



# Principles of information systems

Key: **Some facts that came up in the 2003 exam**  
**Additional facts that came up in the 2003 assignments**  
**Additional facts that came up in the 2002 assignments**

## Chapter 1 - Introduction

**Information system** = a set of components that collect (input), manipulate (process) and share (output) information and provide feedback.

### Information concepts

#### Data versus information

**Data** = raw facts with little value on their own.

**Information** = facts that have been organised (processed) into something meaningful.

The type of information created depends on the *relationships* defined among the data.

**Process** = tasks performed to achieve an outcome. (Turning data into information).

**Knowledge** = *awareness & understanding* of how to make information useful.

**Information** += data made useful through the application of knowledge.

#### Characteristics of valuable information:

**Relevant** - Info must be applicable.

**Economical** - Balance info value with production costs.

**Accurate** - Info without errors.

**Complete** - Contains all the important facts.

**Timely** - Info is delivered when needed.

**Simple** - Information that is concise and not overloaded.

**Flexible** - Info can be used for many purposes (by managers, sales people, etc...)

**Reliable** - Info can be depended on. Reliability depends on the source of information.

**Verifiable** - Info can be checked.

**Accessible** - Info should be obtained in the right format at the right time.

**Secure** - Info should be secure from unauthorised users.

#### The value of information

Measuring value: Additional profit minus the cost of the information.

### System and modelling concepts

**System** = a set of components that interact to accomplish goals.

**System components** = inputs, processing mechanisms, outputs and feedback.

Knowledge is needed to define relationships among inputs and to organise elements.

#### System components and concepts

**System boundary** = the limits of the system.

The *system boundary* defines the system and *distinguishes* it from everything else, whereas the *system configuration* refers to the *organisation* of system elements.

#### System types:

**Temporary** - Exists for a short time.

**Permanent** - Exists for a long time.

**Open** - Interacts with environment.

**Closed** - No interaction with environment.

**Adaptive** - Can change in response to changes in the environment.

**Nonadaptive** - Can't change in response to changes in the environment.

**Dynamic** - Undergoes rapid and constant change.

**Stable** - Undergoes little change.

**Simple** - Few components, with straightforward interaction.

**Complex** - Many elements, highly interconnected.

#### System performance and standards

1. **Efficiency** = doing things right (with minimum waste / effort).

= A measure of what is produced divided by what is consumed. (0-100%)

2. **Effectiveness** = doing the right thing (getting the desired result).

= A measure of the extent to which a system achieves its *goals*.

Divide goals actually achieved by stated goals.

**System performance standard** = a specific *objective* of the system.

E.g. The objective of baking no more than 100 loaves of bread a day.



Once standards are established, performance is measured and compared with the standard.

### System variables and parameters

**System variable** = something that can be controlled by the decision maker (like product price)

**System parameter** = something that can't be controlled (like the cost of raw materials).

### Modelling a system

**Model** = an abstraction used to represent reality to help you understand real-world situations. Many contain assumptions (e.g. length of working time), which should be realistic, and users must be aware of them.

1. **Narrative**: Verbal and written descriptions (reports, documents, conversations).

2. **Physical**: Tangible representation of reality (scale models, E.g. prototype of a new cinema).

3. **Schematic**: Graphic representation of reality (graphs, charts, diagrams, pictures).

4. **Mathematical**: Arithmetic representation of reality (logical models used in business).

### Information systems

#### Input, processing, output, and feedback

1 **Input** = capturing raw data, manually or automatically.

2 **Processing** = converting data into useful outputs, manually or with computers.

3 **Output** = producing useful information in the form of documents or reports.

Computer output: printers and display screens.

Manual output: handwritten documents and reports.

4 **Feedback** = output that is used to make changes to input or processing.

Errors might make it necessary to correct input or change a process.

If output indicates low inventory levels, this feedback can be used to order more.

*Reactive approach* - The feedback system alerts the manager of the problem.

*Proactive approach* - The system predicts future events to avoid problems (= forecasting).

### Manual & computerised information systems

Computerising a manual information system doesn't guarantee improved performance, because if it is flawed, computerising it might magnify the impact of the flaws.

### Computer-Based Information Systems (CBIS)

**Technology infrastructure** (hardware, software, databases, telecommunications, people, procedures) forms the foundation of each CBIS.

1 **Hardware** = computer equipment used to perform input, processing and output activities.

2 **Software** = programs that operate the computer.

3 **Databases** = organised collection of facts and information. (= Very valuable to a CBIS)

4 **Telecommunications**

Telecommunications enables organisations to carry out tasks through computer networks.

*Extranet* = a network that allows selected outsiders to access authorised intranet resources. (You're using an extranet when you track a parcel).

5 **People**

IS personnel = people who manage, run, program, and maintain the system

Users can also be IS personnel.

People are the most important element in most CBISs.

6 **Procedures**

= Strategies, policies, methods and rules for using the CBIS.

A disaster recovery plan is a procedure because it outlines what course of action to take.

### Types of business information systems

1. **E-commerce** (see chapter 8)

= Business transactions executed electronically between parties.

Business-to-business transactions is the fastest growing segment.

2a. **Transaction processing systems (TPS)** (see chapter 9)

= People, procedures, software, databases and devices used to record business transactions.

Used for routine, repetitive ordinary business transactions critical to daily functioning.

E.g. Payroll systems: Input = hours & rates, output = pay cheque.

2b. **Workflow systems**

= Management software that co-ordinates and monitors interrelated tasks.

Primary purpose: To provide tracking, routing... capabilities to improve business processes.

2c. **Enterprise resource planning (ERP)** (see chapter 9)

= Integrated programs capable of managing a company's vital business operations.

It must be able to support multiple languages, currencies, and functional areas.

Most ERP systems support the manufacturing and finance business functions.



E.g. A demand forecast is prepared; The ERP checks what is available; Shortcomings are then manufactured; In the production schedule the ERP checks the raw material inventory; The ERP purchasing subsystem orders the items required.

*Benefits of ERP:*

- \* Support for business functions (human resources, sales, distribution...)
- \* Providing improved work processes
- \* Improving access to timely data for operational decision making
- \* Elimination of costly, inflexible legacy systems
- \* Creating the opportunity to upgrade technology infrastructure

### **3a. Management information systems (MIS)** (see chapter 10)

= People, procedures, software, databases and devices that provide *routine info* to managers.

Focus of a MIS: Operational *efficiency* (doing things right).

MISs typically provide standard *reports* generated with data & info from the TPS.

(See 'Outputs of a MIS, ch 10' for definitions on *scheduled, demand, and exception reports*)

### **3b. Decision support systems (DSS)** (see chapter 10)

= People, procedures, software, databases and devices used to support decision making.

Focus of a DSS: Decision-making *effectiveness* (do the right thing).

Provides immediate assistance in solving complex problems that a MIS can't.

E.g. To determine the best location to build a new factory.

A DSS operates from a managerial perspective and recognises that different managerial styles require different systems.

Emphasis: Supporting rather than replacing managerial decision-making.

*Essential elements:*

Collection of models to support the decision maker (model base),

collection of facts to assist in decision making (database) and

systems and procedures to help decision makers interact with the DSS (user interface).

#### **4a. Artificial intelligence** (see chapter 11)

= A field in which the computer system takes on characteristics of human intelligence.

(See chapter 11 for definitions of robotics, *vision systems*, natural language processing, learning systems, neural networking, and *expert systems*).

#### **4b. Virtual reality** (see chapter 11)

The user is immersed in an artificial, 3D world, presented in full scale.

Through immersion, the user can gain deep understanding of the virtual world's behaviour.

Input devices: head-mounted displays, data gloves, joysticks...

Good medium for communication, entertainment and learning.

Useful applications: training (military), design evaluation, ergonomic studies, treatment of phobias, and games.

#### ▪ **Systems development**

= *Creating or modifying* manual or computerised business systems.

Steps for improving a systems development project:

- \* Systems investigation (Understand the problem to be solved).
- \* Systems analysis (Define the problems and opportunities of the existing system).
- \* Systems design (Determine how the new system will work).
- \* Systems implementation (Create components and put the new system into operation).
- \* Systems maintenance and review (Check and modify the system).

#### ▪ **Why study information systems**

*Computer literacy* = knowledge of computer systems and equipment.

*Information systems literacy* = knowledge of *how* and *why* technology is applied in business.

#### **Information systems in the functional areas of business**

*Finance & accounting* - Forecast revenues, manage cash, analyse investments...

*Sales & marketing* - Product analysis, site analysis, promotion analysis, price analysis...

*Manufacturing* - Process customer orders, develop schedules, monitor product quality...

#### **CAD - Computer-aided design**

*CAM* - Computer-aided manufacturing

*CIM* - Computer-integrated manufacturing

*Human resource management* - Screen applicants, monitor employee productivity...

*Legal information systems* - Analyse product liability, develop legal documents...

#### **Information systems in industry**

*Airline industry* - Internet auction sites offer discount fares.

*Investment firms* - Analyse stocks, bonds, options, provide improved service to customers...



*Banks* - Make sound loans and good investments.

*Transportation industry* - Schedule trucks to deliver goods at least cost.

*Publishing companies* - Analyse markets and develop and publish books.

*Healthcare organisations* - Diagnose illnesses, plan medical treatment, bill patients.

*Retail companies* - Take customer orders on the Web.

*Professional services* - Improve speed and quality of services.

## Chapter 2 - IS in organisations

### ▪ **Organisations and information systems**

**Organisation** = a collection of *people* and *resources* established to accomplish *goals*.

1. Inputs = resources (people, materials, money)

2. Transformation mechanism = processes that increase the value of the inputs.

3. Outputs = goods / services.

Value-added process = a transformation that turns inputs into goods of increasing value.

**Value chain** = a series of activities from upstream and downstream management:

**Upstream management:**

Raw materials → Inbound logistics (organising complex operations) → Warehouse & storage → (Production)

**Downstream management:**

Product storage → Outbound logistics → Marketing & sales → Customer service

The value chain is a concept that reveals how organisations can add value to their products.

Each activity is investigated to determine what can be done to increase the value.

*Role of an IS in value-added processes:*

**Traditional view:**

IS ensures effectiveness & efficiency, turns feedback into info... (The IS is external to the process and serves to monitor / control it).

**Contemporary view:**

ISs are so intertwined with the value-added process that they are considered part of the process itself. (The IS is internal and plays an integral role by providing input, aiding product transformation, producing output...)

### **A. Organisational structure**

= The way organisational *subunits relate* to the overall organisation.

Categories:

#### **1. Traditional**

Major department heads report to a president / top-level manager.

Hierarchical structure: A managerial pyramid shows the hierarchy of decision making.

Strategic → tactical → operational → non-management employees.

Line positions = positions directly associated with making, packing / shipping goods.

E.g. A production supervisor who reports to the vice president of a production.

Staff positions = positions not directly involved with the formal chain of command.

E.g. A legal counsel reporting to the president.

The trend now is to reduce the number of management levels.

**Flat organisational structure:** Fewer management layers empowers employees at lower levels to make decisions without permission.

**Empowerment** = giving employees more responsibility to make decisions, take certain actions, and have more control over their jobs.

**Advantages:**

\* Faster action and quicker resolution of problems

\* Cost reduction

\* Higher quality products and services

Employees feel the responsibility to make the whole organisation work better.

Empowerment happens by providing info directly to employees at lower hierarchy levels.

#### **2. Project**

Structure centred on major products / services.

E.g. When each product is produced by a separate unit.

Traditional functions (marketing, finance, production...) are positioned in each unit.

Many projects are temporary, and the members join other teams when the project is complete

#### **3. Team**

Structure centred on work teams / groups.



Each team has a team leader who reports to an upper-level manager.

**4. Multidimensional (or matrix)**

Incorporates several structures at the same time.

E.g. An organisation can have both traditional functional areas and major project units.

Advantage: Ability to stress both traditional corporate areas and important product lines.

Disadvantage: Multiple lines of authority - Employees have a functional + project boss, which can lead to conflicts, so one boss should have priority.

**B. Organisational culture and change**

**Organisational culture** = the major understandings and assumptions for a business.

These understandings (values, approaches...) can be formed rapidly or over years and are often not stated or documented in goal statements or formal policies.

Organisational culture can affect the development & operation of information systems:

A procedure associated with a new IS might conflict with an informal procedural rule.

**Organisational change** = changes in the way individuals, groups and the enterprise work.

Internal factors causing change: Activities initiated by employees.

External factors causing change: Activities initiated by competitors, laws, economy...

Introducing / modifying an IS causes changes in tasks, work groups...

**Overcoming resistance to change can be the hardest part of bringing IS into a business.**

**Change model** = a representation of change theories that identifies the phases of change.

**Unfreezing** = ceasing old habits and creating a climate receptive to change.

**Moving** = the process of learning new methods and systems.

**Refreezing** = reinforcing changes to make the new process accepted.

**Organisational learning** = adapting to new conditions or altering practices over time.

Employees learn better ways of doing things and incorporate them into daily activities.

Adjustments can be radical or incremental.

**C. Reengineering (process redesign)**

= Making fundamental changes in the way a company does business. (Radical redesign).

Changes: Organisational structure, values, information systems...

Benefits: reduced delivery time, increased quality & profitability, satisfaction...

Hurdle: helping employees understand the benefits.

**D. Continuous improvement**

= Constantly trying to improve business processes.

<i>Business process reengineering</i>	<i>Continuous improvement</i>
Strong action taken for a serious problem	Routine action for minor improvements
Top-down driven by executives	Worker driven
Broad scope; across departments	Narrow scope; focus on tasks
Goal: achieve major breakthrough	Goal: continuous improvements
Often led by outsiders	Led by workers close to the business
IS is integral to the solution	IS provides data to guide improvement team

**E. Technology diffusion, infusion and acceptance**

To be effective, reengineering & continuous improvement efforts must be accepted and used throughout the organisation.

**Technology diffusion** = a measure of how widely technology is spread.

An organisation with ISs in most departments has a high level of technology diffusion.

**Technology infusion** = a measure of how deeply imbedded technology is in an area.

E.g. if you use computers in all aspects of designing something.

**Technology Acceptance Model (TAM)** = an explanation of the factors that can lead to higher acceptance and usage of technology in an organisation.

Includes: Perceived usefulness of the technology

Ease of its use

Quality of the information system

Degree to which the organisation supports the use of the IS.

**F. Total quality management (TQM)**

= Techniques that offer commitment to quality throughout the organisation.

(Quality = the ability of a product to meet customer expectations)

Involves: Developing awareness of customer needs

Adopting a strategic vision for quality

Empowering employees

Rewarding employees for producing high-quality products



## G. Outsourcing and downsizing

= Strategies to contain costs.

**Outsourcing = contracting with outside professional services to meet specific business needs.**

Reasons for outsourcing a business process:

You can focus more closely on core business.

Cost savings, or benefits from the expertise of the service provider.

Examples of business processes that can be outsourced:

Employee hiring

Development of advertising materials

Product sales promotion

Telecommunications network support

**Downsizing = reducing the number of employees to cut costs. (Rightsizing)**

Disadvantages:

Weakened lines of communication

Drop in employee activity

Low morale

To overcome problems:

\* Encourage early retirement

\* Transfer employees to other branches

### ▪ **Competitive advantage**

= A significant long-term benefit to a company over its competition.

#### 1. Factors leading to firms seeking competitive advantage

**5-force model:**

##### A) Rivalry among competitors

Industries with stronger rivalries have more firms seeking competitive advantage.

##### B) Threat of new entrants

A threat exists when it is cheap and easy for someone to enter the industry.

##### C) Threat of substitute products & services

If similar products & services are available, firms get more competitive.

##### D) Bargaining power of customers and E) suppliers

Large buyers influence firms (Less influence if they can't use the threat of buying elsewhere).

Suppliers can help an organisation obtain competitive advantage by entering into *strategic alliances* with them.

When they do so, suppliers act like part of the company.

Suppliers and companies can link their computers & personnel to obtain fast reaction times to get the supplies over quickly when they are needed to satisfy customers.

#### 2. Strategic planning for competitive advantage

##### A. Altering the industry structure

= Changing the industry to become more favourable to the company.

This can be accomplished by gaining more power over suppliers and customers.

(E.g. by insisting that suppliers be located close to major plants).

A company can also create barriers to new companies entering the industry.

(E.g. by buying expensive new technology, which discourages newcomers).

Creating strategic alliances (partnerships)

(Joint production of goods discourages new companies entering the market).

##### B. Creating new products & services

An organisation should introduce new products & services every few months.

##### C. Improving existing product lines & services

Improvements can be either real or perceived.

##### D. Using IS for strategic purposes

ISs can improve organisational effectiveness and support the fundamental business strategy.

**Example of a strategic IS = a large central repository to create a merchandising database.**

Companies must constantly update / acquire new systems to remain competitive.

### ▪ **Performance-based information systems**

There have been 3 major stages in the business use of IS:

A: In the 60s IS were oriented towards cost reduction and productivity.

B: In the 80s IS were oriented towards gaining a competitive advantage.

C: Today there's a shift from strategic management to performance-based management.

(This stage carefully considers both strategic advantage and costs)

#### 1. Productivity



= A measure of the output achieved divided by the input required.  $(O / I) * 100\%$   
= Efficiency in industrial production.

The higher the level of output for a given level of input, the greater the productivity.

Once a basic level of productivity is measured, an IS can monitor and compare it over time.

As well as measuring productivity, an IS can also be used within a process to increase productivity.

Measuring productivity is important because improving productivity boosts a nation's standard of living.

It is difficult to measure the impact that investments in IS have on productivity.

Information technology is not productive by itself - It takes people to deliver gains in output.

If information technology can give employees the knowledge they need to act quickly, this productivity explosion will lead to an increase in the world's standard of living.

## **2. Return on investment (ROI) & value of IS**

ROI = profits generated as a percentage of the investment in IS technology.

### Earnings growth

= The increase in profit.

### Market share

= The percentage of sales that one company's products have in relation to the total market.

### Customer awareness and satisfaction

Surveys & questionnaires determine if customer awareness & satisfaction has increased.

### Total cost of ownership (TCO)

= Measurement of the total costs of owning equipment: computers, networks, support...

## **3. Justifying IS**

To avoid waste, each potential IS project should be reviewed to ensure it meets an important business need, is consistent with corporate strategy, and leads to attainment of goals.

Risk can be assessed by asking:

- How well are the requirements of the system understood?
- To what degree does the project require a lot of effort in technology that is new to the firm?
- Is there a risk of severe repercussions if the project is poorly implemented?

5 common justifications for implementing an IS:

(These are 5 benefits an organisation will derive from implementing an IT project).

### \* *Tangible savings*

= Savings that can be quantified, like money (reduced staff, increased sales...)

### \* *Intangible savings*

= Soft-dollar savings whose magnitude is hard to measure (improved control, customer perceptions, better managerial decisions...)

### \* *Legal requirement*

Implementation of the project is required to meet a federal regulation.

### \* *Modernisation*

Implementation of the project is needed to keep up to date. (Like Y2K compatibility).

### \* *Pilot project*

The project is done to gain experience in a new technology / area.

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## **Careers**

### Operations

Focus on efficiency of IS functions rather than effectiveness.

System operators run and maintain IS equipment.

### Systems development

Focus on specific development projects and ongoing maintenance & review. (Effectiveness)

Systems analysts and programmers.

### Support

Focus on providing assistance in hardware & software use, data administration, training...

A specialised group manages the acquisition of hardware and software, and sets guidelines & standards for the organisation to follow in making purchases.

### *Single vendor solution:*

One outside source supplies all IS needs.

Advantages: cost savings and built-in compatibility.

Risks: lack of flexibility, vendor complacency, missing out on other vendors' new products.

### *Database administrator:*

Focuses on planning, policies, and procedures regarding the use of corporate data.

### *Information centre:*



= A support function that provides users with assistance, training, standards...

#### Information service unit

= A miniature IS department attached to one of the above functional areas.

Project assignments and resources are provided by the functional area to which it reports.

The salaries of staff in the IS unit may be budgeted by either the IS dept or the functional area

#### **IS titles and functions**

##### Chief information officer (CIO)

Role: to employ an IS department's equipment and personnel.

Some top concerns:

- Integrating IS operations with corporate strategies

- Keeping up with technology

- Defining & assessing the value of systems development projects.

Works with the CFO (chief financial officer) and CEO in managing corporate resources.

##### LAN administrators

Set up and manage the network hardware, software and security processes.

### Chapter 3 - Hardware: Input, processing, and output devices

CBIS (computer-based information system) = hardware, software, databases, telecommunications, people and procedures, organised to input, process, and output data and information.

- **Computer systems**

#### **Hardware components**

*Elements of the CPU:*

1. **ALU** (arithmetic/logic unit)

Performs calculations and makes logical comparisons.

2. Control unit

Sequentially accesses program instructions, decodes them, and coordinates the flow of data in and out of the ALU, registers, primary storage, and output devices.

3. Register

= Storage areas used to temporarily hold small units of instructions and data immediately before, during, and after execution by the CPU.

**Primary storage (main memory / memory)** = part of the computer that holds program instructions and data just before / after the registers. (Secondary storage is more permanent).

#### **Hardware components in action**

##### Machine cycle:

**Phase 1: Instruction** (*I-time* = the time it takes to perform phase 1)

Step 1: Fetch instruction (The control unit fetches the instruction from memory)

Step 2: Decode instruction (The instruction is interpreted)

**Phase 2: Execution** (*E-time* = the time it takes to complete execution)

Step 3: Execute the instruction (The ALU does what it is instructed to do)

Step 4: Store results (The results are stored in registers or memory)

Pipelining = executing multiple phases in a single machine cycle.

- **Processing and memory devices**

#### **Processing characteristics and functions**

Processing speed - measured by the time it takes to complete a machine cycle & clock speed

##### Machine cycle time

Machine cycle times are measured in microseconds, nanoseconds and picoseconds.

They can also be measured in MIPS (Millions of Instructions Per Second)

##### Clock speed

= A series of electronic pulses, created by the CPU, that affect machine cycle time.

The control unit of the CPU controls the various stages of the machine cycle by following internal instructions, called microcode.

Microcode = predefined, elementary circuits and logical operations that the processor performs when it executes an instruction.

The control unit executes the microcode in accordance with the clock pulses.

The shorter the interval between pulses, the faster the execution of microcode instructions.

Clock speed is measured in MegaHertz (MHz) - Millions of cycles per second

A hertz is one cycle / pulse per second.





There is no direct relationship between clock speed (MHz) and processing speed (MIPS)  
Wordlength and Bus Line Width

A factor affecting speed is wordlength of the CPU.

**Wordlength = the number of bits the CPU can process at any one time.**

Data is transferred from the CPU to other system components via bus lines.

**Bus line = the physical wiring that connects the components.**

**Bus line width = the number of bits a bus line can transfer at any one time.**

**Bus line width should match CPU wordlength for optimal system performance.**

The megahertz rating is not necessarily a good measure of the processor performance. Intel have developed a benchmark for speed: iCOMP (Intel Comparative Microprocessor Performance) index.

Physical characteristics of the CPU

CPU speed is also limited by physical constraints.

**CPUs are collections of digital circuits imprinted on silicon chips.**

The speed at which current travels between points can be increased by either reducing the distance between the points / reducing the resistance of the medium to the current.

**Moore's law: "The transistor densities on a chip will double every 18 months"**

Another substitute material for silicon chips is superconductive metal.

**Superconductivity: In certain metals, current flows with minimal electrical resistance.**

(Traditional silicon chips create some resistance that slows processing).

Optical processors = chips that use light waves, instead of current, to represent bits.

They can be 500 times faster than traditional electronic circuits.

Complex and Reduced Instruction Set Computing (CISC) & (RISC)

**CISC = a chip design that places as many microcode instructions into the CPU as possible.**

But most operations of a CPU involve only 20% of the available microcode instructions.

**RISC involves reducing the number of microcode instructions to a set of common ones.**

RISC chips are faster than CISC for processing activities that mainly use core instructions.

Most RISC chips use pipelining and they're fast & cheap.

VLIW (Very Long Instruction Word) = a chip that reduces the number of instructions by lengthening each one.

These are potentially even faster than RISC-based chips.

### **Memory characteristics and functions**

Storage capacity

Storage capacity is measured in bytes, with one byte equal to one character.

**Kilobyte = one thousand**

**Megabyte = one million**

**Gigabyte = one billion**

**Terabyte = one trillion** (each level is 1000 times larger!)

Types of memory

**RAM (= main memory) (= volatile memory) chips lose their contents if the current is turned off.**

**EDO RAM (Extended data out) is faster than older types of RAM. (= MAINSTREAM RAM!!!!)**

DRAM (Dynamic)

SDRAM (Synchronous Dynamic) - faster transfer speed between CPU and memory.

**ROM (non-volatile memory) - contents are not lost if the power is removed.**

PROM (Programmable) - first program data into the chip; thereafter it behaves like ROM.

PROM chips are used for storing instructions to popular video games.

Instructions can be programmed onto a PROM chip only once.

EPROM (Erasable Programmable) chips are used when instructions change, infrequently.

**Cache memory = high-speed memory that processors can access quicker than main memory.**

Frequently used data is stored in easily accessible cache memory.

Level 1 (L1) cache is in the processor.

Level 2 (L2) cache memory is optional and found on the motherboard.

Cacheable memory = the main memory that can move its information into cache memory.

### **Multiprocessing**

= Simultaneous execution of 2 / more instructions at the same time.

**Coprocessing executes instructions while the CPU works on another processing activity.**

Coprocessors can be internal / external to the CPU and can have different clock speeds.

Each type of coprocessor performs a specific function.

Parallel processing

**Several processors are linked to operate at the same time.**



A problem is divided into parts, and each part is solved by a separate processor.

▪ **Secondary storage**

= Permanent storage.

Secondary storage is slower than memory

**Access methods**

**Sequential access** - data must be accessed in the order in which it is stored.

SADS = sequential access storage device

**Direct access** - data can be retrieved directly. (= faster)

DASD = direct access storage devices.

While disk drives can be operated as sequential storage devices, they most commonly use direct access storage.

**Devices**

Magnetic tapes

Portions of tape are magnetised to represent bits.

Slower access (sequential) but cheaper than disk storage.

Often used for backup.

Amount of data that can be stored is determined by the number of tracks, density, and the block factor on the tape.

Block factor = the number of logical records per physical record (block).

Data is written to / read from blocks on magnetic tape.

At the end of each block there is an empty space, the IBG - InterBlock Gap.

Transfer rate = the number of characters per second that can be transferred.

Magnetic disks

Thin steel platters, with bits represented by magnetised areas. (E.g. Hard disks / diskettes)

Disk devices can be operated in a sequential mode, but most use direct access.

Hard disks have greater storage capacity and quicker access time than diskettes.

Data is stored as magnetised dots on the disk surface in concentric circles called tracks.

Sector = a subdivision of a track that holds a specific number of characters.

Cylinder = all tracks on a disk pack that are stacked vertically and have the same track no.

Speed of magnetic disks is expressed by: seek / head switching / rotation / data transfer time.

**RAID**

Redundant array of independent / inexpensive disks.

**Extra bits of data are generated, creating a 'reconstruction map' so lost data can be rebuilt.**

*Striping* evenly splits data across multiple disks.

Disk *mirroring* produces a backup disk for each disk. (= the simplest form of RAID)

Disk mirroring is expensive because you need to double the amount of storage capacity.

Other RAID methods are less expensive because they only partly duplicate the data.

RAID is needed if storage devices must be *fault tolerant* (= the ability to continue with no loss of performance if a component fails)

RAID improves system performance and reliability.

SAN

Storage Area Network = technology that uses computer servers, distributed storage devices, and networks to tie the storage system together.

Optical disks

= Rigid disks of plastic onto which data is recorded by lasers that burn pits in the disks.

An optical device uses a laser that measures reflected light caused by pits, to access data.

Each pit represents binary 1; each unpitted area (land) represents binary 0.

Advantage: Greater storage capacities than diskettes.

Disadvantage: Slower access times than diskettes.

CD-ROM - Read only (data can't be modified)

CD-W - Writeable (data can be written once to a disk)

**CD-RW - Rewritable (CDs can be written on and edited over)**

Magneto-optical disk

= A hybrid between a magnetic & optical disk.

Like magnetic disks, MO disks can be read & written to.

Like diskettes, they are removable.

They are faster than diskettes, but not as fast as hard drives.

Their storage capacity can be more than 200MB (much greater than magnetic diskettes)

A laser beam changes the molecular configuration of a magnetic substrate on the disk, creating visual spots, which are measured by another laser beam.



The presence or absence of a spot indicates a bit.

The disk can be erased by demagnetising the substrate, which removes the spots.

#### DVD

Can provide capacity of up to 17 GB. (135 minutes of digital video).

DVD players can read CD-ROMs, but not the other way round.

DVDs are thinner than CDs and their access speeds are faster.

#### Memory cards

= Credit card size devices that can be installed in an adapter / slot in many PCs / laptops.

They are less failure prone than hard disks, are portable, and easy to use.

#### Flash memory

= A silicon computer chip that, unlike RAM, is non-volatile (i.e. keeps its memory).

Flash memory chips are small and can be easily modified and reprogrammed.

Used in cell phones, handheld computers, digital cameras...

Advantages: Quick access, consumes less power, smaller in size.

Disadvantage: Expensive.

#### Expandable storage

Expandable storage devices use removable disk cartridges.

They can be internal / external and are ideal for backups.

More expensive than fixed hard disks, but combine hard disk storage capacity with portability.

They have become popular because they provide:

- \* More direct access methods

- \* Higher capacity

- \* Increased portability

### ▪ **Input and output devices**

#### **Characteristics and functionality**

##### The nature of data

Human-readable data = data that can be understood by humans (instructions on paper...)

Machine-readable data = data that can be understood by computers (bar codes...)

Data can be both human & machine-readable (e.g. magnetic ink on bank cheques)

##### Data entry and input

*Data entry* = converting human-readable data into a machine-readable form.

*Data input* = transferring the machine-readable data into the system.

##### Source data automation

= Capturing & editing data at its source in a form that can be directly input to a computer.

Errors can be detected and corrected immediately.

#### **Input devices**

##### Personal computer input devices

Keyboard & mouse.

##### Voice-recognition devices

Microphones & software record and convert human speech into digital signals.

Advantage: saves time.

##### Digital computer cameras

Pixel = a dot of colour on a photo image / a point of light on a display screen.

##### Terminals

A terminal is connected to a complete computer system with a processor, memory...

##### Scanning devices

###### Optical data readers

OMR (optical mark recognition) - for test scoring.

OCR (optical character recognition) - handwritten documents are converted into digital data.

###### MICR devices

Data printed with magnetic ink is readable by both people and computers.

##### Point-of-sale devices (POS)

= Terminals used in retail to enter sales info into the computer.

##### ATM devices

##### Pen input devices

By touching the screen with a pen input device, you can activate commands.

Pen input requires special hardware & software.

Handwriting recognition software can convert handwriting on the screen into text.

##### Light pens

A light pen uses a light cell in its tip, which determines the pen's location on the screen.



## Touch-sensitive screens

## Bar code scanners

## **Output devices**

### Display monitors (CRT)

Cathode Ray Tubes generate electron beams, which strike a phosphorescent compound on the inside of the screen, which lights up pixels.

Dot pitch = the distance between one pixel and the next.

Greater pixel densities and smaller dot pitches yield sharper images of higher resolution.

A monitor's ability to display colour is a function of:

- the quality of the monitor
- the amount of RAM in the computer
- the monitor's graphics adapter card

CGA (colour graphics adapter) was one of the first technologies to display colour on screens.

SVGA (super video graphics array) displays are standard, providing vivid colours.

### LCD displays

Liquid crystals placed between two polarisers form characters on a backlit screen.

### Printers and plotters

Speed is measured in ppm (pages per minute)

The quality depends on the number of dots per inch (dpi).

Plotters are used for general design work, like blueprints, drawings of buildings...

### Computer output microfilm (COM) devices

Newspapers & journals typically place past publications on microfilm.

### Music devices

MP3 = (Motion Picture Experts Group Audio Layer 3) = a popular music format for the Internet

The MP3 standard allows for the music to be compressed, so it takes less time to download.

## **Special-purpose input and output devices**

Multifunction device = one that can combine a printer, fax machine, scanner, copy machine...

They are cheaper than buying the devices separately and take up less room.

- **Types, standards, selecting, and upgrading**

Network → PC → workstation → midrange → mainframe → supercomputer

## **Computer system types**

Personal computers = Microcomputers

Desktop, laptop, notebook, palmtop, embedded computers,

**network computers (= cheaper version of the PC with less storage & power),**

workstations (= between high-end PCs and low-end midrange computers in terms of cost & processing power. They are used to support engineering & technical users with CAD etc...),

Web appliances (= devices that connect to the Internet, like a cell phone)

Midrange computers = Minicomputers

= Larger computers that can accommodate several users at the same time.

They have excellent processing & decision-support capabilities.

### Mainframe computers

= Large, powerful computers shared by hundreds of concurrent users connected via terminals

They need a room with special Heating, Venting, and Air-Conditioning (HVAC) equipment.

They require specially trained individuals (system engineers) to care for them.

**Computer downsizing = migration of information processing onto smaller computers.**

**Mainframes nowadays run jobs & store files too large for other computers.**

Data warehouses = these large stores of data (like backups of databases...)

**CMOS (complimentary metal oxide semiconductor) = a technology that uses special semiconductor material to achieve low-power dissipation.**

CMOS = a memory chip used to store configuration info about the computer.

**Mainframes have become smaller, faster, cheaper systems as a result of CMOS processors.**

### Supercomputers

They were originally used by the government, but are now used for commercial purposes.

**Used for scientific and military research, and by universities / companies involved in research.**

## **Multimedia computers**

**Equipped with microphones, speakers, cameras... and produce video, audio, text...**

CD-ROM = a popular delivery medium for multimedia because of its large storage capacity.

### Audio

**Sound is converted to a digital recording for storage, and back to sound when played.**

Digital Signal Processor (DSP) chips improve the analogue-to-digital-to-analogue conversion.



## Video

Video is the most difficult element to display because of the large amount of storage required.

Video compression reduces the number of bits required by using mathematical formulas.

You can add a video board to your PC for higher-quality video.

## Standards

E.g. MIDI, Plug 'n Play...

Advantages:

- \* Diminish the cost of integration
- \* Help developers determine which devices will be compatible with the rest of the system
- \* Provide increased options / flexibility
- \* Make upgrading a system less complex

## Selecting and upgrading computer systems

Computer system architecture = the structure / configuration of the hardware components.

Computers may need to be upgraded to support new activities and a changing environment.

## Chapter 4 - Software: Systems and application software

### Overview of software

#### Systems software

= Software that coordinates the activities & functions of the hardware & various programs.

Computer system platform = hardware configuration combined with a software package.

#### Application software

= Programs that help users solve particular computing problems.

#### Supporting individual, group, and organisational goals

Sphere of influence = the scope of problems & opportunities addressed by an organisation.

1. Personal sphere of influence (Information serves the needs of an individual user).

Personal productivity software helps users improve their personal effectiveness. (MS Word...)

2. Workgroup sphere of influence (IS helps a workgroup attain a common goal).

3. Enterprise sphere of influence (IS helps firms in interaction with the environment).

Surrounding environment = customers, suppliers, shareholders, competitors...

### Systems software

#### Operating systems

= A set of programs that controls the hardware and acts as an interface with applications.

Kernel = heart of the OS, which controls critical processes and ties OS components together.

#### Activities of an OS:

##### Performing common hardware functions

Application programs perform tasks like retrieving & displaying information.

These functions must be converted into detailed instructions required by the hardware.

The OS is the intermediary between the application program and the hardware.

##### Providing a user interface

Many mainframe computers use a command-based user interface.

##### Providing a degree of hardware independence

Programs can be isolated from hardware and remain insulated from hardware changes.

Application Program Interface (API) = A link between application software & the OS.

= An interface that allows applications to make use of the OS.

APIs are used to create application software without understanding the workings of the OS.

If APIs didn't exist, developers would have to rewrite programs for new hardware.

##### Memory management

Purpose: To control how memory is accessed and to maximise available memory & storage.

Memory can be divided into different segments / areas.

Virtual memory = memory that allocates space on the hard disk to supplement RAM.

Virtual memory works by swapping programs between memory and disk devices (=Paging).

This reduces CPU idle time and increases the number of jobs that can run.

##### Managing processing tasks

Multitasking = having a user run more than one application at the same time.

Time-sharing = having more than one person use a computer at once.

Time-sharing works by dividing time into small CPU processing time slices.

During a time slice, tasks for the first user are done, then the computer goes to the next user.

The process continues through each user and cycles back to the first user.

Because the CPU processing time slices are small, it appears that all jobs are done at once.



Scalability = the ability of the computer to handle an increasing number of concurrent users.  
Providing networking capability

The OS can provide features that aid users in connecting to a computer network.

Controlling access to system resources

The OS provides security against unauthorised access with log-on procedures & passwords.

The OS can record who uses the system and for how long and report attempted breaches.

File management

The OS ensures that files are available when needed and protected from unauthorised users.

The OS must resolve what to do if many users simultaneously request access to the same file

The OS keeps track of the location, size, date of files and who created them.

**Personal computer operating systems**

MS-DOS

The original Microsoft Windows was an application that ran under DOS.

No multitasking.

DOS with Windows

Graphical operating environment and features like multitasking.

Windows 95/98

Windows NT workstation

Multitasking & networking capabilities.

Using emulation software, NT can run programs written for other operating systems.

NT supports symmetric multiprocessing (=using multiple processors simultaneously).

It also has a centralised security system to monitor various system resources.

It also functions as a Web server and Web content authoring platform.

Windows 2000

A desktop OS aimed at businesses of all sizes.

Unix

Originally developed for minicomputers.

High degree of *portability*: it is compatible with different types of hardware.

Linux

It looks like Unix, but does *not* come from the same source code base.

It's developed under the GNU GPL and its source code is freely available.

Includes: multitasking, virtual memory, shared libraries, memory management, networking...

It is *highly reliable* and *easy to administer*.

The biggest shortfall for Linux is the scarcity of application programs written for the OS.

Solaris

This is the Sun Microsystems variation of Unix.

It is the server OS of choice for large Web sites.

Apple computer operating systems

Apple computers typically use Motorola microprocessors and an Apple OS.

Apple computers are popular in the fields of publishing, education and graphic arts.

Mac OS 9

Features: Multiple users; Key chain passwords (enter it 1x); Sherlock 2 (a search detective).

Mac OS X (ten)

The Mac OS X server is the first modern server OS from Apple.

**Workgroup operating systems**

Windows 2000 server

Many new tasks can be done that are vital for Web sites and corporate Web applications.

Netware

This network OS supports Windows, Macintosh and Unix clients.

It provides software to keep track of computers, programs and people on a network.

**Enterprise operating systems**

Software operates in an environment of network servers to meet enterprise computing needs.

Mainframes are the platform of choice for mission-critical business applications for many firms

OS/390

= A mainframe OS with a network-ready, integrated server environment.

Within it is a full implementation of Unix, so developers can use Unix applications.

MPE/iX (Multiprogramming Executive)

The Internet-enabled OS for the Hewlett-Packard family of computers using RISC processing.

MPE/iX can handle a variety of business tasks (Transaction processing, Web applications...)



## Consumer appliance operating systems

### Microsoft pocket PC

These are pre-installed on TV set-top devices, PCs in cars, handheld PCs...

Includes: Internet connections & GUIs.

### Mobil Linux

An OS that runs on tablet-sized Internet-browsing devices called Web pads.

### Utility programs

They are used to merge & sort sets of data, keep track of jobs being run, scan for viruses...

Disk compression allows more data & programs to be stored on the same hard disk.

When these programs are needed, decompression routines make them available.

Other utility programs: software to write CDs, screen savers.

## Application software

### Types and functions of application software

#### Proprietary application software

= A one-of-a-kind program for a specific application, used to solve a specific problem.

Contract software = a specific software program developed for a particular company.

In-house developed software = developed using the company's resources.

Advantages:

\* You can get exactly *what you need*

\* Being involved in development offers *more control* over the results

\* There is *more flexibility* in making modifications to counteract a new initiative by competitors

Disadvantages:

\* It can take a *long time* and *significant resources*

\* In-house staff will want to get on to other new projects

\* There is *more risk* concerning the features and performance

#### Off-the-shelf application software

= Software that can be purchased, leased, or rented from a software company.

Advantages:

\* *Initial cost is lower*

\* *Lower risk* that the software will fail to meet basic business needs

\* The package is likely to be of *high quality*

Disadvantages:

\* You might have to pay for *features that are not required* and never used

\* The software may *lack important features*

\* Software may *not match current work processes* and data standards

#### Customised package

= A blend of external and internal software development.

Software packages are modified / customised by in-house or external personnel.

Some software companies encourage their customers to make changes, others supply necessary changes for a fee, and others won't allow their software to be modified.

#### Application service provider (ASP)

= A company that provides end user support and the computers on which to run the software.

They can also take a complex corporate software package and simplify it for users.

They provide customisation, implementation... so companies have time for more NB tasks.

Through ASPs, software can be made available quickly.

Users can update info from their applications via Web browsers.

ASPs employ standard software packages, which are easy to support, driving costs lower.

Risks: Sensitive info can be compromised by hackers, and if the network is down.

Advantage: It frees in-house resources from staffing and managing complex projects.

## Personal application software

### Word processing

### Spreadsheet analysis

### Database applications

### Graphics programs

### On-line information services

Like AOL. (Get news, send email, search for jobs...)

### Software suites

= A collection of single-application software packages in a bundle. (MS Office, WordPerfect)

Advantages:

\* The programs are designed to work similarly



\* The programs are cheaper together

**Disadvantages:**

\* One or more applications may not be as desirable as the others

\* Requires a large amount of main memory to run the various applications effectively

**Object linking and embedding (OLE)**

= A feature that allows you to copy objects (= text/graphics...) from one document to another.

Server application = the application that supplies objects you place into others.

Client application = the application that accepts objects from others.

Copying

This method is used when you don't want to change data shared between applications.

To change data, you must update the client application and then repeat the copy procedure.

Linking

Changes made to the server object will automatically appear in all linked client documents.

Double-clicking the object in a client document opens the server application that supplied the object, so that you can then edit that object.

Embedding

You embed an object when you want it to become *part of* the client document.

You don't have to save an object in the server application before embedding it.

Further changes you make appear only in the client document. (Server is no longer required).

**Workgroup application software (Groupware)**

= Collaborative computing software (*helps teams work together towards a common goal*).

*The 3 Cs rule for successful implementation of groupware:*

\* Convenient (It should be easy to use)

\* Content (It must provide relevant and personalised content)

\* Coverage (It should cover everything you need)

Lotus notes

Companies use one software package & user interface to integrate business processes.

E.g. A team can work together from a shared set of documents; Meetings can be scheduled...

Group scheduling (another form of groupware)

Personal information managers (PIM) focus on personal schedules and lists, as opposed to coordinating the schedules of a team.

**Enterprise application software**

= Software that benefits the entire organisation - can be developed / purchased.

ERP = a set of integrated programs that manage a company's vital business operations.

E.g. manufacturing, finance, human resources, sales, distribution...

Benefits:

\* Inefficient systems are eliminated

\* Adoption of improved work processes is eased

\* Access to data for operational decision-making is improved

\* Technology vendors and equipment are standardised

\* Implementation of supply chain management is enabled

▪ **Programming languages**

**Standards and characteristics**

ANSI (American National Standards Institute) developed standards for popular programming languages so that programs written in different forms of the same language work together.

**The evolution of programming languages**

First-generation languages (Low-level)

Machine language uses binary 0 and 1.

Second-generation languages (Low-level)

Assembly language replaces binary digits with symbols that can be understood easily.

Third-generation languages

Consist of high-level languages that use English-like statements and commands.

They are easier to program, but not as efficient in terms of operational speed and memory.

They are relatively *independent of computer hardware*. (C++, BASIC, COBOL, FORTRAN)

Fourth-generation languages (4GL)

These are less procedural and even more English-like than 3<sup>rd</sup> generation languages.

Examples: Visual C++, Visual Basic, Delphi, **SQL**.

OO programming languages

Advantages: reusable code, lower costs, reduced testing, faster implementation times.

Disadvantages: Slower execution times and higher memory requirements.





Examples: Smalltalk, Java (which has cross-platform capabilities).

### Visual programming languages

Use mouse, icons, symbols, menus... to develop programs (E.g. Visual C++)

These languages have never been considered appropriate for developing critical applications.

### Fifth-generation languages

= Knowledge-based programming (You tell the computer what to do, not how)

### Selecting a programming language

Machine and assembly languages provide the most direct control over computer hardware.

Newer languages appear simpler and take less time to develop programs.

### Language translators

= Systems software that converts code into its equivalent in machine language.

Source code = the high-level program code, written by the programmer.

Object code = the machine language code.

2 types of language translators:

#### \* Interpreter

Translates one program statement at a time into machine code (which slows down execution)

#### \* Compiler

Converts a complete program into a machine language.

## ▪ Software issues and trends

### Software bugs

Most bugs arise because software is released as early as possible.

### Open source software

It can be more reliable than commercial software because users can fix problems they find.

### Open-sourcing

= Involving other people in a common development effort.

This spreads development costs and there are more people with highly specialised expertise.

There are more developers and users who can identify and eliminate bugs.

### Software licensing

= Software protected by copyright law - The copyright holder has all rights, not the users.

Vendors try to protect their software from being copied and distributed by individuals.

### Software upgrades

Upgrades cost much less than the original purchase price.

### Global software support

Global support can be outsourced to a third-party distributor, who acts as a middleman between vendor and user, providing distribution, support, and invoicing.

## Chapter 5 - Organising data and information

DBMS = programs that manipulate the database & provide an interface for users & programs.

## ▪ Data management

### Hierarchy of data

Characters, represented by bytes, are put together to form a field.

A field is a name, number etc... that describes an aspect of a business object or activity.

A collection of related data fields is a record.

A collection of related records is a file. (Table). E.g. Names & numbers of all students.

A collection of integrated and related files is a database. (Top of the hierarchy).

### Data entities, attributes, and keys

Entity = a generalised class of objects for which data is stored, like 'employee'. (Record).

Attribute = a characteristic of an entity, like 'employee number'. (Field).

(Data item = the specific value of an attribute which can be found in the fields of the record).

Key = a field / set of fields in a record that is used to identify the record.

Primary key = a field / set of fields that *uniquely* identifies the record.

### The traditional approach versus the database approach

#### Traditional approach

An approach whereby separate data files are created and stored for each application program

Disadvantages:

\* Data redundancy (Duplicated data in separate files. Changes might not be made in all files)

\* Data integrity (= the degree to which data is accurate. Less redundancy → more integrity)

\* Program-data dependence (Programs & data organised for a particular application program are incompatible with programs & data organised differently for another application)



## Database approach

Advantages:

- \* **Reduced data redundancy** (Data is stored in only one location)
- \* **Shared data & resources** (Hardware, software & personnel costs are spread out)
- \* **Improved strategic use of data** (Accurate, up-to-date data can be available to managers)
- \* **Improved data integrity** (because there are no separate files that contain copies of data)
- \* **Easier modification and updating** (Data is stored and modified once)
- \* **Data and program independence** (Data is organised independently of application programs)
- \* **Better access to data and information** (It is **easy to access and retrieve data**)
- \* **Standardisation of data access** (Programs use the same procedures to retrieve data)
- \* **Framework for program development** (Standardised access -> standardised development)
- \* **Better data protection** (Passwords ensure that only authorised people have access to data)

Disadvantages:

- \* High cost of purchasing & operating a DBMS
- \* Increased cost of specialised staff
- \* Increased vulnerability (More data is accessible to the trespasser if security is breached)

DBMS = programs used as an *interface* between a database and the user.

### ▪ **Data modelling and database models**

#### **Data modelling**

Logical design shows an abstract model of how the data should be structured.

Physical design starts from the logical design and fine-tunes it.

**Planned data redundancy = repeating data attributes to improve database performance.**

Data model = a diagram of entities showing their logical relationships.

Enterprise data modelling = data modelling done at the level of the entire enterprise.

**ERDs show relationships between data. (Boxes = entities; diamonds = relationships).**

#### **Database models**

The structure of the relationships in databases follows one of 3 logical database models:

##### **1. Hierarchical (tree) models**

The data is organised in a top-down, or inverted tree, structure.

Best when logical relationships must be represented with the **one-to-many approach**.

##### **2. Network models**

**Expands the hierarchical model: Owner-member relationship - members with many owners.**

With hierarchical and network models, once the relationships are established between data elements, it is difficult to modify them or create new relationships.

##### **3. Relational models**

**Domain = the allowable values for data attributes.**

Defining a domain can increase data accuracy.

**Selecting = Eliminating rows according to certain criteria.**

**Projecting = Eliminating columns in a table.**

**Joining = Combining 2 or more tables.**

**Tables with a common data attribute can be linked** = main advantage of relational databases

#### Data cleanup

= The process of looking for and fixing inconsistencies to ensure data is accurate & complete.

When a database is created with data from multiple sources, those sources may store different values for the same customer due to spelling errors, multiple account numbers etc.

### ▪ **Database management systems**

Common functions shared by all DBMSs:

#### **1. Providing a user view**

When you install a database, you must tell the DBMS the logical and physical structure of the data and relationships among the data.

**Schema = this description of the *entire* database.**

The schema is referenced to find the requested data in relation to another piece of data.

To create different views, subschemas are developed.

**Subschema = a file that contains a description of a *subset* of the database, and identifies which users can modify the data items in that subset.**

A number of subschemas can be developed for different managers, users, and programs.

Typically, the user will access the subschema, which then accesses the schema.

Subschemas give more security because users are allowed to view only parts of the database

#### **2. Creating and modifying the database**

Schemas & subschemas are entered into the DBMS via a data definition language.



**DDL = a collection of instructions & commands used to define & describe data & relationships**  
A DDL describes logical access paths & logical records in the database.

**Data dictionary = a detailed description of all the data used in the database.**

**Typical uses of a data dictionary:**

\* Provides a standard definition of terms & data elements

\* Assists programmers in designing & writing programs

Using the data dictionary, programmers specify the required data elements.

\* **Simplifies database modification**

If a data element must be changed, the dictionary points to specific programs using the data.

*Ways a data dictionary helps achieve advantages of the database approach:*

\* **Reduced data redundancy**

Standard definitions of all data make it is less likely for data items to have different names.

\* **Increased data reliability**

A data dictionary reduces the chance that data will be destroyed / lost.

\* **Faster program development**

Programmers don't have to develop names for data items because the dictionary does that.

\* **Easier modification of data and information**

Modifications to data are easier because users don't need to know where the data is stored.

### **3. Storing and retrieving data**

An application program requests data through the DBMS (logical access path, LAP)

The DBMS accesses a storage device where the data is stored (physical access path, PAP)

Concurrency control = a method to deal with several users accessing one record at once.

You could lock out other access to a record if it is being updated / used by another program.

### **4. Manipulating data and generating reports**

**Data manipulation language (DML) = the commands used to manipulate the database.**

**SQL** = a standardised DML that can be used on PCs to mainframes.

Some database reports: form letters, payroll cheques, invoices, orders for materials...

### **Selecting a database management system**

**Database size**

**Number of concurrent users**

If it can't support many concurrent users, efficiency of the workgroup members will be lowered

Scalability = how well a database performs as the number of concurrent users is increased.

A highly scalable DBMS is desirable to provide flexibility.

**Performance**

How fast the database is able to update records can be the most NB performance criterion.

Also consider the number of concurrent users & the amount of main memory required.

**Integration**

A DBMS must integrate with other applications and databases.

**Features**

Most database programs come with security procedures, privacy protection, and other tools.

Other features: the availability of manuals & documentation, wizards & templates...

**The vendor**

The size, reputation, and financial stability of the vendor should be considered.

**Cost**

Monthly rental / lease costs, maintenance costs, additional hardware & software, personnel...

### **Database developments**

#### **Distributed databases**

**Data may be spread across smaller databases connected via telecommunications devices.**

The user doesn't have to know where the data is physically stored. (The DBMS must know).

**Distributed databases give firms more flexibility in how databases are organised and used.**

**Local offices can create, and use their own databases and share them with other offices.**

**Giving local sites a more direct way to access data provides effectiveness & efficiency.**

Extra challenges: maintaining data security, accuracy, timeliness, conformance to standards.

More users have direct access at different sites, so controlling access is sometimes difficult.

Access to data can be slower because distributed databases rely on telecommunication lines.

**Replicated database = a database that holds a duplicate set of frequently used data.**

This reduces telecommunications costs.

**At the start of the day, the firm sends a copy of NB data to distributed processing locations.**

**At the end of the day, the different sites send the changed data back to the main database.**

Another challenge is integrating the various databases.



### Data warehouses, data marts, and data mining

**OLTP: Transactions are processed immediately, without accumulating them in a batch.**

Traditional OLTP systems are designed to put data into databases very quickly, but these systems are not good at supporting meaningful analysis of the data.

Data stored in OLTP databases is inconsistent, and constantly changing.

The database contains the current transactions, including errors, duplicate entries (i.e. unstable data), and **no historical data (which makes trend analysis impossible).**

#### Data warehouses

**= A database that collects business information from many sources in the enterprise.**

**It provides business users with a multidimensional view of the data they need for analysis.**

The data warehouse provides a specialised decision support database that manages the flow of information from existing corporate databases to end-user decision support applications.

Data warehouses store historical data extracted from operational systems & external sources

This operational and external data is 'cleaned up' to remove inconsistencies, and integrated to create a new information database that is more suitable for business analysis.

To remain fresh and accurate, the data warehouse receives regular updates.

Old data that is no longer needed is purged from the data warehouse.

Advantage of data warehousing: The ability to relate data in new, innovative ways.

#### Data marts

**= A subset of a data warehouse.**

**They bring the data warehouse concept to small and medium-size businesses.**

**Rather than store all enterprise data in one database, data marts contain a subset of the data for a single aspect of a company's business. (E.g finance, inventory, personnel)**

Advantage: They put targeted business information into the hands of more decision makers.

#### Data mining

**- Involves the automated discovery of patterns & relationships in a data warehouse.**

It uses built-in analysis tools to automatically generate a hypothesis about the patterns & trends found in the data, and then predicts future behaviour.

Data mining tools help end users find answers to questions they never even thought to ask.

Most frequent applications for data mining:

- \* Market segmentation (identifies common characteristics of customers buying one product)
- \* Customer churn (predicts which customers are likely to leave you for a competitor)
- \* Fraud detection (identifies which transactions are most likely to be fraudulent)
- \* Direct marketing (identifies which prospects should be included in a mailing list)
- \* Market basket analysis (identifies what products are commonly purchased together)
- \* Trend analysis (reveals the difference between typical customers this month & last month)

#### On-line analytical processing (OLAP)

**OLAP = programs used to store and deliver data warehouse information.**

**= Software that allows users to explore data from a number of different perspectives.**

High-speed analysis of data involves complex relationships: combinations of regions etc...

Access to data can be very *quick* (data is stored in structures optimised for speed).

Multidimensional databases can take a long time to update, but retrieval speed is quick.

OLAP is used to analyse consumer purchase records captured by scanners at tills.

This data is used to spot trends in purchases and to relate sales volume to promotions.

OLAP tools let managers analyse data using *multiple dimensions*, like product, salesperson...

Characteristic	OLTP database	Data Warehousing
<i>Purpose</i>	Supports transaction processing	Supports decision support
<i>Source of data</i>	Business transactions	Multiple files, databases...
<i>Access allowed users</i>	Read & write	Read only
<i>Primary access mode</i>	Simple database update & query	Simple & complex queries
<i>Main database model</i>	Relational	
<i>Level of detail</i>	Detailed transactions	Often summarised data
<i>Historical data</i>	Limited (few weeks / months)	Multiple years
<i>Update process</i>	On-line, ongoing process	Periodic process
<i>Ease of update</i>	Routine & easy	Complex
<i>Data integrity issues</i>	Each transaction is closely edited	Major effort to 'clean' data



Characteristic	OLAP	Data mining
Purpose	Supports data analysis & decision making	
Type of analysis supported	Top-down, query driven	Bottom-up, discovery driven
Skills required of user	Knowledge of the data	Trust in data mining tools

### Open database connectivity (ODBC)

= Standards that ensure that software can be used with any ODBC-compliant database.

ODBC helps with database integration, making it easier to transfer data to different databases. Performance of ODBC-compliant products is less efficient than using specific databases.

### Object-relational database management systems

= A DBMS capable of manipulating audio, video, and graphical data.

Conventional DBMS are not well suited because video... can't easily be stored in rows/tables.

An ORDBMS provides relational database capabilities + the option of adding new data types.

These new data types can be audio, images, unstructured text, spatial data...

These data are stored as objects, which contain both data and processing instructions.

Web-based applications can require object support to link graphical components to the DB.

Disadvantages of image data:

- \* Increased secondary storage requirements
- \* It is sometimes difficult to locate the desired data in the database.

### Hypertext

With hypertext, users can search and manipulate alphanumeric data in an unstructured way.

In an OR database, text data is placed in chunks called nodes.

The user then establishes links between the nodes.

Relationships can be created to user specifications, instead of following a structured model.

### Hypermedia

Like hypertext, but it includes multimedia forms of data - graphics, sound, video...

Data is organised into nodes and relationships are defined.

### Spatial data technology

An OR database stores and accesses data according to locations and permits spatial queries.

Metadata = data that describes the contents of a database.

It tells users when a piece of data was last updated, its format, intended users...

### Business intelligence

= Getting enough of the right info (timely & usable) and analysing it for a good strategy impact

It involves turning data into useful information that is then distributed throughout an enterprise

Competitive intelligence = business intelligence limited to info on competitors and how that knowledge affects strategy, tactics, and operations.

It involves the legal & ethical collection of info, analysis, & dissemination of info to managers.

Info can be collected by conducting interviews, examining published info sources...

Counterintelligence = steps an organisation takes to protect information sought by others.

A good counterintelligence measure: define 'trade secret' info and control its dissemination.

Knowledge management = the process of capturing a company's collective expertise and distributing it wherever it can help produce the biggest payoff.

The goal of knowledge management is to get people to record knowledge and then share it.

## Chapter 6 - Telecommunications and networks

### ▪ An overview of communications systems

#### Communications

Synchronous communication: the receiver gets the message instantaneously. (E.g. phone).

Asynchronous communication: the receiver gets the message later. (E.g. email).

#### Telecommunications

= Electronic transmission of signals, including phone, radio and TV.

Data communications = a subset of telecommunications that refers to electronic collection, processing, and distribution of data - typically between computer system hardware devices.

Model of telecommunications:

1. A sending unit (computer) originates the message.
2. The sending unit transmits a signal to a telecommunications device.
3. The telecommunications device (a hardware component) sends a signal through a medium
4. A telecommunications medium is anything that carries an electronic signal.



5. The signal is received by another telecommunications device
  6. That telecommunications device is connected to the receiving computer.
- Speed, measured in bits per second (bps) is an NB characteristic of telecommunications.

## Networks

Networks can be used to share hardware, programs, and databases across the organisation.

### ▪ Telecommunications

#### Types of media

##### Twisted-pair wire cable

A typical cable contains 2 / more twisted pairs of wire, usually copper.

Proper twisting of the wire prevents electrical interference.

Because the twisted-pair wires are insulated, they can be packaged together in one group.

##### *Shielded twisted-pair wire cable*

Has a conducting layer that makes the cable less prone to electrical interference ('noise').

##### *Unshielded twisted-pair wire cable (UTP)*

No special insulation shield.

UTP cables have historically been used for telephone service.

##### Coaxial cable

Consists of an inner conductor wire surrounded by insulation, called the dielectric.

The dielectric is surrounded by a conductive shield, which is covered by insulation (the jacket)

Less noise & higher data transmission rate than twisted-pair wire cable.

More expensive than twisted-pair, but less so than fibre-optic.

##### Fibre-optic cable

Consists of thin strands of glass / plastic bound together in a jacket, and transmits light beams

These light beams are generated by lasers and are conducted along the transparent fibres.

These fibres have a thin coating (cladding), which prevents light from leaking out of the fibre.

The smaller diameter of fibre-optic cable makes it ideal if there isn't much room.

Because fibre-optic cables are immune to electrical interference, signals can be transmitted over longer distances with fewer expensive repeaters to amplify / rebroadcast the data.

More expensive to purchase & install than twisted pair & coaxial.

Security: It is virtually impossible to tap into fibre-optic cable without being detected.

##### Microwave transmission

Microwave is a high-frequency radio signal that is sent through the air.

*Line-of-site:* The straight line between transmitter & receiver must be unobstructed.

A communications satellite is a microwave station placed in outer space.

It receives a signal from an earth station, amplifies it & rebroadcasts it at a different frequency

Advantage: Satellites can receive & broadcast over large geographic regions.

##### Cellular transmission

A local area, such as a city, is divided into cells.

When you move to another cell, the cellular system passes the connection to that cell.

Combining cellular transmission with special devices allows people to get email, news etc...

##### Infrared transmission

Signals are sent through the air via light waves.

Infrared transmission requires *line-of-site* transmission and short distances.

Can be used to connect various small devices and computers.

Advantage: The devices can be installed without expensive wiring & network connections.

## Devices

### Modems

= A device that translates data from digital to analogue and analogue to digital.

#### Fax modems

Fax devices allow businesses to transmit digital files via standard telephone lines.

#### Special-purpose modems

*Cellular modems* in laptops allow mobile people to communicate with other computers.

You connect to other computers when in an area that has cellular transmission service.

A *Cable modem* can deliver network access faster than a standard modem, and is always on.

### Multiplexers

= Devices that allow several signals to be transmitted over a *single* medium at the same time.

### Front-end processors

= Special-purpose computers that manage communications to and from a computer system.

Functions:

\* Direct flow of incoming & outgoing jobs



- \* Communications management
  - \* Poll terminals & other devices to see if they have messages to send
  - \* Develop logs / reports of all communications traffic
  - \* Edit data before it enters the main processor
  - \* Determine message priority
  - \* Automatically choose alternative & efficient communications paths over multiple lines
  - \* Provide general data security for the main system CPU
- Because they perform these tasks, the midrange / mainframe computer can process more.

### Carriers and services

Telecommunications carriers provide technology (lines, modems...) to transmit data.

1. Common carriers = long-distance phone companies.
2. Value-added carriers = companies with private telecom... systems that charge for services.

#### Switched and dedicated lines

Switched lines allow one transmission device to be connected to other transmission devices.

A switch is a special-purpose circuit that directs messages along specific paths.

Dedicated line (= leased line) provides a constant connection between two points.

No switching or dialling is needed - the two devices are always connected.

#### Private branch exchange (PBX)

A communications system that manages voice & data transfer in a building & to outside lines.

Switching equipment routes phone calls & messages within the building.

Hundreds of internal phone lines can be connected to a few phone company lines.

PBXs can also serve as connections between different office devices.

Advantage: A business needs fewer phone lines coming in from the outside.

Disadvantage: The company has to buy, rent, or lease the PBX equipment.

#### WATS (Wide-area telecommunications) service

= A billing method for heavy users of voice services.

When you dial a toll-free number (like customer services) the company pays for the call.

#### Phone and dialling services

(ANI) Automatic number identification (caller ID) equipment shows who's phoning.

The ANI can help people screen calls before they are answered.

Some services offered by common carriers:

- \* The ability to use the number of the caller to look up info in a database about the customer.
- \* Access codes to screen out junk calls and wrong numbers.
- \* Call priorities (E.g. receive only certain calls during certain times).
- \* The ability to use one number for a business phone, home phone, PC, fax, etc.
- \* Intelligent dialling (redialling a number when the line is busy).

#### Digital subscriber line (DSL)

Uses existing phone wires to provide transmission speeds exceeding 500Kbps.

A special modem is required.

#### Integrated services digital network (ISDN)

Uses existing common-carrier lines to transmit voice, video and image data in digital form.

They are faster than phone lines and can carry more signals than analogue networks.

They allow for easier sharing complex (i.e. multimedia) forms of data across phone lines.

Communications devices require a special ISDN board.

#### T1 carrier

= A line that increases the number of voice calls that can be handled through existing cables.

T1 is also suitable for data and image transmissions.

Advantages: Very fast broadband service, typically used by corporations and universities.

Disadvantages: Very expensive, and users pay a monthly fee based on distance.

▪

### Networks and distributed processing

#### Basic processing strategies

There are 3 strategies for using two / more computer systems:

##### 1. Centralised processing

All processing occurs in a single location.

This approach offers the highest degree of control / security.

##### 2. Decentralised processing

Processing devices are placed at various remote locations.

The individual computer systems are isolated and don't communicate with each other.

Suitable for companies that have independent operating divisions.

##### 3. Distributed processing



Computers are placed at remote locations but are connected to each other and share data. Benefit: Processing can be allocated to the location(s) where it can most effectively occur. Balancing the effectiveness of individual systems maximises the capabilities of the overall IS.

### Network concepts and considerations

A logical model shows how the network will be organised and arranged.

A physical model describes how the hardware & software in the network will be linked.

#### Network topology

= A logical model that describes how networks are structured / configured.

#### Ring network

Computers are placed in a circle.

There is no central coordinating computer and messages are routed in one direction.

#### Bus network

Computers and devices are on a single line.

Each device is connected to the bus and can communicate directly with all other devices.

This is one of the most popular types of personal computer networks.

#### Hierarchical network

Uses a tree-like structure with messages passed along the branches of the hierarchy.

It doesn't require a centralised computer to control communications.

The easiest to repair because you can isolate and repair one branch without affecting others.

#### Star network

Has a central hub, and other computers are located at the end of lines that originate from it.

The central computer controls and directs messages.

If the central computer breaks down, it results in a breakdown of the entire network.

#### Hybrid network

= A combination of 2 / more topologies.

### Network types

#### 1. LAN

= A network that connects computers within the same geographic area.

When a PC is connected to a LAN, a network interface card is usually required.

Peer-to-peer network: each computer is independent, but its files / printer can be shared.

Peer-to-peer networks have no server.

Peer-to-peer performance is slower because computers are sharing each other's resources.

#### 2. WAN

= Network over large geographic areas using microwave & satellite transmission / phone lines

#### 3. International networks

= Networks that link systems between countries.

Global area networks must meet specific national & international laws.

Some countries have strict laws restricting the use of telecommunications and databases.

International networks in developing countries can have inadequate equipment.

#### Home and small business networks

### Terminal-to-host, file server, and client/server systems

#### Terminal-to-host

The applications reside on one host computer, and are accessed through a dumb terminal.

Dumb terminals can't process data, so the host computer does the computations.

#### File server

The application and database reside on the one host computer, called the file server.

The DBMS runs on the end user's PC / workstation.

If the user needs some data that resides on the file server, the file server sends the user the entire file containing the data requested, including a lot of data the user doesn't want / need.

The downloaded data is analysed, manipulated, & displayed by a program on the user's PC.

#### Client/server

Multiple computer platforms (= servers) are dedicated to special functions: database management, printing, communications, and program execution.

The servers are accessible by all computers on the network.

Servers distribute programs and data files to clients as they request them.

Processing is split between computers and can be done at the client or server.

A client can converse with many servers concurrently.

When a user wants to extract data from a database, a data request server intercepts the requests and determines on which data server the data resides.

The server then formats the request into a message that the database server will understand.





When the database server gets the message, it extracts and formats the requested data and sends the results to the client.

Only the data needed is sent, not the entire file.

*Advantages over terminal-to-host and file server approaches:*

- \* Reduced cost potential

More functionality at a lower cost.

- \* Improved performance

Client/server architecture minimises traffic on the network.

Only the data needed to satisfy a user query is moved from the database to the client.

- \* Increased security

Security can be implemented directly on the database server, which can be shared.

*Disadvantages / problems:*

- \* Increased cost potential

Moving to client/server architecture is a major 2-5 year conversion process.

- \* Loss of control

Controlling the client/server environment to prevent unauthorised use and viruses is difficult.

- \* Complex multi-vendor environment

Implementation of client/server architecture leads to operating in a multivendor environment.

Problems can be difficult to identify and isolate to the appropriate vendor.

## **Communications software and protocols**

### Communications software

= Software that provides important functions in a network, like error checking & data security.

Communications software can also maintain a log listing all communications that took place.

NOS = systems software that allows computers on a network to communicate.

A NOS performs operating system functions: memory & task management, coordination...

When network equipment is needed the NOS ensures that these resources are correctly used

Network management software enables you to monitor computer use, scan for viruses, etc...

Network management software simplifies file updating - changes are made on the server only

Network management software protects software from being copied or downloaded illegally.

Benefits of network management software: Fewer hours spent on routine tasks, faster responses to problems, and greater overall network control.

### Communications protocols

Protocols = rules that ensure communications among computers of different types.

**OSI model = model for network architectures that promotes development of modular networks**

7. **Application layer:** Controls user input and executes the user's application program.

6. **Presentation layer:** Formats the data so it can be presented to the user / host.

5. **Session layer:** Initiates, maintains, and ends each session.

4. **Transport layer:** Enables the user & host nodes to communicate with each other.

3. **Network layer:** Causes the physical layer to transfer the frames from node to node.

2. **Data link layer:** Formats the data into a record called a frame and performs error detection.

1. **Physical layer:** Transmits the data from one node to another.

**TCP/IP = the primary communications protocol of the Internet.**

**SNA (Systems network architecture) = a protocol used for IBM systems.**

**Ethernet** = a popular communications protocol often used with LANs that use a bus topology.

The standard ensures compatibility, so people can attach to one cable to share facilities.

**X.400 and X.500** = protocols used in many organisations.

X.400 = a set of messaging handling standards used to process transactions electronically.

X.500 = standards dictating the design of networking directories containing info on users.

## **Bridges, routers, gateways and switches**

### Bridge

= A connection between networks at the media access control portion of the data link layer.

The two networks must use the same communications protocol.

### Router

= A connection operating at the **network level**, with better addressing software than bridges.

**Bridges simply pass along everything, but routers can also determine preferred paths.**

Routers also perform useful network management functions.

**Routers can break a network into subnets** to create separate administrative network domains.

Routers are also used as security firewalls between networks and the public Internet.

**A specific router works with only one particular protocol.**



## Gateway

Operates at / above the OSI transport layer and links networks with different protocols.

**Gateways allow networks with very different architectures to communicate.**

## Switch

= A device that routes / switches data to its destination.

Two ways to establish the desired connection:

Matrix approach: each input channel has a predefined connection with each output channel.

Shared memory approach: the input controller writes material to a reserved area of memory and the specified output channel reads the material from this memory area.

A gateway may connect 2 different architectures, but a switch can connect to several.

### ▪ **Telecommunications applications**

#### **Linking personal computers to mainframes and networks**

By linking PCs to mainframes, data can be downloaded / uploaded.

Some communication software programs will instruct the computer to connect to another one, download info, and then disconnect from the telecommunications line.

These are called unattended systems because they perform these functions automatically.

#### **Voice and electronic mail**

Voice mail = technology that enables users to leave, receive, and store verbal messages.

#### **Electronic software and document distribution**

**Electronic software distribution: software on a file server can be downloaded by users.**

This is quicker, cheaper and more convenient than traditional ways of acquiring software.

Disadvantage: Downloading large programs can take a long time.

**Electronic document distribution = transporting documents over networks.**

This saves time and money versus standard mailing and storage of hard-copy documents.

#### **Telecommuting**

This saves companies money.

#### **Videoconferencing**

= A telecommunication system that combines video and phone capabilities with conferencing.

Managerial effectiveness increases through faster response to problems.

The document and application-sharing feature enhances group productivity and efficiency.

#### **Electronic data interchange (EDI)**

= An inter-company, application-to-application communication of data in standard format, permitting the recipient to perform the functions of a standard business transaction.

Network systems connect corporate computers among organisations so that output from one system can be processed directly as input to another, without human intervention.

EDI eliminates the need for paper documents and cuts down on costly errors.

#### **Public network services**

= Systems that give PC users access to vast databases and other services, for a fee.

Customers can book airline reservations, get TV program info, analyse stock prices...

AOL provides many services: news, email, investment information...

#### **Distance learning**

#### **Specialised systems and services**

Specialised services: E.g. professional legal, patent, and technical information.

Regional services: E.g. Electronic bulletin boards.

Global positioning systems (GPS) = other types of specialised telecommunications services.

## Chapter 7 - The Internet, intranets and extranets

### ▪ **Use and functioning of the Internet**

**Arpanet = a project started by the US department of defence in 1969.**

It linked military research contractors and universities.

#### **How the Internet works**

If sender & receiver are on different networks, the sending computer sends the message to another computer that can forward it.

The message may be sent through a router to reach the forwarding computer.

The forwarding host delivers the message directly or passes it to another forwarding host.

**The networks pass data in packets, which carry the addresses of sender and receiver.**

**Internet protocol (IP) = the set of conventions used to pass packets from one host to another.**

(IP = a communication standard that enables traffic to be routed between networks).

**IP operates at the network layer of the OSI model.**



**Transmission control protocol (TCP)** = a *transport layer* protocol used in combination with IP.  
**Backbone** = one of the Internet's high-speed, long-distance communications links.  
**Domain name part of a URL** = everything after the 'www'.

### Accessing the Internet

#### 1. Connect via LAN server

You need: a network adapter card, and either open datalink interface (ODI) or network driver interface specification (NDIS) packet drivers.

These drivers allow multiple transport protocols to run on one network card simultaneously.

#### 2. Connect via SLIP / PPP (Serial line Internet protocol / Point-to-point protocol)

= Protocols that transmit packets over telephone lines, allowing dial-up access to the Internet.

You need: a modem, the TCP/IP protocol software, and SLIP / PPP software.

Users must have an ISP that lets them dial into a SLIP/PPP server.

#### 3. Connect via an on-line service

You need: a modem, communications software, and an on-line information service account.

There is normally a fixed monthly cost for basic services, including email.

E.g. America Online and Microsoft Network.

### Internet service providers

**ISP** = a company that provides access to the Internet. E.g. altavista.com

They don't offer the extended informational services offered by commercial on-line services.

### Internet services

#### Email

Since not all networks use the same email format, a gateway translates the format of the email message into one that the next network can understand.

#### Telnet and FTP

**Telnet** enables you to log on to other computers on the Internet to gain access to public files.

It's useful for looking at library card files and large databases. (Also called remote logon).

**File transfer protocol:** Files can be transferred / copied between a host and remote computer.

#### Usenet and newsgroups

**Usenet** = a system that uses email to provide a centralised news service.

It is a protocol that describes how messages can be stored on and sent between computers.

Email messages are sent to a host computer that acts as a Usenet server.

This server gathers information about a single topic into a central place for messages.

The user can then log on to the server to read these messages.

Usenet forms a virtual forum for the electronic community, which is divided into newsgroups.

**Newsgroups (what make up Usenet)** = on-line discussion groups that focus on specific topics.

Messages are posted to newsgroups and are then broadcast to other computer systems.

Newsgroups are organised into hierarchies by general topic with subtopics.

Each group takes the form of a bulletin board where members post & reply to messages.

#### Chat rooms

= A facility that enables people to engage in interactive conversation over the Internet.

### Internet phone and videoconferencing services

Internet phone service enables you to communicate with Internet users who have equipment and software compatible to yours.

**Voice-over-IP (VOIP)** = technology that enables network managers to route phone calls & fax transmissions over the same network they use for data.

Gateways installed at both ends of the communications link convert voice to IP packets.

Voice travels over the intranet / Internet.

Using packets allows multiple parties to share digital lines, so data transmission is more efficient than traditional phone conversations (which require a line each).

When the packets hit the destination gateway, the message is depacketised, converted back into voice, and sent out via local phone lines.

A codec (compression-decompression) device prepares the voice transmission by squeezing the recorded sound data and slicing it into packets for transmission over the Internet.

On the receiving end, a codec reassembles and decompresses the data for playback.

With Internet videoconferencing, a video codec converts visual images into digital bits & back.

### Content streaming

= A method for transferring multimedia files over the Internet so that the data stream of voice and pictures plays continuously, without a break.

It lets users browse large files in real time (You view a streamed video as it is being received).



## Instant messaging

Allows 2 / more people to communicate on-line (instantly) using the Internet.  
2 / more screens open up, each one displaying what people are typing, in real time.

## Shopping on the Web

Bot = a software tool that searches the Web for information, products, prices, etc...

## Web auctions

= An Internet site that matches people who want to sell with people who want to buy.

## Music, radio and video on the Web

### Office on the Web

Internet office = a Web site that contains files, phone numbers, email addresses, calendars...  
You can send documents from the Web site to co-workers and search your appointment book

## Internet sites in 3 dimensions

### Free software and services

- **The WWW**

The WWW started with Tim Berners-Lee's development of an internal system at CERN.

The Web is a menu-based system that uses the client/server model.

Hypermedia = tools that connect the data on Web pages.

XML = a markup language for documents with *structured information*, like words, pictures...

With XML, there is no predefined tag set - Tags and their relationships must be defined.

(XML includes capabilities to define & share document information over the Web).

CSSs improve Web page *inheritance and presentation*.

DHTML provides *dynamic presentation* of Web content.

### Web browsers

= Software that creates a hypermedia-based menu, providing a graphical interface to the Web

Applet = a small program embedded in Web pages.

### Search engines

= Search tools that produce an index of all text on the sites they examine. E.g. yahoo.com

They do NOT scan all known Web pages each time a search is initiated!

Meta-search engines send keywords to search engines and return results from all queries.

Keyword search engines produce an index of all the text on the sites they examine.

Directory search engines operate like a catalogue card, assigning sites to specific categories.

## Java

Applets: When the user clicks on the appropriate part of the HTML page to retrieve it from a Web server, the applet is downloaded onto the client where it begins executing.

The client computer checks if the applet is already stored locally before requesting it.

To develop an applet, you write code for the client side and install that on the Web server.

The user accesses the Web page and pulls it down to his PC, which serves as a client.

The Web page contains an additional HTML tag called APP, which refers to the applet.

Java software can run on any type of computer. (= Cross-platform)

Java programs & applets can run on any operating system. (= OS independent)

### Push technology

= Webcasting.

Information is automatically sent to the user, rather than waiting for the user to request it.

You need to install software that acts like a TV antenna, capturing transmitted content.

Disadvantages:

- \* Information overload

- \* The volume of data is so great that push technology can clog up the Internet.

## Business uses of the Web

Businesses can use the Web as a tool for marketing, sales, and customer support.

### Developing Web content

Not all browsers will work the same way when used to view the same Web page.

- **Intranets and extranets**

Advantage of intranets: People are familiar with the Internet, so they need little training.

Another advantage: Support for real-time meetings over networks.

Intranets are ideal for a mobile sales force that needs access to rapidly changing info.

*Workgroup computing* = an approach to supporting people working together in teams.

A key aspect: The ability to store & share information in any form. (Knowledge base)

Key feature: being able to reorganise and retrieve all this data simply.

Workgroup computing also supports work flow processes, tracking the status of documents - who has them, who is behind schedule, and who gets them next.



**Extranet** = a network that links selected resources of the intranet with outsiders (customers...)

Secured intranet and extranet access applications usually require the use of a VPN

**VPN (virtual private network)** = a secure connection between 2 points across the Internet.

**Tunnelling** = the process by which VPNs transfer info by encapsulating traffic in IP packets.

\* A user sends data to the company's firewall

\* The data is converted into a coded form which is then sent to the company's ISP

\* The data is transmitted through tunnels across the Internet to the recipient's ISP

\* The receiving company's firewall decodes it and sends it to the receiver's PC

#### ▪ **Net issues**

##### **Management issues**

Internet Society & IAB (Internet Activities Board) foster the continued growth of the Internet.

One of the main functions: To manage the network protocols used by the Internet.

##### **Service bottlenecks**

Cause of bottlenecks = the phenomenal growth in traffic.

Two primary Internet bottlenecks: *Slow modems* and the *copper-based phone wire system*.

Connection agreements exist among the backbone companies to accept one another's traffic.

Routers can also become bottlenecked.

For each packet, every router must scan a huge address book of destinations and pick one.

These routers can get overloaded and lose packets.

The TCP/IP protocol detects missing packets and requests the sending device to resend it.

As the network devices continually try to resend lost packets, it leads to long response times.

**Solutions to overcome the bottleneck problem:**

\* Backbone providers can upgrade their backbone lines

\* Router manufacturers can develop improved models with increases in hardware capacity and more efficient software to provide quick access to addresses

\* Traffic can be prioritised - customers could pay more for guaranteed delivery speed

##### **Privacy, security, and unauthorised Internet sites**

**Cookie** = a text file that an Internet company can place on your hard disk.

**Cryptography** = converting a message into a secret code and back.

Plaintext = the unencoded message

Ciphertext = the encoded message.

Encryption = converting plaintext into ciphertext.

Decryption = converting ciphertext back into plaintext.

Cryptosystem = a software package that uses an algorithm and a key to encrypt and decrypt.

**Digital signature** = an encryption technique used to verify the identity of a message sender.

Encryption can prevent fraud by authenticating sender's identities with digital signatures.

##### **Firewalls**

= A device that sits between your internal network and the outside Internet.

It limits access into & out of your network based on your organisation's access policy.

For a higher level of security, you can have an *assured pipeline*, which uses more sophisticated methods to prevent access.

A firewall looks at only the *header* of a packet, but an assured pipeline looks at the *entire request* for data and then determines whether the request is valid.

## Chapter 8 - Electronic commerce

#### ▪ **An introduction to E-commerce**

E-commerce involves business transactions executed electronically between companies, consumers, or the public sector.

##### **Multistage model for E-commerce**

###### **1. Search and identification**

Prepare a list of needed items, browse the online catalogue and fill out an RFQ form.

The heart of any B2C e-commerce system is the customer's ability to search for and identify items for sale.

E.g. An employee accesses a catalogue and browses to find the desired machine part.

Bots can be used for search and identification.

###### **2. Selection and negotiation**

Once the price quotations have been received from each supplier, make choices.

The supplier's service and delivery speed can be important in selection.



### **3. Purchasing products and services electronically**

Complete the purchase order by sending an electronic form to the supplier.

### **4. Product and service delivery**

Electronic distribution eliminates inventory problems for manufacturers.

### **5. After-sales service**

Customer information is captured from the order and stored in the customer database.

Companies can add the capability to answer after-sales questions to their Web sites.

## **E-commerce challenges**

1. To define an effective e-commerce model and strategy.

3 basic components of a successful e-commerce model:

### **Community**

Message boards and chat rooms are used to build a loyal community of interested people.

### **Content**

Providing useful, accurate, and timely content gets people to return to your site.

### **Commerce**

Commerce involves consumers paying to purchase goods posted / advertised online.

2. To manage shipments of individual units directly to consumers.

**Split-case distribution** = a system that requires cases of goods to be opened on the receiving dock and the individual items from the cases are stored in the manufacturer's warehouse.

The distribution system must also be able to ship and track individual items.

3. To integrate Web-based order processing systems with traditional mainframe systems.

Front-end Web-enabled applications need to be integrated to traditional back-end ones.

## **The E-commerce supply chain**

Supply chain management = a key value chain composed of 3 sub-processes:

### **1. Demand planning**

Involves: analysing customers' buying patterns & developing customer demand forecasts.

### **2. Supply planning**

Allocates the right amount of resources to meet demand and includes: strategic / inventory / distribution / procurement / transportation planning & supply allocation.

### **3. Demand fulfilment**

Fulfils demands quickly and efficiently and includes: order capturing, customer verification, order promising, **backlog management**, and order fulfilment.

### **Increased revenues and decreased costs**

By eliminating steps in order & delivery, more sales can be completed in the same time period

### **Improved customer satisfaction**

More detailed info about delivery dates and current status can increase customer loyalty.

### **Inventory reduction across the supply chain**

Better customer order info → reduced inventory at all intermediate storage points.

## **Business to business (B2B)**

Manufacturers can buy at a low cost worldwide.

Enterprises can sell to a global market right from the start.

## **Business to consumer (B2C)**

### **E-commerce applications**

#### **Retail and wholesale**

Electronic retailing = the direct sale from business to consumer through electronic storefronts.

**Cybermall** = a single Web site that offers many products & services at one Internet location.

E-commerce software can help you find duplicates, so you can spot opportunities to save.

#### **Manufacturing**

Electronic exchange = a forum where manufacturers, suppliers, and competitors buy and sell goods, trade market information, and run back-office operations.

Advantages of EE: speed, smaller inventory, competitive marketplace, lower prices.

Disadvantages of EE: companies can lose trade secrets, suppliers' prices are driven down, expensive to participate in multiple exchanges, government scrutiny of participants...

#### **Marketing**

The Web gives firms more info about customer behaviour than other marketing approaches.

**Market segmentation** = identifying specific markets and targeting them with adverts.

**Relationship management** = using detailed info about a customer to set prices, negotiate terms, tailor promotions and customise the relationship with that customer.



## Investment and finance

### On-line stock trading

A portfolio tracker allows you to enter info about the securities you own. (= indispensable tool)

You can then access the tracker site to see how your stocks are doing.

You can also program trackers to watch for certain events, like stock prices changing...

### On-line banking

With electronic bill payment, you set up a list of frequent payees.

When you want to pay your bills, you enter the code / name, amount, and the date to pay.

Electronic bill presentment = when the biller posts an image of your statement on the Internet, and alerts you by email that your bill has arrived so you can direct your bank to pay it.

## Auctions

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## Technology infrastructure

### Hardware

E-commerce solutions should be designed to be upgraded to meet unexpected user traffic.

You can use a third-party company that rents space on its computer system, provides a high-speed connection to the Internet, and personnel to operate & manage the server.

If you want to take full responsibility for acquiring & operating the Web server hardware & software instead, you need considerable up-front capital and trained individuals.

### Web server software

Apache HTTP server and Microsoft Internet Information Server are the two most popular Web server software packages.

### Security and identification

These services identify and verify employees coming into the server from the Internet.

Access controls provide / deny access to files based on the user name or URL.

### Retrieving and sending Web pages

A Web server processes and responds to client requests that are sent using HTTP.

### Web site tracking

Web servers capture visitor information, which is placed into a Web log file for analysis.

Web log file = a file that contains information about visitors to a web site.

### Web site development

Web site development tools can be used to develop a Web site.

### Web page construction

Web page construction software uses Web editors and extensions to produce Web pages.

## E-commerce software

5 core tasks that e-commerce software must support:

### 1. Catalogue management

An interactive catalogue delivers customised content to a user's screen.

The data required to support large catalogues is stored in a database.

### 2. Product configuration

Product configuration software is used by buyers to build the product they need online.

This is useful when an item has many components and options.

### 3. Shopping cart facilities

When you click an item, its details (price, product no...) are stored automatically.

### 4. E-commerce transaction processing

Basic TP software takes data from the shopping cart and does calculations.

Software can also route order info to shipping companies.

### 5. Web traffic data analysis

Data captured in the Web log file can be turned into useful info to improve your website.

## Network and packet switching

Each network approach relies on basic packet switching technology & the use of routers.

Weigh up: cost, availability, reliability, security, and redundancy issues.

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## Electronic payment systems

Digital certificate = an email attachment that verifies the sender.

Certified authority (CA) = a trusted third-party organisation that issues digital certificates.

## Secure sockets layer

SSL = a communications protocol used to secure sensitive data.

SSL sits above the TCP layer of the OSI model.

Handshake stage: authenticate server - determine encryption algorithm - exchange keys.

Following the handshake stage, data may be transferred.



### Electronic cash

You must open an account with a bank and show ID to obtain e-cash. When you want to withdraw e-cash, go to the bank's site and present ID (digital certificate). After verifying the ID, the bank issues you the e-cash and deducts money from your account. The e-cash is stored in your electronic wallet on your hard drive / smart card.

#### Identified electronic cash:

Contains info revealing the ID of the person who originally withdrew the money from the bank. The bank can determine what you bought, where, when, etc...

#### Anonymous electronic cash (digital cash):

Once it is withdrawn from an account, it can be spent without leaving a transaction trail.

### Electronic wallets

Holds credit card info, e-cash, owner ID, and address info. When consumers click on items to purchase, they just click on their e-wallet to order the item.

### Smart, credit, charge, and debit cards

Debit cards allow you to spend only what is in your bank account.

Smart cards are better protected from misuse, because the information is encrypted.

#### Threats to E-commerce

##### Security

Biometric technology digitally encodes physical attributes.

##### Intellectual property

= Items protected by patents, copyrights / trademarks.

##### Fraud

###### On-line auction fraud

It is up to the buyer & seller to resolve details of payment and delivery. The auction sites offer no guarantees.

###### Spam

Spam allows peddlers to hawk their products instantly at no cost.

###### Pyramid schemes

###### Investment fraud

Investment fraud occurs through the sale of bogus investments.

###### Stock scams

Chat rooms make it easy for scammers to talk up / down a stock based on false information.

Thinly traded stocks are the most easily manipulated in Internet stock scams.

##### Privacy

Clickstream data = the data gathered based on the Web sites you visit and what you click on. Safe harbour principles = a set of principles that address e-commerce data privacy issues. A company following these principles must notify consumers of the purpose of data collection.

#### Strategies for successful E-commerce

##### Developing an effective Web presence

###### Putting up a Web site

###### Web site hosting services

Web site hosting companies provide tools & services required to set up a Web page.

###### Storefront brokers

= Companies that act as middlemen between your site and on-line merchants.

Your products are displayed on your own Web pages, handled by another on-line merchant.

The storefront broker deals with the details of the transactions.

###### Building traffic to your Web site

A Meta tag contains keywords representing your site's content.

## Chapter 9 - Transaction processing and ERP systems

AI / ES	Information	More	More	Less	Less
MIS / DSS		Decision support	Sophistication	Routine	Input & output
TPS	Data	Less	Less	More	More

#### An overview of TPS

A TPS is used to record completed business transactions.

Information concepts are applied to routine, repetitive, and ordinary business transactions.

TPS functions are built into an ERP system.

E.g. Order entry, inventory control, payroll, accounts payable, accounts receivable, ledger...





Input includes: Customer & purchase orders, receipts, time cards, invoices, payroll cheques...  
Processing includes: Data collection, edit, manipulation, storage, & document production.

The TPS is an integrated component of an organisation's total IS because output from a TPS is used as input for other systems.

### **Traditional transaction processing methods and objectives**

**Batch processing:** Transactions are accumulated and processed as a single unit.

**OLTP (On-Line Transaction Processing):** Each transaction is processed immediately.

**On-line entry with delayed processing = a compromise between batch & OLTP.**

Transactions are entered when they occur, but they are not processed immediately.

*Objectives of TPSs:*

Process data generated by and about transactions

Primary objective of a TPS: Capture, process & store transactions and produce documents.

Maintain a high degree of accuracy and integrity

One objective of any TPS is error-free data input and processing.

Fraudulent transactions must be avoided. (Use digital certificates).

Produce timely documents and reports

Transactions can be processed in seconds, improving the company's cash flow.

Increase labour efficiency

A computer linked to a company's cash registers replaces a room full of clerks & typewriters.

Help provide increased service

EDI systems allow customers to place orders electronically, instead of waiting in queues.

Help build and maintain customer loyalty

TPSs are often the means for customers to communicate, so keep them satisfied & returning.

Achieve competitive advantage

Ways that TPSs help companies gain competitive advantage:

- \* Increase customer loyalty
- \* Provide superior service to customers
- \* Have a better relationship with suppliers
- \* Superior information gathering
- \* Reduce costs dramatically

### **Transaction processing activities**

The transaction processing cycle:

Data collection

= The process of capturing and gathering all data necessary to complete transactions.

It begins with a transaction and results in the origination of data that is input to the TPS.

Source data automation = when data is captured at its source, with minimal manual effort, and in a form that can be directly entered into the computer. (E.g. using scanners).

Data editing

= **Checking data for validity and completeness** (E.g. Cost data must be numeric)

Often, the codes associated with a transaction are edited against a database with valid codes. If any code entered is not present in the database, the transaction is rejected.

Data correction

= **Re-entering miskeyed data that was discovered during the data editing routine.**

The system should provide error messages that alert the person entering info.

Data manipulation

= **Performing calculations on business transactions, classifying data, sorting, summarising...**

Data storage

= **Updating databases with new transactions.**

Document production and reports

= Generating output records and reports.

### **Control and management issues**

Business resumption planning

= **The process of anticipating and providing for disasters.**

Focus on 2 issues:

- \* Maintaining the integrity of corporate information
- \* Keeping the IS running until normal operations can be resumed

Identify potential threats, such as natural disasters, misuse of computers...

Occasionally hold an unannounced 'test disaster' to ensure that the disaster plan is effective.

Disaster recovery

= **The implementation of the business resumption plan.**



Primary tools = backups for hardware, software, databases, telecommunications & personnel. A common backup for hardware is a similar / compatible system owned by another company. Some companies back up their hardware with duplicate systems and equipment of their own. Two firms in different industries with compatible systems can help back each other up. Hot site = a duplicate system that is operational and ready to use.

Cold site / shell = a computer environment that includes rooms, electrical service, storage devices, telecommunications links...

If there is a problem with the primary mainframe, the primary hardware is brought into the cold site and the complete system is made operational.

Backup for software & hardware: you can make duplicate copies of all programs & data.

Keep one backup copy in the IS department and another one off-site in a safe place.

Utility packages inexpensively provide backup features for desktop computers.

Backup for telecommunications: recovery plans for the whole network or just the critical nodes

Backup for personnel: cross-train so that employees can perform an alternate job if required.

#### Transaction processing system audit

\* Does the system meet the business need for which it was implemented?

\* What procedures and controls have been established?

\* Are these procedures and controls being used properly?

Other areas investigated during an audit include:

Distribution of output documents & reports, training & education associated with existing & new systems, the time necessary to perform various tasks, general areas of improvement...

There is no investigation pertaining to the accuracy of performance forecasts!

*Internal audit:* conducted by employees of the organisation.

*External audit:* performed by accounting firms / people not associated with the organisation.

The auditor inspects all programs, documentation, control techniques, the disaster plan, insurance protection, fire protection...

This is accomplished by interviewing IS personnel and performing tests on the system.

Audit trail allows auditors to trace output from the computer system to the source documents.

### ▪ **Traditional transaction processing applications**

#### **Order processing systems**

##### Order entry

The order entry system captures the basic data needed to process a customer order.

With an on-line order processing system, the inventory status of each item is checked.

If an order item can't be filled, a back order is created.

Order takers can review customer payment history data to see if credit can be extended.

With EDI, a customer can place orders directly from its purchasing TPS into the order processing TPS of another organisation.

With EDI, orders can be placed any time of day / night, and there is immediate notification.

##### Sales configuration

The sales configuration system ensures that the products and services ordered are sufficient to accomplish the customer's objectives and will work well together.

Sales configuration programs can suggest optional equipment, solve customer problems and answer customer questions, eliminate mistakes, reduce costs, increase revenues.

##### Shipment planning

The shipment *planning* system determines which orders will be filled and from which location.

The output shows where each order is to be filled and gives a precise schedule.

The system also prepares a picking list that is used to select the ordered goods.

##### Shipment execution

The shipment *execution* system coordinates the outflow of products from the organisation.

The shipping department is given responsibility for packing & delivering the products.

The system receives the picking list from the shipment planning system.

After shipment execution, 'shipped orders' transactions go to the invoicing system.

These transactions specify what items were shipped, the quantity, and to whom.

This data is used to generate a customer invoice.

The shipment execution system also produces packing documents, which are enclosed with the items being shipped, to tell customers what is in the shipment, on back-order...

##### Inventory control

For each item being picked, a transaction is passed to the inventory control system.

In this way, inventory records reflect the exact quantity on hand of each stock-keeping unit.

Once products have been picked out of inventory, other documents & reports are initiated.



E.g. Inventory status report - summarises all inventory items shipped over a specific time.  
One objective is to place just the right amount of inventory on the factory floor.  
Competitive advantage: real-time inventory control systems, wireless LAN communications...  
Advantage: Inventory data is more accurate and current for people performing order entry etc  
Invoicing

Customer invoices are generated based on records from the shipment execution TPS.  
Most invoicing programs automatically compute discounts, taxes, and miscellaneous charges.  
Customer interaction

Customer interaction system monitors & tracks each customer interaction with the company.  
Goal: To build customer loyalty.

Additional data is captured at the time of each sale and is passed to people who can use it.  
The customer interaction data can be used to keep customers satisfied, improve products...

#### Routing and scheduling

A routing system determines the best way to get products from one location to another.

A scheduling system determines the best time to deliver goods & services.

Scheduling & routing programs are connected to the organisation's order & inventory TPS.

### **Purchasing systems**

#### Inventory control

The firm must ensure that there's enough raw / packing material, & maintenance parts.

#### Purchase order processing

The purchase order processing system helps complete transactions quickly and efficiently.

The buying process is facilitated by keeping data on suppliers' goods and services.

Many companies form strategic partnerships with a major supplier for important materials.

Partners are chosen based on prices and their ability to deliver quality products on time.

#### Receiving

The receiving system creates a record for the expected receipts.

A centralised receiving department takes incoming items, inspects them, and routes them.

Any items that fail inspection are sent back to the supplier.

#### Accounts payable

The accounts payable system increases control over purchasing while regulating cash flow.

Major outputs = cheques to suppliers for materials & services.

Input from the purchase order processing system provides an electronic record to the accounts payable application that updates the database.

Accounts payable cheques include the items ordered, amount of each item, totals...

Companies can also pay their suppliers electronically using EDI, the Internet etc.

Common report produced: Purchases journal, which summarises bill-paying activities.

### **Accounting systems**

#### Budget

The budget transaction processing system amasses budget data and distributes it to users.

#### Accounts receivable

The accounts receivable system manages the cash flow by keeping track of money owed.

When goods are shipped, the customer's accounts payable system receives an invoicing transaction, & the customer's account is updated in the supplier's accounts receivable system

Major output: monthly bills / statements sent to customers.

#### Payroll

Primary outputs: payroll cheque & stub, and the payroll register (=summary report)

The number of hours worked is collected, and weekly / monthly paycheques are prepared.

Payroll systems can handle: overtime, commissions, tax forms, savings plans...

Payroll journal = a report that contains all employees; names, hours, pay rate...

Financial managers use the payroll journal to monitor & control pay to individual employees.

#### Asset management

Capital assets last several years, while their value depreciates, resulting in a tax reduction.

The asset management TPS controls investments & manages depreciation for tax benefits.

#### General ledger

Every monetary transaction that occurs must be recorded in a general ledger.

A computerised general ledger system allows automated financial reporting and data entry.

The ledger application produces a detailed list of all business transactions & activities.

Reports: profit & loss statements, balance sheets, general ledger statements.



## Enterprise resource planning

### An overview of ERP

The key to ERP is real-time monitoring of business functions (which permits timely analysis). ERP configures all aspects of the IS environment to support how your firm runs its business.

### Advantages of ERP:

#### Elimination of costly, inflexible legacy systems

Separate systems are replaced with a single *integrated* set of applications.

#### Improvement of work processes

**Best practices = the most efficient & effective ways to complete a business process.**

ERP vendors do research to define the best business practices.

#### Increase in Access to data for operational decision making

An integrated database means one set of data supports all business functions.

This allows companies to provide greater customer service & support.

#### Upgrade of technology infrastructure

Standardisation on fewer technologies and vendors reduces ongoing maintenance costs.

### Disadvantages of ERP:

#### Expense and time in implementation

ERP is time-consuming, difficult, and expensive to implement.

#### Difficulty implementing change

Sometimes companies have to make big operational changes to conform to the ERP.

#### Difficulty integrating with other systems

Some companies have difficulty making other systems operate with their ERP.

#### Risks in using one vendor

It is expensive to change vendors, so your vendor might not be responsive.

Your vendor's product may become outdated or they might go out of business.

**SAP R/3 is the most widely used ERP solution in the world.**

## Chapter 10 - Information and decision support systems

### Decision making and problem solving

#### Decision making as a component of problem solving

Problem solving begins with decision-making.

#### 3 stages of the decision-making phase:

##### 1. Intelligence stage

Identify potential problems / opportunities & investigate resource & environmental constraints.

##### 2. Design stage

Develop alternative solutions to the problem & evaluate the feasibility of these alternatives.

##### 3. Choice stage

Select a course of action.

**Problem solving goes beyond decision-making to include 2 more stages:**

##### 4. Implementation stage

Put the solution into effect.

##### 5. Monitoring stage

Evaluate the implementation to determine whether the anticipated results were achieved.

#### Programmed versus non-programmed decisions

Programmed decisions = made using a rule / procedure.

(You can program a computer to order inventory when levels reach a certain minimum).

Non-programmed (ad hoc) decisions deal with unusual / exceptional situations.

(Decisions contain unique characteristics for which the application of rules is not obvious).

#### Optimisation, satisficing, and heuristic approaches

##### Optimisation model

= A process to find the best solution, considering constraints, profit goal, conditions...

##### Satisficing model

= A model that will find a good - but not necessarily the best - problem solution.

Satisficing is usually used because it can be too expensive / difficult to get the best solution.

##### Heuristics

= Commonly accepted guidelines / procedures that usually find a good solution.

### An overview of management information systems

#### Management information systems in perspective

A MIS provides info & support for effective decision-making and feedback on daily operations.



The insight provided helps managers control, organise, and plan more effectively & efficiently. Each MIS is an integrated collection of sub-systems, organised along functional lines. You can increase the overall efficiency of the MIS by improving the integration of sub-systems. Decision support, executive support, and expert systems also assist in decision-making.

### Inputs to a MIS

**Internal sources of data:** TPS, ERP.

External sources of data: Customers, suppliers, competitors, stockholders, Internet...

The MIS uses the data to process it into information for managers, mainly in report form.

### Outputs of a MIS

#### Scheduled reports

= Reports produced periodically (daily / weekly / monthly)

E.g. A summary report of payroll costs helps managers control future payroll costs.

**Key-indicator report** = a summary of the previous day's critical activities.

#### Demand reports

= Reports that give info on request.

E.g. Managers can seek a demand report on inventory levels for a particular item.

#### Exception reports

= Automatic reports that are produced when a situation is unusual / requires action.

E.g. An exception report can be produced if inventory levels are too low.

#### Drill down reports

= Reports that provide increasingly detailed data about a situation.

### Characteristics of a MIS

- \* Provide reports with fixed & standard formats
- \* Produce hard-copy & soft-copy reports
- \* Use internal data stored in the computer system
- \* Allow end users to develop their own custom reports
- \* Require user requests for reports developed by systems personnel

### Functional aspects of the MIS

#### Financial MIS

Provides financial information to financial managers.

- \* Integrates financial & operational information from multiple sources into a single MIS.
- \* Provides easy access to data for financial & non-financial users.
- \* Makes financial data available on a timely basis.
- \* Enables analysis of financial data along multiple dimensions (time, geography, customer...)
- \* Analyses historical & current financial activity.
- \* Monitors & controls the use of funds over time.

#### Important financial subsystems:

##### Profit / loss and cost systems

Revenue and expense data from the TPS becomes a source of financial info for the MIS.

**Profit centres** = departments that track total expenses and net profits.

Revenue centres = divisions that track sales / revenues. (Like marketing / sales departments)

Cost centres = divisions that do not directly generate revenue. (Manufacturing / R&D dept...)

Data on profit, revenue, and cost centres is gathered, summarised, and reported by the MIS.

#### Auditing

= Determining the accuracy of financial statements produced by the financial MIS.

Internal audits are conducted to see how well the organisation is doing in terms of goals.

External audits are conducted to provide an unbiased picture of the organisation's finances.

#### Uses and management of funds

Outputs from the funds usage & management subsystem can locate cash flow problems.

Internal uses of funds: Additional inventory, labour, investments in new products, research...

External uses of funds: Investments (bank accounts, stocks, bonds...)

#### Manufacturing MIS

**Objective:** To produce products that meet customer needs at the lowest possible cost.

The manufacturing MIS monitors the process of converting raw materials to finished goods.

#### Some common information subsystems & outputs used in manufacturing:

##### Design and engineering

During early stages of development, engineering depts are involved in many design aspects.

CAD can assist the design process.

##### Master production scheduling

Objective: To provide detailed plans for scheduling of manufacturing facilities.



Software packages can forecast current and future demand for products & services.  
Sensitivity analysis allows you to see how the schedule would change with other assumptions

### Inventory control

Inventory control programs allow reordering, forecasting, report generation, budget analysis...

EOQ = Economic Order Quantity = how much inventory should be reordered for minimal cost

ROP = ReOrder Point = a critical inventory quantity level. ('Danger level').

MRP = Material Requirements Planning = techniques that help coordinate thousands of inventory items when the demand for one item is dependent on the demand for another.

MRPII = Manufacturing Resource Planning = a system based on network scheduling that enables people to run their business with a high level of customer service & productivity.

This helps companies ensure the right product is in the right place at the right time.

### (JIT) Just-in-time inventory and manufacturing

Inventory is delivered just before being used in a product, to keep inventory levels low.

Disadvantage: If one plant is shut down, another one might have no inventory to continue.

### Process control

CAM = Computer-Assisted Manufacturing = a system that controls manufacturing equipment.

CIM = Computer-Integrated Manufacturing = a system that uses computers to link the components of the production process into an effective system.

FMS = Flexible Manufacturing System = an approach that allows manufacturing facilities to rapidly change from making one product to making another.

### Quality control and testing

Quality control = a process that ensures that the finished product meets customers' needs.

Info generated from quality-control programs helps workers locate problems in equipment.

### Marketing MIS

Supports product development, distribution, pricing decisions, promotions & sales forecasting.

CRMs (Customer Relationship Management) help a company manage customer encounters.

### Marketing research

Purpose: To conduct a formal study of the market and customer preferences.

Research data is manipulated to generate reports on things like customer satisfaction.

Reports help managers be better informed to help the organisation meet performance goals.

### Product development

Factors like plant capacity, labour skills... are important in product development decisions.

Software analyses these factors and selects appropriate mix of labour, materials, equipment...

### Promotion and advertising

NB factors: Size of promotion budget & allocation of it to different promotional campaigns.

Computer programs set up the original budget and monitor expenditures and effectiveness.

### Product pricing

Computer programs can help determine price elasticity and pricing policies.

Sales analysis is important to identify products that contribute to profits.

Reports can be generated to help marketing managers make good sales decisions.

### Human resource MIS

It allows a company to cut **personnel** costs while serving the required business processes.

Outputs: HR planning reports, job application reviews, skills inventory reports, salary surveys

### Human resource planning

Purpose: To put the right number and kinds of people in the right jobs when they are needed.

### Personnel selection and recruiting

Computers can schedule recruiting efforts and trips and test potential employees' skills.

For each applicant, the results of the interviews, tests... can be analysed and printed.

This report (job applicant review profile) can assist corporate recruiting teams in final selection

### Training and skills inventory

Many organisations conduct their own training with the assistance of technology.

When the training is over, the employees may be asked to take computer-scored tests.

The results are given to the supervisor in the form of skills inventory reports.

### Scheduling and job placement

Employee schedules are developed, showing their job assignments over the next month.

Job placements are determined by skills inventory reports, which show where they're suited.

### Wage and salary administration

Wage data can be manipulated by the HR MIS to give wage info & reports to managers.

These reports (salary surveys) can be used to compare salaries with budget plans.

Wage & salary administration also entails designing retirement programs for employees.



### Other management information systems

#### Accounting MISs

Provides info on accounts payable, accounts receivable, payroll, etc.

#### Geographic information systems (GIS)

= A computer system that stores, manipulates and displays data identified according to area.

Users can pair maps with tabular data to describe aspects of a particular region.

### ▪ An overview of decision support systems

Used for problem-specific decision-making for semi-structured & unstructured problems

They are used at all levels in an organisation.

#### Characteristics of a decision support system

\* Handle large amounts of data from different sources

\* Provide report and presentation flexibility

\* Offer both textual and graphical orientation

\* Support drill down analysis (Get more levels of detail by drilling down through data)

\* Perform complex, sophisticated analysis and comparisons

What-if analysis = making hypothetical changes to problem data and observing the impact.

Simulation = the ability of the DSS to duplicate the features of a real system.

Goal-seeking analysis = determining the problem data required for a given result.

#### Capabilities of a decision support system

##### Support for problem-solving phases

Phases of problem-solving: intelligence, design, choice, implementation, monitoring.

##### Support for different decision frequencies

Ad hoc DSS = concerned with situations that come up only a few times.

Institutional DSS = concerned with decisions that occur many times.

##### Support for different problem structures

Highly structured problems = straightforward, requiring known facts & relationships.

Semi structured / unstructured problems are more complex.

##### Support for various decision-making levels

Operational-level managers, tactical-level decision makers, and strategic managers.

#### A comparison of DSSs and MISs

Factor	DSS	MIS
Problem type	Unstructured problems	Structured problems
Users	Users have more control	Users have less control
Support	People still make the decisions	Some MISs make automatic decisions
Emphasis	Actual decision-making styles	Emphasises info only
Approach	Direct support system that provides interactive reports	Indirect support system that uses regular reports
System	The equipment is on-line and related to real time	Weekly printed reports won't provide immediate results
Speed	Less time to develop and better able to respond	Longer response time
Output	Usually screen, with ability to generate printed reports	Oriented towards printed reports
Development	Users are more directly involved in its development	Often several years old

### ▪ Components of a decision support system

#### The model base

Purpose: To give decision makers access to models and to assist them in making decisions.

MMS = Model Management Software - co-ordinates the use of models in a DSS.

#### Financial models

Provide cash flow, internal rate of return and other investment analysis.

#### Statistical analysis models

Provide summary statistics, trend projections, hypothesis testing... (SPSS & SAS)

#### Graphical models

Assist decision makers in designing, developing, and using graphic displays of information.

#### Project management models

Used to handle & co-ordinate large projects and identify critical activities & tasks.



## The dialogue manager

It allows users to access & manipulate a DSS using *common business terms*.

### ▪ The group decision support system

GDSS consists of most DSS elements, plus software for providing group support.

#### Characteristics of a GDSS

\* Special design

Special procedures, devices, and approaches are needed in group decision-making settings.

\* Ease of use

\* Flexibility

Supports different approaches and integrates different perspectives into a common view.

\* Decision-making support

**Delphi approach** = when group decision makers are geographically dispersed.

Brainstorming = when members offer ideas off the top of their heads.

Group consensus approach = when members are forced to reach a unanimous decision.

Nominal group technique = when a final decision is made by voting.

\* Anonymous input

It allows decision makers to concentrate on the input, without considering who gave it.

\* Reduction of negative group behaviour

Problems: People can take over a discussion, sidetrack the group, not examine alternatives...

GDSS designers are developing systems to reduce these types of problems.

A trained meeting facilitator is often employed to help lead the group decision-making process

\* Parallel communication

Group members can make comments at the same time → short meetings & better decisions.

\* Automated record keeping

Each comment entered into a group member's PC can be anonymously recorded.

#### GDSS software

Called groupware / workgroup software.

#### GDSS alternatives

##### The decision room

Decision makers are in the same building / area and are *occasional* GDSS users.

A decision room is set up, and there's both face-to-face and technology interaction.

##### The Local area decision network

Decision makers are in the same building / area and are *frequent* GDSS users.

Members have GDSS equipment in their offices and connect via a LAN.

##### The teleconferencing alternative

Decision makers are far apart, and are *infrequent* GDSS users.

Decision rooms are electronically connected in teleconferences and videoconferences.

##### The wide area decision network

Decision makers are far apart, and are *frequent* GDSS users.

Decision makers located throughout the world are linked electronically through a WAN.

Virtual workgroups = teams of people around the world working on common problems.

### ▪ The executive support system (ESS)

#### Executive support systems in perspective

**ESS = a special type of DSS, designed to support higher-level decisions (*strategic planning*).**

DSS allows users to *answer* questions, but ESS allows executives to *ask* the right questions.

General characteristics:

\* Tailored to individual executives

\* Easy to use

\* Have drill down abilities

\* Support the need for external data

\* Can help with situations that have a high degree of uncertainty

\* Support future-oriented decision making

\* Are linked with value-added business processes

#### Capabilities of an executive support system

\* Support for defining an overall vision

\* Support for strategic planning

\* Support for strategic organising & staffing

\* Support for strategic control

\* Support for crisis management





## Ch 11 - Specialised business information systems: AI, expert & virtual reality

### ▪ **An overview of artificial intelligence**

Ask Jeeves demonstrates characteristics of AI: It lets users seek info by asking questions.

#### **Artificial intelligence in perspective**

Objective of AI systems include:

- \* Achieving organisational objectives
- \* Assisting of medical diagnosis
- \* Duplication of the functions of the human brain

The objective is NOT to replace human decision making *completely*.

#### **The nature of intelligence**

Some characteristics of intelligent behaviour:

- \* Learn from experience and apply the knowledge acquired from experience
- \* Handle complex situations
- \* Solve problems when important information is missing
- \* Determine what is important
- \* React quickly and correctly to a new situation
- \* Understand visual images

(A perceptive system approximates the way a human sees, hears and feels objects).

- \* Process and manipulate symbols
- \* Be creative and imaginative
- \* Use heuristics

#### **The major branches of AI**

##### Expert systems

They give the computer the ability to make suggestions and act like an expert in a certain field

##### Robotics

Mechanical devices perform tasks that require precision / are tedious a hazard for humans.

##### Vision systems

Hardware & software permits computers to capture, store, and manipulate visual images.

E.g. Performing fingerprint analysis / identifying people based on facial features.

Generally, robots with vision systems recognise only black, white, and grey shades.

##### Natural language processing

A computer can understand and react to statements and commands made in English.

3 levels of voice recognition:

- \* Command (recognises dozens to hundreds of words)
- \* Discrete (recognises dictated speech with pauses between words)
- \* Continuous (recognises natural speech)

Dragon Naturally Speaking uses continuous voice recognition / natural speech.

##### Learning systems

The computer changes how it functions / reacts to situations based on feedback it receives.

E.g. If the computer doesn't win a game, it remembers not to make those same moves.

##### Neural networks

A computer system simulates the functioning of a human brain.

Neural networks can process many pieces of data at once and learn to *recognise patterns*.

Special features:

- \* Ability to retrieve information even if some of the neural nodes fail
- \* Fast modification of stored data as a result of new information
- \* Ability to discover relationships and trends in large databases
- \* Ability to solve complex problems for which all the information is not present

### ▪ **An overview of expert systems**

Expert systems use *heuristics* (rules of thumb) to arrive at conclusions and make suggestions

#### **Characteristics of an expert system**

- \* Can *explain* their reasoning / suggested decisions
- \* Can display 'intelligent' behaviour (The computer makes suggestions, acting like an expert)
- \* Can draw conclusions from complex relationships
- \* Can provide portable knowledge (i.e. capture human expertise that otherwise might be lost)
- \* Can deal with uncertainty (uses probability, statistics, heuristics)

Limiting characteristics:

- \* Not widely used / tested



- \* Difficult to use
- \* Limited to relatively narrow problems
- \* Cannot readily deal with 'mixed' knowledge
- \* Possibility of error
- \* Cannot refine own knowledge base (Can't eliminate redundant / contradictory rules)
- \* Difficult to maintain (adding new knowledge requires sophisticated programming)
- \* May have high development costs (Expert system shells can reduce costs = a collection of software tools used to develop expert systems)
- \* Raise legal & ethical concerns

### Capabilities of an expert system

Intelligent agents (software robots / bots) = special purpose knowledge-based information systems that accomplish specific tasks for the user.

#### Strategic goal setting

Expert systems can suggest strategic goals and explore the impact of adopting them.

#### Planning

Can investigate the impact of plans, the ways they will help an organisation compete...

#### Design

Use design principles, understanding of procedures, and design rules to assist in design.

#### Decision making

Suggest alternatives, ways of looking at problems, and logical approaches to decision-making

#### Quality control and monitoring

Can monitor systems and propose solutions to system problems.

#### Diagnosis

Expert systems can analyse test results and patient symptoms.

Can provide the doctor with the probable cause of the problem and propose treatments.

### When to use expert systems

- \* Provide high payoff / reduced downside risk
- \* Capture and preserve irreplaceable human expertise
- \* Develop a system more consistent than human experts
- \* Provide expertise needed at many locations at the same time / where it is dangerous
- \* Provide expertise that is expensive / rare
- \* Develop a solution faster than human experts can
- \* Provide expertise needed for training & development

### Components of expert systems

#### Knowledge base

Stores all information, data, rules, cases, and relationships used by the expert system.

A knowledge base must be developed for each unique application.

If-then statements are rules that suggest certain conclusions.

*Purpose of a knowledge base:*

To hold the relevant facts and information for the specific expert system.

*Assembling human experts:*

It is a challenge to assemble the knowledge of multiple human experts.

Human experts can disagree on interpretations, presenting a dilemma for designers.

*The use of fuzzy logic:*

Fuzzy logic = a research area that allows shades of grey (conditions are not true / false).

Used in embedded technology (auto-focus cameras, temperature sensors...)

*The use of rules:*

Rules relating data and conclusions can be developed for any knowledge base.

*The use of cases:*

Cases can be selected by comparing the parameters of the new problem with stored cases.

#### Inference engine

= The component that delivers the expert advice.

The inference engine must find the right facts, interpretations and rules, and assemble them.

Some ways of accomplishing tasks:

1. *Backward chaining:*

= Starting with conclusions and working backwards to the supporting facts.

If the facts don't support the conclusion, another conclusion is selected and tested.

2. *Forward chaining:*

= Starting with the facts and working forwards to the conclusions.

*Comparing backward & forward chaining:*



Forward chaining can reach conclusions and yield more info with *fewer* queries.  
However, forward chaining requires *more* processing and sophistication.

Mixed chaining = a combination of backward & forward chaining.

#### Explanation facility

The expert system indicates all the facts and rules used in reaching the conclusion.

#### Knowledge acquisition facility

= The part that provides the means of capturing & storing components of the knowledge base

Knowledge acquisition software can have easy-to-use menus, making maintenance easier.

#### User interface

There is specialised user interface software for designing, creating, updating, & using an ES.

### **Expert systems development**

#### The development process

Determine requirements: Identify the system's objectives and potential use.

Identify experts.

#### Participants in developing and using expert systems

\* *Domain expert*

Domain expert = the person / group whose knowledge is captured.

\* *Knowledge engineer & knowledge users*

Knowledge engineer = person with training in design & development of an expert system.

Knowledge user = person / group who use the expert system.

#### Expert systems development tools and techniques

\* *Expert system shells and products*

Expert system shell = a collection of software packages and tools used to design, develop, implement, and maintain expert systems.

#### Advantages of expert system shells and products

\* Easy to develop and modify

\* Use of satisficing (giving good, but not necessarily optimal, solutions to complex problems)

\* Use of heuristics (helps handle situations with imprecise relationships)

\* Development by knowledge engineers and users

#### Expert systems development alternatives

\* *In-house development: develop from scratch*

The most costly alternative, but you have more control over the features.

Disadvantage: Can result in a more complex system, with higher maintenance costs.

\* *In-house development: develop from a shell*

The same shell can be used to develop many expert systems.

Easier to develop and less complex to maintain.

Disadvantage: The system may need to be modified and the features can be harder to control

\* *Off-the-shelf purchase: use existing packages*

Least expensive approach.

Advantages: Cost, time, can also be easy to maintain and update.

Disadvantage: Might not satisfy unique organisation needs.

### **Applications of expert systems and AI**

Credit granting (Expert systems at banks review credit applications...), games, information management and retrieval, legal profession, AI and expert systems embedded in products, plant layout, hospitals and medical facilities, help desks and assistance, employee performance evaluation, loan analysis, virus detection, repair and maintenance, shipping, marketing, warehouse optimisation.

### **Integrating expert systems**

An expert system can be integrated with other systems through a common database.

#### ▪ **Virtual reality**

Virtual reality systems enable users to move and react in a computer-simulated environment.

Users can sense and manipulate virtual objects like real objects.

#### **Interface devices**

Head mounted displays monitor the location of the head and the direction you're looking.

BOOM = a head-coupled stereoscopic display device.

CAVE provides the illusion of immersion by projecting stereo images on walls.

Earphones update audio signals.

The haptic interface relays the sense of touch (e.g. by using a glove) - challenging to create.

#### **Immersive virtual reality**

The virtual world is presented in full scale.



### Other forms of virtual reality

Applications that are not fully immersive:

E.g. Mouse-controlled navigation through a 3D environment on a screen.

Telepresence systems immerse you in a world captured by video cameras at a distance.

### Useful applications

Medicine

Education

Real estate marketing (You can take a virtual walk through properties without wasting time)

Computer-generated images

## Chapter 12 - Systems investigation and analysis

### ▪ An overview of systems development

#### Participants

The *systems development team* (stakeholders, users, managers, systems development specialists...) is responsible for determining the objectives of the IS and delivering it.

Stakeholders = individuals who ultimately *benefit* from the systems development project.

Users = people who *interact* with the system regularly. (Employees, managers, customers...)

Systems analysts = professionals who analyse and design business systems.

Programmers = people who modify / develop programs to satisfy user requirements.

#### Initiating systems development

Systems development efforts begin when someone capable of initiating organisational change perceives a potential benefit from a new / modified system.

Many people can't initiate change because of constraints like status, power, authority...

Managers are most often empowered to initiate change, so they most often initiate projects.

Reasons for initiating systems development projects:

- \* Problems with existing system
- \* Desire to exploit new opportunities
- \* Increasing competition
- \* Desire to make more effective use of information
- \* Organisational growth
- \* Merger / acquisition
- \* Change in market / external environment
- \* New laws / regulations

#### IS planning

An organisation's strategic plan affects the type of system needed.

IS planning = translating strategic & organisational goals into systems development initiatives

Benefit: Long-range view of information technology use in the organisation.

Benefit: IS planning ensures better use of IS resources (funds, personnel, time).

Developing a competitive advantage

Creative analysis = investigation of new approaches to existing problems.

Critical analysis = unbiased questioning of whether elements are related in the best ways.

Critical analysis actions:

- \* Go beyond automating manual systems

(Ask why things are done a certain way and consider alternative approaches).

- \* Question statements & assumptions

(Question users about their needs and clarify their responses).

- \* Identify & resolve objectives & orientations that conflict

(Different departments can have different objectives. Resolve these differences first).

#### Establishing objectives

Mission-critical systems = systems that play a pivotal role in goal attainment. (E.g. TPS)

Critical success factors (CSF) = factors essential to the success of functional areas.

The CSF is converted into specific objectives for a system.

Performance objectives

System performance is determined by these factors:

- \* Quality / usefulness of the output (Is the system generating the right information?)
- \* Quality / usefulness of the format of the output (Is the form usable & understood?)
- \* Speed at which output is generated (Is the output timely enough to meet objectives?)

Cost objectives

- \* Development costs (Costs required to get the system up and running)



- \* Costs related to the uniqueness of the system (expensive & reusable or cheap & limited?)
- \* Fixed investments in hardware.
- \* Ongoing operating costs of the system (Personnel, software, supplies, electricity...)

### E-commerce

Companies can extend their IS to customers, suppliers, partners... to conduct business faster  
Business applications on the Web must integrate with infrastructure (databases, ERP...)

### Trends in systems development and ERP

ERP software drives planners to explore and develop different types of systems.

Some ERP users try using it to make business decisions.

- \* Companies like sticking with their ERP vendor, and look to them for other solutions too.
- \* Many software vendors build software that integrates with the ERP vendor's package.
- \* Many companies, after implementing their own company's ERP project, are branching out to provide consulting to other companies.

### ▪ Systems development life cycles

#### 1. Traditional SDLC

##### 1. Investigate

Identify problems and determine if they are worth solving.

Result: Defined project with business problems and allocated resources.

##### 2. Analyse

Determine *what* the IS must do to solve the problem.

Result: List of requirements and priorities.

##### 3. Design

Determine *how* the IS will obtain the solution.

Result: Technical design that describes the new system / how the current one will be modified

##### 4. Implement

Create / acquire the system components, place the IS into operation, and train the users.

Result: An installed, operational IS that meets the needs for which it was developed.

##### 5. Maintain & review

Modify the system so that it continues to meet changing business needs.

##### Advantages:

Formal review at the end of each phase allows maximum *management control*.

There is much documentation (like ERD) that is useful when the system is modified.

Every system requirement is related to a business need.

Resulting products can be reviewed to verify that they satisfy requirements.

##### Disadvantages:

The user doesn't use the solution until the system is nearly complete.

Often, user needs go unstated or are misunderstood.

Inflexible approach - changes can't be accommodated during development.

Documentation is expensive and time-consuming to create, and difficult to keep current.

#### 2. Prototyping

= An iterative approach to systems development.

In each iteration, analyse requirements, design solutions, and implement a part of the system.

Operational prototype = a prototype that works.

Non-operational prototype = just a model. It can be developed faster than an operational one.

##### Advantages

- \* It can be produced quickly.
- \* Users can try it and provide feedback.
- \* Users become positive about the system as they see it emerging.

\* Errors are detected early.

##### Disadvantages

\* It's hard to reject the initial solution, because each iteration builds on the previous one.

\* No end-of-phase reviews, so the project never seems to end. (Low management control)

\* Documentation is absent / incomplete, since the focus is on development.

\* Backup, recovery, performance, & security issues can be overlooked in the haste to develop

#### 3. RAD and JAD

RAD employs tools, techniques and methodologies to speed application development.

RAD reduces paper documentation, generates source code, and facilitates user participation.

Goal: to accelerate the process so that applications can go into production quickly.

RAD uses the JAD process for *data collection* and *requirements analysis*.

JAD = group meetings where stakeholders analyse the system and define the requirements.



Throughout the RAD project, users and developers work as a team: result = quicker delivery. RAD is best suited for decision support and MIS, and less well suited for TPS.

Advantages

- \* The application is put into production sooner than with any other approach.
- \* Documentation is produced as a by-product of completing project tasks.
- \* RAD forces teamwork and lots of interaction between users & stakeholders.

Disadvantages

- \* This intense SDLC can burn out developers (Low management control).
- \* Analysts and users must be skilled in RAD tools & techniques.
- \* RAD requires a larger percentage of stakeholders' & users' time than other approaches.

**4. End-user systems development life cycle**

= A systems development project where the main effort is undertaken by managers & users.

They have better insight into their own needs, and can develop systems quickly. IS professionals encourage them by offering guidance & support.

▪ **Factors affecting systems development success**

**1. Degree of change**

Continuous improvement versus reengineering

*Continuous development projects* - high degree of success, but modest benefits.

*Reengineering projects* - high degree of risk, but high potential for benefits.

Managing change

The ability to manage change is critical to the success of systems development.

People don't adapt easily, so management must deal with problems early.

Common problems:

- \* Fear that the employee will lose his job / power / influence
- \* Belief that the system will create more work than it eliminates
- \* Reluctance to work with 'computer people'
- \* Anxiety that the system will negatively alter the organisation's structure
- \* Belief that other problems are more pressing than those solved by the system
- \* Unwillingness to learn new procedures / approaches

**2. Quality of project planning**

Proper planning minimises schedule, budget and expectation problems.

<i>Problem factors</i>	<i>Countermeasure</i>
Solving the wrong problem	Establish a connection between project & goals
Poor problem definition & analysis	Follow a standard systems development approach
Poor communication	Communicate
Project is too ambitious	Narrow the focus to address the most NB stuff
Lack of top management support	Identify a senior manager to champion the project
Lack of management & user involvement	Recruit key stakeholders to be active participants
Inadequate / improper system design	Follow a standard systems development approach
Poor testing & implementation	Plan sufficient time for this
Users are unable to use the system effectively	Develop a training program and budget sufficient time to execute it
Lack of concern for maintenance	Include an estimate of people effort & costs for maintenance

**3. Use of project management tools**

*Project schedule* = a detailed description of what is to be done.

*Project milestone* = a critical date for the completion of a major part of the project.

*Project deadline* = the date the entire project is to be completed and operational.

Each activity has an earliest start time, earliest finish time, and *slack time* (= the amount of time an activity can be delayed without delaying the entire project)

*Critical path* = all activities that, if delayed, would delay the entire project. (Zero slack)

PERT and Gantt charts monitor activities, & determine if they're on time and within budget.

*Program evaluation and review technique (PERT)* = an approach for developing a schedule.

3 time estimates are created for an activity:

- a) Shortest possible time
- b) Most likely time
- c) Longest possible time

A formula is then applied to come up with a single PERT time estimate.

Gantt chart = A graphical tool for planning, monitoring, and coordinating projects.

It consists of a grid that lists activities and deadlines.

When a task is completed, a line is placed in the cell to indicate completion.



#### 4. Use of formal quality assurance processes

Historically, software development put overemphasis on schedule & cost rather than quality. ISO 9000 = international quality standards used by IS organisations to ensure product quality. These standards help businesses define & document their own quality procedures. Many organisations incorporate: ISO 9000, TQM, and statistical process control principles. Organisations often form their own quality assurance groups to work with project teams, encouraging them to follow established standards.

#### 5. Use of CASE tools

CASE tools = tools that automate many tasks required in systems development. They enforce adherence to the SDLC, thus instilling rigour and standardisation to the process.

Upper-CASE tools = packages that focus on early stages of systems development.

Tools assist with investigation, analysis, and design activities.

Lower-CASE tools = packages that focus on the later implementation stage.

They automatically generate structured program code.

Integrated-CASE tools (I-CASE) = tools that provide links between upper & lower CASE.

They allow lower-CASE packages to generate program code from upper-CASE packages.

Many CASE tools allow more than one person to work on the same system at a time, via a multiuser interface which coordinates & integrates work performed by all team members.

Advantages	Disadvantages
Produce systems with longer operational life	Initial systems are more expensive to build
Systems meet user needs more closely	Accurate definition of user needs is required
Systems with excellent documentation	May be difficult to customise
Systems need less support	Maintenance staff need to be trained
More flexible systems are produced	May be difficult to use with existing systems

#### OO systems development (OOSD)

Programming modules are developed internally / obtained from an external source.

Once you have these modules, you can modify and integrate them with other modules.

OOSD combines the logic of the SDLC with the power of OO modelling and programming.

OOSD follows a defined SDLC with phases that are completed with many iterations.

OOSD involves:

1. Identifying problems appropriate for the OO approach.
2. Defining what kind of system users require.

Define objects part of the user's work environment (OO analysis) and build an object model.

#### 3. Designing the system

Define all the objects in the system and the ways they interact (OO design).

Develop logical and physical models of the system by adding details to the object model.

#### 4. Programming / modifying modules

Implementation takes the object model and turns it into a set of interacting objects in a system

OO programming languages let you create classes corresponding to the business objects.

#### 5. Evaluation by users

The initial implementation is evaluated and improved.

Additional scenarios and objects are added, and the cycle repeats.

Finally, a complete, tested, and approved system is available for use.

#### 6. Periodic review and maintenance

The completed system is reviewed regularly and modified as necessary.

Benefits of OO development:

Design & implementation are easier & cheaper due to pre-developed programming modules.

Maintenance can be simplified if programming objects can be reused when upgrading.

Self-contained objects can be changed /replaced with little disruption to the rest of the system

### 1. Systems investigation

Answer the following questions:

- \* What primary *problems* might a new / enhanced system solve?
- \* What *opportunities* might a new / enhanced system provide?
- \* What new hardware, software, databases, personnel, procedures... will be needed?
- \* What are the potential *costs*?
- \* What are the associated *risks*?

#### Initiating systems investigation

Systems request form is filled out by someone who wants the IS dept to initiate investigation.

The form includes:

- \* Problems / opportunities for the system



- \* Objectives of systems investigation
- \* Overview of the proposed system
- \* Expected costs & benefits of the proposed system

### **Participants in systems investigation**

Functional managers are heavily involved during the investigation phase.

Other members: Users, stakeholders outside management...

Gather & analyse data, prepare a justification report, and present results to top managers.

### **Feasibility analysis**

Feasibility analysis assesses the following:

#### \* **Technical feasibility**

= Assessment of whether hardware / software can be acquired / developed.

#### \* **Operational feasibility**

= A measure of whether the project can be put into operation.

#### \* **Schedule feasibility**

= Determination of whether the project can be completed in a certain amount of time.

#### \* **Economic feasibility**

= Determination of whether the project makes financial sense.

#### \* **Legal feasibility**

= Determination of whether there are laws that may prevent / limit a project.

#### **Net present value**

= An approach for ranking competing projects and for determining economic feasibility.

= The net amount by which savings exceed expenses, after cost of capital & passage of time.

### **Systems investigation report**

Summarises the results of investigation & feasibility analysis and recommends go / no go.

Steering committee (senior management & users from the IS dept) reviews the report.

They might agree with the recommendation / suggest a change in project focus / cancel.

## ▪ **2. Systems analysis**

Gather data on the existing system and determine requirements for a new system.

Primary outcome: Prioritised list of system requirements.

### **General considerations**

Clarify overall organisation goals and determine how the existing / proposed IS meets them.

### **Participants in systems analysis**

Members of the original development team (Users, stakeholders, IS personnel, management)

List objectives and activities, and schedule deadlines for each stage, with required resources.

Establish major milestones to help the team monitor progress.

### **Data collection**

Purpose: To seek additional info about the problems / needs of the investigation report.

During this process, the strengths and weaknesses of the existing system are emphasised.

#### Identifying sources of data

*Internal sources:* Users, organisational charts, forms, financial reports, manuals...

*External sources:* Customers, suppliers, stockholders, competitors, consultants...

#### Performing data collection

**Structured interviews:** The questions are written in advance.

**Unstructured interviews:** The interviewer can ask follow-up questions immediately.

**Direct observations:** A member of the analysis team observes the existing system in action.

**Questionnaires:** When many data sources are spread over a wide geographic area.

**Statistical sampling:** Apply the characteristics of a random sample to the whole group.

### **Data analysis**

#### Data modelling

**ERDs** describe objects and the ways they are associated.

(Can't fully describe business problems because they *lack descriptions* of related activities).

#### Activity modelling

**DFDs** model objects, associations, and activities by describing how data flows around objects

They show the logical sequence of associations and activities, not the physical processes.

**Entity symbol** - shows a source / destination of a data element.

#### Application flowcharts

Show relationships among applications or systems which provide / receive data to/from others

#### Grid charts

= Tables that show relationships among various aspects of a systems development effort.

E.g. It can show which applications use which databases.





### CASE tools

Most upper CASE tools have graphics programs that generate diagrams & figures.  
*CASE repository* = a database of system descriptions, parameters, and objectives.

### **Requirements analysis**

Purpose: To determine user, stakeholder and organisational needs.

Find out how satisfied people are and what improvements can be made.

#### Asking directly

This works best for stable systems in which stakeholders understand the system's functions.

#### Critical success factors (CSF)

Managers are asked to list only the factors critical to the success of their area.

#### The IS plan

The IS plan translates strategic & organisational goals into systems development initiatives.

Strategic planning documents can be used to define system requirements.

These requirements are very likely to be compatible with future systems development projects

#### Screen and report layout

Screens & reports relating to systems output are specified first, to check the solution's correct.

Users who interact with the screen can be presented with more data and less descriptive info.

Infrequent screen users should have more descriptive info, to explain the data they're viewing

Screen layout diagrams can document the screen user's desire for the new application.

Report layout charts reveal the format & content of reports the application will prepare.

#### Requirements analysis tools

CASE tools are often used to store ERDs, DFDs, screen & report layout forms etc...

### **The systems analysis report**

The formal report should cover:

- \* Strengths & weaknesses of the existing system from a stakeholder's perspective.
- \* The user requirements for the new system
- \* The organisational requirements for the new system.
- \* A description of what the new IS should do to solve the problem

## Chapter 13 - Systems design, implementation, maintenance, and review

### ▪ **3. Systems design**

#### **Logical and physical design**

##### **\* Logical design**

Describes functional requirements: *what* the system will do to solve the problems identified.

##### *Output design*

Screen and layout tools can be used to capture the output requirements for the system.

##### *Input design*

Screen & report layouts can be used to reveal the type, format, and content of input data.

##### *Processing design*

Determine the types of calculations, comparisons, and general data manipulations required.

##### *File & database design*

Specify the capabilities of these systems (E.g. the ability to obtain instant updates).

##### *Telecommunications design*

Graphics programs and CASE tools can be used to facilitate logical network design.

##### *Procedures design*

Procedures can be described by using text and word processing programs.

##### *Controls & security design*

Plan how to avoid / recover from a computer-related disaster.

##### *Personnel and job design*

Specify job titles & descriptions, using an organisation chart and word processing programs.

##### **\* Physical design**

Specifies the characteristics of the system components: *how* they work together.

##### *Hardware design*

Specify equipment by performance characteristics (E.g. large capacity).

##### *Software design*

Specify software by capabilities (E.g. ability to accommodate many users).

##### *Database design*

Specify the type, structure, and function of the databases.



### *Telecommunications design*

Specify the necessary characteristics of the communications software, media, & devices.

### *Personnel design*

Specify the background and experience of individuals needed.

### *Procedures & control design*

Specify how each application is to run, as well as how to minimise potential crime and fraud.

### **Special system design considerations**

#### Procedures for signing on

A sign-on procedure consists of ID numbers, passwords, and safeguards needed for access.

A system sign-on allows the user to gain access to the computer system.

An application sign-on allows the user to start a particular application.

Three levels of the sign-on (logon) procedure:

1. Identification - Your ID no and password identify you as a valid user.
2. Verification - You enter an additional code before access is given.
3. Authorisation - Allows users to gain access to restricted parts of a system.

#### Interactive processing

People directly interact with the processing component and communicate in real-time mode.

Interactive real-time processing requires these special design features for ease of use:

- \* *Menu-driven systems* (Pick what you want from a list of alternatives)
- \* *Help commands* (When activated, the program responds with help information)
- \* *Table lookup facilities* (Simplify and shorten data entry - The program looks up info in tables and displays it on the screen for confirmation)
- \* *Restart procedures* (You can restart an application where it left off if there is a problem)

#### Designing good interactive dialogue

\* *Clarity* (The system should ask for info using language easily understood by users)

\* *Response time* (System responses should be as quick as human responses)

\* *Consistency* (The system should use the same commands etc. for all applications)

\* *Format* (The format should be attractive, with consideration for colour, positions...)

\* *Jargon* (Avoid jargon known only to IS specialists)

\* *Respect* (Dialogue shouldn't talk down to / insult the user)

#### Preventing, detecting, and correcting errors

Deal with potential errors *early* in the design phase.

### **Emergency alternate procedures and disaster recovery**

If an IS becomes unusable, the end users need a set of emergency procedures to follow.

These may be manual procedures to work around the unavailable automated work process.

Disaster planning = the process of anticipating and providing for disasters.

Disaster planning focuses on:

- \* Maintaining the integrity of corporate information
- \* Keeping the IS running until normal operations can be resumed

Identify potential threats (natural disasters, employee errors, poor internal control procedures)

Disaster recovery = the implementation of the disaster plan.

#### Hardware backup

Companies often arrange with vendors to provide access to a system in the event of loss.

*Hot site* = a duplicate, compatible hardware system that's operational and ready to use.

If the primary computer has problems, the hot site can be used immediately as a backup.

*Cold site* (shell) = a computer environment including rooms, electrical service, telecommunications links, data storage devices, etc... (This site is *not* operational).

If the primary computer has problems, backup hardware is brought into the cold site, and the complete system is made operational.

#### Software and database backup

2 backups should be made: One kept in the IS dept, and the other off-site.

*Selective backup* = creating backup copies of certain files (if it's too costly to backup *all* files).

*Incremental backup* = making backup copies of files *changed* during the last few days / week.

Incremental backup uses an *image log* (= a file containing only changes to applications).

#### Telecommunications backup

You can recover whole networks or backup the most critical nodes with duplicate components

#### Personnel backup

Provide cross training so that individuals can perform alternate jobs if required.

You can make an agreement with an outsourcing company to supply IS personnel if needed.



**Security, fraud, and the invasion of privacy**

Determine potential problems, rank them, and decide how to handle them.

**Systems controls**

= Rules & procedures to maintain data security.

Closed shop = an IS dept where only authorised operators can run the computers.

Open shop = an IS dept where other people are also authorised to run the computers.

Deterrence controls = rules & procedures to prevent problems before they occur.

Good control techniques help an organisation contain and recover from problems.

Containment control minimises the impact of a problem while it is occurring.

Recovery control involves responding to a problem that has already occurred.

Input controls

Purpose: to reduce errors while protecting the system against improper / fraudulent input.

E.g. Password & identification controls, fingerprint techniques...

Processing controls

Purpose: To ensure processing is as error-free as possible (Duplicate hardware & software).

Storage controls prevent users from accidentally destroying data.

E.g. Passwords, backup copies of data, storage rooms... are some storage controls.

Output controls

Purpose: To ensure that output is handled correctly.

E.g. Output recorded in a file can indicate what was generated, with the time & destination.

Database controls

Purpose: To ensure an efficient and effective database system.

E.g. Subschemas, ID numbers, passwords... - many can be provided by the DBMS.

Telecommunications controls

Purpose: To provide accurate & reliable data transfer among systems.

E.g. encryption devices & expert systems can be used to prevent unauthorised access.

Personnel controls

Purpose: To ensure only authorised personnel have access to certain systems.

E.g. ID badges, smart cards... can prevent unauthorised people entering strategic areas.

**The importance of vendor support**

Vendors sometimes provide services, in addition to the hardware / software.

When selecting, consider the vendor's: reliability, type of service, willingness to demonstrate products, ability to repair hardware / modify software, availability of IS personnel training...

**Generating systems design alternatives**

RFP = a document that specifies detailed hardware / software requirements, for vendors.

Financial options

	<b>Advantages</b>	<b>Disadvantages</b>
<b>Renting (Short-term)</b>	No risk of obsolescence No long-term financial investment No initial investment of funds Maintenance usually included	No ownership of equipment <i>High monthly costs</i> Restrictive rental agreements
<b>Leasing (Longer-term)</b>	No risk of obsolescence No long-term financial investment No initial investment of funds <i>Cheaper than renting</i>	High cost of cancelling lease <i>Longer time commitment than renting</i> No ownership of equipment
<b>Purchasing</b>	Total control over equipment Can sell equipment at any time Can depreciate equipment Low cost, if owned for many years	High initial investment Additional cost of maintenance <i>Possibility of obsolescence</i> Other expenses: taxes & insurance

**Evaluating and selecting a system design**

Preliminary evaluation

After all the proposals have been submitted, dismiss unwanted proposals.

Vendors whose proposals meet the original criteria are asked to make a formal presentation.

The vendors should list firms that use their equipment so you can contact them for evaluation.

Final evaluation

Investigate the proposals offered by the remaining vendors in detail.

Vendors must make a final presentation and fully demonstrate the system.

After the final presentations & demonstrations, the organisation makes the final selection.

Things to consider: Cost comparisons, hardware performance, delivery dates, flexibility...



## Evaluation techniques

### 1. Group consensus

A decision-making group is responsible for making the final evaluation & selection. Useful for evaluating things like which screen layout / report format is best.

### 2. Cost / benefit analysis

Costs and benefits are listed and compared.

Useful for evaluating options whose costs can be quantified, like hardware selection.

### 3. Benchmark tests

Computer systems operating under the same conditions are compared.

Useful for comparing the end user system response time on two similar systems.

### 4. Point evaluation

Each evaluation factor is assigned a weight, in percentage points, based on importance.

Each IS to be compared gets a score from 0 - 100 for each factor, and these are totalled.

Useful when there are many factors to evaluate, like which software best matches needs.

## Freezing design specifications

Near the end of the design stage, an organisation prohibits further changes in the design.

This is to avoid scope creep, cost overruns, and missed user expectations.

## The contract

Computer vendors can provide standard contracts (that protect the vendor, not the company).

Many organisations use legal firms to develop their own contracts.

These include: What they expect from the system, equipment specifications, software, training, installation, maintenance, deadlines, penalty clauses, RFP...

## The design report

= The result of systems design, reflecting decisions made for design.

Includes: technical description of outputs, inputs, user interfaces, hardware, software...

## 4. Systems implementation

### 1. Acquiring hardware from an IS vendor

You can purchase, lease, or rent computer hardware and other resources.

### 2. Acquiring software: Build or buy?

You can build / buy / use a blend of external and internal software development.

#### Externally developed software

\* Review needs & requirements (analyse the program's ability to satisfy organisational needs)

\* Acquire software (RFP, negotiate the contract...)

\* Modify / customise software (some vendors assist with modification; others don't allow it)

\* Acquire software interfaces (= programs that allow the new software to work with the old)

\* Test and accept the software (test it by users in the working environment before accepting)

\* Maintain the software and make necessary modifications

#### In-house-developed software

Sometimes, companies that develop their own software decide to sell it to other companies.

#### Chief programmer teams

= A group of skilled IS professionals who design and implement a set of programs.

Teams have: a chief programmer, backup programmer, other programmers, librarian & clerks.

#### The programming life cycle

##### 1. Language selection

Consider: difficulty of the problem, type of processing, type of problem, ease of changing it.

##### 2. Program coding

Programmers follow plans & documents developed earlier.

##### 3. Testing & debugging

Testing makes sure the program performs as intended, and debugging eliminates errors.

##### 4. Documentation

Technical documentation (Comments explain things, for when the program is modified)

User documentation (Shows users how the program can and should be used)

##### 5. Implementation (conversion)

The software is installed and made operational.

## Tools & techniques for software development

### Structured design

Breaks a large problem into smaller problems, each simple enough to manage and solve.

These modules can be reused in new and different programs.

### Structured programming

It improves the logical program flow by breaking the program into groups of statements.



There can only be one entering point into the block of statements, and one exit point.

**3 types of structures: sequence, decision (if-else, switch), and loop (for, while, do while).**

Structured programming: The top-down approach

You start with the main module and work down to the other modules.

CASE tools

Lower-CASE tools can provide: an IDE with compilers, syntax checkers, code generators...

Cross-platform development

Allows programmers to develop programs that can run on systems with different platforms.

Benefit: programs can run on both small and large systems, so you can develop on your PC.

Integrated development environments

Provide all the tools you need for programming into one integrated package.

Structured walkthroughs

**= A planned review of the progress of a program module, structure chart, or human procedure**

They help you review and evaluate the progress of components of a (non) / structured project.

**Acquiring database and telecommunications systems**

Follow the same approaches as for acquiring hardware and software.

### **3. User preparation**

Active participation - Users participate in systems analysis.

Marketing - Organisations can market new systems to users via brochures, newsletters...

Training - Users can be trained by internal personnel or by external training firms.

Continuing support - Provides assistance to users after installation, to make sure they benefit.

Documentation - Another important aspect of continuing support.

### **4. IS personnel: hiring and training**

Training programs should be conducted for the IS personnel who will be using the system.

### **5. Site preparation**

The site may require special wiring, air-conditioning, renovations, additional furniture, security.

### **6. Data preparation**

You can hire temporary data-entry operators to convert the manual data into computer files.

### **7. Installation**

The IS manager should supervise installation by the manufacturer and do tests afterwards.

### **8. Testing**

a) Unit testing = testing of individual programs. (Test programs with abnormal data).

b) System testing = testing the entire system of programs. (Ensures outputs & inputs match).

c) Volume testing = testing the application with a large amount of data.

d) Integration testing = testing all related systems together. (Makes sure they can interact).

e) Acceptance testing = conducting any tests required by the user. (Objectives are satisfied).

### **9. Start-up**

= The process of making the final tested IS fully operational.

Direct conversion (plunge / direct cutover)

**The old system is stopped and the new one is started on a given date.**

Least desirable approach because of the potential for problems when the old system ends.

Phase-in approach (piecemeal approach)

**Components are slowly phased in while components of the old system are slowly phased out.**

Popular technique preferred by many organisations.

Pilot start-up

**The new system is run for one group of users first, to see if there are any problems.**

Parallel start-up

**Both the old and new systems are run together for a period of time.**

The output of the new system is compared with the old, and differences are reconciled.

### **10. User acceptance**

User acceptance document = a formal agreement signed by the user that states that a phase of the installation / the complete system is approved.

This legal document removed the vendor from liability for problems afterwards.

## **5. Systems maintenance**

### **Reasons for maintenance**

- \* Bugs in the program
- \* Technical and hardware problems
- \* Changes in business processes
- \* New requests from stakeholders, users, and managers
- \* Corporate mergers and acquisitions



- \* Government regulations
- \* Change in the OS / hardware

#### **4 Types of maintenance:**

##### Slipstream upgrade

= A minor upgrade that requires adjusting code and recompiling it.

##### Patch

= A minor change to correct a problem / make a small enhancement.

It is usually an addition 'patched into' an existing program.

##### Release

= A significant change that requires changes in the documentation of the software.

##### Version

= A major program change, typically encompassing many new features.

#### **The request for maintenance form**

= A form authorising modification of programs, signed by a business manager.

The IS group reviews the form and identifies programs to be changed and the programmers.

#### **Performing maintenance**

Sometimes the team that designs and builds the system also performs maintenance.

Sometimes a separate maintenance team is responsible for modifying & fixing the software.

Maintenance uses the same tools & techniques as the earlier phases. (CASE, flowcharts...)

It is *essential* that the tools used in maintenance allow *easy documentation* to reflect changes.

#### **The financial implications of maintenance**

People spend too much time & money on maintenance.

Keep track of *why* the system is maintained, and decide when it's cheaper to build a new one.

#### **The relationship between maintenance and design**

More time spent on design up front can mean less time spent on maintenance later.

#### ▪ **5. Systems review**

= Analysing systems to make sure they are operating as intended.

Performance and benefits of the system are compared with what was planned.

Systems review can be performed by internal employees, external consultants, or both.

Problems and opportunities uncovered will trigger systems development again.

#### **Types of review procedures**

##### Event-driven review

Triggered by a problem / opportunity such as an error, merger, new market for products...

##### Time-driven review

Performed after a specified amount of time.

#### **Factors to consider during systems review**

The organisation's mission & goals, hardware & software, database, telecommunications, IS personnel, control, training, costs, complexity, efficiency, response time, documentation.

#### **System performance measurement**

= Monitoring the system to observe the number of errors encountered, the amount of memory required, the amount of processing time needed...

System performance products = software that measure all components of the IS.