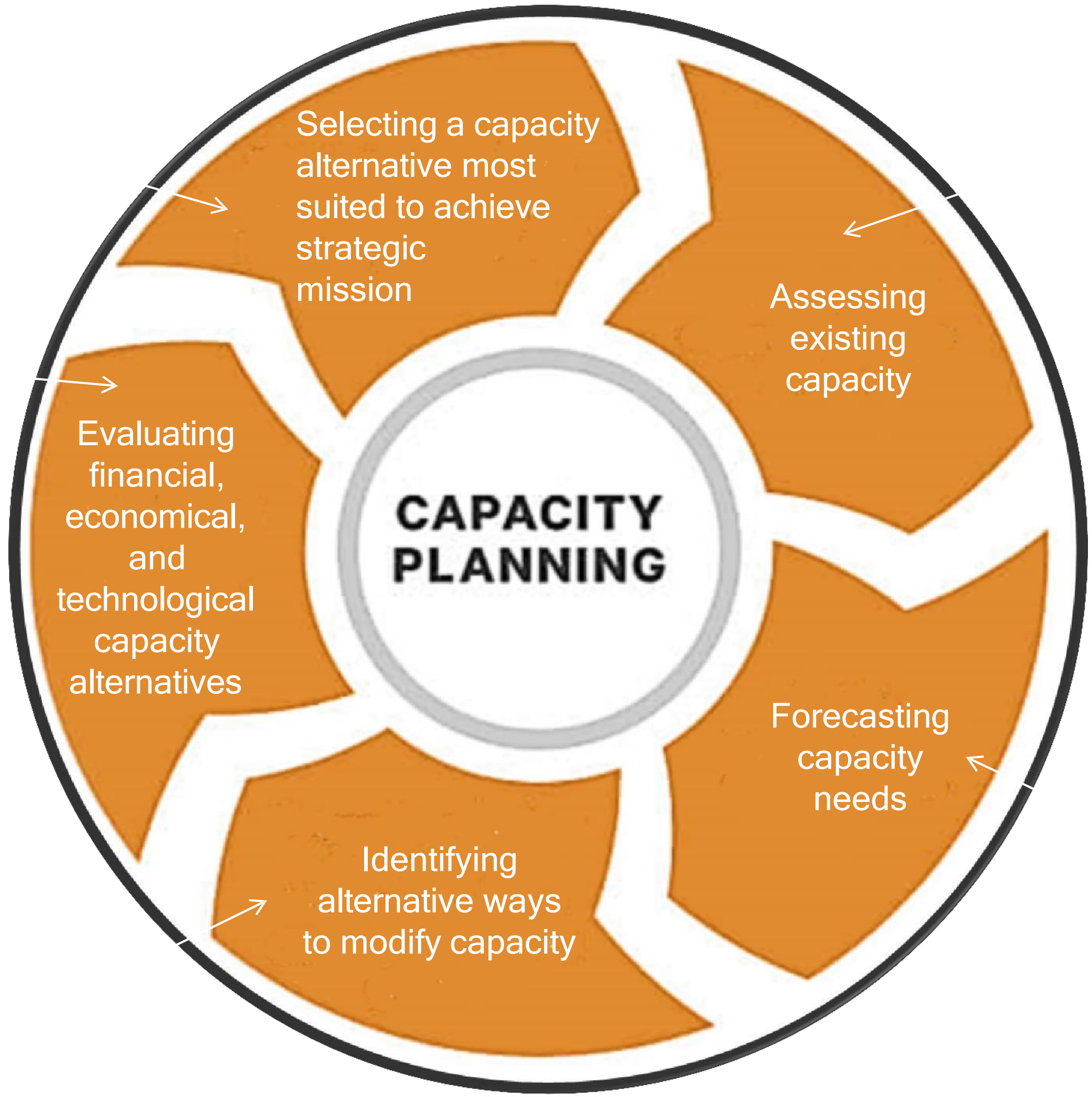
- *Adjusta* are the work force size,
- The pro the number of hours worked per day or week (this amounts to the use of overtime work or idle time), and
- Invent if it can be used to *store capacity* in one period so it can serve demand in later one period (Services usually cannot store inventory of their output). Sometimes and are used.
- If only one variable is adjusted to deal with a non-uniform demand within the planning horizon, it is called the ; the adjustment of more than one variable is called a .

Basic questions in capacity planning

- What kind of capacity is needed?
- How much is needed?
- When is it needed?

Is there any relationship between consumer demand and production capacity of any manufacturing firm? Discuss from the point of any manufactured products of your choice.

Capacity planning normally involves the following activities:


Selecting a capacity alternative most suited to achieve strategic mission
Assessing existing capacity
CAPACITY PLANNING
Forecasting capacity needs
Identifying alternative ways to modify capacity
Evaluating financial, economical, and technological capacity alternatives

From the point of current market trends of Indian Car Manufacturing sector do you thing the manufacturer should think about the modification of their capacity of production? Why or why not? Discuss.

Importance of Capacity Planning

- capacity essentially limits the rate of output possible.
- which will tend to minimize operating costs.
- Typically the greater the capacity of a productive unit, the greater its costs.
- and the fact that, once they are implemented, it may be difficult or impossible to modify those decisions without incurring major costs.
-
  - Sales Vs Capacity
  - Cost & Price

Do you think Country like SriLanka should manufacture automobile in the country? Why or why not? Discuss your opinion incorporating the concept of public demand and capacity of production in SriLanka.

Discussion questions

1. Define and describe the operating capacity of a college of business administration. How should its capacity be measured?
2. Discuss the fundamental differences between long term and short term capacity decisions.
3. Capacity will be modified in response to demand. Demand will be modified in response to capacity. Which statement is correct? Why?
4. What is capacity planning?

Aggregate Production planning

Frito-Lay

- three dozen brands
-
-
-

Aggregate Planning

the forecasted demand

minimizing the total cost

Planning Horizon

Long range

Intermediate range

Short range

Now

2 months

1 Year

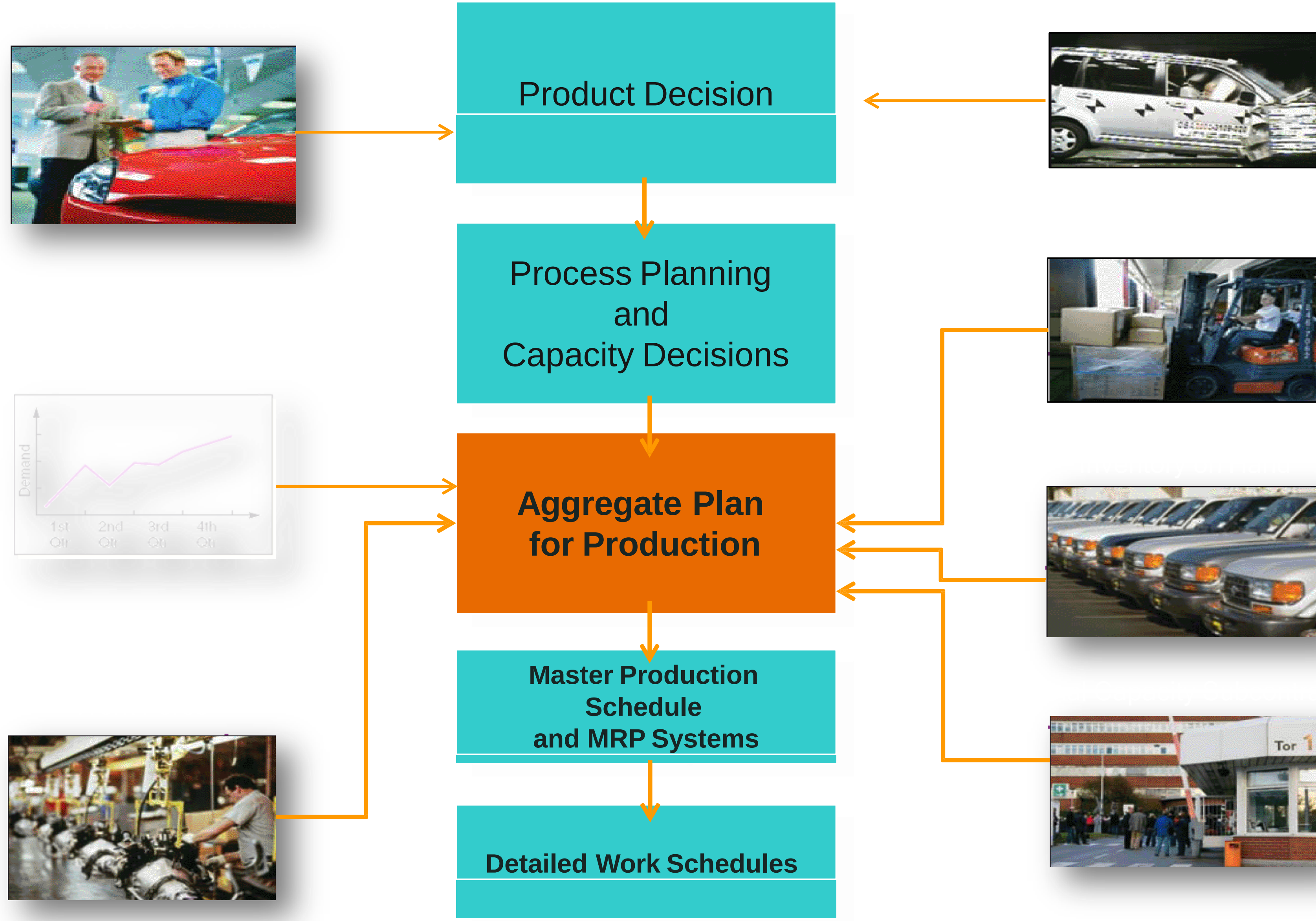
DIMR

Responsibility	Planning tasks and horizon
Top executives	Long-range plans (over one year) Research and Development New product plans Capital investments Facility location/expansion
Operations managers	Intermediate-range plans (2 to 12 months) Sales planning Production planning and budgeting Setting employment, inventory, subcontracting levels Analyzing operating plans
Operations managers, supervisors, foremen	• Short-range plans (up to 3 months) • Job assignments • Ordering • Job scheduling • Dispatching • Overtime • Part-time help


Colgate
Total
Sensitive
HELPS REPAIR EARLY DAMAGE
CLEANS DEEPLY BETWEEN TEETH
£3.92
£3.92
MaxFresh
MaxWhite
PERFECT WHITE
ENAMEL STRENGTH
Oral-B
£2.17
£2.47
£1.37
£1

Aggregate Planning Inputs

- Demand forecasting for aggregate unit
- Resources
  - Workforce/production rate
  - Facilities and equipment
- Policies
  - Subcontracting
  - Overtime
  - Inventory levels
  - Back orders


Product Decision
Process Planning and Capacity Decisions
Aggregate Plan for Production
Master Production Schedule and MRP Systems
Detailed Work Schedules

Aggregate Planning Strategies

part-timers, overtime, or idle time

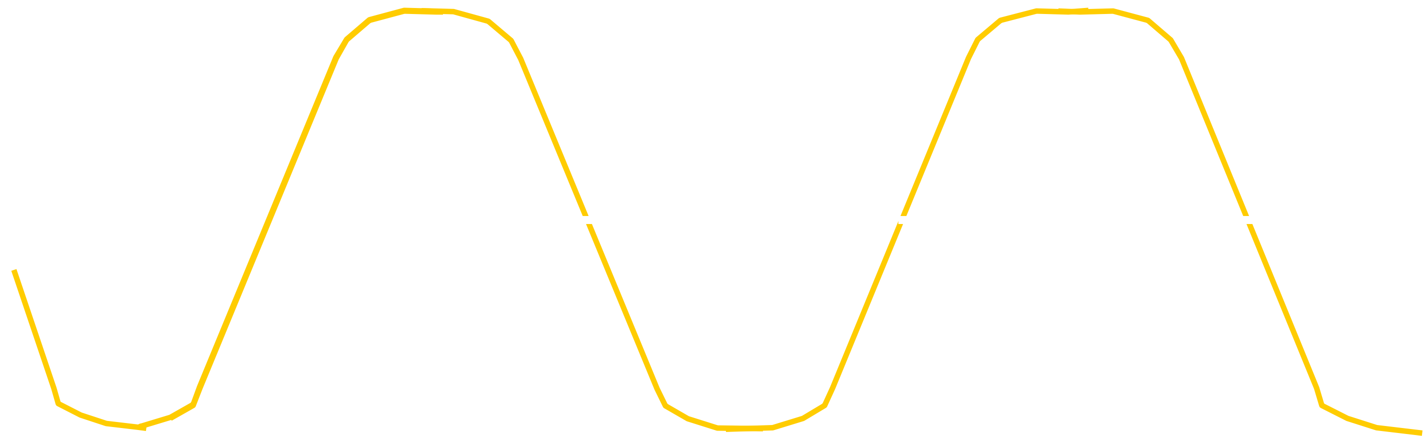
subcontractors

4. Backordering,

stable employment leads to better quality, less turnover, less absenteeism, and more employee commitment.

8. This strategy works well when demand is stable

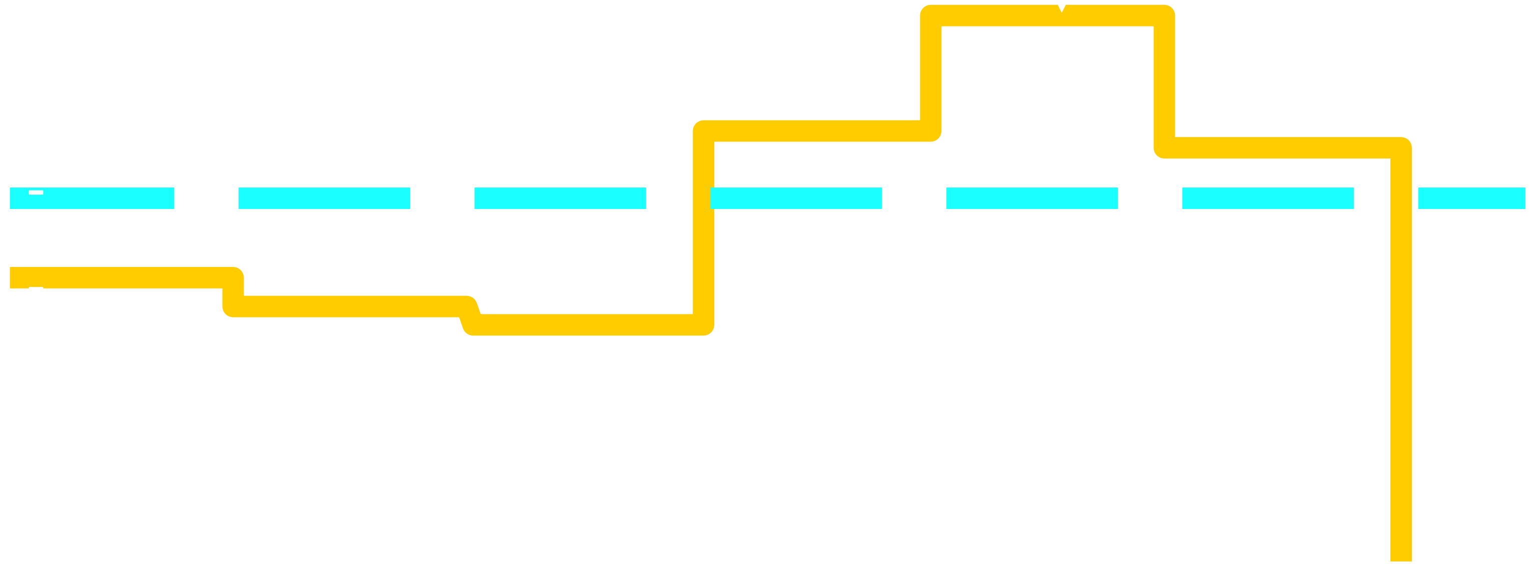
Level Production



Example 1

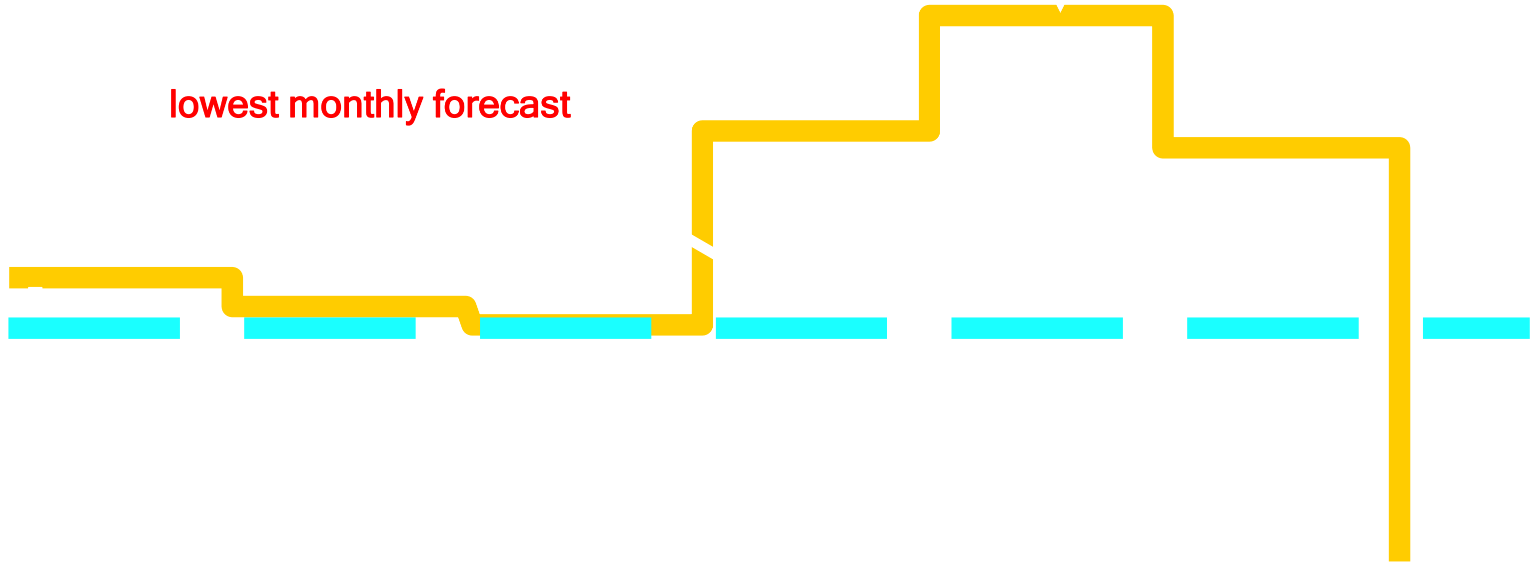
Month	Expected Demand	Production Days	Demand Per Day (computed)
Jan	900	22	41
Feb	700	18	39
Mar	800	21	38
Apr	1,200	21	57
May	1,500	22	68
June	1,100	20	55
	6,200	124	

Example 1



Jan Feb Mar Apr May
June
↓ ↓↓↓↓↓
18 21 1 22 20
2 2
2

Example 2



Jan Feb Mar Apr May

June

18 21 1 22 20

2 2

2

Chase Demand

Chase Demand

Mixed Strategies

- Two or more options, such as overtime, subcontracting, hiring and layoff, etc., are used.
- There are both inventory changes and work force and production rate changes over the planning horizon.
- Typically, mixed strategies are better (result in lower costs) than pure strategies

Master Production Schedule

Master Production Schedule

It indicates the and of planned production by taking into account desired delivery quantity and timing as well as on-hand inventory.

The MPS is one of the primary outputs of the master scheduling process.

DIMR

Disaggregating the aggregate plan

For example, televisions manufacturer may have an aggregate plan that calls for 200 television in .

This company produces inch TVs, therefore this three-month aggregate plan must be translated into specific numbers of TVs of each type prior to actually purchasing the appropriate materials and parts, scheduling operations, and planning inventory requirements.

Aggregate Plan to Master Schedule

Aggregate Planning

Disaggregation

Master Schedule

Jan	Feb	Mar.
200	**300**	**400**

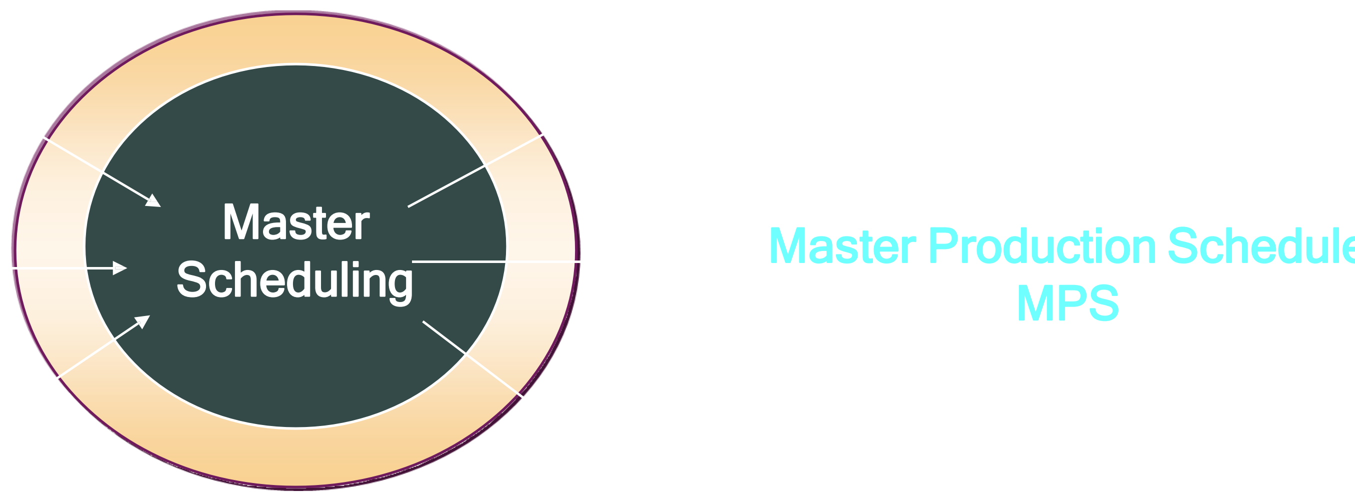
Type	Jan.	Feb.	Mar
21 inch	100	100	100
26 inch	75	150	200
29 inch	25	50	100
Total	**200**	**300**	**400**

Master scheduling

The result of the aggregate plan is a showing:

- ✓ the quantity and timing of specific end items for a scheduled horizon, which often covers about ahead.

Master Scheduling Process



Master schedule

Example: Master Schedule

A company that makes *industrial pumps* wants to prepare a Master Production Schedule (MPS) for June and July.

- ✓ Marketing has forecasted demand of 120 pumps for June and 160 pumps for July.
- ✓ These have been evenly distributed over the four weeks in each month: 30 per week in June and 40 per week in July.

Example: Master Schedule

Now suppose that there are currently 64 pumps in inventory (i.e., beginning inventory),

There are customer orders that have been committed for the first five weeks (booked) and must be filled which are 33, 20, 10, 4, and 2 respectively.

Suppose a production lot size of 70 pumps is used.

Prepare the Master Production Schedule

Beginning Inventory

	JUNE				JULY			
64	1	2	3	4	5	6	7	8
Forecast	30	30	30	30	40	40	40	40
Customer Orders (committed)	33	20	10	4	2			
Projected on-hand inventory	31	1	-29					

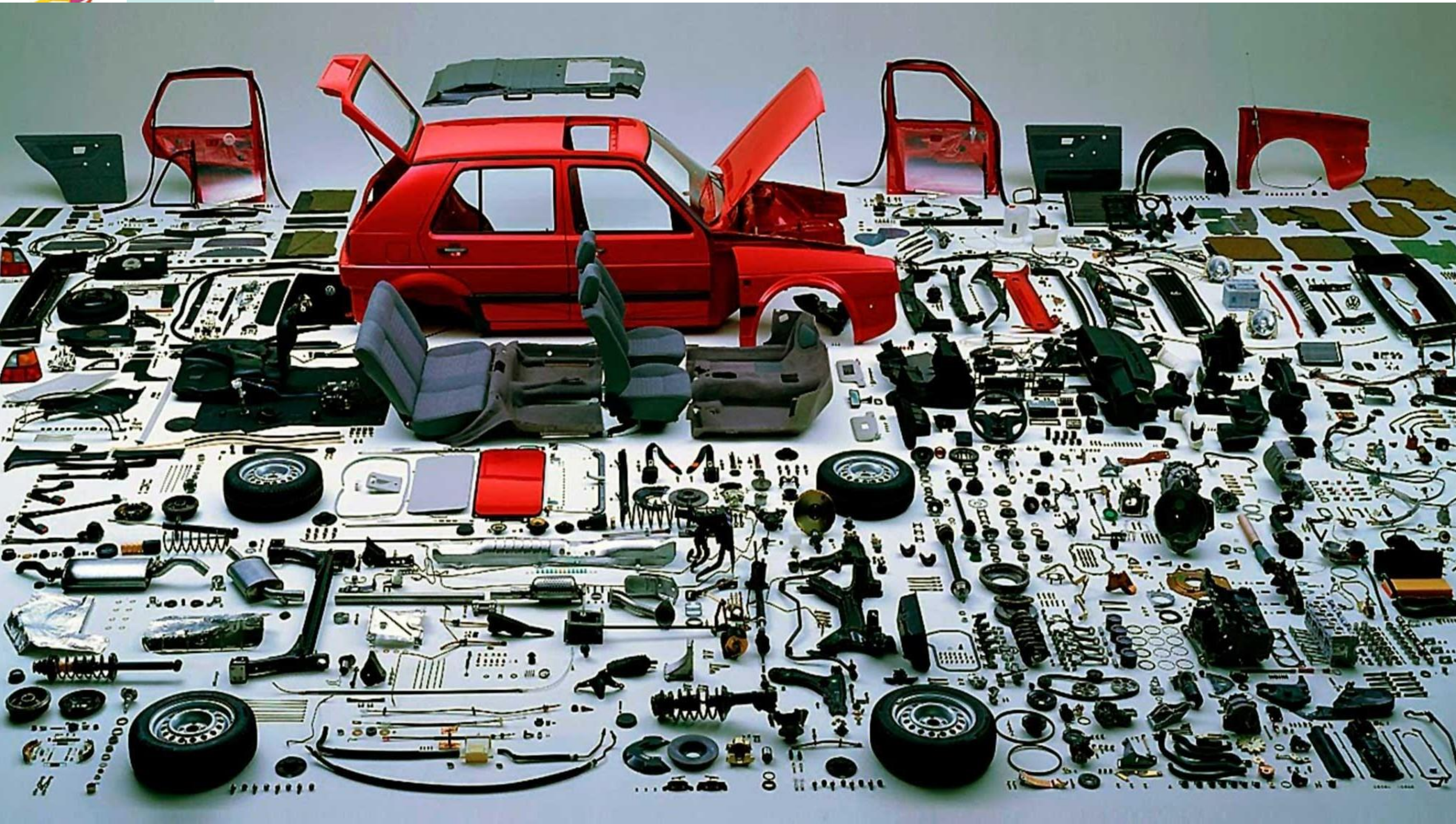
Forecast is larger than Customer orders in week 3

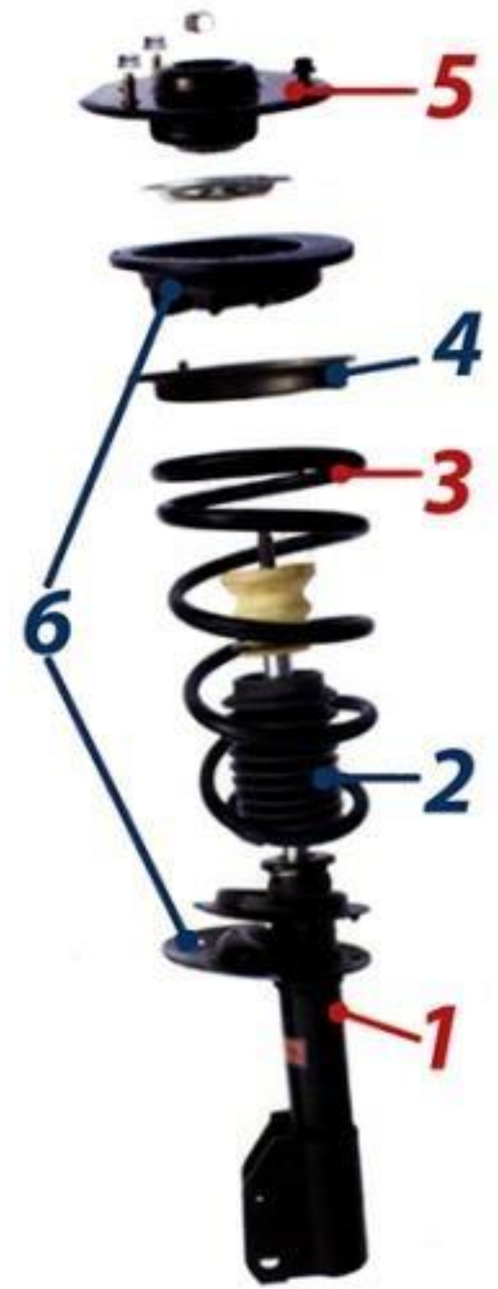
Customer orders are larger than forecast in week 1

Forecast is larger than Customer orders in week 2

Solution: The master schedule

Week	Inventory from previous week	Requirements	Net inventory before MPS	MPS	Projected inventory
1	64	33	31		31
2	31	30	01		01
3	01	30	-29	70	41
4	41	30	11		11
5	11	40	-29	70	41
6	41	40	01		01
7	01	40	-39	70	31
8	31	40	-09	70	61




5
4
3
6
2
1

- Materials requirements planning (MRP)

time scheduling information

50

250

Aggregate Product Plan

Firm orders from known customers

Forecasts of demand from estimates

Engineering Design Changes

Master Production Schedule (MPS)

Inventory Transactions

Bill of Material file

Material Planning (MRP)

Inventory Record file

Reports

Given the *product structure tree* for “A” and the lead time and demand information below, provide a materials requirements plan that defines the number of units of each component and when they will be needed.

A

B(4) C(2)

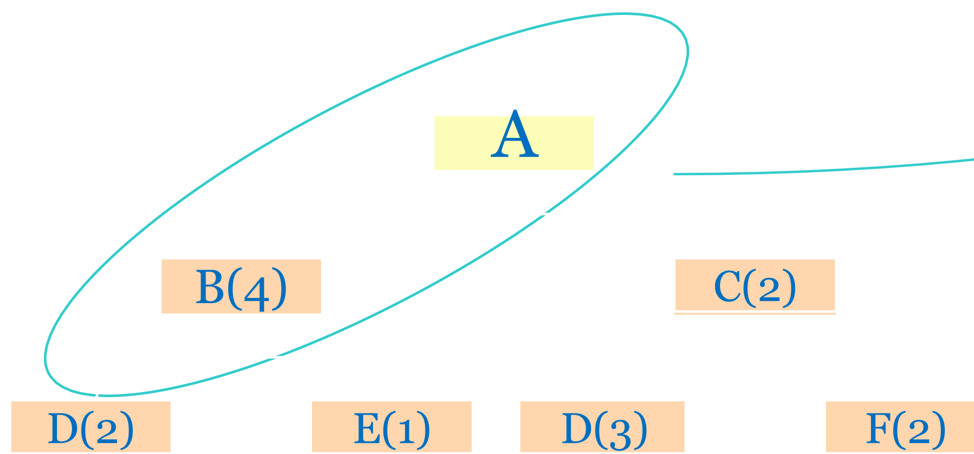
D(2) E(1) D(3) F(2)

Lead Times	
A	1 day
B	2 days
C	1 day
D	3 days
E	4 days
F	1 day

Demand	
Day 10	50 A
Day 8	20 B (Spares)
Day 6	15 D (Spares)

Next, we need to start scheduling the components that make up “A”. In the case of component “B” we need 4 B’s for each A. Since we need 50 A’s, that means 200 B’s. And again, we back the schedule up for the necessary 2 days of lead time.

	Day:	1	2	3	4	5	6	7	8	9	10
A	Required										50
	Order Placement									50	
B	Required								20	200	
	Order Placement						20	200			



4x50=200

Item		Day: 1	2	3	4	5	6	7	8	9	10
A	Required										50
LT=1	Order Placement									50	
B	Required								20	200	
LT=2	Order Placement						20	200			
C	Required										
LT=1	Order Placement										
D	Required										
LT=3	Order Placement										
E	Required										
LT=4	Order Placement										

Finally, repeating the process for all components, we have the final materials requirements plan:

	Day:	1	2	3	4	5	6	7	8	9	10
A	Required										50
LT=1	Order Placement									50	
B	Required								20	200	
LT=2	Order Placement						20	200			
C	Required									100	
LT=1	Order Placement								100		
D	Required						55	400	300		
LT=3	Order Placement			55	400	300					
E	Required						20	200			
LT=4	Order Placement		20	200							
F	Required								200		
LT=1	Order Placement							200			

A

B(4) C(2)

D(2) E(1) D(3) F(2)

Part D: Day 6

40 + 15 spares

Manufacturing Resource Planning (MRP II)

This is a development that seeks to address some of the shortcomings of MRP. It includes all of the elements of MRP, it: is based around the Bill of Materials,

uses a Master Production Schedule (MPS)

MRP II includes feedback from the shop floor on how the work has progressed, to all levels of the schedule so that the next run can be updated on a regular basis. For this reason it is sometimes called 'Closed Loop MRP'.

Distribution resource planning (DRP)

Distribution resource planning (**DRP**) is a method used in business administration for planning orders within a supply chain. **DRP** enables the user to set certain inventory control parameters (like a safety stock) and calculate the time-phased inventory requirements.

Capacity Requirements Planning (CRP)

Capacity Requirements Planning (**CRP**) is the process of determining what personnel and equipment capacities (times) are needed to meet the production objectives embodied **in the** master schedule and the material requirements plan.

Schedulin g

Process of arranging, controlling and optimizing work and workloads in a production process or manufacturing process.

Allocate plant and machinery resources, plan human resources, plan production processes and purchase materials.

Minimize the production time and costs, by telling a production facility when to make, with which staff, and on which equipment. Production scheduling aims to maximize the efficiency of the operation and reduce costs.

Loading

A load means the quantity of work, and allocating the quantity of work to the processes necessary to manufacture each item is called loading.

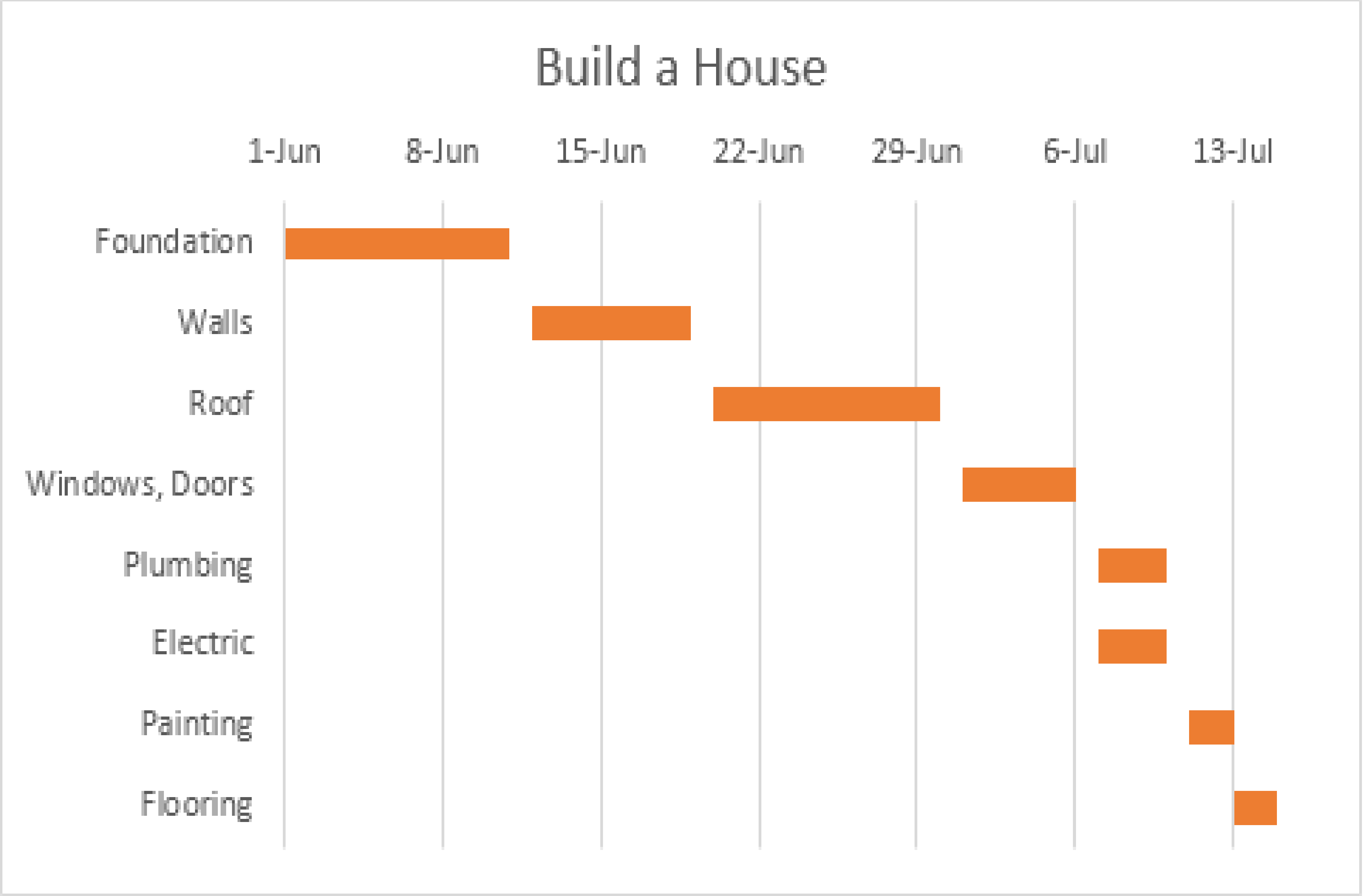
Gantt Chart

A Gantt chart, or harmonogram, is a type of bar chart that illustrates a project schedule.

This chart lists the tasks to be performed on the vertical axis, and time intervals on the horizontal axis.

The width of the horizontal bars in the graph shows the duration of each activity.

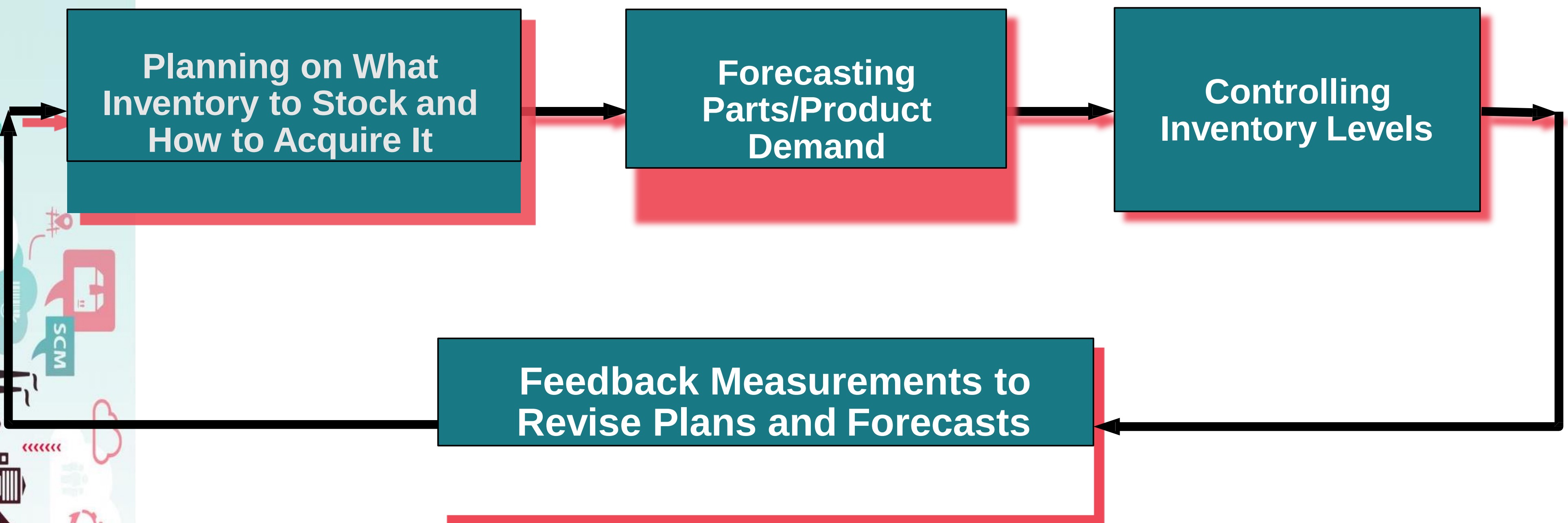
Gantt charts illustrate the start and finish dates of the terminal elements and summary elements of a project..


Build a House
1-Jun
8-Jun
15-Jun
22-Jun
29-Jun
6-Jul
13-Jul
Foundation
Walls
Roof
Windows, Doors
Plumbing
Electric
Painting
Flooring

UNIT 4: Inventory Management

Inventory management is the branch of business management that covers the planning and control of the inventory.

Inventory planning and control



Introduction

- Inventory is an expensive and important asset to many companies.
- Inventory is any stored resource used to satisfy a current or future need.
- Common examples are raw materials, work-in-process, and finished goods.
- Most companies try to balance high and low inventory levels with cost minimization as a goal.
  - Lower inventory levels can reduce costs.
  - Low inventory levels may result in stock outs and dissatisfied customers.

Introduction

All organizations have some type of inventory control system.

Inventory planning helps determine what goods and/or services need to be produced.

Inventory planning helps determine whether the organization produces the goods or services or whether they are purchased from another organization.

Inventory planning also involves demand forecasting.

Inventory Classes

Materials flow

suppliers → manufacturing → customers

raw materials | work-in-process (WIP). | finished goods

The progressive states of a material

SEMI-FINISHED goods

Maintenance, Repair, and Operational Supplies (MRO)

Items used in support of general operations and maintenance such as maintenance supplies, spare parts, and consumables used in the manufacturing process and supporting operations. These items are used in production but do not become part of the product.

Inventory Functions

Safety Stock – Safety stock is also called buffer stock.

Lot-size Inventory- quantity price discounts, reduce shipping and setup costs

De-coupling stock

Pipeline Inventory

Anticipation Inventory

Hedge Inventory

Importance of Inventory Control

- Five uses of inventory:
  - The decoupling function
  - Storing resources
  - Irregular supply and demand
  - Quantity discounts
  - Avoiding stockouts and shortages
- Decouple manufacturing processes.
  - Inventory is used as a buffer between stages in a manufacturing process.
  - This reduces delays and improves efficiency.

Importance of Inventory Control

- Storing resources.
  - Seasonal products may be stored to satisfy off-season demand.
  - Materials can be stored as raw materials, work-in-process, or finished goods.
    - component of partially completed subassemblies.
- Compensate for irregular supply and demand.
  - Demand and supply may not be constant over time.
  - Inventory can be used to buffer the variability.

Importance of Inventory Control

- Take advantage of quantity discounts.
  - Lower prices may be available for larger orders.
  - Extra costs associated with holding more inventory must be balanced against lower purchase price.
- Avoid stockouts and shortages.
  - Stockouts may result in lost sales.
  - Dissatisfied customers may choose to buy from another supplier.

Inventory Decisions

- There are two fundamental decisions in controlling inventory:
  - How much to order.
  - When to order.
- The major objective is to minimize total inventory costs.
- Common inventory costs are:
  - Cost of the items (purchase or material cost).
  - Cost of ordering.
  - Cost of carrying, or holding, inventory.
  - Cost of stockouts.

Inventory Cost Factors

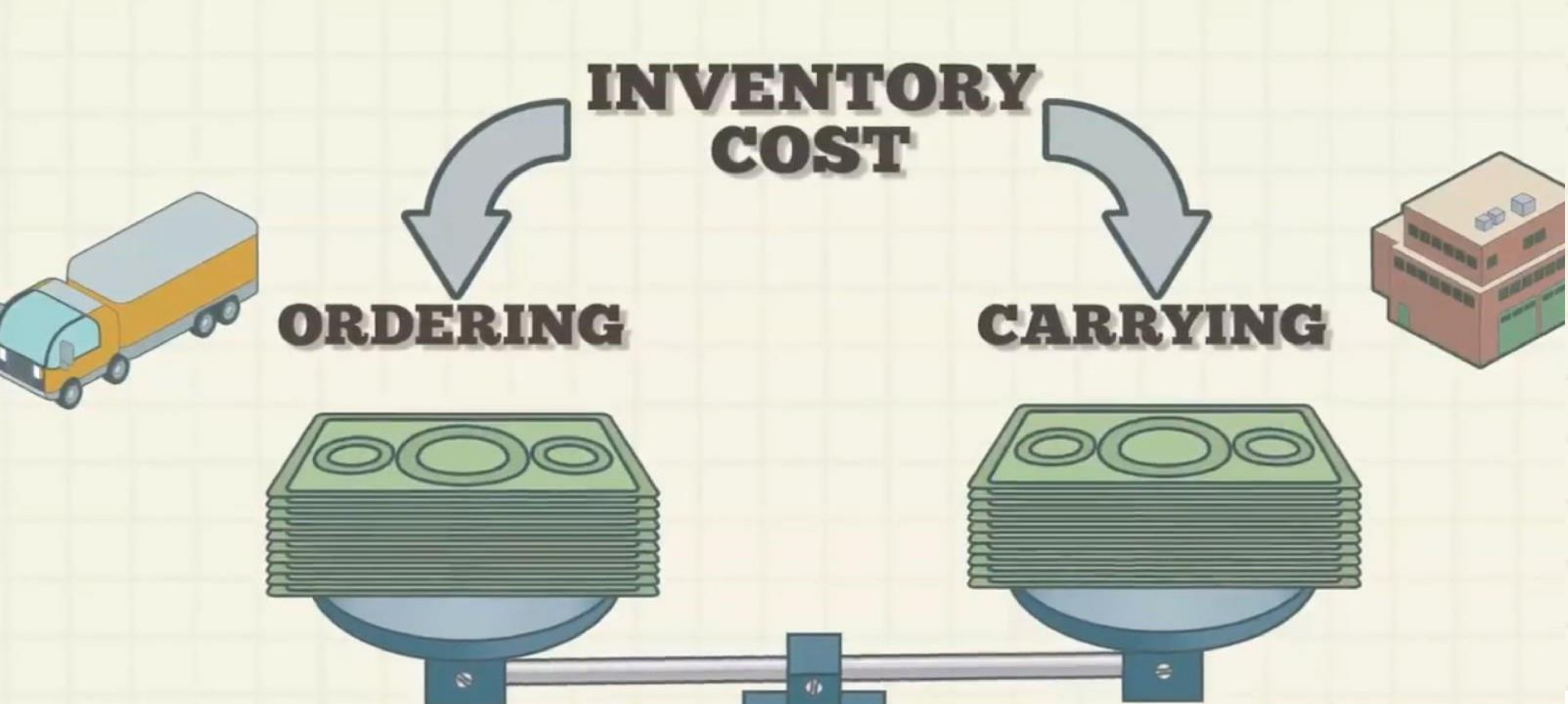
ORDERING COST FACTORS	CARRYING COST FACTORS
Developing and sending purchase orders	Cost of capital
Processing and inspecting incoming inventory	Taxes
Bill paying	Insurance
Inventory inquiries	Spoilage
Utilities, phone bills, and so on, for the purchasing department	Theft
Salaries and wages for the purchasing department employees	Obsolescence
Supplies, such as forms and paper, for the purchasing department	Salaries and wages for warehouse employees
	Utilities and building costs for the warehouse
	Supplies, such as forms and paper, for the warehouse

Inventory Cost Factors

- Ordering costs are generally independent of order quantity.
  - Many involve personnel time.
  - The amount of work is the same no matter the size of the order.
- Carrying costs generally varies with the amount of inventory, or the order size.
  - The labor, space, and other costs increase as the order size increases.
- The actual cost of items purchased can vary if there are quantity discounts available.

Economic Order Quantity

- The *economic order quantity* (EOQ) model is one of the oldest and most commonly known inventory control techniques.
- It is easy to use but has a number of important assumptions.
- Objective is to minimize total cost of inventory.

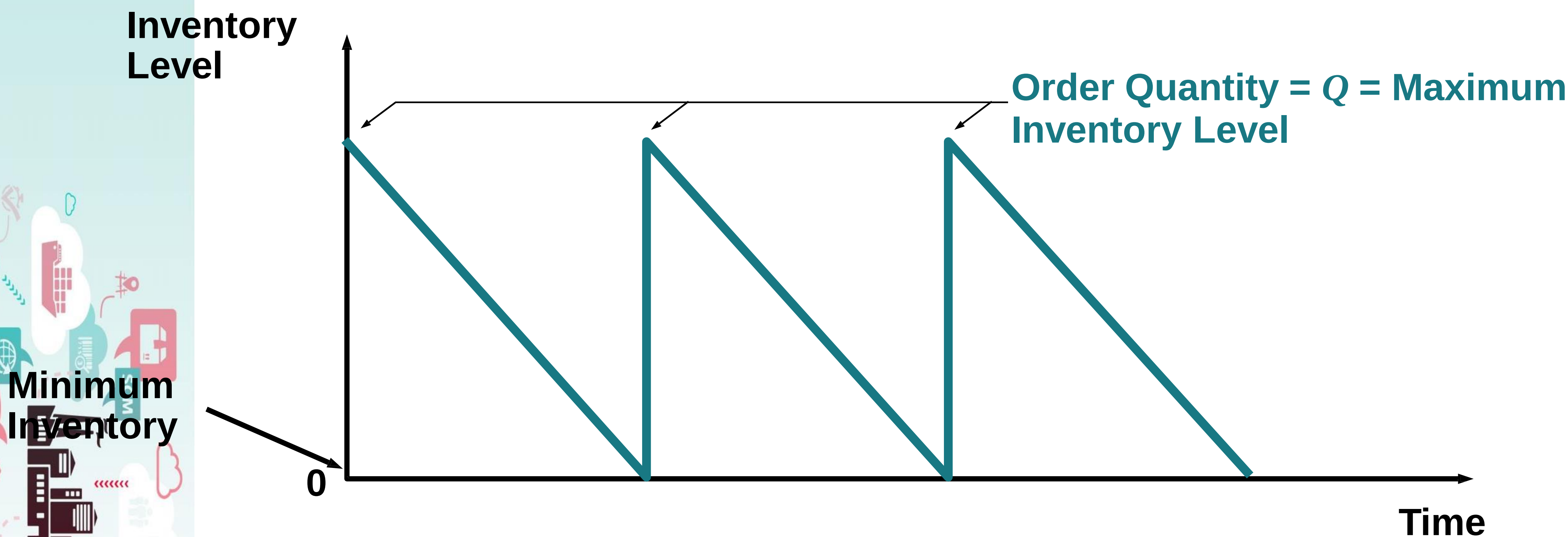

INVENTORY
COST
ORDERING
CARRYING

Economic Order Quantity

Assumptions:

1. Demand is known and constant.
2. Lead time is known and constant.
3. Receipt of inventory is instantaneous.
4. Purchase cost per unit is constant throughout the year.
5. The only variable costs are the cost of placing an order, *ordering cost*, and the cost of holding or storing inventory over time, *holding* or *carrying cost*, and these are constant throughout the year.
6. Orders are placed so that stockouts or shortages are avoided completely.

Inventory Usage Over Time



Inventory Costs in the EOQ Situation

$$\text{Average inventory level} = \frac{Q}{2}$$

	INVENTORY LEVEL		
DAY	BEGINNING	ENDING	AVERAGE
April 1 (order received)	10	8	9
April 2	8	6	7
April 3	6	4	5
April 4	4	2	3
April 5	2	0	1

Maximum level April 1 = 10 units
Total of daily averages = 9 + 7 + 5 + 3 + 1 = 25
Number of days = 5, Average inventory level = 25/5 = 5 units

Inventory Costs in the EOQ Situation

Q = number of pieces to order
EOQ = Q^* = optimal number of pieces to order
D = annual demand in units for the inventory item
C_o = ordering cost of each order
C_h = holding or carrying cost per unit per year

$$\text{Annual ordering cost} = \begin{pmatrix}\text{Number of orders} \\ \text{placed per year}\end{pmatrix} \times \begin{pmatrix}\text{Ordering} \\ \text{cost per} \\ \text{order}\end{pmatrix}$$

$$= \frac{D}{Q} C_o$$

Inventory Costs in the EOQ Situation

Mathematical equations can be developed using:

Q = number of pieces to order

EOQ = Q^* = optimal number of pieces to order

D = annual demand in units for the inventory item

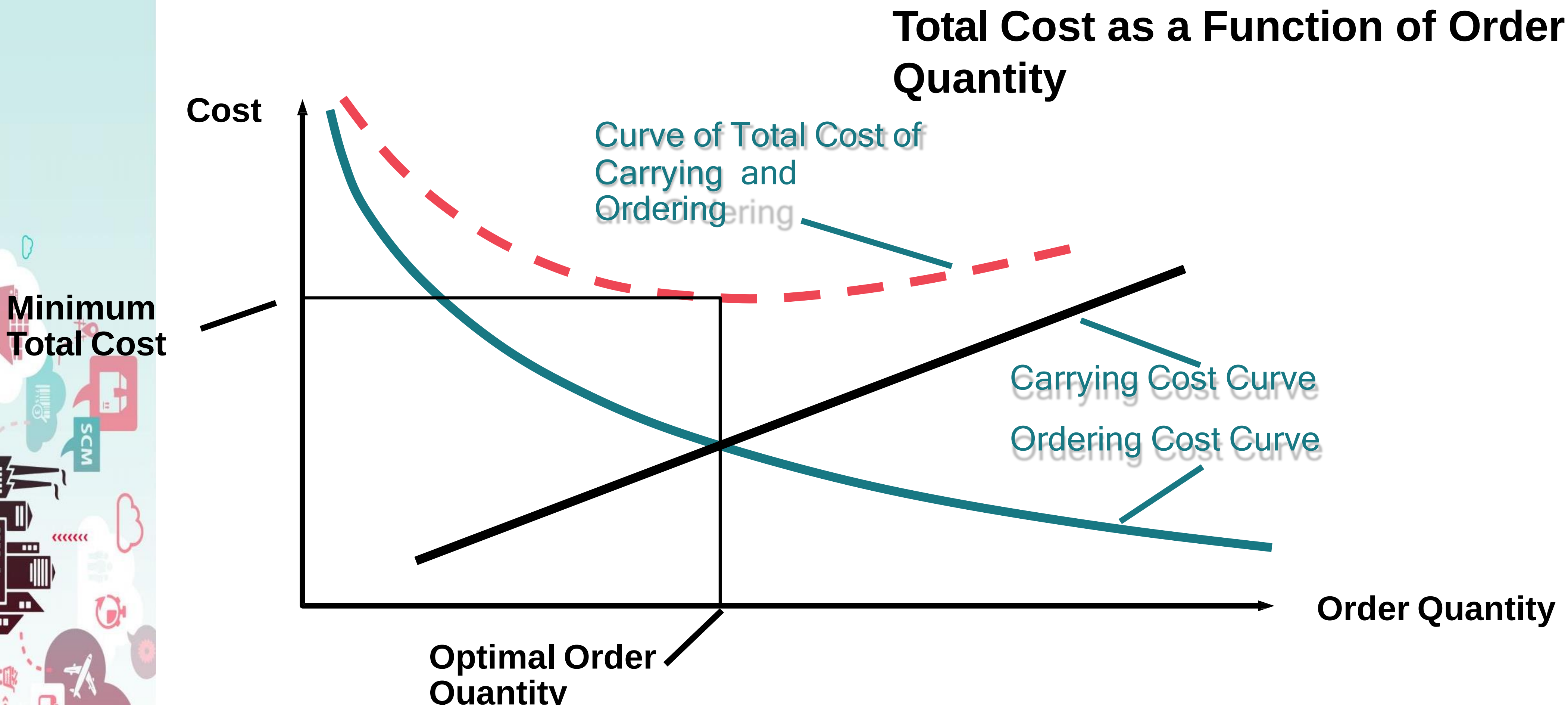
C_o = ordering cost of each order

C_h = holding or carrying cost per unit per year

$$\text{Annual holding cost} = \begin{pmatrix}\text{Average}\\ \text{inventory}\end{pmatrix} \times \begin{pmatrix}\text{Carrying cost per}\\ \text{unit per year}\end{pmatrix}$$

$$= \frac{Q}{2} C_h$$

Inventory Costs in the EOQ Situation



Finding the EOQ

According to the graph, when the EOQ assumptions are met, total cost is minimized when annual ordering cost equals annual holding cost.

Solving for Q

$$\frac{D}{Q}C_o = \frac{Q}{2}C_h \qquad 2DC_o = Q^2C_h$$

$$\frac{2DC_o}{C_h} = Q^2 \qquad \sqrt{\frac{2DC_o}{C_h}} = Q = \text{EOQ} = Q^*$$

Economic Order Quantity (EOQ) Model

Summary of equations:

$$\text{Annual ordering cost} = \frac{D}{Q} C_o$$

$$\text{Annual holding cost} = \frac{Q}{2} C_h$$

$$EOQ = Q^* = \sqrt{\frac{2 D C_o}{C_h}}$$

Sumco Pump Company

- Sumco Pump Company sells pump housings to other companies.
- The firm would like to reduce inventory costs by finding optimal order quantity.
  - Annual demand = 1,000 units and cost of per unit is $ 100
  - Ordering cost = $10 per order
  - Average carrying cost per unit per year = $0.50

$$Q^* = \sqrt{\frac{2DC_o}{C_h}} = \sqrt{\frac{2(1,000)(10)}{0.50}} = \sqrt{40,000} = 200 \text{ units}$$

Sumco Pump Company

Total cost = Material cost + Ordering cost + Holding cost

$$\textbf{Total cost} = DC + \frac{D}{Q}C_o + \frac{Q}{2}C_h$$

$$= 1000 \times 100 + \frac{1,000}{200}(10) + \frac{200}{2}(0.5)$$

$$= 100000 + 50 + 50$$

$$= 100100$$

$$\textbf{Total cost} = DC + \frac{D}{Q}C_o + \frac{Q}{2}C_h$$

80000*50 +80000/8000*1200+8000/2*3

ABC Ltd. uses EOQ logic to determine the order quantity for its various components and is planning its orders. The Annual consumption is 80,000 units, Cost to place one order is Rs. 1,200, Cost per unit is Rs. 50 and carrying cost is 6% of Unit cost. Find EOQ, No. of order per year, Ordering Cost and Carrying Cost and Total Cost of Inventory.

Midwest Precision Control Corporation is trying to decide between two alternate Order Plans for its inventory of a certain item. Irrespective of the plan to be followed, demand for the item is expected to be 1,000 units annually. Under Plan 1st, Midwest would use a teletype for ordering; order costs would be Rs. 40 per order. Inventory holding costs (carrying cost) would be Rs. 100 per unit per annum. Under Plan 2nd order costs would be Rs. 30 per order. And holding costs would 20% and unit Cost is Rs. 480. Find out EOQ and Total Inventory Cost than decide which Plan would result in the lowest total inventory cost?

A local TV repairs shop uses 36,000 units of a part each year (A maximum consumption of 100 units per working day). It costs Rs. 20 to place and receive an order. The shop orders in lots of 400 units. It cost Rs. 4 to carry one unit per year of inventory.

Requirements:

(1) Calculate total annual ordering cost

(2) Calculate total annual carrying cost

(3) Calculate total annual inventory cost

(4) Calculate the Economic Order Quantity

(5) Calculate the total annual cost inventory cost using EOQ inventory Policy

(6) How much save using EOQ

(7) Compute ordering point assuming the lead time is 3 days d*L

Purchase Cost of Inventory Items

Inventory carrying cost is often expressed as an annual percentage of the unit cost or price of the inventory.

This requires a new variable.

$$I = \left(\text{Annual inventory holding charge as a percentage of unit price or cost} \right)$$

- The cost of storing inventory for one year is then

$$C_h = IC$$

thus,

$$Q^* = \sqrt{\frac{2DC_o}{IC}}$$

Sensitivity Analysis with the EOQ Model

- The EOQ model assumes all values are know and fixed over time.
- Generally, however, some values are estimated or may change.
- Determining the effects of these changes is called *sensitivity analysis.*
- Because of the square root in the formula, changes in the inputs result in relatively small changes in the order quantity.

$$EOQ = \sqrt{\frac{2DC_o}{C_h}}$$

Sensitivity Analysis with the EOQ Model

- In the Sumco Pump example:

$$EOQ = \sqrt{\frac{2(1,000)(10)}{0.50}} = 200\ \text{units}$$

- If the ordering cost were increased four times from $10 to $40, the order quantity would only double

$$EOQ = \sqrt{\frac{2(1,000)(40)}{0.50}} = 400\ \text{units}$$

- In general, the EOQ changes by the square root of the change to any of the inputs.

Reorder Point: Determining When To Order

- Once the order quantity is determined, the next decision is *when to order.*
- The time between placing an order and its receipt is called the *lead time* (L) or *delivery time.*
- When to order is generally expressed as a *reorder point* (ROP).

$$\text{ROP} = \begin{pmatrix}\textbf{Demand per}\\ \textbf{day}\end{pmatrix} \times \begin{pmatrix}\textbf{Lead time for a new order}\\ \textbf{in days}\end{pmatrix}$$

$$= d \times L$$

Procomp's Computer Chips

Demand for the computer chip is 8,000 per year.

Daily demand is 40 units.

Delivery takes three working days.

$$\mathrm{ROP} = d \times L = \textbf{40 units per day} \times \textbf{3 days}$$
$$= \textbf{120 units}$$

- An order based on the EOQ calculation is placed when the inventory reaches 120 units.
- The order arrives 3 days later just as the inventory is depleted.

Quantity Discount Models

- Quantity discounts are commonly available.
- The basic EOQ model is adjusted by adding in the purchase or materials cost.

Total cost = Material cost + Ordering cost + Holding cost

$$\text{Total cost} = DC + \frac{D}{Q}C_o + \frac{Q}{2}C_h$$

where

D = annual demand in units

C_o = ordering cost of each order

C = cost per unit

C_h = holding or carrying cost per unit per year

Quantity Discount Models

Because unit cost is now variable,

Holding cost $= C_h = IC$

$I =$ holding cost as a percentage of the unit cost (C)

To

$$\text{Total cost} = DC + \frac{D}{Q}C_o + \frac{Q}{2}C_h$$

where

$D =$ annual demand in units

C_o = ordering cost of each order

C = cost per unit

C_h = holding or carrying cost per unit per year

Quantity Discount Models

- A typical quantity discount schedule can look like the table below.
- However, buying at the lowest unit cost is not always the best choice.

DISCOUNT NUMBER	DISCOUNT QUANTITY	DISCOUNT (%)	DISCOUNT COST ($)
1	0 to 999	0	5.00
2	1,000 to 1,999	4	4.80
3	2,000 and over	5	4.75

Brass Department Store

- Brass Department Store stocks toy race cars.
- Their supplier has given them the quantity discount schedule shown
  - Annual demand is 5,000 cars, ordering cost is $49, and holding cost is 20% of the cost of the car
- The first step is to compute EOQ values for each discount.

$$EOQ_1 = \sqrt{\frac{(2)(5,000)(49)}{(0.2)(5.00)}} = 700 \text{ cars per order}$$

$$EOQ_2 = \sqrt{\frac{(2)(5,000)(49)}{(0.2)(4.80)}} = 714 \text{ cars per order}$$

$$EOQ_3 = \sqrt{\frac{(2)(5,000)(49)}{(0.2)(4.75)}} = 718 \text{ cars per order}$$

Brass Department Store Example

- The second step is adjust quantities below the allowable discount range.
- The EOQ for discount 1 is allowable.
- The EOQs for discounts 2 and 3 are outside the allowable range and have to be adjusted to the smallest quantity possible to purchase and receive the discount:

$$Q_1 = 700$$
$$Q_2 = 1{,}000$$
$$Q_3 = 2{,}000$$

Brass Department Store

The third step is to compute the total cost for each quantity.

DISCOUNT NUMBER	UNIT PRICE (C)	ORDER QUANTITY (Q)	ANNUAL MATERIAL COST ($) $= DC$	ANNUAL ORDERING COST ($) $= (D/Q)C_o$	ANNUAL CARRYING COST ($) $= (Q/2)C_h$	TOTAL ($)
1	$5.00	700	25,000	350.00	350.00	25,700.00
2	4.80	1,000	24,000	245.00	480.00	24,725.00
3	4.75	2,000	23,750	122.50	950.00	24,822.50

The final step is to choose the alternative with the lowest total cost.

BIKO is a bike retailer located in the outskirts of Paris.

BIKO purchases bikes from PMX in orders of 250 bikes which is the current economic order quantity.

PMX is now offering the following bulk discounts to its customers:

2% discount on orders above 200 units

4% discount on orders above 500 units

6% discount on orders above 600 units

BIKO is wondering if the EOQ model is still the most economical and whether increasing the order size would actually be more beneficial.

Following information is relevant to forming the decision:

Annual demand is 5000 units

Ordering cost is $100 per order

Annual holding cost is comprised of the following:

- 5% insurance premium for the average inventory held during the year calculated using the net purchase price
- Warehousing cost of $6 per unit

Purchase price is $200 per unit before discount

ABC Analysis

- The purpose of ABC analysis is to divide the inventory into three groups based on the overall inventory value of the items.
- Group A items account for the major portion of inventory costs.
  - Typically about 70% of the dollar value but only 10% of the quantity of items.
  - Forecasting and inventory management must be done carefully.
- Group B items are more moderately priced.
  - May represent 20% of the cost and 20% of the quantity.
- Group C items are very low cost but high volume.
  - It is not cost effective to spend a lot of time managing these items.

DIMR

ABC

	A Highly Important	B Moderately Important	C Less Important
% Value	70%	20%	10%
% Quantity	10%	20%	70%

Summary of ABC Analysis

INVENTORY GROUP	DOLLAR USAGE (%)	INVENTORY ITEMS (%)	ARE QUANTITATIVE CONTROL TECHNIQUES USED?
A	70	10	Yes
B	20	20	In some cases
C	10	70	No

Products	Value in Rs.
Product 1	20
Product 2	76
Product 3	90
Product 4	320
Product 5	120
Product 6	10
Product 7	400
Product 8	25
Product 9	43
Product 10	16
Product 11	32
Product 12	60
Product 13	78
Product 14	234
Product 15	154

Item No.	Consumption Qty	Price/unit
R-016	2500	200.00
R-004	1400	325.00
R-012	5000	200.00
R-006	2000	320.00
R-007	4500	50.00
R-009	900	325.00
R-019	2000	100.00
R-010	3000	44.00
R-011	1300	100.00
R-003	400	320.00
R-013	600	200.00
R-014	2000	50.00
R-015	2000	325.00
R-008	2346	200.00
R-017	5200	320.00
R-018	2000	200.00
R-005	450	325.00

FSN Analysis:-

FSN stands for FAST MOVING , SLOW MOVING and NON-MOVING. Here, classification is based on the pattern of issues from stores and is useful in controlling obsolescence.

To carry out an FSN analysis, the date of receipt or the last date of issue, whichever is later, is taken to determine the number of months, which have lapsed since the last transaction. The items are usually grouped in periods of 12 months.

FSN analysis is helpful in identifying active items which need to be reviewed regularly and surplus items which have to be examined further. Non-moving items may be examined further and their disposal can be considered.

SOS Classification:-

Raw materials, especially agricultural inputs are generally classified by the seasonal, off-seasonal systems since the prices during the season would generally be lower.

The seasonal items which are available only for a limited period should be procured and stocked for meeting the needs of the full year. The prices of the seasonal items which are available throughout the year are generally less during the harvest season.

The quantity required of such items should, therefore, be determined after comparing the cost savings on account of lower prices, if purchased during season, with the higher cost of carrying inventories if purchased throughout the year.

A Buying and stocking strategy for seasonal items depend on a large number of factors and more and more sophistication is taken place in this sphere and operational techniques are used to obtain optimum results.

XYZ Analysis:-

While the ABC analysis is based on the assumption on value, XYZ analysis is based on the value of inventory undertaken during the closing of annual accounts. X items are those having high value, Y items are those whose inventory values are medium and Z items are those whose inventory values are low.

The percentages are similar to ABC analysis. This analysis helps find items with heavy stock.

GOLF Classification:-

The letter stands for

Government,

Ordinary,

Local and

Foreign.

There are mainly imported items which are canalized through the State Trading Corporation (STC) Minerals and Metals Trading Corporation, etc. Indian Drugs and Pharmaceutical Ltd (IDPL), Mica trading corporation etc. These are special procedures of inventory control which may not applicable to ordinary items as they require special procedures.

MNG Analysis:-

The grouping of inventory items in this analysis takes place as:

M- Moving items – The items which are consumed from time to time are normally referred to as moving items.

N- Non moving items – These items which are not and consumed in last one year are covered under this group.

G- Ghost items – This group refers to such items which neither have been received nor issued during the year. The balance of such items shown in stock registers of the organization will be nil, both at the beginning and at the end of the previous financial year.

VED

Basis of Criticality

Vital

Essential

Desirable

HML

High Value

Medium Value

Low Value

Inventory turns ratios

An efficient company keeps the least inventory on hand to make the sales it does.

Goods are available when required and spend the least amount of time waiting in a warehouse.

Capital & opportunity cost,.

Michael Dell revolutionized the computer industry with his made-to-order business model- zero inventories

Inventory is a make or break item in the financials of a company, there is obviously an interest amongst analysts and investors who want to have a close watch on its performance.

Hence, the inventory turnover ratio is amongst their favorites.

$$\text{Inventory Turnover Ratio} = \frac{\text{Cost Of Goods Sold}}{\text{Average Inventory}}$$

$$\text{Average Inventory} = \frac{(\text{Beginning Inventory} + \text{Ending Inventory})}{2}$$

Instead of Sales, Cost of Goods Sold is used to calculate this specific turnover ratio. This is because inventories are stored at cost price.

Inventory turnover ratio needs to be compared with the performance of others. Usually the comparison is done between:

The company’s own inventory turnover ratio for previous years.

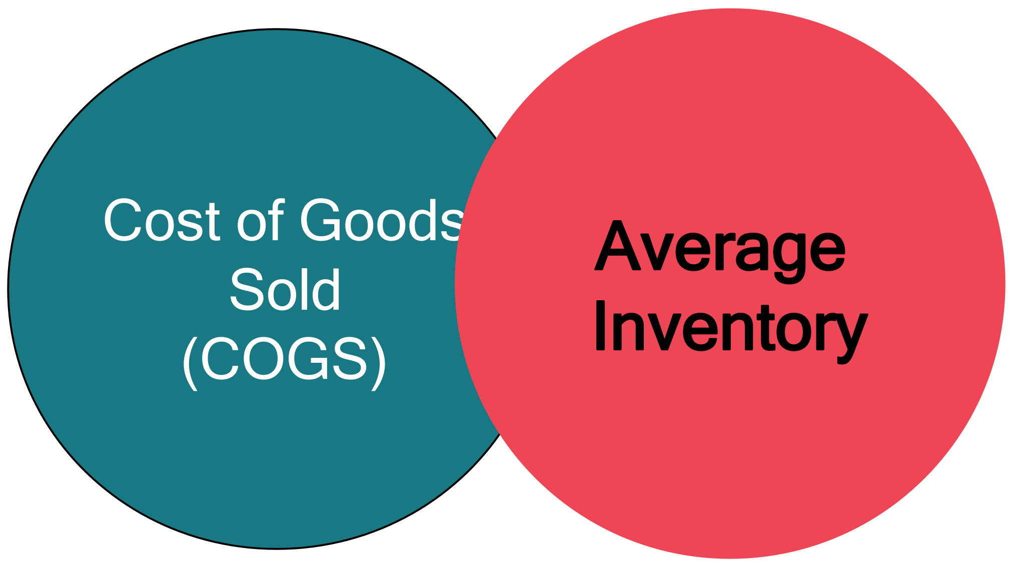
The inventory turnover ratio of other companies in the same or different industry. Different industries are usually considered in the calculation of inventory turnover ratio.

This is because the best practices can usually be applied regardless of the industry. Dell’s made to order business model has been replicated countless times in different industries.

“Inventory Turnover Ratio helps in evaluating **HOW WELL THE MANAGEMENT IS WORKING** in managing the inventory and generating sales from it”

It is the measure of HOW QUICKLY YOUR BUSINESS SELLS through its inventory in a given period of time and needs to replace it again

Inventory turnover is a financial ratio which depends on



Deciding the Inventory Turnover Period

The time period can range from one single day or an entire year or it can be a particular week.

We cannot CALCULATE INVENTORY TURNOVER AT A PARTICULAR INSTANT

Calculating the Cost of Goods Sold(COGS)

Cost of goods sold is the direct total expense associated with the production of goods sold or the cost of the goods you ACQUIRE TO SELL TO THE CUSTOMERS

Inventory turnover period

Inventory turnover period in simple words is also known as the AVERAGE NUMBER OF DAYS REQUIRED TO SELL A PRODUCT

inventory turnover Ration Interpretation

High inventory turnover indicates fast moving inventories and efficient operations

Low inventory turnover indicates that the company's goods are spending a lot of time being stored in the warehouse

Items with high turnover are good because there are MANY PRODUCTS THAT TEND TO EXPIRE SOON or get out of season quickly

Republican Manufacturing Co. has a cost of goods sold of $5M for the current year. The company's cost of beginning inventory was $600,000 and the cost of ending inventory was $400,000.

inventory turnover is rated at 10 times a year.

inventory turnover days

$$Inventory\ Turnover\ days = \frac{\underline{Average\ Inventory}}{Cost\ of\ Goods\ Sold} \text{ x } 365$$

$$Inventory\ Turnover\ days = \text{x} \frac{60000+40000)/2}{5000000} 365$$

$Inventory\ Turnover\ days\ 36.5$ Days

Calculate inventory turnover and days inventories on hand for ABC, Inc. based on the information given below:

Opening inventories	$25,000
Closing inventories	$30,000
Cost of goods manufactured	$245,000

Inventory Systems/Model

Inventory systems answer the questions: When to order and how much to order

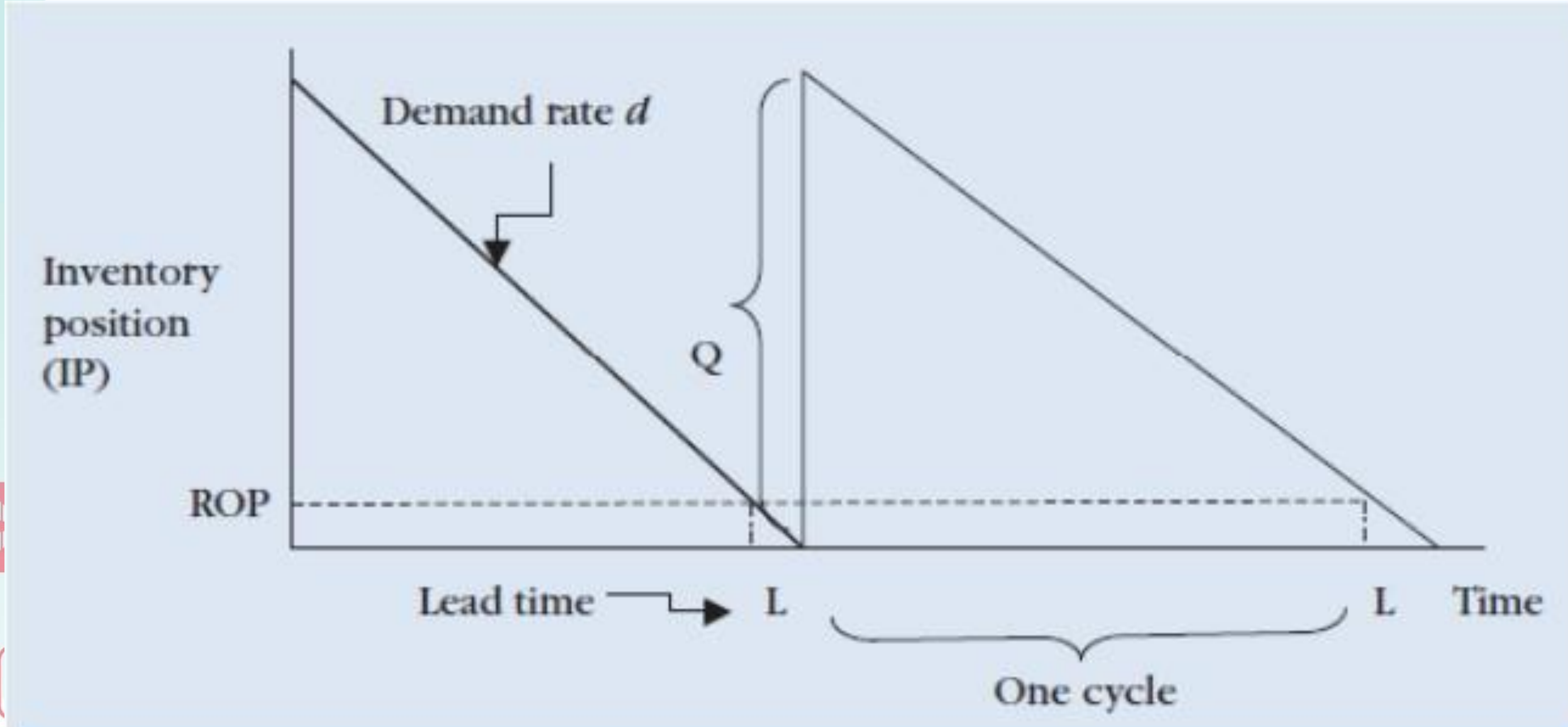
There are two categories:

- **Fixed-Order Quantity System** - an order of fixed quantity, Q, is placed when inventory drops to a reorder point, ROP
- **Fixed-Time Period System** - inventory is checked in fixed time periods, T, and the quantity ordered varies

Fixed Order quantity Model

- assumes a constant demand rate of d
- the inventory position, IP, is reduced by a rate of d
- order placed when the reorder point, ROP is reached
- when inventory is received, the IP is increased by the order quantity, Q

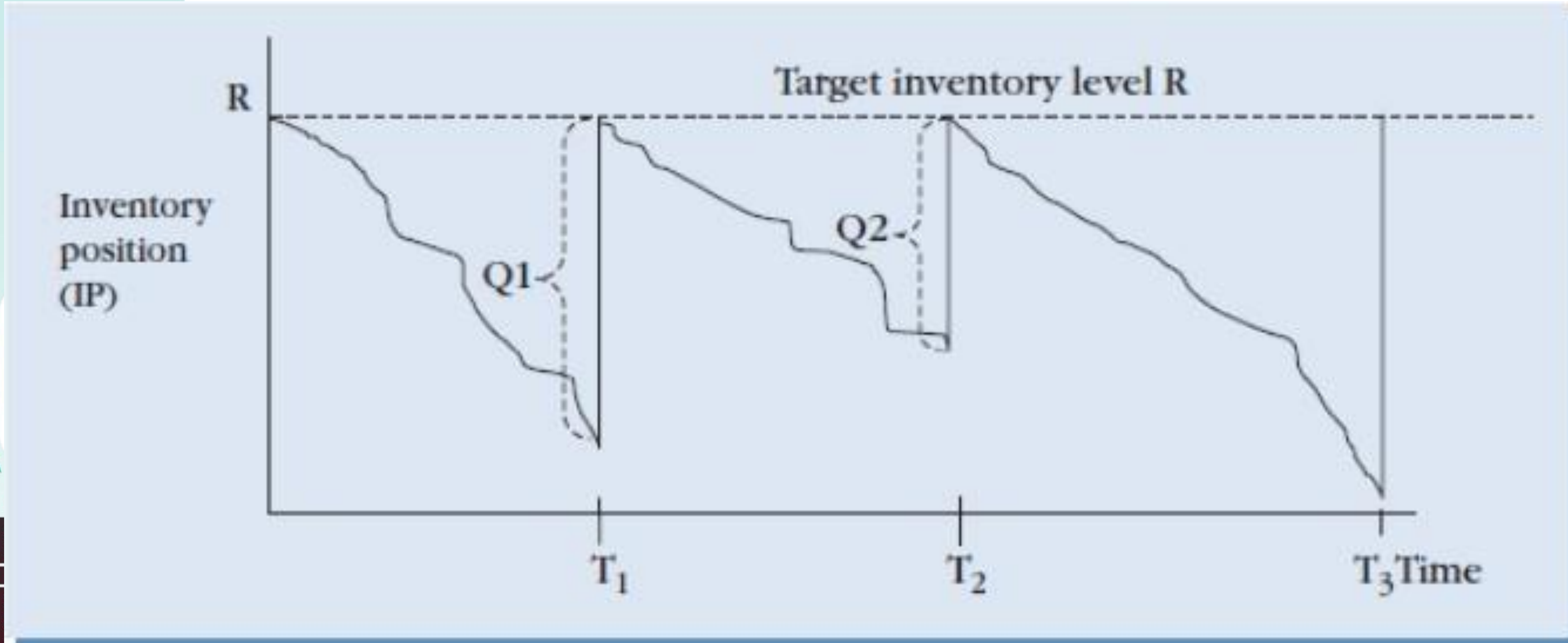
- there is a lead time, L, during which we have to wait for the order
- inventory is checked on a continual basis
- Q is computed as the economic order quantity, EOQ



Demand rate d
Inventory position (IP)
Q
ROP
Lead time
L
L
Time
One cycle

Fixed-Time Period System

- inventory levels checked in fixed time periods, T
- a target inventory level, R, is restored when order received
- sometimes called Periodic Review System
- quantity ordered varies: Q = R - IP where: Q = order quantity R = target inventory level IP = inventory position



Target inventory level R
R
Inventory
position
(IP)
Q1
Q2
T_1
T_2
T_3 Time

	Fixed-order quantity	Fixed-time period
How much to order?	Order quantity Q = EOQ	Order quantity Q = R – IP
When to order?	When inventory level drops to reorder point – ROP	When review period arrives – T
Order quantity	Fixed	Variable
Recordkeeping	Continual	Periodic—at review interval
Size of inventory	Lower	Higher
Time to maintain	Higher	Lower
Type of items	Higher valued items	Quantity discount options

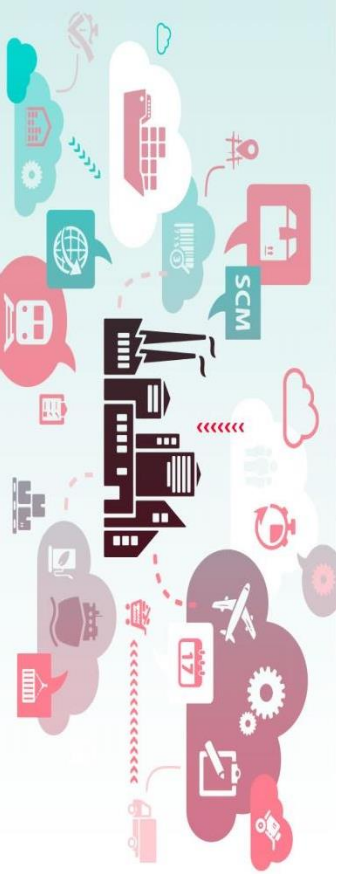
Vendor Managed Inventory (VMI)

VMI arrangements have the vendor responsible for managing the inventory located at a customer's facility

The vendor:

- stocks inventory
- places replenishment orders
- arranges the display
- typically owns inventory until purchased
- is required to work closely with customer

DIMR



UNIT 5:

Supply Chain Management

Supply chain concept,

Generalized Supply Chain Management Model –

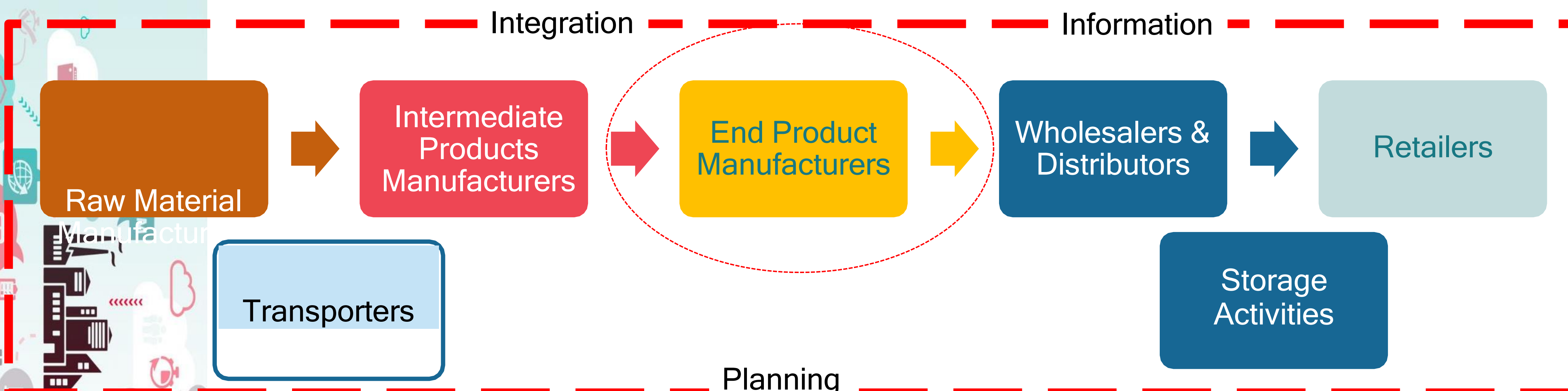
Key Issues in SCM – Collaboration, Enterprise Extension, responsiveness, Cash to Cash Conversion.

Customer Service: Supply Chain Management and customer service linkages, Availability service reliability perfect order, customer satisfaction.

Enablers of SCM - Facilities, Inventory, Transportation, Information, sourcing, Pricing.

What is a Supply Chain?

Flow of Products and Services from:



What Is Supply Chain Management?

A set of approaches utilized to efficiently integrate **suppliers**, **manufacturers**, **warehouses**, and **stores**, so that merchandise is produced and distributed at the **right quantities**, to the **right locations**, and at the **right time,** in order to minimize system wide costs while satisfying service level requirements.

Suppliers

Manufacturers

Warehouses

Stores

Produce

Merchandise

Distributed

Right Quantity

Right Location

Right Time

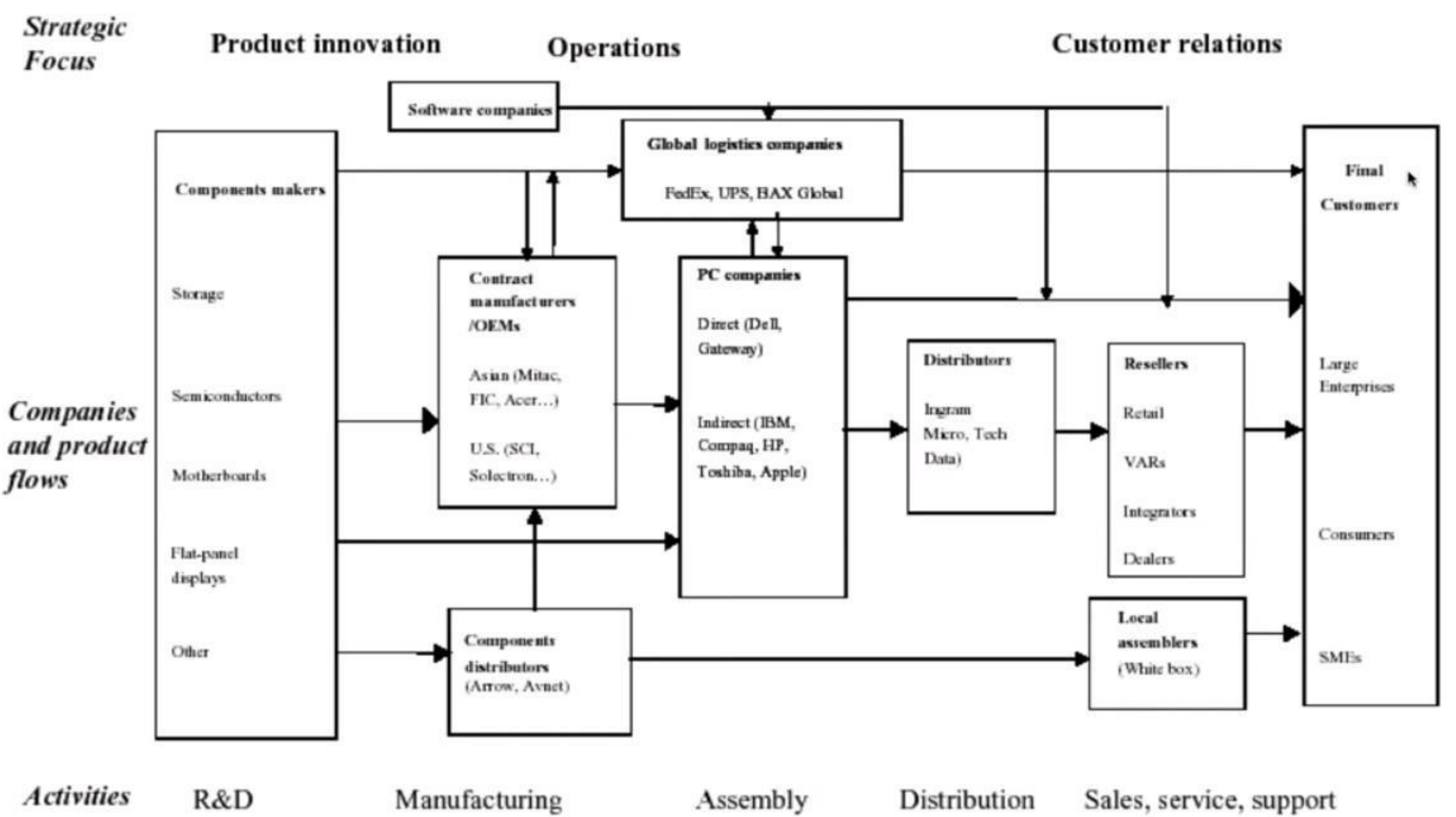
Minimum Cost

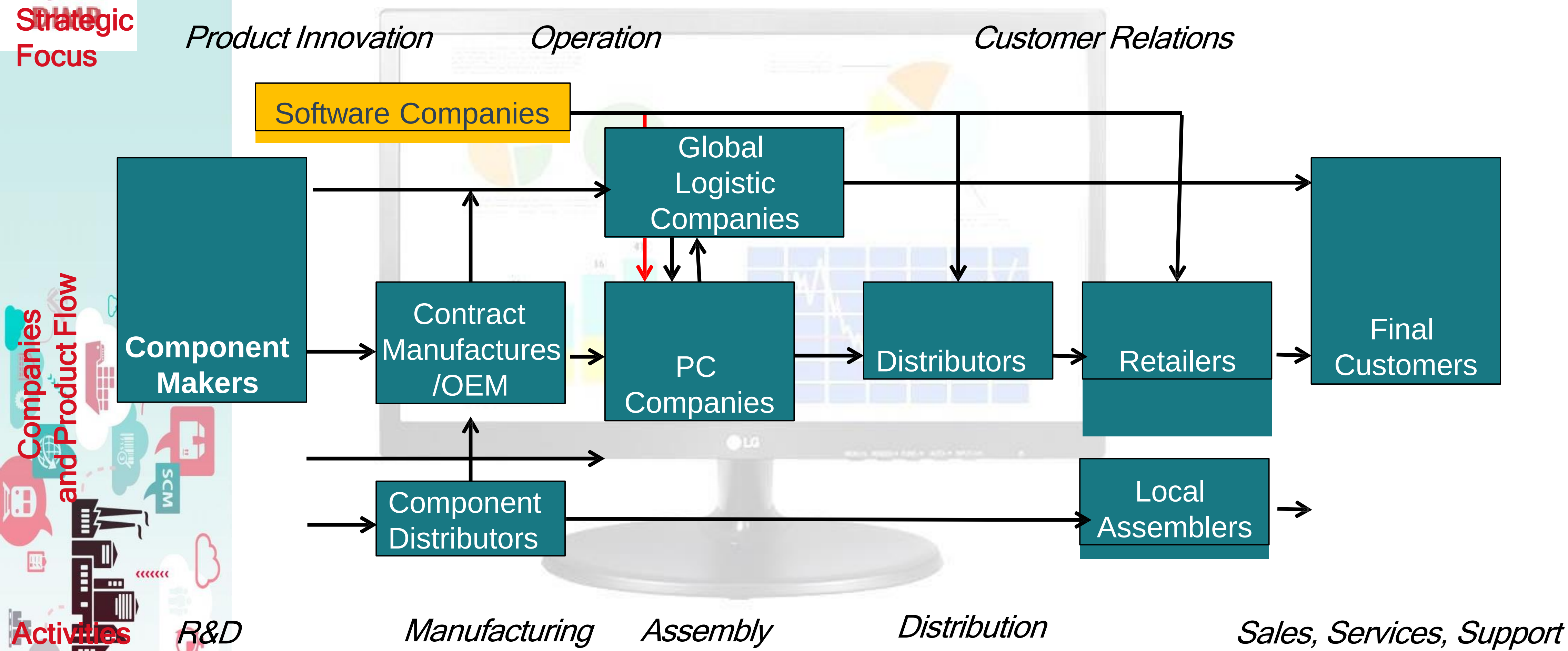
Max. Customer Satisfaction

Two Other Formal Definitions

The design and management of seamless, value added process across organizational boundaries to meet the real needs of the end customer.- Institute for Supply Management

Managing supply and demand, sourcing raw materials and parts, manufacturing and assembly, warehousing and inventory tracking, order entry and order management, distribution across all channels, and delivery to the customer.- The Supply Chain Council


Strategic Focus
Product innovation
Operations
Customer relations
Software companies
Global logistics companies
FedEx, UPS, BAX Global
Components makers
Storage
Semiconductors
Motherboards
Flat-panel displays
Other
Contract manufacturers /OEMs
Asian (Mitac, FIC, Acer…)
U.S. (SCI, Solectron…)
PC companies
Direct (Dell, Gateway)
Indirect (IBM, Compaq, HP, Toshiba, Apple)
Distributors
Ingram Micro, Tech Data)
Resellers
Retail
VARs
Integrators
Dealers
Final Customers
Large Enterprises
Consumers
SMEs
Companies and product flows
Components distributors (Arrow, Avnet)
Local assemblers (White box)
Activities
R&D
Manufacturing
Assembly
Distribution
Sales, service, support


Strategic Focus
Product Innovation
Operation
Customer Relations
Software Companies
Global Logistic Companies
Component Makers
Contract Manufactures /OEM
PC Companies
Distributors
Retailers
Final Customers
Local Assemblers
Component Distributors
Companies and Product Flow
Activities
R&D
Manufacturing
Assembly
Distribution
Sales, Services, Support

Key Observations in SC

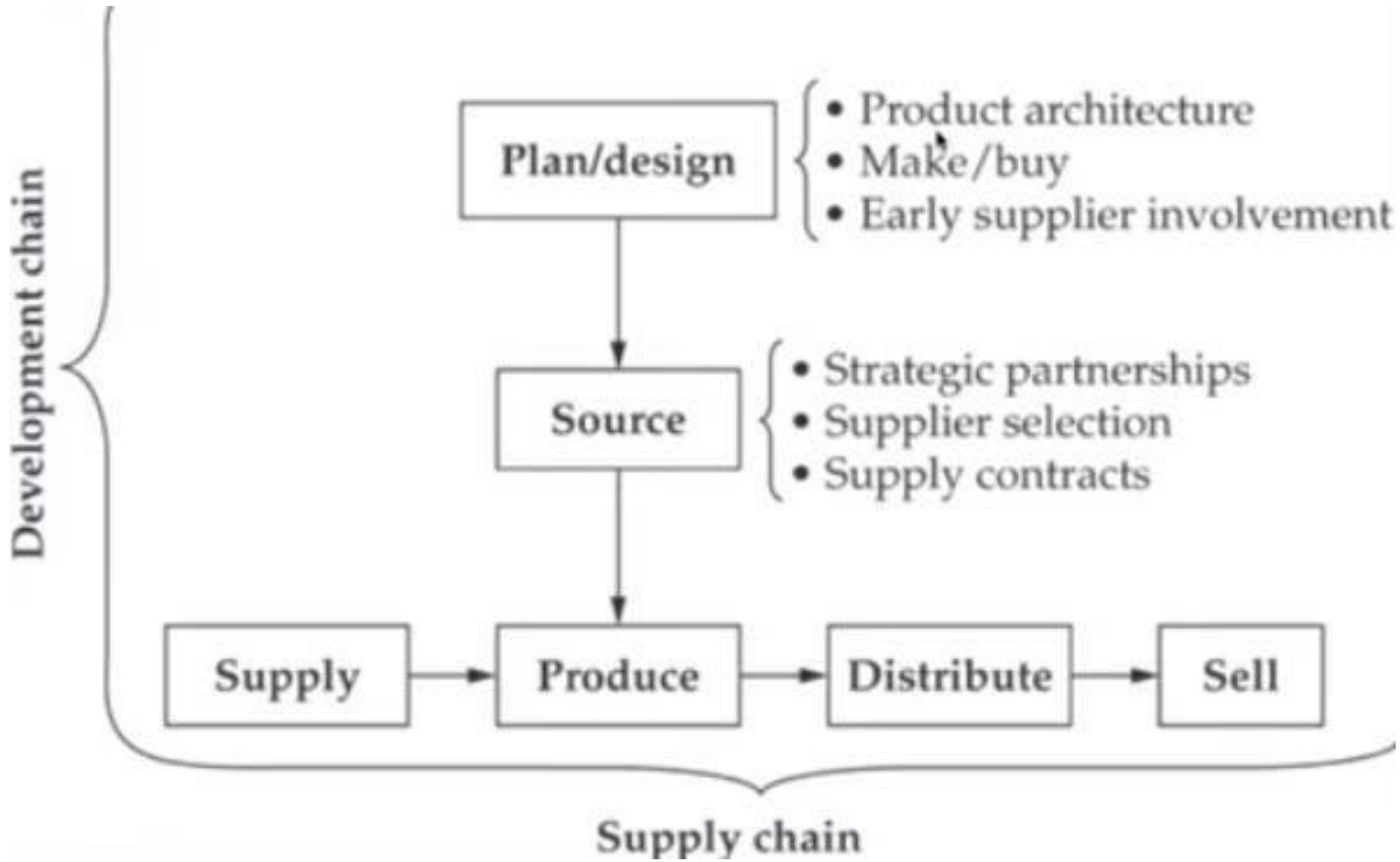
- Every Facility that impact cost need to be considered.
  - Supplier's – Supplier
  - Customer's - Customer
- Efficiency and Cost –effectiveness through out the system is required
  - System Level Approach
- Multiple level of activities
  - Strategic-Tactical-Operational

Other Related Observations

- Supply chain strategy cannot be determined in isolation. Supply chain strategy linked to the Development Chain.
- Challenging to minimize system costs and maximize system service levels. The chain has many players.
- Inherent presence of uncertainty and risk; demand forecasts and lead times are often uncertain.

The Development Chain

- Set of activities and processes associated with new product introduction. Includes:
  - product design phase
  - associated capabilities and knowledge
  - sourcing decisions
  - production plans


Development chain
Plan/design
• Product architecture
• Make/buy
• Early supplier involvement
Source
• Strategic partnerships
• Supplier selection
• Supply contracts
Supply
Produce
Distribute
Sell
Supply chain