# Operations Management - Lecture notes, lectures 1 - 11

Operations Management (City University)

# ***Chapter 1: Operations management:***

**3 core functions:**
- Marketing function (communicating)
- Product/service development function (creating)
- Operations function (fulfilling)

**Support functions:**
- The accounting and finance function
- The human resources function

**Inputs to the process:**
*Transformed resources:*
- Materials (shape, composition)
- Information
- Customers (hairdressers)

*Transforming resources:*
- Facilities
- Staff

(Description of difference between services and products)

**Facilitating services**: Services that are produced by an operation to support its products.
**Facilitating products**: Products that are produced by an operation to support its services.

‘’All operations are service providers.’’

**Supply network**: The network of supplier and customer operations that have relationships with an operation.
**Internal supplier**: Processes or individuals within an operation that supply products or services to other processes or individuals within the operation.
**Internal customer**: Processes or individuals within an operation who are the customers for other internal processes or individuals’ outputs.
**Hierarchy of operations**: The idea that all operations processes are made up of smaller operations process.

‘’Operations management is relevant to all parts of the business’’

**Two meanings of operations:**
- Operations as a function
- Operations as an activity

**‘End-to-end’ business processes**: Processes that totally fulfill a defined external customer need.
**Business process reengineering**: The philosophy that recommends the redesign of processes to fulfill defined external customer needs.

Different characteristics of operations processes:
- **Volume**: repeatability, systemization.
- **Variety**: Standardization, flexible
- **Variation**: variation in demand

- **Visibility**: process exposure

**Front office:** The high visibility part of an operation
**Back office**: The low visibility part of an operation

Activities that apply to all types of operation:
- Understanding the operation's strategic objectives
- Developing an operations strategy for the organization
- Designing an operations strategy for the organization
- Planning and controlling the operation
- Improving the performance of the operation
- The broad responsibilities of operations management

**Why is operations management important?**
- Reduce costs
- Increase revenue
- Reduce the amount of investment
- Provide the basis for future innovation

➔ More profitability!

**Operations management:**
- Operations strategy
- Improvement
- Planning and control
- Design

**Operations strategy:**
- The operation's strategic objectives
- The operation's competitive role and position
- Improvement
- Operations strategy

Summary page 25,

## *Chapter 2: The strategic role and objectives of operations*

''Operations management can 'make or break' any business''
''Operations should implement, support and drive strategy''

**Four stages of operations contribution:**
1. Internal neutrality (avoiding making mistakes)
2. External neutrality (trying to implement 'best practice')
3. Internally supportive (providing a credible strategy)
4. Externally supportive (innovative, creative and proactive, one step ahead competitors)

Five basic 'performance objectives': (can be added value)
- Quality
- Speed (time between requesting and receiving)
- Dependability
- Flexibility

- Cost (advantage)

**Quality is a major influence on customer satisfaction or dissatisfaction**

➔ Quality reduces costs
➔ Quality increases dependability

➔ Speed reduces inventories
➔ Speeds reduces risks

➔ Dependability saves time
➔ Dependability saves money
➔ Dependability gives stability

➔ Agility: the ability to respond quickly and at low cost as market requirements change.
➔ Flexibility speeds up response
➔ Flexibility saves time
➔ Flexibility maintains dependability

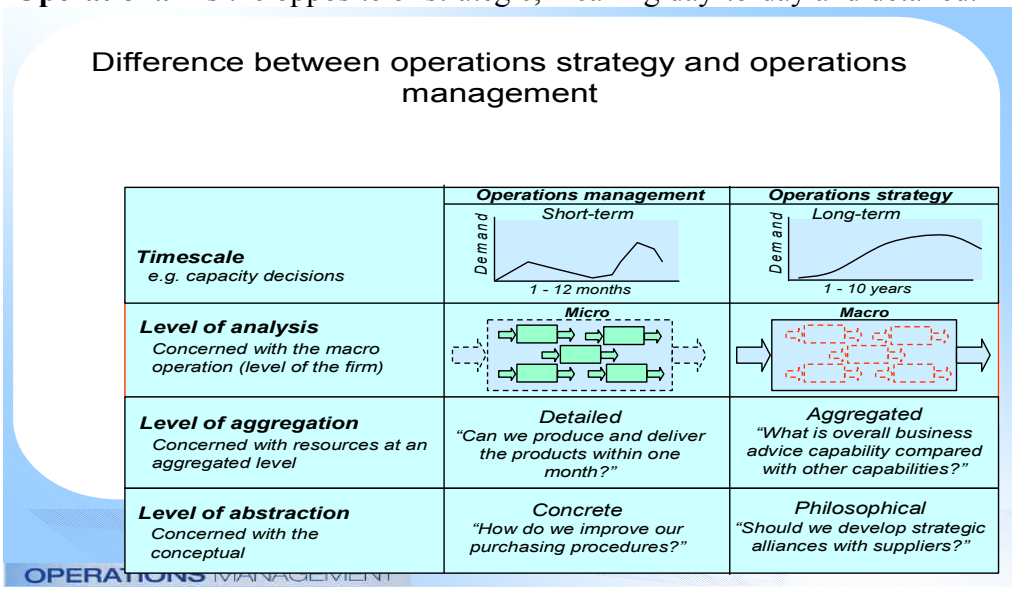
Productivity: Output from the operation/Input to the operation
Single factor productivity: Output from the operation/One input to the operation
Multi-factor productivity: Output from the operation/All inputs to the operation

➔ Improving productivity
➔ Cost reduction through internal effectiveness

## ***Chapter 3: Operations strategy***

**Strategic decisions**: Those which are widespread in their effect, define the position of the organization relative to its environment and move the organization closer to its long-term goals.

'**Operations**' are the resources that create products and services.
**'Operational**' is the opposite of strategic, meaning day-to-day and detailed.



**Perspectives of operations strategy:**

**Top-down**: The influence of the corporate or business strategy on operations decisions (*what the business wants operations to do*).

- **Corporate strategy:** The strategic positioning of a corporation and the businesses with it.
- **Business strategy**: The strategic positioning of a business in relation to its customers, markets and competitors; a subset of corporate strategy.
- **Functional strategy**: The overall direction and role of a function within the business; a subset of business strategy.

**Bottom-up**: The influence of operational experience on operations decision (*What day-to-day experience suggests operations should do*).

- **Emergent strategy**: A strategy that is gradually shaped over time and based on experience rather than theoretical positioning.

**Market requirements**: The performance objectives that inflect the market position of an operation's products or services, also a perspective on operations strategy (*What the market position requires operations to do*).

- **Competitive factors:** The factors such as delivery time, product or service specification, prices, etc. that define customers' requirements.
- **Order-winning factors**: The arrangement of resources that are devoted to the production and delivery of products and services. (The factors with which you can win new customers)
- **Qualifying factors**: Aspects of competitiveness where the operation's performance has to be above a particular level to be considered by the customer.

**Operations resource capabilities**: The inherent ability of operations processes and resources; also a perspective on operations strategy (*What operations resources can do*).

- **Resource-based view (RBV):** The perspective on strategy that stresses the importance of capabilities (sometimes known as core competences) in determining sustainable competitive advantage.

**The process of operations strategy:**

**Implementation: The five Ps**

1. *Purpose*: duidelijkheid
2. *Point of entry*: support
3. *Process*
4. *Project management*
5. *Participation*

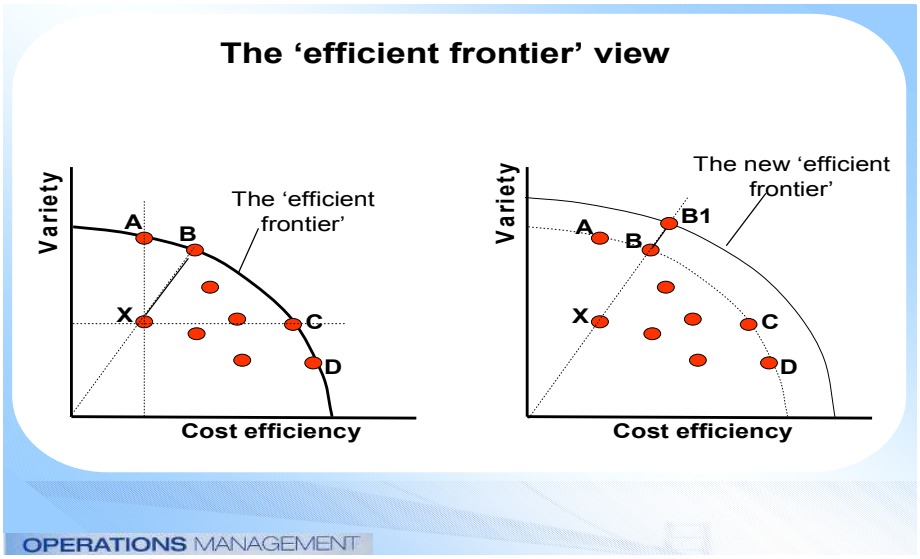
**The process of operations strategy guides the trade-offs between performance objectives:**

- The strategy should address the relative priority of the operation's performance objectives.
- Operations strategy influences the trade-off between an operation's performance.
- → **variety against cost efficiency!**

**An operations strategy should be:**

- Appropriate
- Comprehensive

- Coherent
- Consistent over time ...

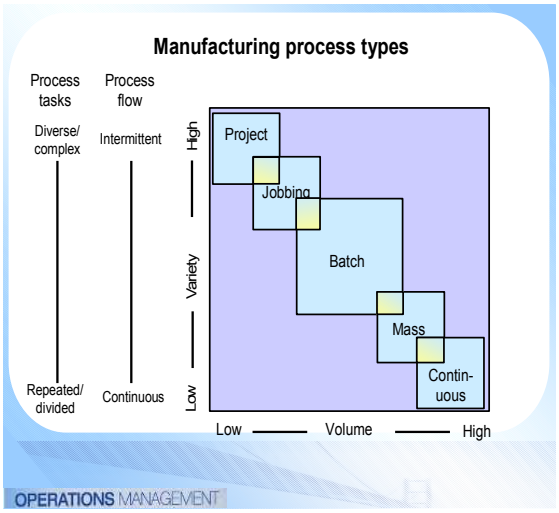


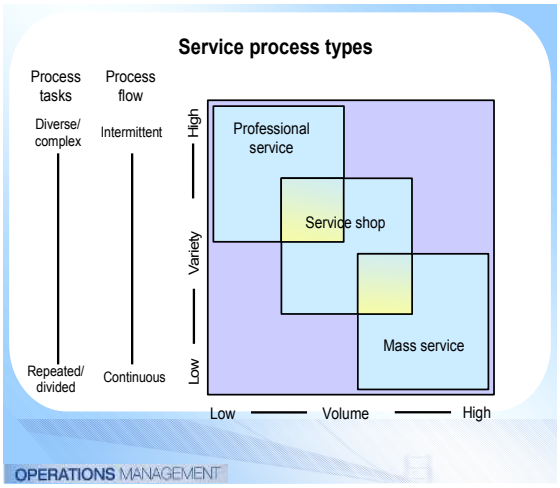

## *Chapter 4: Process Design*

- Process design and product/service design are interrelated (overlap is greater in operations which produce services).
- Process design should reflect process objectives.

**Life cycle analysis**: A technique that analyses all the production inputs, life cycle use of a product and its final disposal in terms of total energy used and wastes emitted.

**Process of products:**
**Project processes**: Processes that deal with discrete, usually highly customized, products.
**Jobbing processes**: Processes that deal with high variety and low volumes, although there may be some repetition of flow and activities.
**Batch processes**: Processes that treat batches of products together, and where each batch has its own process route.
**Mass processes**: Processes that produce goods in high volume relatively low variety.
**Continuous processes**: Processes that are high volume and low variety; usually products made on continuous process are produced in an endless flow, such as petrochemicals or electricity.




**Processes of services:**

**Professional services**: Service processes that are devoted to producing knowledge-based or advice-based services, usually involving high customer contact and high customization, examples include management consultant, lawyers, architects, etc.

**Service shops**: Service processes that are positioned between professional services and mass services, usually with medium levels of volume and customization.

**Mass services**: Service processes that have a high number of transactions, often involving limited customization, for example mass transportation services, call centres, etc.

**Process mapping/blueprinting/analysis**: Describing processes in terms of how the activities within the process relate to each other.

- **Throughput time:** Average elapsed time taken for inputs to become outputs.
- **Throughput rate (flow rate):** is the rate at which units emerge from the process, i.e. the number of units passing through the process per unit of time.
- **Work in process**: The number of units within a process waiting to be processed further. The number of units in the process is an average over a period of time.
- **Utilization**: The proportion of available time that the resources within the process are performing useful work.
- **Work content**: The total amount of work required to produce a unit of output, usually measured in standard times.
- **Throughput time = work-in-process × cycle time**
- **Cycle time = throughput time /WIP**
- **Throughput efficiency: Work content/Throughput time × 100**

## *Chapter 5: The design of products and services*

**Design**: Design helps businesses connect strongly with their customers by anticipating their real needs.

Benefits:

- 90% of growing businesses say design is important, but only 26% of static businesses say design is important.
- Design can reduce costs (making processes more efficient, cutting material costs)
- Design can reduce time

- Businesses which see design as integral have developed new products and services in the last three years, compared with only a third of businesses overall.
- Effective users of design had financial performances 200% better than average.

What is designed in a product or service?
All products and services can be considered as having three aspects:

- A **concept**: Which is the understanding of the nature , use and value of the service or product;
- A **package**: of 'component' products and services that provide those benefits defined in the concept (core products and services, supporting products and services);
- The **process**: which defines the way in which the component products and services will be created and delivered.

''The design activity is one of the most important operations processes''

**<u>The stages of design:</u>**

- Concept generation: A stage in the product and service design process that formalizes the underlying idea behind a product or service.
- Screening
- Evaluation and improvement
- Prototyping and final design

**Concept generation:**

- Ideas from customers
- Listening to customers
- Ideas from competitor activity
- Ideas from staff

Ideas from research and development

**Concept screening:**
*Design criteria:*

- Feasibility (can we do it?): The ability of an operation to produce a process, product or service.
- Acceptability (do we want to do it?): The attractiveness to the operation of a process, product or service.
- Vulnerability (do we want to take the risk?): The risks taken by the operation in adopting a process, product or service.

*Design funnel:* A model that depicts the design process as the progressive reduction of design options from many alternatives down to the final design.
*Balancing evaluation with creativity*: The systematic process of evaluation is important but it must be balanced by the need for design creativity. Creativity is important in product/service design.

**Preliminary design:**

- *Specifying the components of the package:*
    - Component (or product) structure: Diagram that shows the constituent component parts of a product or service package and the order in which the component parts are brought together (often called components structure)
- *Reducing design complexity*

    - Standardization: The degree to which processes, products or services are prevented from varying over time.
    - Commonality: The degree to which a range of products or services incorporate identical components (also called parts commonality)
    - Modularization: The use of standardized sub-components of a product or service that can be put together in different ways to create a high degree of variety.
- *Defining the process to create the package*

**Design evaluation and improvement:**
- *Quality function deployment*: A technique used to ensure that the eventual design of a product or service actually meets the needs of its customers (sometimes called house of quality). With *whats*: customer requirements and *hows*: design characteristics
- *Value engineering*: An approach to cost reduction in product design that examines the purpose of a product or service, its basic functions and its secondary functions.
- *Taguchi methods*: A design technique that uses design combinations to test the robustness of a design.

**Prototyping and final design:**
- *Virtual prototype*: A computer-based model of a product, process or service that can be tested for its characteristics before the actual process, product or service is produced.
- *Computer-aided design*: A system that provides the computer-ability to create and modify product, service or process drawings.

**The benefits of interactive design:**
- *Interactive design*: The idea that the design of products and services on one hand, and the processes that create them on the other, should be integrated.
- *Interactive design can shorten time to market.*
- Simultaneous development:
    - Sequential approach to design
    - Simultaneous or concurrent approach to design
    - Simultaneous (or concurrent) engineering: Overlapping these stages in the design process so that one stage in the design activity can start before the preceding stage is finished, the intention being to shorten time to market and save design cost (also called simultaneous engineering or concurrent engineering).
- Early conflict resolution: Characterizing the design activity as a whole series of decisions is a useful way of thinking about design.
- Project-based organization structures: (spreek allemaal voor zich)

## ***Chapter 6: Supply network design***

**The supply network perspective:**
A supply network perspective means setting an operation in the context of all the other operations with which it interacts, some of which are its suppliers and it customers.
- **Supply network**: The network of supplier and customer operations that have relationships with an operation.

- **Supply side**: The chains of suppliers, suppliers' suppliers, etc. that provide parts, information o services to an operation.
- **Demand side**: The chains of customers, customers' customers etc. that receive the products and services produced by an operation.
- **First-tier**: The description applied to suppliers and customers who are in immediate relationships with an operation with no intermediary operations.
- **Second-tier**: The description applied to suppliers and customers who are separated from the operation only by first-tier suppliers and customers.
- **Immediate supply network**: The suppliers and customers who have direct contact with an operation
- **Total supply network**: All the suppliers and customers who are involved in supply chains that 'pass through' an operation.

**Why consider the whole supply network?**

1. It helps an understanding of competitiveness
2. It helps identify significant links in the network
3. Its helps focus on long-term issues.

**<u>Design decisions in supply networks:</u>**

- **Outsourcing**: The practice of contracting out to a supplier work previously done within the operation.
- **Vertical integration**: The extent to which an operation chooses to own the network of processes that produce a product or service, the term is often associated with the 'do or buy' decision.
- **Location**: The geographical position of an operation or process.
- **Long-term capacity management**: The set of decisions that determine the level of physical capacity of an operation in whatever the operation considers to be long-term; this will vary between industries, but is usually in excess of one year.

**Configuring the supply network:**

- Changing the shape of the supply network
- *Disintermediation*: The emergence of an operation in a supply network that separates two operations that were previously in direct contact.
- Co-opetition: four types of players: Suppliers, customers, competitors and complementors.
- In-source of out-source? Do or buy? The vertical integration decision: Outsourcing is a strategic decision.

**The location of capacity:**

- *Reasons for location decisions:*
    - Changes in demand
    - Changes in supply

- *The objectives of the location decision:*
    - The spatially variable costs of the operation: The costs that are significant in the location decision that vary with geographical position;
    - The service the operation is able to provide to its customers;
    - The revenue potential of the operation.
- *Supply-side influences:*
    - Labour costs

    - Land costs
    - Energy costs
    - Transportation costs
- *Community factors:*
    - E.g.: local tax rates, language, restrictions, political stability
- *Demand-side influences:*
    - Labour skills
    - The suitability of the site itself
    - Image of the location
    - Convenience for customers
- *Location techniques:*
    - **Weighed-score method**: A technique for comparing the attractiveness of alternative locations that allocates a score to the factors that are significant in the decision and weights each score by the significance of the factor.
    - **Centre-of-gravity method**: A technique that uses the physical analogy of balance to determine the geographical location that balances the weighted importance of the other operation with which the one being located has a direct relationship.

**Long-term capacity management:**

- *The optimum capacity level:*
    - **Fixed cost breaks:** The volumes of output at which it is necessary to invest in operations facilities that bear a fixed cost.
    - **Economies of scale**: The manner in which the costs of running an operation decrease as it gets larger.
    - **Diseconomies of scale:** A term used to describe the extra costs that are incurred in running an operation as it gets larger.
- *Scale of capacity and the demand-capacity balance*
- *Balance capacity*
- *The timing of capacity change*
    - **Capacity leading:** The strategy of planning capacity levels such that they are always greater or equal to forecast demand.
    - **Capacity lagging:** The strategy of planning capacity levels such that they are always less than or equal to forecast demand.
    - **Smoothing with inventory**
- *Break-even analysis of capacity expansion:* Fixed-cost breaks are important in determining break-even points.

## ***Chapter 7: Layout and flow***

### ***What is layout?***

The 'layout' of an operation or process means how its transforming resources are positioned relative to each other and how its various tasks are allocated to these transforming resources. The layout decision is relatively infrequent but important.

What makes a good layout?

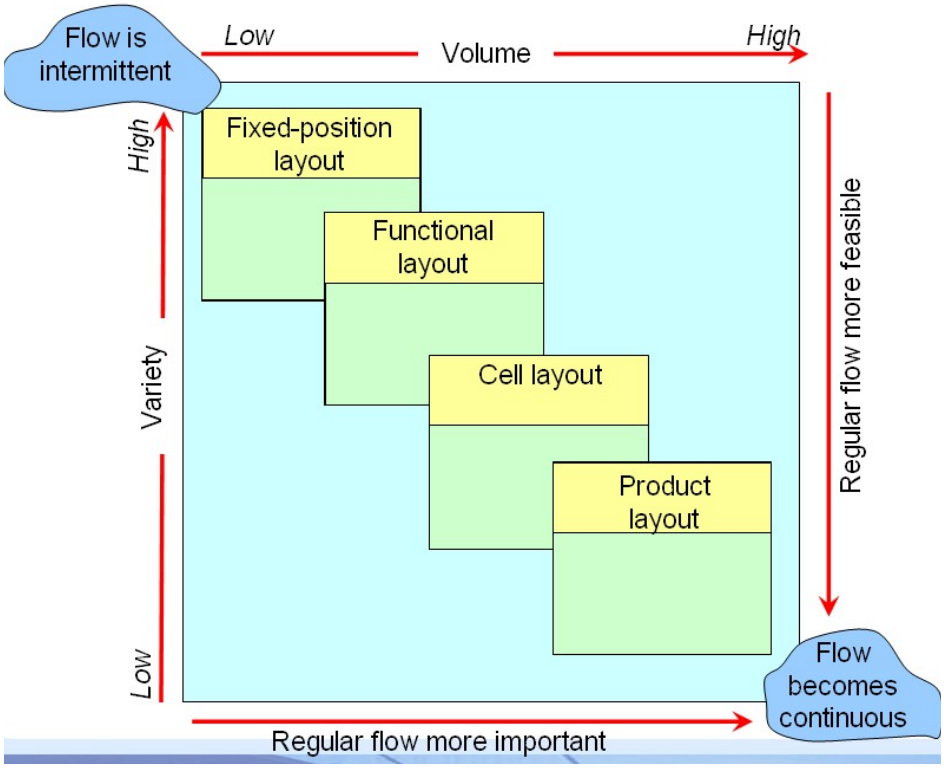
- Inherent safety
- Length of flow
- Clarity of flow

- Staff conditions
- Management coordination
- Accessibility
- Use of space
- Long-term flexibility

Layout is influenced by process types.

***<u>The basic layout types:</u>***

- **Fixed-position layout**: Locating the position of a product or service such that it remains largely stationary, while transforming resources are moved to and from it.
    - They have adequate space for their needs;
    - They can receive and store their deliveries of materials;
    - All contractors can have access to the part of the project on which they are working without interfering with each other's movements;
    - The total movement of contractors and their vehicles and materials is minimized as far as possible.
- **Functional layout** (toegespitst op dezelfde functies)
    - E.g.: hospital, supermarket.
    - General purpose & flexible resources
    - Lower capital intensity & automation
    - Higher labor intensity
    - Resources have greater flexibility
    - Processing rates are slower
    - Material handling costs are higher
    - Scheduling resources & work flow is more complex
    - Space requirements are higher
- **Cell layout** (toegespitst op ongeveer dezelfde operations): Locating transforming resources with a common purpose such as processing the same types of product serving similar types of customer, etc., together in close proximity (a cell).
    - E.g.: some computer component manufacture.
    - *Shop-within-a-shop*: An operations layout that groups facilities that have a common purpose together: the term was originally used in retail operations but is now sometimes used in other industries, very similar to the idea of a cell layout.
- **Product layout** (toegespitst op product): Locating transforming resources in a sequence defined by the processing needs of a product or service.
    - **Line layout:** A more descriptive term for what is technically a product layout.
    - Specialized equipment
    - High capital intensity & wide use of automation
    - Processing rates are faster
    - Material handling costs are lower
    - Less space required for inventories
    - Less volume or design flexibility
- **Mixed layouts**




***Detailed design of the layout:***

**Detailed design in fixed-position layout:** The objective of the detailed design of fixed-position layouts is to achieve a layout for the operation which allows all the transforming resources to maximize their contribution to the transformation process by allowing them to provide an effective service to the transformed resources.

**Detailed design in functional layout:**

**Combinatorial complexity** (functional layout): The idea that many different ways of processing products and services at many different locations or points in time combine to result in an exceptionally large number of feasible options; the term is often used in facilities layout and scheduling to justify non-optimal solutions (because there are too many options to explore).

- Information for functional layouts
  - **Flow record chart:** A diagram used in layout to record the flow of product or services between facilities.
  - **Relationship chart:** A diagram used in layout to summarize the relative desirability of facilities to be close to each other.
- Minimizing distance travelled
- The general functional layout design method
- Computer-aided functional layout design
  - **Heuristic procedures:** 'Rules of thumb' or simple reasoning short cuts that are developed to provide good but non-optimal solutions, usually to operations decisions that involve combinatorial complexity.
  - **CRAFT:** Computerized Relative Allocation of Facilities Technique, a heuristic technique for developing good, but non-optimal, solutions.

**Detailed design in cell layout:**

- *The extent and nature of the cells it has chosen to adopt;* The extent and nature of cells can best be described by examining the amount of the direct and indirect resources which are allocated within the cell.
- *Which resources to allocate to which cells.*

- *Production flow analysis:*
    - **Cluster analysis:** A technique used in the design of cell layouts to find which process groups fit naturally together.
    - **Production flow analysis (PFA):** A technique that examines product requirements and process grouping simultaneously to allocate tasks and machines to cells in cell layout.
    - **Remainder cell:** The cell that has to cope with all the products that do not conveniently fit into other cells.

**Detailed design in product layout:**

- *What cycle time is needed?*
- *How many stages are needed?*
    - **Total work content:** The total amount of work required to produce a unit of output, usually measured in standard times.
- *How should the task-time variation be dealt with?*
- *How should the layout be balanced?*
    - **Balancing work time allocation:**
        - **Line balancing:** The activity of attempting to equalize the load on each station or part of a line layout or mass process.
        - **Balancing loss:** The quantification of the lack of balance in a production line, defined as the percentage of time not used for productive purposed with the total time invested in making a product.
    - **Balancing techniques: precedence diagram**
    - **Arranging the stages:**
        - **Long thin:** A process designed to have many sequential stages, each performing a relatively small part of the total task, the opposite of short fat processes.
        - **Short fat:** Processes designed with relatively few sequential stages, each of which performs a relatively large part of the total task, the opposite of long thin processes.

**The advantages of the long thin arrangement:**

- *Controlled flow of materials or customers*
- *Simple materials handling*
- *Lower capital requirements*
- *More efficient operation*

**The advantages of the short fat arrangement:**

- *Higher mix flexibility*
- *Higher volume flexibility*
- *Higher robustness*
- *Less monotonous work*

## ***Chapter 8: Process technology***

**What is process technology?**

- **Process technology:** The machines and devices that create and/or deliver goods and services.
- **Indirect process technology:** Technology that assists in the management of processes rather than directly contributes to the creation of products and services, for example, information technology that schedules activities.
- **Integrating technologies:** The distinction between material, information and customer processing technologies is for convenience only because many newer technologies with greater information-processing capability process combinations of materials, people and customers.
    - **Electronic point of sale (EPOS):** Technology that record sales and payment transactions as and when they happen.
- **Operations management and process technology: Operations managers do not need to be experts but do need to know the principles behind the technology.**

**Materials-processing technology:**

**Computer numerically controlled machine tools (CNC):** Machines that use a computer to control their activities, as opposed to those controlled directly through human intervention.
**Robots:** Automatic manipulators of transformed resources whose movement can be programmed and reprogrammed.
**Automated guided vehicles (AGVs):** Small, independently powered vehicles that move material to and from value-adding operations.
**Flexible manufacturing systems (FMS):** Manufacturing systems that bring together several technologies into a coherent system, such as metal cutting and material handling technologies, usually their activities are controlled by a single governing computer.
**Computer-integrated manufacturing (CIM):** A term used to describe the integration of computer-based monitoring and control of all aspects of a manufacturing process, often using a common database and communicating via some form of computer network.

**Information-processing technology:**

**Information technology (IT):** Any device, or collection of devices, that collects, manipulates, stores or distributes information, nearly always used to mean computer-based devices.

- *Centralized and decentralized information processing:*
    - **Distributed processing:** A term used in information technology to indicate the use of smaller computers distributed around an operation and linked together so that they can communicate with each other, the opposite of centralized information processing.
    - **Local area network (LAN):** A communications network that operates, usually over a limited distance, to connect devices such as PCs, servers, etc.
    - **Ethernet:** A technology that facilitates local area network that allows any device attached to a single cable to communicate with any other devices attached to the same cable; also now used for wireless communication that allows mobile devices to connect to a local area network.
- *Telecommunications and information technology:* Integrated services digital networks (ISDNs)
- *The internet*
    - **World Wide Web (www):** The protocols and standards that are used on the internet for formatting, retrieving, storing and displaying information.

    - **Extranets:** Computer networks that link organizations together and connect with each organization's internal network.
- ***E-business:*** The use of internet-based technologies either to support existing business processes or to create entirely new business opportunities.
    - **E-commerce:** The use of the internet to facilitate buying and selling activities
    - **Advantages:** Increased reach and richness.
- ***M-business:*** M-business is the phrase now frequently used to cover applications that combine broadband internet and mobile telephony devices.
- ***Management information systems (MISs):*** Information systems that manipulate information so that it can be used in managing an organization.
- ***Decision support systems (DSSs):*** A management information system that aids or supports managerial decision making; it may include both databases and sophisticated analytical models.
- ***Expert systems (ES):*** Computer-based problem-solving systems that, to some degree, mimic human problem-solving logic.
- *Automatic identification technologies:*
    - **Bar code:** A unique product code that enables a part or product type to be identified when read a bare code scanner.
    - **Radio Frequency Identification (RFID)**

**Customer-processing technology:**

- *Technology involving customer interaction*
    - **Active interaction technology:** Customer processing technology with which a customer interacts directly, for example, cash machines.
    - **Passive interactive technology:** Customer processing technology over which a customer has no, or very limited, control, for example, cinemas and moving walkways.
    - **Hidden technologies**
- *Interaction with technology through an intermediary*
    - E.g.: check in at the airport: airline staff
- *Customer training: factors:*
    - The complexity of the service
    - Repetition of the service
    - Low variety of focus

**Process technology should reflect volume and variety:**

- **Technology should reflect the volume-variety requirements of the operation.**
- *The degree of automation of the technology*
    - **Capital intensity**
- *The scale-scalability of the technology*
- *The coupling/connectivity of the technology:* Coupling means the linking together of separate activities within a single piece of process technology to form an interconnected processing system.

**Choice of technology:**

- *Market requirements evaluation:*
    - Quality
    - Speed
    - Dependability

    - Flexibility
    - Cost
- *Operations resource evaluation:*
    - Constraints
    - Capabilities
- *Financial evaluation:*
    - Time value of money (NPV)

## ***Chapter 9: Job design and work organization***

**What is job design?**

**Job design:** The way in which we structure the content and environment of individual staff member's jobs within the workplace and the interface with the technology or facilities that they use.

- What are the environmental conditions of the workplace?
- What technology is available and how will it be used?
- What tasks are to be allocated to each person in the operation?
- What is the best method of performing each job?
- How long will it take and how many people will be needed?
- How do we maintain commitment?

**Designing environmental conditions – ergonomics:**

**Ergonomics:** A branch of job design that is primarily concerned with the physiological aspects of job design, with how the human body fits with process facilities and the environment; can also be referred to as human factors, or human factors engineering.

- There must be a fit between people and the jobs they do.
- It is important to take a 'scientific' approach to job design.

- *Ergonomic environmental design*
    - **Occupational health and safety** legislation.
        - Working temperature
        - Illumination levels
        - Noise levels
        - Ergonomics in the office

**Designing the human interface – ergonomic workplace design:**

- **Repetitive strain injury (RSI):** Damage to the body because of repetition of activities.
- *Anthropometric aspects:*
    - **Anthropometric data:** Data that relates to peoples' size, shape and other physical abilities, used in the design of jobs and physical facilities

**Designing task allocation – the division of labour:**

**Division of labour:** An approach to job design that involves dividing a task down into relatively small parts, each of which is accomplished by a single person.

- Advantages:
    - It promotes faster learning

    - Automation becomes easier
    - Reduced non-productive work
- Drawbacks:
    - Monotony
    - Physical injury
    - Low flexibility
    - Poor robustness

**<u>Designing job methods – scientific management:</u>**
**Scientific management:** A school of management theory dating from the early twentieth century; more analytical and systematic than 'scientific' as such, sometimes referred to (pejoratively) as **Taylorism**, after Frederick Taylor who was influential in founding its principles.

**Method study:** The analytical study of methods of doing jobs with the aim of finding the ´best´ or an improved job method.

- Step 1: Select the work to be studied
- Step 2: Record all the relevant facts of the present method
- Step 3: Examine those facts critically and in sequence.
- Step 4: Develop the most practical, economic and effective method
- Install the new method
- Maintain the method by periodically checking it in use

- **Principles of motion economy:** A checklist used to develop new methods in work study that is intended to eliminate elements of the job, combine elements together, simplify the activity or change the sequence of events so as to improve efficiency.

**Work measurement:** A branch of work study that is concerned with measuring the time that should be taken for performing jobs.

**Work study:** The term generally used to encompass method study and work measurement, derives from the scientific management school.

**<u>Work measurement in job design</u>:**

- **Qualified worker:** Term used is work study to denote a person who is accepted as having the necessary physical attributes, intelligence, skill, education and knowledge to perform the task.
- **Defined level of performance:** Specified job
- **Standard performance:** Term used in work measurement to indicate the rate of output that qualified workers will achieve without over exertion as an average over the working day provided they are motivated to apply themselves, now generally accepted as a very vague concept.
- **Basic times:** The time taken to do a job without any extra allowances for recovery.
- **Time study:** A term used in work measurement to indicate the process of timing (usually with a stopwatch) and rating jobs, it involves observing times, adjusting or normalizing each observed time (rating) and averaging the adjusted times.
    - *Step 1: Observing, measuring and <u>rating</u>* (a work study technique that attempts to assess a worker's rate of working relative to the observer's concept of standard performance, controversial and now accepted as being an ambiguous process)

    - *Step 2: Adjusting the observed times* (observed rating/standard rating=basic time)
    - *Step 3: Average the basic times*
- ***Standard times:*** A term used in work measurement indicating the time taken to do a job and including allowances for recovery and relaxation.
- ***Allowances:*** Term used in work study to indicate the extra time allowed for rest, relaxation and personal needs.
- *Other work measurement techniques:*
    - **Synthesis from elemental data:** Work measurement technique for building up a time from previously timed elements.
    - **Predetermined motion-time systems (PMTS):** A work measurement technique were standard elemental times obtained from published tables are used to construct a time estimate for a whole job.
    - **Analytical estimating:** Is a work measurement technique which is a development of estimating whereby the time required to carry out the elements of a job at a defined level of performance is estimated from knowledge and experience of the elements concerned.
    - **Activity sampling:** is a technique in which a large number of instantaneous observations is made over a period of time of a group of machines, processes or workers. Each observation records what is happening at that instant and the percentage of observations recorded for a particular activity or delay is a measure of the percentage of time during which that activity or delay occurs.

**<u>Designing for job commitment – behavioural approaches to job design:</u>**

- ***Job rotation:*** The practice of encouraging the movement of individuals between different aspects of a job in order to increase motivation.
- ***Job enlargement:*** A term used in job design to indicate increasing the amount of work given to individuals in order to make the job less monotonous.
- ***Job enrichment:*** A term used in job design to indicate increasing the variety and number of tasks within an individual's job, this may include increased decision making and autonomy.
- ***Empowerment:*** A term used in job design to indicate increasing the authority given to people to make decisions within the job or changes to the job itself.
- ***Team working:*** **Team-based work organization.**
- ***Flexible working***
    - *Skills flexibility:*
        - **Multi-skilling:** Increasing the range of skills of individuals in order to increase motivation and-or improve flexibility.
    - *Time flexibility:*
        - **Flexi-time working:** Increasing the possibility of individuals varying the time during which they work
        - **Annual hours:** A type of flexitime working that controls the amount of time worked by individuals on an annual rather than a shorter basis.
    - *Location flexibility – teleworking*
        - **Teleworking:** The ability to work form home using telecommunications and/or computer technology.
            - Occasional telecommuting
            - 'Hotelling'
            - Home working
            - Fully mobile

*Control versus commitment:* Job design is about trying to strike a balance between control and commitment.

## ***Chapter 10: Planning and control***

Planning and control reconciles supply and demand.
**Planning concerns what should happen in the future:** The formalization of what is intended to happen at some time in the future.
**Control copes with changes:** The process of monitoring operations activity and coping with any deviations from the plan; usually involves elements of replanning.

- *Long-term planning and control:*
  - Uses aggregated demand forecasts
  - Determines resources in aggregated form
  - Objectives set in largely financial terms
- *Medium-term planning and control*
  - Uses partially disaggregated demand forecasts
  - Determines resources and contingencies
  - Objectives set in both financial and operations terms
- *Short-term planning and control*
  - Uses totally disaggregated forecasts or actual demand
  - Makes interventions to resources to correct deviations from plans
  - Ad hoc consideration of operations objectives

### ***The nature of supply and demand:***

- ***Uncertainty in supply and demand***
- ***Dependent and independent demand***
  - **Dependent demand:** Demand that is relatively predictable because it is derived from some other known factor.
  - **Independent demand:** Demand that is not obviously or directly dependent on the demand for another product or service.
- ***Responding to demand***
  - **Resource-to-order:** Operations that buy-in resources and produce only when they are demanded by specific customers.
  - **Create-to-order or make-to-order:** Operations that produce products only when they are demanded by specific customers.
  - **Make-to-stock:** Operations that produce products prior to their being demanded by specific customers.
- ***P:D ratios***
  - **P:D ratio:** A ratio that contrasts the total length of time customers have to wait between asking for a product or service and receiving it (D) and the total throughput time to produce the product or service (P).
  - *P and D times depend on the operation*
  - *P:D ratios indicate the degree of speculation*

### ***Planning and control activities***

- ***Loading:*** The amount of work that is allocated to a work centre.

- **Valuable operating time:** The amount of time at a piece of equipment or work centre that is available for productive working after stoppages and inefficiencies have been accounted for.
- **Finite loading:** An approach to planning and control that only allocates work to a work centre up to a set limit (usually its useful capacity).
- **Infinite loading:** An approach to planning and control that allocates work to work centres irrespective of any capacity or other limits.
- ***Sequencing:*** The activity within planning and control that decides on the order in which work is to be performed.
    - Sequencing on:
        - **Customer priority**
        - **Due date (DD)**
        - **Last in first out (LIFO)**
        - **First in first out (FIFO)**
        - **Longest operation time (LOT)**
        - **Shortest operation time (SOT)**
        - **Johnson's Rule:** Allocate SOT of first work centre first (and so forth), allocate SOT of second work centre last or as near last as possible. (and so forth).
- ***Scheduling:*** A term used in planning and control to indicate the detailed timetable of what work should be done, when it should be done and where it should be done.
    - **Forward scheduling:** Loading work onto work centres as soon as it is practical to do so, as opposed to backward scheduling.
    - **Backward scheduling:** Starting jobs at a time when they should be finished exactly when they are due, as opposed to forward scheduling.
    - *Scheduling work patterns:*
        - **Rostering:** A term used in planning and control, usually to indicate staff scheduling, the allocation of working times to individuals so as to adjust the capacity of an operation.
- ***Monitoring and controlling the operation:***
    - **Push control:** A term used in planning and control to indicate that work is being sent forward to workstations as soon as it is finished on the previous workstation.
    - **Pull control:** A term used in planning and control to indicate that a workstation requests work from the previous station only when it is required, one of the fundamental principles of just-in-time planning and control.
    - **Drum, buffer, rope:** An approach to operations control that comes from the theory of constraints (TOC) and uses the bottleneck stage in an process to control materials movement.
    - **Theory of constraints (TOC):** Philosophy of operations management that focused attention on capacity constraints or bottleneck parts of an operation; uses software known as optimized production technology (OPT).

## ***Chapter 11: Capacity planning and control***

**Capacity:** The maximum level of value-added activity that an operation, or process, or facility is capable of over a period of time. There are **capacity constraints**.

***Planning and controlling capacity:***

- **Long-term capacity strategy:** Strategies concerned with introducing (or deleting) major increments of physical capacity.
- **Medium-term capacity planning and control:** This usually involves an assessment of the demand forecasts over a period of 2-18 months ahead, during which time planned output can be varied.
- **Short-term capacity planning and control:** day-to-day adjustments.
- **Aggregated planning and control:** A term used to indicate medium-term capacity planning that aggregates different products and services together in order to get a broad view of demand and capacity.
- *Objectives of capacity planning and control:*
    - Costs
    - Revenues
    - Working capital
    - Quality of goods or services
    - Speed of response
    - Dependability of supply
    - Flexibility (especially volume)

***Measuring demand and capacity:***

- **Forecasting is a key input to capacity planning and control.**
- *Forecasting demand fluctuations:*
    - *Seasonality of demand:*
        - *Demand seasonality*
        - *Supply seasonality*
    - *Weekly and daily demand fluctuations.*
- *Measuring capacity*
    - **Output capacity measure**
    - **Input capacity measures**
    - *Capacity depends on activity mix*
    - **Design capacity:** The capacity of a process or facility as it is designed to be, often greater than effective capacity.
    - **Effective capacity:** The useful capacity of a process or operation after maintenance, changeover and other stoppages and loading has been accounted for.
    - **Utilization:** The ratio of the actual output from a process or facility to its design capacity.
    - **Efficiency:** The ratio of the actual output from a process or facility to its effective capacity.
    - **Overall equipment effectiveness (OEE):** A method of judging the effectiveness of how operations equipment is used.
        - The time that equipment is available to operate.
        - The quality of the product or service it produces.
        - The speed, or throughput rate, of the equipment.
            - OEE = a × p × q
                - Met: a= availability rate= total operating time / loading time.
                - Met: p=performance rate= net operating time / total operating time.

- Met q=quality rate= valuable operating time / net operating time.

***The alternative capacity plans:***

## *Chapter 12: Inventory planning and control:*

**Inventory:** Also known as stock, the stored accumulation of transformed resources in a process; usually applies to material resources but may also be used for inventories of information; inventories of customers or customers of customers are usually queues.

*Why inventories exist:* Inventories will be there because there is a difference in the timing or rate of supply and demand.

*Types of inventory:*
**Buffer inventory:** An inventory that compensates in supply and demand, can also be called **safety inventory.**
**Cycle inventory:** Inventory that occurs when one stage in a process cannot supply all the items it produces simultaneously and so has to build up inventory of one item while it processes the others.
**De-coupling inventory:** The inventory that is used to allow work centres or processes to operate relatively independently.
**Anticipation inventory:** Inventory that is accumulated to cope with expected future demand or interruptions in supply.
**Pipeline inventory:** The inventory that exists because material cannot be transported instantaneously.

*The position of inventory:*
- **Raw material**
- **Components inventories**
- **Work-in-progress (WIP)**
- **Finished goods inventory**
- **Multi-echelon inventory**

**The volume decision – how much to order**
*Inventory costs:*
1. Cost of placing the order
2. Price discount costs
3. Stock-out costs
4. Working capital costs
5. Storage costs
6. Obsolescence costs
7. Operating inefficiency costs

**Consignment stock:** This means that suppliers deliver large quantities of inventory to their customers to store but will charge for the goods only as and when they are used.

The average inventory = Q/2
The time interval between deliveries = Q/D
The frequency of deliveries = the reciprocal of the time interval = D/Q

**Economic order quantity (EOQ): The quantity of items to order that supposedly minimizes the total cost of inventory management, derived from various EOQ formulae.**
Generally, holding costs are taken into account by including:

- Working capital costs;
- Storage costs;
- Obsolescence risk costs;
- Cost of placing the order;
- Price discount costs.

Holding costs = holding cost/unit × average inventory
$= C_h \times Q/2$
Ordering costs = ordering cost × number of orders per period
$= C_o \times D/Q$
Total cost = holding cost + order cost
$= C_t = C_hQ/2 + C_oD/Q$

Rate of change of total cost is given by the first differential of $C_t$ with respect to Q:
$dC_t/dQ = C_h/2 - C_oD/Q^2$ →lowest cost is given by differential of $C_t = 0$ where Qo = the EOQ.
Rearranging this expression gives:

$$Qo = EOQ = \sqrt{\frac{2CoD}{Ch}}$$

When using the EOQ:
Time between orders = EOQ/D
Order frequency = D/EOQ

**Economic batch quantity (EBQ): The amount of items to be produced by a machine or process that supposedly minimizes the costs associated with production and inventory holding.**

Maximum stock level = M
Slope of inventory build-up = P – D
Slope of inventory build-up = M ÷ Q/P
$= MP/Q$

So, $MP/Q = P - D$
$M = Q(P - D)/P$
Average inventory level = M/2
$= Q(P - D)/2P$
As before: Total cost = holding cost + order cost
$C_t = C_hQ(P - D)/2P + C_oD/Q$
$dC_t/dQ = C_h(P - D)/2P - C_oD/Q^2$
Again, equating to zero and solving Q gives the minimum-cost order quantity EBQ:

$$EBQ = \sqrt{\frac{2CoD}{Ch(1-(\frac{D}{P}))}}$$

The optimum time interval between order, $t_f$, is therefore:
$t_f = EOQ/D$

*The timing decision – when to place an order:*
**Re-order point:** The point in time at which more items are ordered, usually calculated to ensure that inventory does not run out before the next batch of inventory arrives.

**Re-order level:** The level of inventory at which more items are ordered, usually calculated to ensure that inventory does not run out before the next batch of inventory arrives.

**Lead-time usage:** The amount of inventory that will be used between ordering replenishment and the inventory arriving, usually described by a probability distribution to account for uncertainty in demand and lead time.
**Continuous review:** An approach to managing inventory that makes inventory-related decisions when inventory reaches a particular level, as opposed to period review.
**Periodic review:** An approach to making inventory decisions that defines points in time for examining inventory levels and then makes decisions accordingly, as opposed to continuous review.

The simple **two-bin-system** involves storing the re-order point quantity plus the safety inventory quantity in the second bin and using parts from the first bin. When the first bin empties, that is the signal to order the next re-order quantity. Sometimes the safety inventory is stored in a third bin (the **three-bin-system)**, so it is clear when demand is exceeding that which was expected.

*Inventory analysis and control systems:*
**Usage value:** A term used in inventory control to indicate the quantity of items used or sold multiplied by their value or price.

**Pareto law:** A general law found to operate in many situations that indicates that 20 per cent of something causes 80 per cent of something else, often used in inventory management (20 per cent of products produce 80 per cent of sales value) and improvement activities (20 per cent of types of problems produce 80 per cent of disruption).

**ABC inventory control:** An approach to inventory control that classes inventory (A,B,C) by its usage value and varies the approach to managing it accordingly.

- Class A items are those 20 per cent or so of high-usage value items which account for around 80 per cent of the total usage value.
- Class B items are those of medium-usage value, usually the next 30 per cent of items which often account for around 10 per cent of the total usage value.
- Class C items are those low-usage value items which, although comprising around 50 per cent of the total types of items stocked, probably account for only around 10 percent of the total usage value of the operation.

*Measuring inventory:*
The first is to calculate the amount of time the inventory would last, subject to normal demand, if it were not replenished. This is sometimes called the number of weeks' (or days', months', years' etc.) cover of the stock. The second method is to calculate how often the stock is used up in a period, usually one year. This is called the **stock turn** or turnover of stock and is the reciprocal of the stock-cover figure mentioned earlier.

*Inventory information systems:*

- Updating stock records

- Generating orders
- Generating inventory reports
- Forecasting

*Common problems with inventory systems:*
**Perpetual inventory principle:** A principle used in inventory control that inventory records should be automatically updated every time items are received or taken out of stock.
Opening stock level + receipts in – despatches out = new stock level

- Keying errors; entering the wrong product code;
- Quantity errors; a mis-count of items put into or taken from stock;
- Damaged or deteriorated inventory not recorded as such, or not correctly deleted from the records when it is destroyed;
- The wrong items being taken out of stock, but the records not being corrected when they are returned to stock;
- Delays between the transactions being made and the records being updated;
- Items stolen from inventory (common in retail environments, but also not unusual in industrial and commercial inventories).

## ***Chapter 13: Supply chain planning and control***

**A supply network is all the operations linked together to provide goods and services:** The network of supplier and customer operations that have relationships with an operation.

**A supply chain is a strand of linked operations:** A linkage or strand of operations that provides goods and services through to end customers; within a supply network several supply chains will cross through an individual operation.

**Supply chain pipeline:** A linkage or strand of operations that provides goods and services through to end customers; within a supply network several supply chains will cross through an individual operation.

*Supply chain objectives:*

- Quality
- Speed
- Dependability
- Flexibility
- Cost

*The activities of supply chain management:*
**Purchasing (sometimes called procurement):** The organizational function, often part of the operations function, that forms contracts with suppliers to buy in materials and services.

**Single-sourcing:** The practice of obtaining all of one type of input product, component, or service from a single supplier, as opposed to multi-sourcing.

**Multi-sourcing:** The practice of obtaining the same type of product, component, or service from more than one supplier in order to maintain market bargaining power or continuity of supply.

**E-procurement:** The use of the internet to organize purchasing, this may include indentifying potential suppliers and auctions as well as the administrative tasks of issuing orders etc.

**The benefits of e-procurement go beyond reducing costs.**

**Global sourcing:** The expansion in the proportion of products and (occasionally) services which businesses are willing to source from outside their home country.

- Through: EU, NAFTA, MERCOSUR
- World competition
- Transportation infrastructures are more sophisticated and cheaper than they once were.

**Logistics:** A term in supply chain management broadly analogous to physical distribution management.
**Distribution**
**Physical distribution management:** Organizing the integrated movement and storage of materials.
**Back-loading**
**Order fulfillment:** All the activities involved in supplying a customer's order, often used in e-retailing but now also used in other types of operation.
**Materials management**
**Merchandising:** A term used to describe a role in retail operations management that often combines inventory management and purchasing with organizing the layout of the shop floor.

*Types of relationships in supply chains:*

**Virtual operation:** An operation performs few, if any, value-adding activities itself, rather it organizes a network of supplier operations, seen as the ultimate in outsourcing.

***Partnership relationships:*** A type of relationship in supply chains that encourages relatively enduring cooperative agreements for the joint accomplishment of business goals.
Partnerships are close relationships, the degree of which is influenced by a number of factors, as follows:

- Sharing success
- Long-term expectations
- Multiple points of contact
- Joint learning
- Few relationships
- Joint coordination of activities
- Information transparency
- Joint problem solving
- Thrust

**Customer relationship management (CRM):** It helps to sell products and services more effectively and increase revenues by:

- Providing services and products that are exactly what your customers want;
- Retaining existing customers and discovering new ones;
- Offering better customer service;
- Cross selling products more effectively.

CRM tries to help organizations understand who their customers are and what their value is over a life time.

*Supply chain behavior:*
**Efficient supply chain**
**Responsive supply chain**
**The bullwhip effect:** The tendency of supply chains to amplify relatively small changes at the demand side of a supply chain such that the disruption at the supply end of the chain is much greater.

*The decision of how much to produce each month was governed by the following relationship:*
Total available for sale in any period = total required in the same period
Starting stock + production rate = demand + closing stock
Starting stock + production rate = 2 × demand (because closing stock must be equal to demand)
Production rate = 2× demand – starting stock

**Information sharing helps improve supply chain performance.**

**Channel alignment helps improve supply chain performance.**
**Vendor-managed inventory:** A way of avoiding fluctuations in orders between operations in the chain (through differences in forecasting methods) is to allow an upstream supplier to manage the inventories of its downstream customer.

**Operational efficiency helps improve supply chain performance**

**Supply chain time compression:** This means speeding up the flow of materials down the chain and the flow of information back up the chain.

**Supply chain risk:** A study of the vulnerability of supply chains to disruption.

## ***Chapter 14: Enterprise resource planning (ERP)***

*What is ERP?*

**Enterprise resource planning (ERP):** The integration of all significant resource planning systems in an organization that, in an operations context, integrates planning and control with the other functions of the business.

**Materials requirement planning (MRP):** A set of calculations embedded in a system that helps operations make volume and timing calculations for planning and control purposes.

**ERP:**
- *Product information:*
  **Bill of material (BOM):** A list of the component parts required to make up the total package for a product or service together with information regarding their level in the product or component structure and the quantities of each component required.
- *Demand information:*

**Master production schedule (MPS):** The important schedule that forms the main input to material requirements planning, it contains a statement of the volume and timing of the end products to be made.

- *Expansion:*
  **Manufacturing resource planning (MRP II):** An expansion of material requirements planning to include greater integration with information in other parts of the organization and often greater sophistication in scheduling calculations.
- *Collaborative commerce:*
  **Web-integrated ERP:** Enterprise resource planning that is extended to include the ERP type systems of other organizations such as customers and suppliers.

*Materials requirements planning (MRP):*

*Demand management:*

- Customer orders
- Forecast demand
- Combining orders and forecasts

*Master production schedule:*

- Sources of information for the MPS
  - Known orders
  - Key capacity constraints
  - Inventory levels
  - Spares demand
  - Safety stock requirements
  - Exhibition/promotion requirements
  - R&D demand
  - Sister plant demand
  - Forecast demand
- Chase or level master production schedules
- **Available to promise (ATP)**

*The bill of materials:*

- Levels of assembly

*The 'shape' of the component structure:*

- **Component structure (product structure) shape:** Diagram that shows the constituent component parts of a product or service package and the order in which the component parts are brought together (often called components structure)
  - A-shape product structures: the business has only a limited product range to offer the customer.
  - T-shape product structures: Operations that have a small number of raw materials but which produce a very wide range of highly customized end products.
  - V-shape product structures: Similar to T-shape, but less standardization.
  - X-shape product structures: Some product designs consist of a small number of standard modules. These standard modules are represented by the cross of the X. They are combined with a customized selection of features and options, giving a wide range of finished products. Automotive manufacturers typically use this X-shape product structure. The same chassis assemblies, transmission assemblies, braking systems and engines are often used on a wide range of vehicles.

*Single-level and indented bills of materials*
*Inventory records:*

- **Item master file:** contains the unique standard identification code for each part or component.
- **Transaction file:** keeps a record of receipts into stock, issues from stock and a running balance. This means the transaction file is updated at the time a receipt or issue occurs.
- **Location file:** identifies where inventory is located. Some operations have fixed locations so that a particular part can always be found at a particular location. But those which cannot do this may simply locate parts in the most convenient place. This requires careful control, as the same item may be kept in several different locations at any one time.

*MRP calculations:*
**MRP netting process:** The process of calculating net requirements using the master production schedule and the bills of material.

- Back-scheduling

MRP capacity checks:

- Resource requirements plan (RRPs) involve looking forward in the long term to predict the requirements for large structural parts of the operation, such as the numbers, locations and sizes of new plants;
- Rough-cut capacity plans (RCCPs) are used in the medium to short term to check the master production schedules against known capacity bottlenecks, in case capacity constraints are broken. The feedback loop at this level checks the MPS and key resources only;
- Capacity requirements plans (CRPs) look at the day-to-day effect of the works orders issued from the MRP on the loading individual process stages.

*Manufacturing resource planning (MRP II)*

*Enterprise resource planning (ERP):*
*The benefits of ERP:*

- Because software communicates across all functions, there is absolute visibility of what is happening in all parts of the business.
- The discipline of forcing business process-based changes is an effective mechanism for making all parts of the business more efficient.
- There is better 'sense of control' of operations that will form the basis for continuous improvement (albeit within the confines of the common process structures).
- It enables for more sophisticated communication with customers, suppliers and other business partners, often giving more accurate and timely information.
- It is capable of integrating whole supply chains including suppliers' suppliers and customers' customers.

Other:

- It is based on a client/server architecture; that is, access to the information systems is open to anyone whose computer is linked to central computers.
- It can include decision-support facilities which enable operations decision makers to include the latest company information.

- It can be interfaced with standard applications programs which are in common use most managers, such as spreadsheets etc.
- Often, ERP systems are able to operate on most common platforms such as Windows or UNIX or Linux.

*ERP changes the way companies do business:*
- Companies did invest in ERP because competitors also did.

***Web-integrated ERP:*** Enterprise resource planning that is extended to include the ERP type systems of other organizations such as customers and suppliers.
*Supply chain ERP*

*Optimized production technology (OPT):*
**Theory of constraints (TOC):** Philosophy of operations management that focused attention on capacity constraints or bottleneck parts of an operation; uses software known as optimized production technology (OPT).

**Optimized Production Technology (OPT):** Software and concept originated by Eliyahu Goldratt to exploit his theory of constraints (TOC).

*Page 457 OPT principles.*

## *Chapter 15: Lean operations and JIT*

**Lean operations:** It means moving towards the elimination of all waste in order to develop an operation that is faster, more dependable, produces higher-quality products and services, and, above all, operates at low cost.

**Just-in-time (JIT):** A method of planning and control and an operations philosophy that aims to meet demand instantaneously with perfect quality and no waste.

**Insulation of the stages from one another**
**JIT sees inventory as a blanket of obscurity.**
**Inventory obscures intrinsic problems.**

*JIT and capacity utilization:*
No high capacity utilization.

*The lean philosophy:*
The lean approach to managing operations is founded on doing the simple things well, on gradually doing them better and (above all) on squeezing out waste every step of the way.
- Elimination of waste.
- Involvement of staff in the operation.
- The drive for continuous improvement.

The seven forms of waste:
- Over-production
- Waiting time
- Transport
- Process

- Inventory
- Motion
- Defectives

The 5S's:

1. Sort: Eliminate what is not needed and keep what is needed.
2. Straighten: Position things in such a way that they can be easily reached whenever they are needed.
3. Shine: Keep things clean and tidy; no refuse or dirt in the work area
4. Standardize: Maintain cleanliness and order – perpetual neatness
5. Sustain: Develop a commitment and pride in keeping to standards.

**Value stream mapping:** Value stream mapping (also known as 'end-to-end' system mapping) is a simple but effective approach to understanding the flow of material and information as a product or service has value added as it progresses through a process, operation, or supply chain. It visually maps a product or services 'production' path from start to finish. It is similar to process mapping but different in four ways:

- it uses a broader range of information than most process maps;
- it is usually at a higher level (5-10 activities) than most process maps;
- it often has a wider scope, frequently spanning the whole supply chain;
- it can be used to identify where to focus future improvement activities.

*The involvement of everyone*
**Respect-for-humans**
*Continuous improvement:* **Kaizen.**

*JIT techniques:*

*Adopt basic working practices:*
**Basic working practices:**

- discipline
- flexibility
- equality
- autonomy
- development of personnel
- quality of working life (QWL)
- creativity
- total people involvement

*Design for ease of processing*

*Emphasize operations focus:*

- learning to focus each process on a limited, manageable sets of products, technologies, volumes and markets;
- learning to structure operations objectives and those of all supporting services so that they are focused and coherent rather than being inconsistent and conflicting.

*Use small, simple machines*

*Layout for smooth flow*

*Adopt total productive maintenance*

*Reduce setup times:*

- **Setup reduction:** The process of reducing the time taken to changeover a process from one activity to the next; also called single minute exchange of dies (SMED) after its origins in the metal pressing industry.
- There are three major methods of achieving the transfer of internal setup work to external work:
    - Pre-set tools so that a complete unit is fixed to the machine instead of having to be built up while the machine is stopped. Preferably, all adjustment should be carried out externally, so that the internal setup is an assembly operation only;
    - Attach the different tools to a standard fixture. Again, this enables the internal setup to consist of a simple and standardized fixture. Again, this enables the internal setup to consist of a simple and standardized assembly operation;
    - Facilitate the loading and unloading of new tools, for example by using simple devices such as roller conveyors.

*Ensure visibility:*
**Andon:** A light above a workstation that indicates its state, whether working, waiting for work, broken down, etc…, Andon lights may be used to stop the whole line when one station stops.

*Adopt JIT through the supply chain*

*JIT planning and control:*

*Kanban control:*

- **Kanban:** Japanese term for card or signal: it is a simple controlling device that is used to authorize the release of materials in pull control systems such as those used in JIT.
    - *The move or conveyance kanban*
    - *The production kanban*
    - *The vendor kanban*
- **Levelled scheduling (Heijunka):** The idea that the mix and volume of activity should even out over time so as to make output routine and regular.
- **Synchronization:**
    - *Runners* are products or parts which are produced frequently, such as every week.
    - *Repeaters* are products or parts which are produced regularly, but at longer time intervals.
    - *Strangers* are products or parts which are produced at irregular and possibly unpredictable time intervals.
- **Mixed modeling:** Or the repeated mix of parts. It means that ultimately processes can be made so flexible that they achieve the JIT ideal of a ‘batch size of one’. The sequence of individual items emerging from a process could be reduced progressively until it produced a steady stream of each item flowing continuously. So, for example, rather than produce 200 As, 120Bs and 80 Cs, a steady mixed stream in the same ratio is produced (AABABCABCA)

*Levelled delivery schedules:* levelled scheduling applied to transportation processes.

*JIT and MRP:*

***Key characteristics of MRP:***

- MRP is generally used as a push system. Inventory is driven through each process in response to detailed, time-phased plans, calculated by part number.
- MRP uses order derived from the master schedule as the unit of control. Therefore, achievement against schedule is key control monitor.
- MRP systems usually need a complex, centralized computer-based organization to support the necessary hardware, software and systems. This can make the needs of the customer appear remote to staff whose responsibilities lie two or three levels down the organization structure.
- MRP is highly dependent on the accuracy of data derived from bills of materials, stock records and so on.
- MRP systems assume a fixed operations environment, with fixed lead times which are used to calculate when materials should arrive at the next operation. However, loading conditions and toher factors mean that lead times are, in reality, far from fixed. MRP systems find it extremely difficult to cope with variable lead times.

***Key characteristics of JIT:***

- The flow between each stage in the manufacturing process is pulled by demand from the previous stage.
- The control of the pull between stages is accomplished by using simple cards, tokens or empty squares to trigger movements and production. This results in simple, visual and transparent control.
- Decision making for operations control is largely decentralized; tactical decisions do not rely on computer-based information processing.
- JIT scheduling is 'rate-based' (calculated in terms of output of a part per unit of time) rather than volume-based (the absolute number of parts to be made in a given day or week).
- JIT assumes ( and encourages) resource flexibility and minimized lead times.
- JIT planning and control concepts are only one parts of a wider and explicit JIT philosophy of operations.

*Separate systems for different products*
*MRP for overall control and JIT for internal control*