Computing Revision

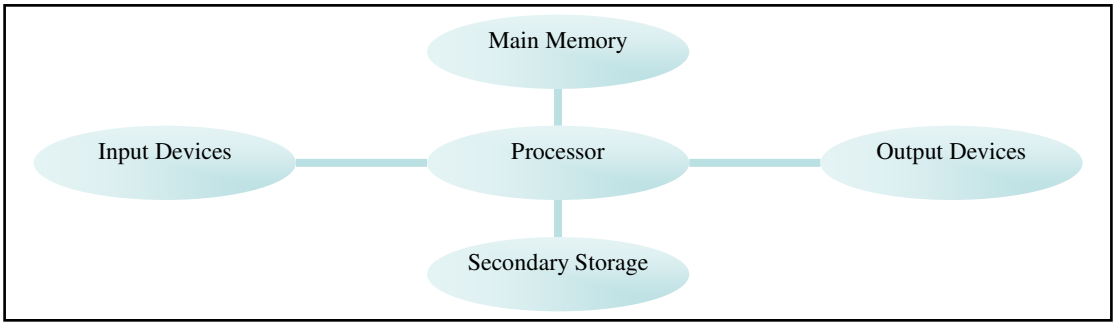
Hardware

Hardware: The physicals components which make up the computer.
Firmware: Software which is "hard coded" into the circuit boards.

Different types of computers

- **Special-Purpose:** Dedicated computers which do one specific thing like control traffic lights, or the temperature in a greenhouse.
- **Embedded Computers**: Normally use firmware, these are the computers found in cars, microwaves, TVs etc.
- **Personal Computer** (Microcomputer): What we see at home, in small offices etc.
- **Minicomputers**: Often used in large multi-user systems, there is one minicomputer, with many (hundreds) of workstations attached to it.
- **Mainframes**: May have thousands of workstations attached to it, need not be "on-site", in fact often away from main offices due to the space they occupy.
- **Supercomputers**: Largest type of computers, used for research and fields involving lots of computations. Used by (for example) NASA, Stock Exchanges and the CIA.

Parts of the computer



- **Processor:**
  - In a normal PC, the processor is also know as the microprocessor. Its usually around 1cm^2. The processor (or CPU) is held on the motherboard of a computer, along with the main memory (RAM) and other things.
  - The processor has three main units,
    - Control unit. This performs the following three operations to control al operations in the computer
      - Gets the next instruction
      - Decodes the instruction
      - Executes the decoded instruction
    - Arithmetic Logic Unit (ALU). This can perform perform basic arithmetic and logical expressions such as +, -, ÷, ×, >, <,
    - Registers, these are memory cells in the processor.
- **Main Memory**
  - The program currently being executed, as well as all data used by this program is held in the Main Memory (RAM). The memory is divided into storage units called bytes.
  - The main memory is RAM (random-access-memory), meaning it can

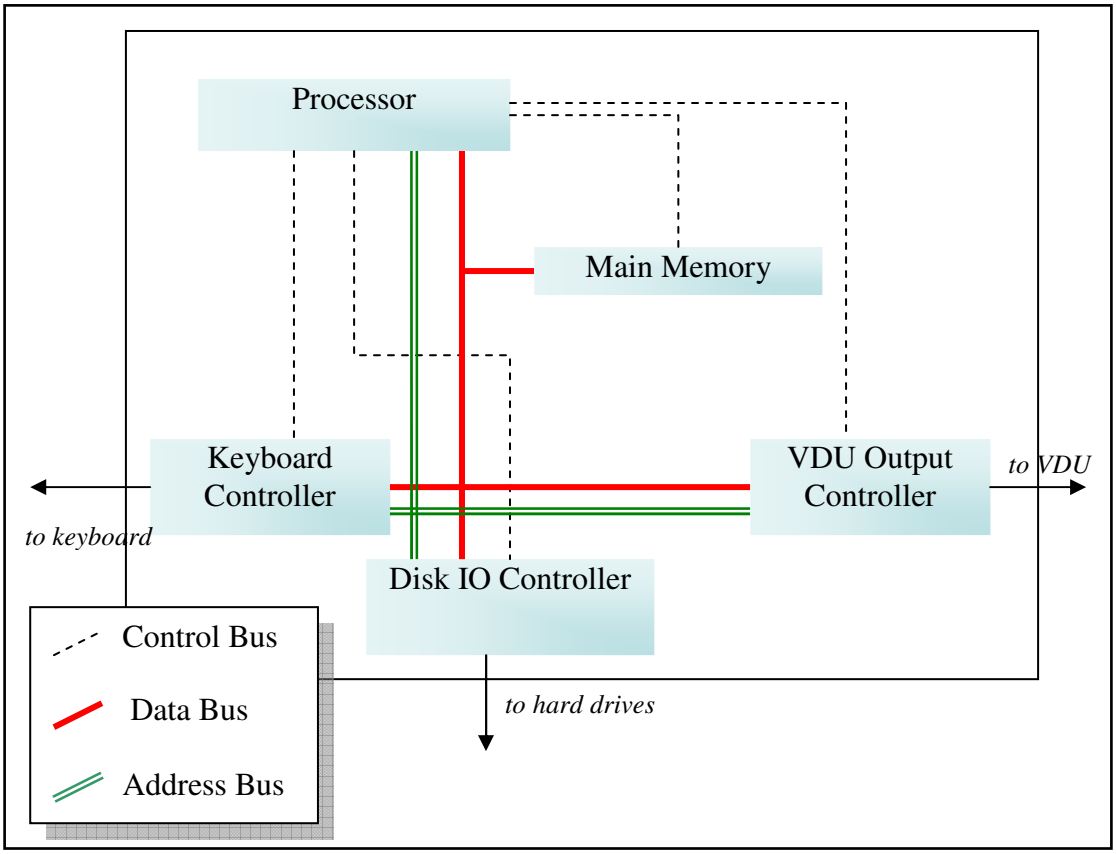
be written to over and over again. However RAM is volatile, meaning that when you turn the PC off, all the data in the Main Memory is lost.
    - The computer also has ROM (read-only-memory). This is non-volatile (its contents are preserved when the power is turned off), however it cannot be over-written. It is primarily used in PCs to save the bootstap loader—which is the program which starts the computer up. It is also used in devices like washing machines and TVs which store all their code in ROM.
    - Lastly the computer has Cache Memory. This is a temporary store of instructions between the processor and the main memory. Rather than keep calling data out of the main memory, the cache stores frequently used data, and data it expects to be used. For example the processor may request a byte from a file, the cache will retrieve a whole block of data around that byte, in the expectation the processor will ask for it in a minute.
- **Disk (Secondary) Storage**
    - Disk, Auxiliary, External or Secondary storage is where everything you don't want to be lost when you turn the computer off is stored. The operating system, the programs you run, the documents you use, are all stored on disk (your C:\ is your disk drive). You also have removable media, such as Floppy Disks and CD/DVDs.
        - Hard drives are magnetic disk storage, these are concentric circles divided into sectors. The disk is spun to obtain the data magnetically. A typical PC hard drive can hold 40-160GB of data.
        - In mainframe computers a hard drive will have much higher storage capacity by having many magnetic disks and readers.
        - Magnetic tapes can be used for archiving and backups. A tape can be used to store several GB of data. A limitation of tape is that it can only be read from start to end, making *editing* data a slow process.
        - Optical disks, including CDs and DVDs. A CD typically stores 650MB of information, while a DVD may store a few GB. Both are readily available in writeable (can be written once) or RW (can be written and overwritten) form.
        - Flash memory is used in PDAs, mobile phones, cameras, MP3 players and in memory sticks. It can be overwritten and is inexpensive. It may store 32-1024 MB,
- **I/O Controller**
    - The I/O controller manages Input and Output devices, some may only be one way (for example a keyboard controller), while some are two-way (for example a floppy disk controller).
    - The controller will have an interface to connect device(s) to, and interface connection to a system or IO bus and a set of storage registers.
- **Input Devices**
    - Keyboard. There is the risk of transcription errors and RSI; it can be time consuming for large bodies of text.
    - Microphone for speech recognition. Limited accuracy, software training needed.

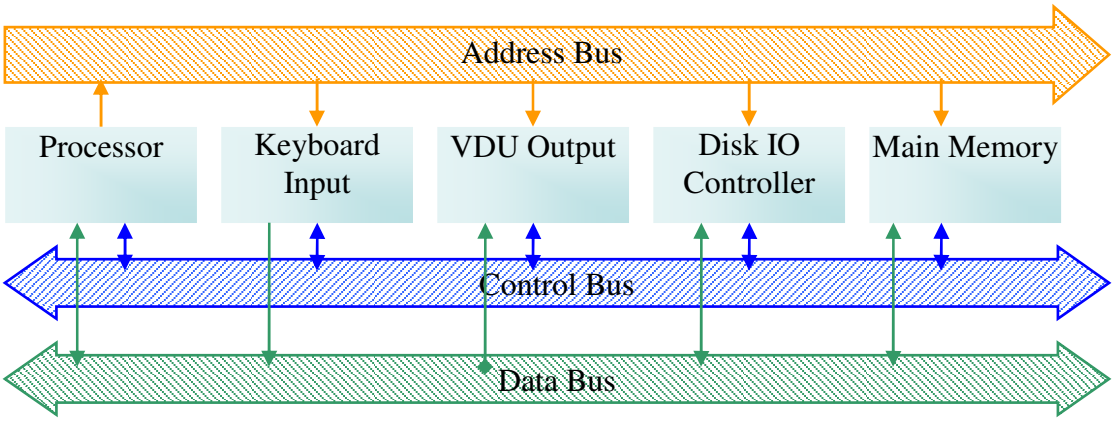
- Scanners can input images into the computer.
- OCR can be used to read a body of printed text into the computer.
- OMR can be used to easily read multiple choice exam papers; registers; forms, etc very quickly.
- Key to disk, in this system the data is inputted several times by different operators, with the computer comparing to find discrepancies. This would be used in a batch system where a lot of data is inputted for later processing.
- Pointing devices; including light pen, joystick, mouse, trackball, touchpad, touch screen and graphics pad. A touch screen may be used in a kiosk system, whereas more accurate devices are used in computer graphics applications.
- MICR (Magnetic Ink Character Recognition). This is used mainly for processing cheques; the data is stored as visible characters and a magnetic source which can be read even if the visible characters are damaged. Very fast to process.
- Magnetic Strip reader. The magnetic strip can store around 220 characters, and is used in loyalty cards, security access cards and rail tickets.
- Smart cards are the next generation of magnetic strip cards; these have a small chip which can be both read to and written from.
- Bar Codes are used in shopping and distribution since they are easily read with a handheld device.
- Digital Camera, these can capture photos directly to a digital image which is then stored in the camera's flash memory before being transferred to the computer.

- **Output Devices**
  - Printers. These are the most common way of obtaining a hard copy of something; one has to bear in mind with a printer the volume of output needed, the quality of output needed, the location with regards to noise and temperature, whether it needs to be colour and whether multiple copies can easily be made. There are various types of printer
    - Dot Matrix. This has pins which print dots to form letters and shapes.
    - Ink jet. These are high resolution and work by firing droplets of ink at the page, they consume a lot of ink if used often.
    - Laser printers. These work with toner being transferred onto the page then fused in place by heat and pressure. These are fast and high quality but expensive, they are economical with toner.
    - Plotters. These are used to creating printouts of vector images; they can produce high quality scaled images for use as blueprints, technical images, etc.
  - The monitor or Visual Display Unit (VDU) is the main output device used by most computers. It has three key attributes:
    - Size. This is the physical size of the screen.
    - Resolution. This is the number of pixels used to represent the whole screen.
    - Colour. This is the number of colours which can be displayed. It is determined by how many bits are put aside for each pixel – if one bit represents one pixel then only two colours can be

displayed (on and off). With 8 bits 256 colours can be displayed, with 16 bits 65,000 can be displayed. The total video memory needed is then the number of bits per pixel, multiplied by the resolution (number of pixels).

Buses





A bus is a set of parallel wires which connect components in the computer. Data is sent along the data bus, controlled by the control bus and the address bus informs the components where to get the data from. Only one device may use a bus at any time.

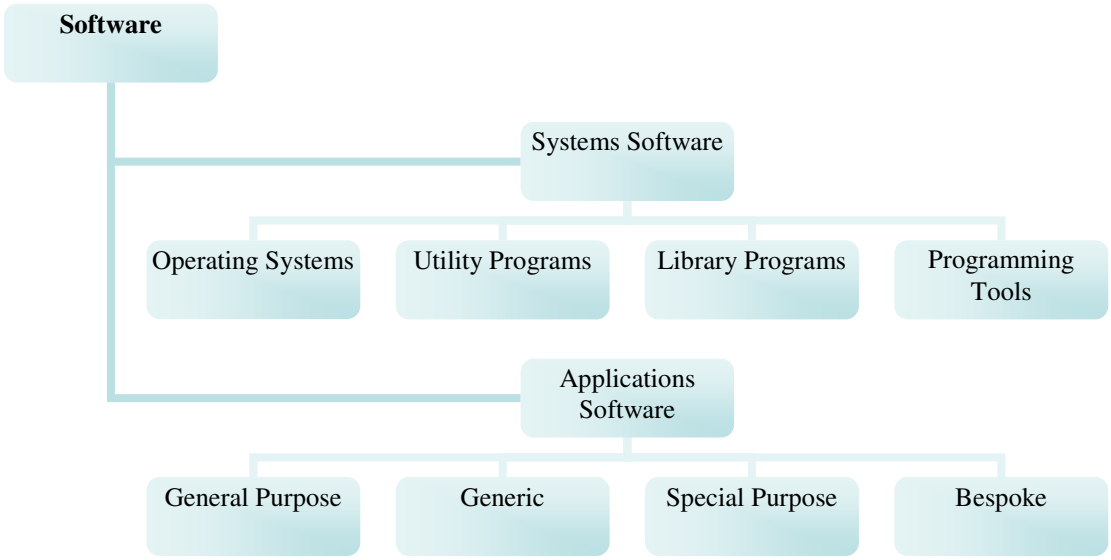
- **Control Bus**

  - Control bus lines run between components to ensure there are no conflicts of use in the data and address buses.
  - The control bus transmits commands, timing and status information.
- **Data Bus**
  - The data bus is the path allowing data to be transferred between components; the width of this bus (i.e. how many parallel wires it has) determines the speed and performance of the computer.
- **Address Bus**
  - When the processor wishes to read something from memory is puts the address into the address bus and that address is read later.
  - The size of the address bus determines the maximum memory capacity of the computer; for example if there are 8 lines, that is a maximum memory of 256 addresses (1111 1111).

Software

Software: A general term used to describe all the programs which run on a computer.

Classification of Software



- **Systems Software:** performs tasks needed for the computer to run.
- **Operating System:** An interface between the user and the hardware. Applications software is designed to run on a specific Operating System. Example: Windows XP.
- **Library Programs:** These are generally Utility programs, stored in an area on the network so they can be used by everyone.
- **Utility Programs:** Programs that make life easier for the user; examples being WinZip, and disk Defragmenter.
- **Programming Languages:** Compilers, interpreters, assemblers.
- **Applications Software:** Software which replaces a task previously independent of a computer. Like a word processor replaces writing.
- **General Purpose:** All common applications programs fall into this category. You also get **Software Suites** like Microsoft Office, or OpenOffice, which have general purpose programs for most tasks (spreadsheet, word processor etc) with a common "look and feel" and integration between those programs. (I.e. Mail Merge). Some examples of general purpose packages include:
    - Word processing software. This has features such as:
        - Change font size; set font italics, bold, underline, superscript, subscript.
        - Align text.
        - Check spelling and grammar
        - Create tables of contents and indexes.
        - Add headers and footers.
        - Set up templates.
        - Work in tables and columns
        - Perform Mail Merge.
    - Desktop Publishing software. This has features such as:
        - Use templates.

        - Lay out items exactly as required
        - Easy use of graphics, scanned images and photos.
        - Adaptation to different media (such as WebPages).
    - E-Mail
        - Advantages of E-mail
            - Can be send anywhere in the world for the same price (line dependant)
            - Quicker to type and less formal.
            - Same message can be sent simultaneously to many recipients
            - Files can be sent as attachments.
            - Messages arrive near instantaneously.
        - Disadvantages of E-mail
            - Viruses may be sent
            - SPAM is flooding the e-mail system
    - Presentation Software.
        - May be used on display stands or in shopping malls or tourist centres.
        - Can set transition effects and automatic timing.
        - Sounds and animations may be used.
    - Spreadsheets. These have features such as:
        - Format cell fonts and sizes
        - Merge cells
        - Use a lookup table
        - Enter formulae into cells
        - Create graphs and charts.
- **Generic Software:** A spreadsheet program is generic software because is can have infinite applications, for payroll, invoices, stock control etc. A program which *just* calculates payroll, is called **Special Purpose** software, since it only has that one purpose.
- **Bespoke Software:** Bespoke software is software written specifically for a company. A customer describes their problem, and a program to solve that problem is coded especially.

Bespoke Software

Advantages	***Disadvantages***
It does exactly what it needs to	More expensive
It can be written to run on specific hardware	No other users to contact; less help and support available.
It has no unwanted features	Less documentation available might not have a manual. Less options for staff training.
It can integrate with existing systems	Wait time while program is created.
There may be no suitable package available off the shelf.	May contain more bugs and glitches than off-the-shelf.

Spreadsheets

Remember the basic formula; know that a lookup table can be used to get a value related to another value (for example get the cost from a stockID number). Absolute cell referencing is important if cells are being filled in by dragging down.

Operating Systems

The operating system is software that handles the interface for hardware and manages resources.

The operating system has several key functions

- **Memory Management**. The OS is responsible for allocating memory to different programs allowing the computer to multitask.
- **Resource Allocation**. This allocates resources to programs running; this allows multitasking. Inputs and outputs device usage can be schedules so programs get it when they need it.
- **Backing Store Management.** The OS controls data transfer to secondary storage. It also maintains a directory structure to make files easily found.
- **Interrupt Handling.** The OS detects interrupts such as the user cancelling a task; a printer reporting that it has jammed, etc.
- **Allowing a user to communicate with the computer.** The user gives instructions to the OS which it can then process.
- **Virtual Machine.** The OS provides a virtual machine; this is a way of hiding the complexities of the computer and presenting the user with an easy interface to hardware devices. This makes the computer easy to use; things are only mouse-clicks away.

There are several classifications of operating systems

- **Batch**. Processing is carried out from beginning to end without user interaction. For example a payroll system runs once a week generating pay slips automatically.
- **Interactive.** User and computer are in direct two-way communication. For example a booking system in a shop.
- **Real-Time.** Monitor something in "real time", the same things are monitored and changes in them trigger events. For example in a power plant temperatures must be monitored and if overheating occurs cooling should be automatically initiated instantly.
- **Network.** Includes software to communicate with other computers via a network and allows sharing of resources between computers.

File Systems

The file manager needs to store information about each file on the computer; the file manager is responsible for finding all files the user/OS requests. This information may include:

- File Type (system, hidden, batch, text, executable)
- Location on Disk.
- File Size (in bytes)
- Access Rights

- Date of creation, last access, etc.

Files are stored in folders and drives. The path name is the full path to a file; both its filename and the directory structure to get to it. A hard disk may be partitioned into several drives (C:\, D:\ etc), each drive may contain folders (C:\Windows), and each folder may contain files (C:\Windows\Cmd.exe). There may be more than one hard disk.

Access rights usually come in four levels:

- Read – Whether the user may view the contents of that file
- Read & Execute – Whether the user may execute the contents of that program
- Write – Whether the user may save changes to the file.
- Modify – Whether the user may save changes to, and delete a file.

Backup & Archive

Backing up is making a copy of data so that in the event of data loss it can be recovered from the backup.

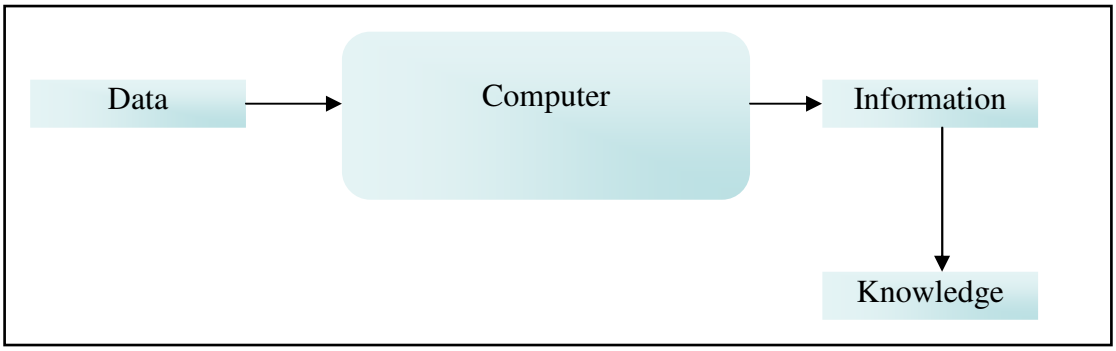
Archiving is moving files which are no longer frequently needed to remote storage.

Data

A data source may be direct or indirect. A direct source of data is where data is collected for the purpose in which it is used; for example a clocking system logs employee's hours – this is a direct source of data for the payroll system. An indirect source of data is where data that was collected for a different purpose is used; for example a supermarket might build up a customer profile using past receipts in conjunction with a loyalty card system.

Data: the raw facts and figures a computer accepts as input and then processed to provide useful information.

Information: Any form of communication that provides understandable and useful knowledge to the recipient, such as a bar chart of grades.



There are various ways to represent data; it may be in the form of:

- A pure binary integer
- A binary coded decimal
- An ASCII, EBCDIC or Unicode character
- A sound waveform
- A bitmap
- Boolean, which is true or false; a single bit.

Binary

Binary is a different number system; in binary there are two digits, 1 (ON) or 0 (OFF). One digit, (a bit) is either 1 or 0. Bits are grouped as 8 bit bytes. 1024 bytes makes a kilobyte, 1024 kilobytes makes a megabyte, and so on with giga and tera.

Conversion to and from binary into decimal is possible by considering place value.

Decimal	128	64	32	16	8	4	2	1
78	0	1	0	0	1	1	1	0

The word size of a computer is the number of bits that the CPU can simultaneously process; processors have 8, 16, 32 or 64 but word sizes – the word size will be a big factor of a computer's speed.

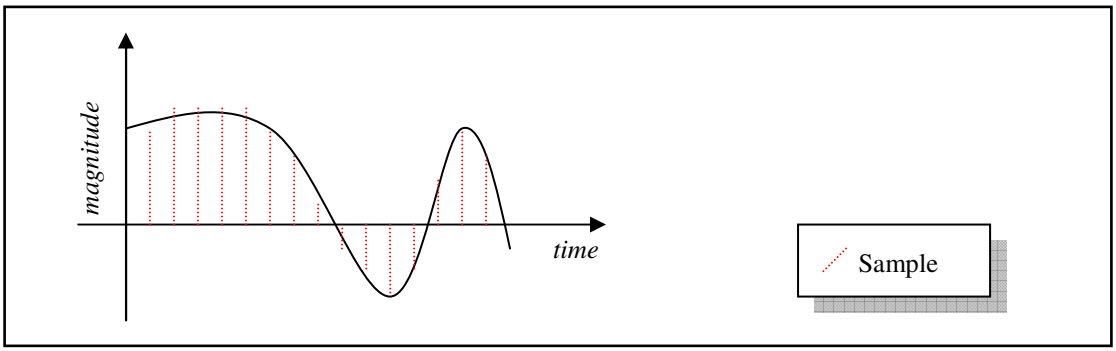
In a binary coded decimal each number of the decimal is coded as a 4-bit binary value. Therefore 54 becomes the binary 5 & the binary 4. So that's 0101 0100.

ASCII

In the ASCII system a character such as "A" has a corresponding code in binary. So if the user presses the "A" button the code 01000001 will be sent to the computer. In ASCII 8 bits (one byte) are used to represent one character.

Digital Audio

Sound waves are analogue in nature, in that they have a continous waveform. To get sounds into a computer they need to be converted into digital, i.e. a binary form, so that the computer can process them. This is done with a analogue to digital converter. These work by sampling the analogue sound at a given frequency and recording the magnitude of the sound at that stage. The magnitude is stored typically as a 16bit code; increasing this size will increase the sound quality; the sound quality is also increased by taking more frequent samples.



The sound wave can then be recreated by the computer using a digital-to-analogue (D-A) converter.

Bitmap Images

Bitmap images work by storing each pixel's data in a file. The pixel is the smallest unit of the drawing and its colour is stored.

1	0	0
0	1	0
0	1	0

Here each box in the grid is a pixel; colour information for each pixel is stored. Because this is a monochrome image only 1 bit need be used for each pixel.

In a monochrome image only one bit is needed per pixel, for 256 colours 8 bits are needed per pixel; and so on. The image quality is defined by the number of pixels and its colour depth.

Bitmap image formats include .bmp, .gif, .jpg and .png. Bitmap images often become blocky, pixelated, when enlarged.

Vector Images

Vector images work by storing an image as a series of vectors; this enables linear drawings (such as building plans) to be created in a vector imaging program and once made these images can be reproduced at any size without any loss of quality.

Most output devices display bitmap images, vector images are better used with devices such as plotters for creating building plans and accurate technical drawings.

Files and Records

- A field is a grouping of data, for which there is a data entry for each record in a table.
- A record is a "row" in the table of data where columns are fields. All the information about one item is kept in a record.
- A file is a collection of records.
- A database may contain or link many files to create links between files.

A file may be text, meaning that is can be understood in a text editor and is a system of characters organised on a line by line basis. Text file types include .html and .txt. Files which cannot be sensibly displayed in a text editor are non-text files; such types include .bmp, .jpg and .exe.

Files may either be fixed record length or variable record length. In a fixed record length system each field has a max length; every character not filled with data is left as a blank. In a variable length system the end of each field is marked with a special character.

```
Paul______Nicholls__12A_#Amanda____Lancaster_12E_#
```

A fixed length file

```
Paul*Nicholls*12A#Amanda*Lancaster*12E#
```

A variable length file

Using variable length files has advantages and disadvantages:

Advantages	***Disadvantages***
Less space wasted on empty medium	More complex processing needed
Fields may be as long as needed	Records cannot be updated as easily (need to re-write whole file)
Closely packed data means quicker read-speeds	It's harder to estimate file size.

File size can be estimated by multiplying the number of bytes per record by the number of records.

File Types

Files may be master files of transaction files. Master files are permanent files of data, and they are the principle source of information for a job. Transaction files are a collection of records used in batch processing to update a master file. There are also reference files which contain variable information such as prices, tax rates, etc.

Files may be organised as serial, sequential or random (direct) access.

In a serial file the records are stored one after the other, in no particular order. This may be used in a transaction file to store, for example, orders as they are received.

A sequential file is organised by key sequence, it is ordered. Sequential files are more efficient as it is easier to find a record within it. A serial transaction file may be used to update a sequential master file.

In a direct or random access file; also known as a hash file; records are stored in a disk location which relates to their primary key. This method is **not** available on a tape drive. For example with a primary key of 12, the memory address 418 may be calculated – and that is where the data is kept. To get it out again the requested key is converted back to the memory address and the data extracted. The method of obtaining the memory address is known as a hashing algorithm; it is important to have an algorithm that can generate any given address within the file, and minimises collisions – where two primary keys produce the same memory address. In a random access file no data is physically deleted; it is just marked as deleted and is then able to be overwritten if another record needs the memory space.

When to use each type:

Serial	***Sequential***	***Random***
Transaction files; recording data in the order that events take place. For example POS, mail order, etc. Typically this file would then be used to update a sequential master file later.	Sequential files are used in high hit-rate application such as payroll; this is where a high proportion of the records are needed at one time, so the tape can run all the way though getting all the data in one go. It is not efficient if only a few records need to be accessed.	Direct files are used when fast access to individual records are needed. For example on a network the table of user names and passwords might be a random file. It may also be used in a booking system where fast access to individual records is important.

File Security

Data is at risk from:

- Natural hazards; fire, flood, earthquakes etc.
- Deliberate destruction by malicious users, terrorists, etc.
- Illegal access by hackers
- Accidental damage by misuse, corruption, system failure, hardware malfunction.

Data can be secured by:

- Careful vetting of employees
- Removing login details for ex-employees
- Separation of duties; meaning no one user would be able to defraud the system by themselves.
- Locks and ID cards to prevent access to computers
- Use of passwords to gain entry to computers
- Educating staff on security.
- Appointing a security manager to oversee; and monitor computer usage.
- Data encryption can scramble data so that it's not easily intercepted. Data is encrypted with a "key", and this key must be used to un-encrypt it at the other end.
- Access rights control who can see, read and write to what resources.
- Biometric information can be used to uniquely identify employees.
- Periodic backups
- Contingency plans and disaster planning to ensure backup procedures are in place in terms of hardware and communications lines.

Passwords have to be stored in the system; and they are stored in an encrypted format to prevent them being read. This encryption is irreversible. Some basic rules can also improve the security of passwords:

- Passwords must be of a minimum length
- Passwords should be suppressed when displayed.
- Files containing passwords are encrypted
- All users should keep their passwords confidential and not write them down.
- Passwords should be changed regularly.

Data Processing and Integrity

Data integrity refers to the accuracy of data; data may become invalid at different stages of its life; including:

- Errors on input; i.e. mis-types, etc
- Errors in operating procedure; for example a program being run twice when it should only be run once.
- Program errors, these may not have been fixed and could lead to data corruption.
- Viruses which could delete or corrupt data
- Transmission errors in which interference may cause bits to be wrongly received.

To guard against these various things one can;

- **Input and Procedure errors.**
  - When one is inputting data various things can be done to minimise input and operating procedure errors:
    - Data can only be entered by authorised personnel.
    - A key to disk system in which data is entered twice and checked for inconsistencies.

        - Tools and rules in place to guard against duplicate entries and to verify data's accuracy and completeness.
    - All output should then be checked for inconsistencies; and any sensitive output should be shredded afterwards.
    - Direct data capture, for example OCR and OMR have advantages in terms of speed and accuracy; however there are still many systems in which operators must key in data. In these situations there are many scenarios for invalid data input' which must be guarded against in terms of software; procedure and training.
    - The following validation checks may be performed:
        - Presence check; i.e. if the field is required
        - Format check; i.e. a telephone number can contain only numbers
        - Range check; i.e. an ordered size is within allowed limits
        - Uniqueness check; i.e. the same customer may not be in the system twice
        - Type check; i.e. the weight is numeric.
        - File lookup check; i.e. only a valid customer may be added to the system
        - Check digit check. This is an extra digit added to the end of a code number which is generated from those digits of that code number. For example in an ISBN number the last character is calculated; and if the inputted value does not generate the same check digit then there is an error.
        - Batch header check. In a batch processing system a control total can be taken, for example in an ordering system the total amount payable may be added up for that batch. A hash total is where the sum of a field is added up purely for validation; these numbers added and the total gained may not make sense, for example the sum of dress sizes in an order. The system then compares the hash/control totals given to it to what it calculates from the inputted data; if an inconsistency occurs then the data needs to be re-checked.
- **Transmission Errors**
    - In order to guard against the possibility of data being wrongly transmitted in the computer a parity bit is added to each character. In an even parity machine the total number of '1' bits must be even, and in an odd the total number of '1'bits must be odd.
    - If a transmission is received in which the parity is wrong; i.e. the number of '1's is odd in an even parity machine then an error has occurred.
    - A checksum may also be sent; where sum of all the digits is sent as a further check.:
- **Virus Protection**
    - Ensure only reputable software is used; and that it is sealed upon receipt.
    - Not permitting removable media to be brought into the system by employees.
    - Using anti-virus software.

Data Protection Act

The 1984/1988 Data protection act outlines that:

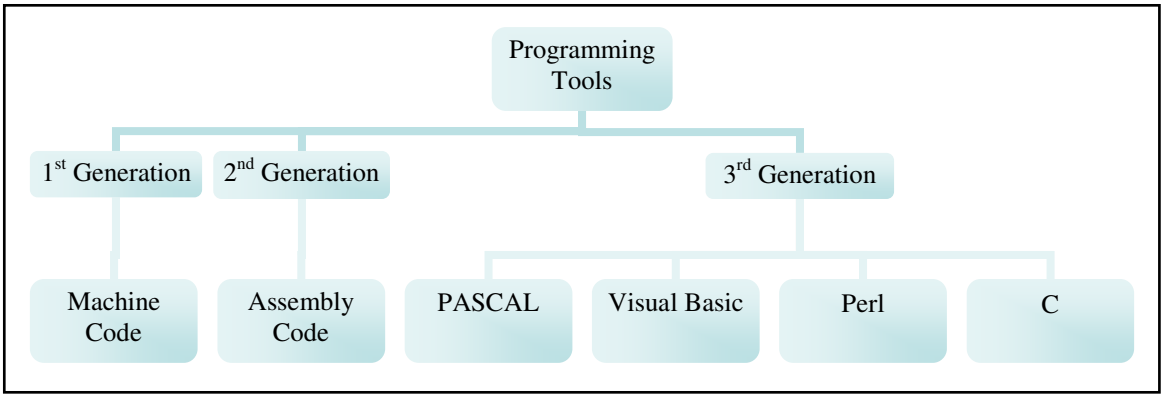
- Data must be fairly and lawfully obtained and processed.
- Data can only be processed for specified purposes.
- Data kept must be adequate, relevant and up-to-date.
- Data should not be kept longer than needed.
- Data must be processed in accordance with the data subject's rights.
- Data must be kept securely to guard against unauthorised access and data loss.
- Data must be kept private, not transferred to other countries which do not have adequate data protection rights.
- Data users have the right to access information held about them.

All data users have to register with the information commissioner; the act is exempt on a few areas including:

- Payroll, pensions and accounts.
- Names and addresses used for distribution.
- Data may be disclosed to a subject's agent.
- National security areas and the prevention of crime.
- For the collection of tax and duty.

Programming

Programming Generations



Using a higher level programming language such as Visual Basic over Assembly code means that programs can be written in a more human-readable language; they have less lines as one line of Visual Basic may relate to many lines of Assembly and even more of machine code. This makes them easier to debug too.

Machine code is the raw transmissions around the computer; the assembler converts assembly code to machine code which the computer components can understand. Assembly code may be used in the operating system to control devices; and well as in firmware and embedded devices. Most types of computer will have their own assembly code. High level code however is not machine dependant, meaning the same code written on one machine can be compiled to run on any other machine.

An imperative high level language is where instructions are carried out in the programmer define sequence.

Translators

- **Assembler**
  - A program which translates assembly code into machine code.
- **Compiler**
  - A compiler takes the entirety of a program, checks it though and makes it into an executable file of object code, which can be run at a later date without need for the source code or programming tools.
  - A compiler may be used to distribute software; since the user does not need special tools or the source code.
- **Interpreter**
  - An interpreter reads code line by line and executes it; it does each statement line by line; breaking when it finds an error.
  - An interpreter may be used to debug programs since it is easy to spot on which line the error occurred.

PASCAL Statements

Variable declaration	`var Surname : String;`
Array declaration	`var Total : array[1..10] of real;`

Procedure	`procedure Details(var Name : string);`
	`begin`
	`end;`

Function	`function Check(var Name : string) : string;`
Assignment	`Spaces := Spaces + 1;`
Iteration	`For Count := 1 to 10` `  Do Writeln(Count);`

Selection	`If Number = 0`
	`  Then Number := Number + 1`
	`  Else Number := Number - 1;`

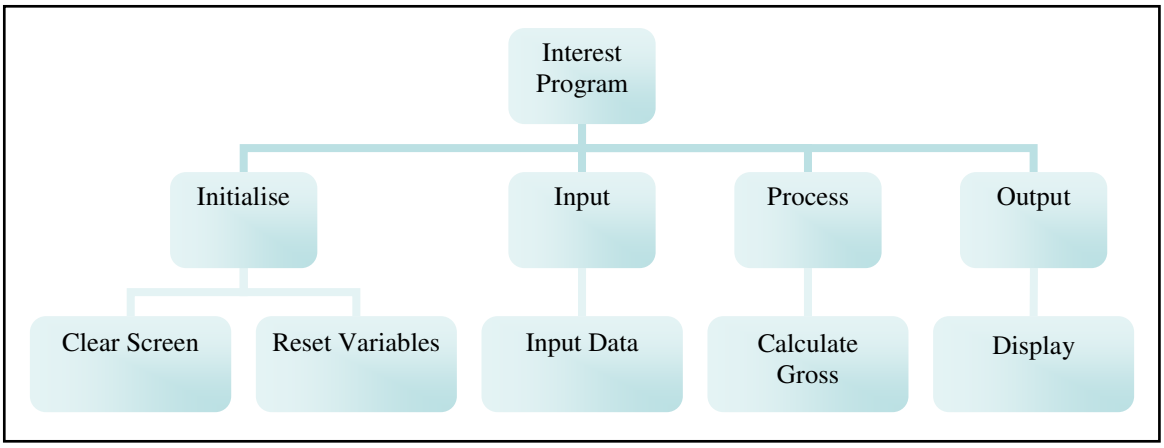
Structured Programming

Breaking down programs with routines such as functions and procedures makes the code easier to read; and avoids redundant code. A function differs from a procedure because a function takes a value; does something with it; then returns a different value. However a procedure just takes values and does something with them; it does not return the values afterwards.

When programming, care should be taken to ensure that:

- The program is reliable; it always does what it is supposed to
- The program is maintainable; it can be updated or edited if needed
- The program code is readable; another programmer could make sense of the code.
- The program must be efficient, performing its job quickly
- The program should be storage saving, using as little memory as possible.

Programs typically follow a top down design, a module may deal with a specific task, within that module procedures and functions perform all the steps of that task. This design can be shown in a structure chart.



Programs have three key types of statement:

- Iteration
  - Performing the same bit of code over and over again
- Assignment
  - Setting the value of a variable
- Selection
  - Performing different operations depending on something.

Pseudocode

Pseudocode can be used to simplify a program to break down the steps it has to perform. These steps form an alogirthm; which specifies approximately what the source code will look like. For example

```
Set TotalMark = 0
Set TotalStudents = 0

For each student
     TotalMark = TotalMark + StudentsMark
     TotalStudents = TotalStudents + 1

Set Average = TotalMark / TotalStudents
Output Average
```

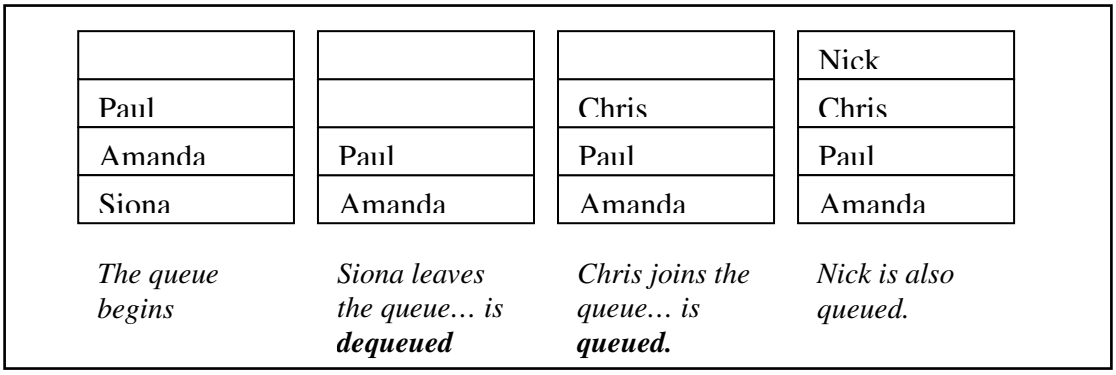
Modular Programming

Modular programming ensures that:

- Code is not repeated, i.e. no redundancy
- Each module can be documented and is easy to understand by itself
- Program maintenance is easier since individual modules can be tested and edited.
- In a large project each programmer can work on a specific module and pool the modules at the end.
- Modules can be tested independently
- A large project becomes easier to oversee and monitor
- Its easy to switch programmers on a module; the module is self contained and should be easy for any programmer to understand.

Queues

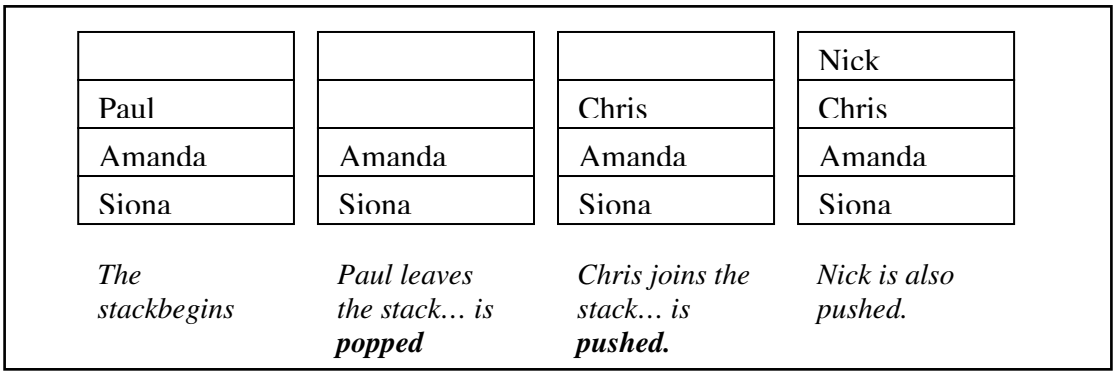
Queues operating a FIFO (first in first out) system; rather like a regular queue at a shop etc. For example jobs the processor has to do can be queued; on a first come first serve basis.



A queue may be used to monitor a queue, control a list of tasks to execute and in simulations.

Stacks

Stacks work in a LIFO fashion, last in first out. This can be visualised as a stack of plates where things can only be added to and taken from the top of the pile.



Stacks can be used in calculations, conversions and when reversing a queue.

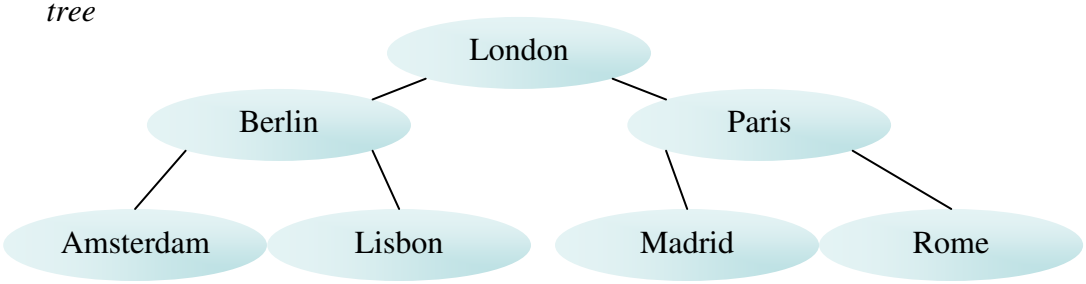
Binary Trees

The following steps are needed to construct a binary tree:

- Place the first item as the root
- Take each subsequent item in turn
    - Start at the root each time, if the item is less than the root branch to the left, if it is more than the root branch to the right.
    - Apply this to each node encountered.

Binary trees can then be searched; and the data printed in sequence.

To form London, Paris, Rome, Berlin, Amsterdam, Lisbon and Madrid into a tree



Database Concepts

In a traditional flat file approach each department of a company may keep its own files containing data. For example a personnel department may keep a list of employees; their date of birth, next of kin, health care information etc, while the payroll department keeps a separate lists of employees containing names, and bank details.

This system has three key problems:

- € Data is duplicated, meaning wasted space – redundancy.
- € Data may be updated in one place, but not another, causing inconsistency.
- € Data is not easily shared between departments.

To overcome this we can use a centralised relational database; this keeps all the data in a common place which all departments can link to. Unfortunately a central pool of data means that security issues need to be addresses; and also any changes a department needs to make to its record structure may affect other departments too and cause company-wide problems.

- € **Relational Database:** A collection of tables in which relationships are modelled by shared attributes.
- € **Primary Key:** an attribute that will uniquely identify each record in a table. For example a customer ID number.
- € **Secondary Key:** an attribute that will identify a particular instance of an entity; but not necessarily uniquely. For example a genre in a table of music tracks.
- € **Foreign Key:** an attribute in one table which is the primary key in another.

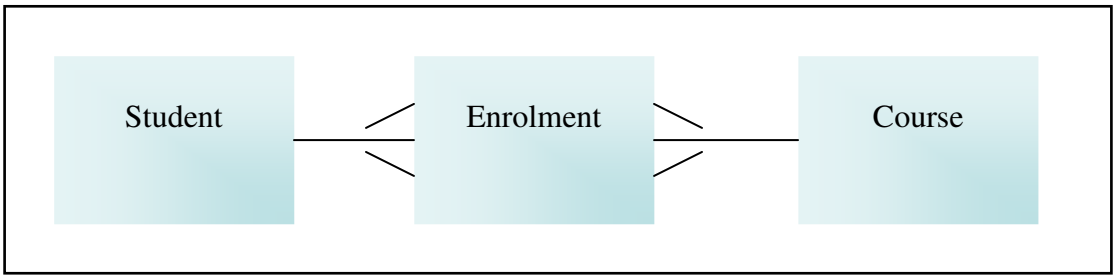
A database table can have indexes on attributes; an index maintains an ordered list of the records, ordered by an attribute. This allows the data to be easily sorted by those indexed fields. In large tables this can considerably speed things up when opening the table – however it slows data entry. A primary index is a index on the primary key of a table.

Tables should be described in the following standard notation:

TableName (**PrimaryKey**, Field1, Field2, *ForeignKey*)

Relationships

Relationships between tables link one table to another to create a more efficient system. Relationships can be either one to one, one to many or many to many. One to one relationships are redundant – they should all be kept in the one table. Many to many relationships cannot easily be modelled, and so a cross table is required to create two many to one relationships. This is shown below in the case of an admissions system. Many students sit many courses; however by use of an enrolment table one student has many enrolments and one course has many enrolments.



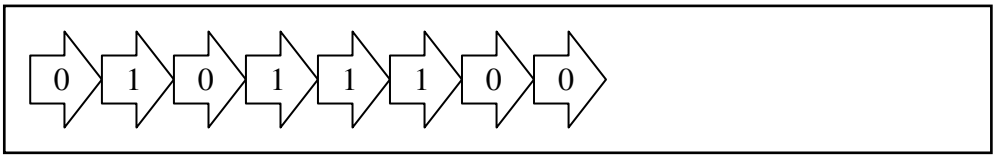
Queries

Information can be obtained from a Query By Example; in this method one may combine tables and select which attributes to display in the resultant table. Search criteria can be specified and the query can be saved.

Data Communication

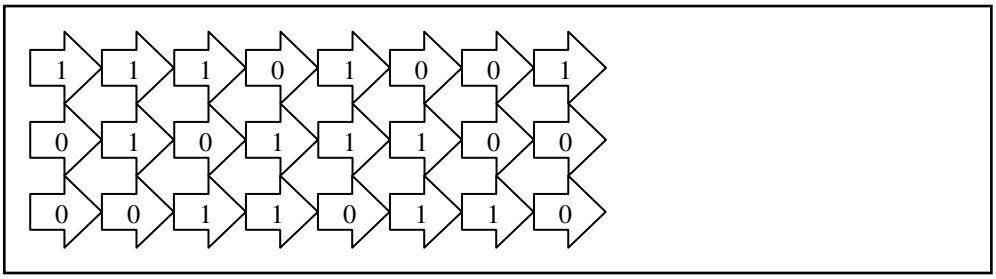
Serial and Parallel

- **Serial**



Bits are sent one bit at a time over a single wire from source to destination. Very high transfer rates can be achieved, and this method can work over nearly any distance.

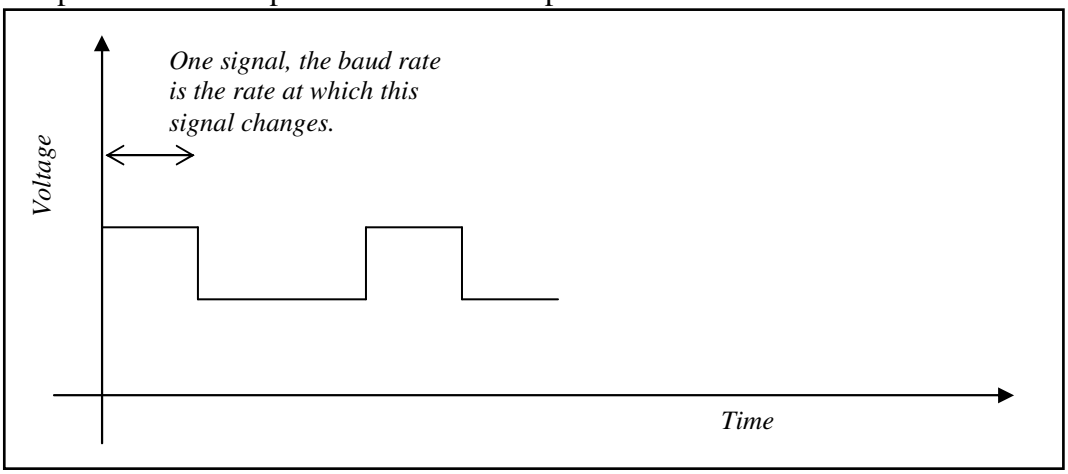
- **Parallel**



Several bits are sent simultaneously over a number of parallel wires, this is used inside the computer (i.e. buses) and often between printers and computers. Parallel transfer is faster than serial, however when used over a long distance due to differences in resistivity in the wires data can become skewed and corrupt.

Transmission

The baud rate is the rate at which the signal changes. The bit rate is the number of bits it is possible to send per second. For example:



Bit rate = baud rate × number of bits per signal

In base band only two bits may be sent in a single signal (1 or 0), however in broadband many bits may be sent in each signal. Bandwidth is defined as the range of frequencies that a medium can correctly transmit.

In asynchronous data transmission one character is sent at a time, with each one being preceded and followed by start and stop bits.

A protocol is a series of rules governing communication between devices. Handshaking is a system whereby two devices communicate to decide whether they are ready to start sharing data.

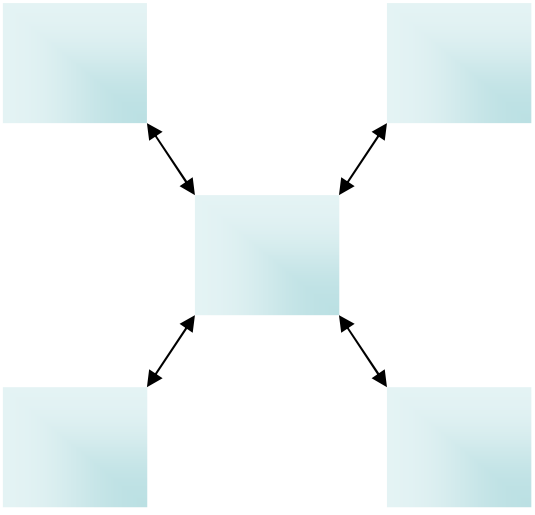
Local Area Networks

A LAN is a method of connecting computers in a small geographical area, for example one building or site. Computers are connected to the LAN using a network adaptor and cabling. There are advantages and disadvantages of a network:

Advantages	***Disadvantages***
Sharing of resources such as files, peripherals, etc.	Users become dependant on the network; if it fails then computers are useless individually.
Data can be backed up to a central server.	System security can be compromised more easily by network attacks.
Its easier to setup new users and equipment.	A badly setup system may be inefficient.
Allows for E-Mail	

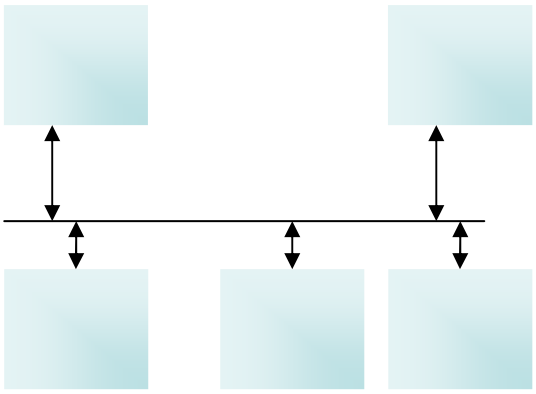
Network Topologies

- **Star**



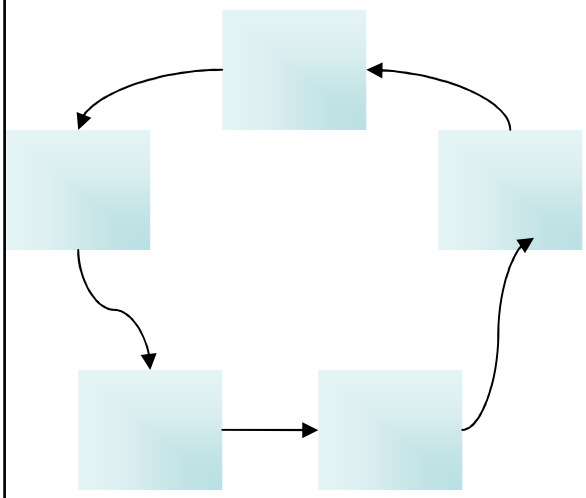
- *Advantage*
  - *If one cable fails only one machine is affected.*
  - *Easy to isolate faults.*
  - *Easily add new stations.*
  - *More secure (all data goes through central machine)*
- *Disadvantages*
  - *Most expensive in terms of cabling etc.*
  - *Can be slowed by central machine.*

- **Bus**



- *Advantage*
  - *Easy and inexpensive.*
  - *Easy to add new stations*
- *Disadvantages.*
  - *If any cable fails the whole system fails.*
  - *Cable failure is difficult to isolate.*
  - *Network performance decreases sharply with a lot of traffic.*

- **Ring**



- *Advantage*
  - *No dependency on a central machine.*
  - *Very high transmission rates possible.*
- *Disadvantages*
  - *If one node breaks, all machines are disrupted.*

Wide Area Networks

A WAN connects geographically remote computers or networks, for example machines on a different site, town or country. This communication link may take place over medium mediums including:

- Public telephone network
    - In order for digital information to be sent over the phone line it has to be converted to analogue. This is done using a MOdulator DEModulator or Modem. Usually this is done with a dial up connection, where users usually pay for the time on the internet they use.
- Dedicated leased lines
    - A direct line connected to a remote computer which is permanently on. This is more expensive but may work out cheaper that dialup when used over a long period of time.
- Radio waves
- Fibre optic cables.
- Microwaves
- Satellites.

The Internet

The internet is a world-wide collection of computers using the same protocol. The internet is not governed by any authority and is comprised of many computers sharing information. A URL (Uniform Resource Locator) is used to find a page on the internet.

In the example http://www.saps2.mine.nu/v2/index.php

http://	This is the protocol, defining *how* data is to be transmitted. Examples are http, ftp and https.
www	The host computer to connect to
Sap2.mine.nu	Domain name
/v2	Subfolder
Index.php	File

Each machine on a network has a unique IP address, this is usually mapped to an easier to remember domain name.

An intranet is a LAN providing similar facilities to an internet within a specific organisation.

Health and Safety

Requirements

Employers are required to:

- Perform an analysis of workstations to evaluate safety and health conditions
- Provide training to employees in the use of workstation components.
- Provide regular eye tests for workstation users.
- Ensure employees take regular breaks or changes in activity.

Employees are required to:

- Use workstations and equipment correctly and in accordance with training.
- Bring problems to the attention of their employer immediately.

Manufactures are required to:

- Ensure their products conform to EEC directives.

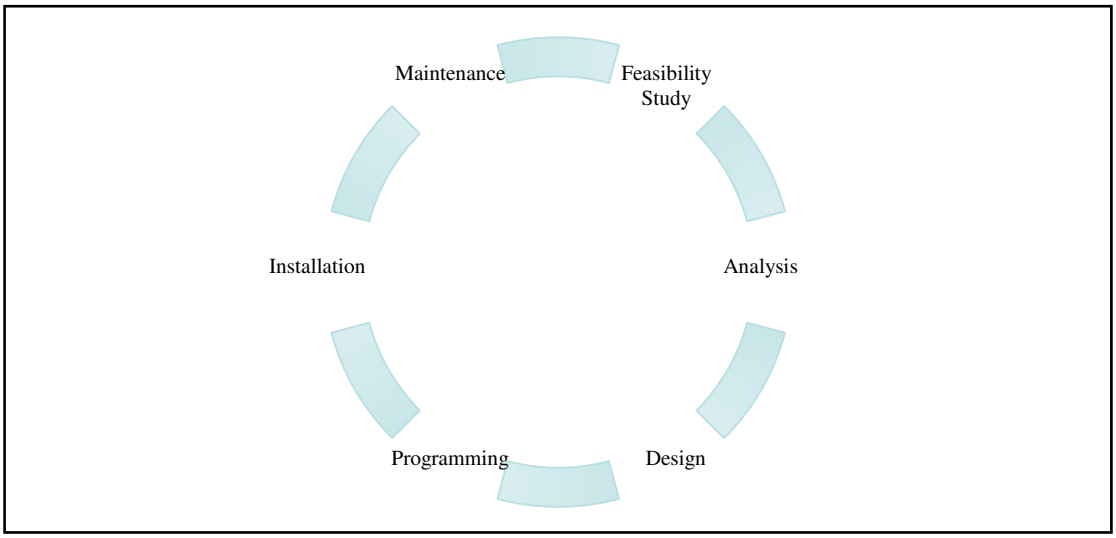
Ergonomics

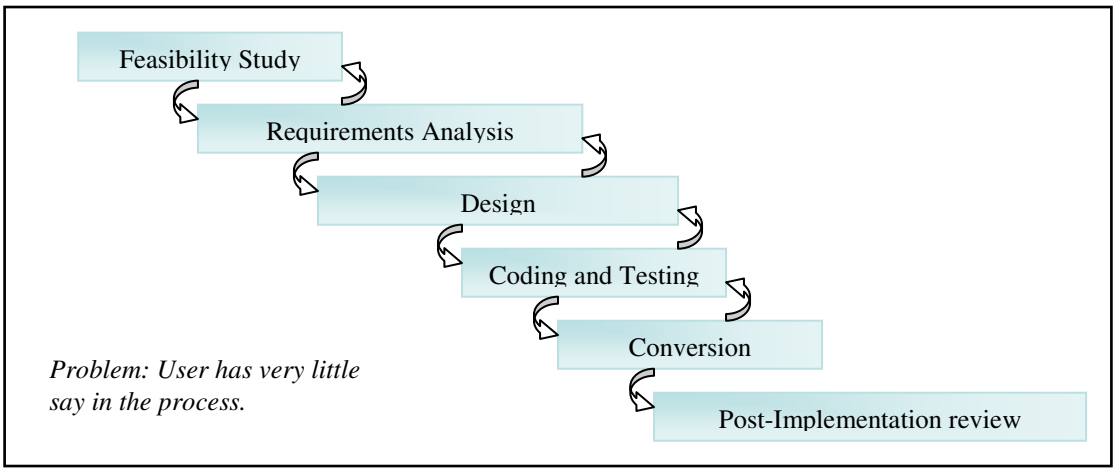
The ergonomic environment is the design and functionality of the environment, and encompasses many factors including:

- Lighting, which must be adequate.
- Furniture, which must be adjustable and with a backrest.
- Ventilation.
- Noise.
- Workspace, including mouse mats, document holders, etc.
- Hardware, screens must be flicker-free, etc. Large amounts of data should not be entered into a laptop.
- Software. Software should be designed to make the task as easy as possible.

Systems Design

System Lifecycle.





A new system may be needed when:

- The current system no longer fulfils its purpose.
- Technology has made the old system antiquated or redundant.
- The current system may be too expensive or inflexible to maintain.

Feasibility.

- **T** echnical feasibility
- **E** conomic feasibility
- **L** egal feasibility
- **O** perational feasibility
- **S** chedule feasibility.

Analysis

- Interview staff at different levels
- Examine current output of the system.
- Send out and analyse questionnaires.
- Observation of current procedures.

These findings are then constructed into data flow diagrams to get a feel for how a system works. Options should then be laid out as to possible solutions, including hardware and software requirements, as well as whether or not further consultation is required.

Design

When choosing a solution the following needs to be considered.

- Usability. How easy the system is to use, whether training will be needed and enough on-screen help is given.
- Performance. If things are going to run too slow then this needs to be taken into account.
- Suitability. Does the solution actually solve the problem?
- Maintainability. Can the system be maintained and updated over time?

When each part of the system is produced it has to be tested, this can be done with:

- Dry run testing, where the code is manually traced.
- Unit testing where each routine is tested individually.
- Integration testing. This involves testing a complete suite to ensure they all function correctly when put *together*.

Implementation

Technical documentation should be produced to ensure the system can be maintained at a later date. Such documentation should include:

- Data flow diagrams.
- Up to date system specifications.
- A description for each part of the system
- Test data
- Structure diagrams
- Organisational detail in files, etc.
- Examples and printouts of generated displays, and input forms.

Implementation involves installing required hardware and software, as well as training and conversion of data stores.

Evaluation

The system should be evaluated against its original design criteria, how easy it is to use and how effective it is.

Maintenance

There are different types of maintenance which a system may need:

- Perfective. Correcting minor flaws in a system
- Adaptive. As business needs change part of the system may need adapting.
- Corrective. Correcting bugs and glitches in the system.

Human Computer Interface

HCI is the interaction between the user and the computer; how the user makes the computer do what they want it to do. A good HCI must be safe, effective, efficient and as enjoyable as possible.

To design a HCI one needs to consider:

- Who will use the system
- What tasks the system will do
- The environment in which the computer is used
- What is technologically feasible.

An interface may be:

- **Command Line**
  - For example MS DOS. Commands are typed, and output printed to the screen or a printer. Simple commands have to be used in context. Only a keyboard is required.
- **Menu Driven**
  - Menus may be full screen, "pop up" or "pull down". In this system a keyboard or mouse is used to navigate a series of menus which take them to the tasks they need to complete.
- **Natural Language**
  - This has the advantage of being easy for the user, it is natural and requires minimal training. It is flexible and very powerful.
  - The disadvantages are that firstly it is hard for a computer to understand "slang" or non-standard language, secondly a natural language can mislead the user into thinking the computer is intelligent and relying on it too much. A technical language is also usually far more concise.
  - In a similar way speech input may be used; however this requires powerful software and is often inaccurate.
- **Forms & Dialogs**
  - Forms need to be well designed to make sure they follow sequentially and are as easy to fill in as possible.
- **WIMP**
  - The Windows, Icons, Mouse and Pull-Downs system is used commonly in Microsoft Windows applications. It provides a common user interface which makes it easy to use any application keeping to this common interface.