# INTRODUCTION TO NETWORKING AND DATA COMMUNICATION

*Chapter outline*

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**Definition of terms used in networking**.

A **computer network** can be defined as a collection of computers linked together using *transmission media* for the purpose of communication and *resource sharing*. The term transmission media refers to any physical or non-physical link between two or more computers and in which a signal can be made to flow from source to destination. Some of the shared resources include *programs, printers, storage devices, communication links* etc.

**Data communication**

Data communication refers to the process of transmitting data signal from one point to another through the network. If all aspects related to data communication are taken into consideration, computer networking is the most recent, efficient and reliable means of transmitting data.

**Terms used in data communication**

Some of the terms used in data communication include: *data signal, signal modulation and demodulation, multiplexing, bandwidth, base band, broadband transmission and attenuation.*

*Data signal:* A data signal is a voltage level in the circuit which represents the flow of data. In data communication, data signals can either be *analog* or *digital* in nature. Analog data is made up of continuous varying waveform while digital data is made up of a non-continuous discrete waveform.

*Signal modulation and demodulation:* This is the process of converting data signals to a form that is suitable or transmission over a transmission medium. For example, a modem converts a digital signal to analog by superimposing it on an analog carrier signal which can be transmitted over analog telephone lines. This process is called *modulation.* A modem at the receiving end converts the analog signal into digital form, a process known as *demodulation.*

*Multiplexing:* Multiplexing is the process of sending *multiple data* signals over the *same medium* e.g. a wire conductor can be made to carry several data signals either simultaneously or at different times. *Demultiplexing* is the process of separating the multiplexed signals at the receiving end. Imagine a situation where one hundred computers in town A want to communicate with others of equal number in town B. If multiplexing is not used, each of the computers in town A will need a direct cable linking it to its partner in town B! However, with multiplexing, the computers can be made to

share a single cable laid between the two towns hence save cost. The different frequencies create what is called different *logical channels* in the medium. .

*Bandwidth:* A bandwidth is the maximum amount of data that a transmission medium can carry at anyone time. For example, a certain cable may have a bandwidth of *100 Mbps* (Mega bits per second).

*Baseband signal:* Baseband signal is a digital signal that is generated and applied to the transmission medium directly without modulation. The signal takes the form of voltages of different magnitudes applied to the medium. The baseband signal utilises the full capacity of the transmission medium, hence at anyone time; only one signal can be sent. However, multiple signals can be sent at different times if they are multiplexed.

*Broadband transmission:* In broadband transmission, an analog signal is sent over the transmission medium using a particular frequency. This means that several data signals can simultaneously be sent through the same medium but at different frequencies. Frequency bands between these data signals prevent them from overlapping.

*Attenuation:* This is the decrease in magnitude and energy as a signal progressively moves along a transmission medium. If the signal is not boosted, it will totally be .lost along the way and may never reach the destination. Attenuation or signal loss is usually corrected by placing signal amplifiers also called *repeater stations* along the medium at appropriate distances in order to receive the weak signal, clean it, amplify it then retransmit it.


**Modes of data communication**
There are three modes of data communication namely: *simplex, half*
*Duplex* and *full duplex.*
Simplex transmission refers to communication in only one direction. An example of simplex communication is the normal radio or television broadcast. The listener or viewer cannot communicate back through the radio or television receiver back to the broadcaster.

Half duplex refers to communication in both directions but one direction at a time. A sender must send the data before the recipient can reply. For example, if two police officers are communicating using a 'walkie talkie' radio, one has to say "over" to mark the end of every statement in order for the other to respond.

Full duplex communication occurs in both directions simultaneously. An example of full duplex communication can be found in computers that are sending and receiving data on a network.

**Types of computer networks**

Computer networks can be classified using several aspects but the most common classification is according to size. Currently, there are several types of networks but the three most common are:
1. Local area network (LAN)
2. Metropolitan area network (MAN)
3. Wide area network (WAN)

### Local area network (LAN)
Local area network is a computer network that spans a relatively small geographical area like in one building or a school. One local area network can be connected to other local area network over any distance via data transmission lines or wireless media.

Most local area networks connect personal computers and *server computers* on a small network. **A server computer** is a computer dedicated to servicing requests for resources from other computers (workstations) on a network. Most local area networks are configured such that each workstation has its own central processing unit with which it executes programs, but it is also able to access data and devices anywhere on the local area network. Local area networks enable many users- to share expensive devices, such as laser printers, as well as data. Users can also use the local area network to communicate with each other, by sending messages or engaging in chat sessions.

Local area networks are capable of transmitting data at very fast rates, much faster than data transmitted over telephone lines.                                    .

### Metropolitan area networks (MAN)
A metropolitan area network is a network that covers a metropolitan area like a town or city. The metropolitan area network size typically covers a radius of between 5 to 50 km. The metropolitan area network infrastructure may be owned by a single company that has offices across a metropolitan area or by a *service provider* who provides network services to subscribers in the area. In essence, a metropolitan area network is made up of many local area networks in a metropolitan area.

### Wide area networks (WAN)
A wide area net work is larger than a metropolitan area network and covers a large geographical area such as a country, a continent or the whole world. It consists of many local area networks and metropolitan area networks connected together to form one large network such as the Internet.

### Purpose and limitations of networking

### Purpose of networking
Some of the reasons for setting up computer networks include: *resource sharing, remote communication, distributed processing facilities, cost effectiveness* and *reliability.*

### Resource sharing
A resource in the network environment means data/information, files, printers, modems, communication links, storage devices, fax machines, application programs and any other component that can' be attached to the network for access by users.

Take for example an office setup where a number of users in a small business require access to. Common information. As long as all the computers are connected, they can share their files, exchange mail, send,
Faxes, schedule meetings and print documents from any point on the network. Users do not need to transfer files via removable storage but would send the work to a network

printer. This centralised access to data and information leads to less waste of time and hence greater productivity.

Imagine the benefits of a user being able to directly fax a document from the softcopy in his/her word processor, rather than having to print it out, and then feed it into the fax machine.

In most network arrangements, the shared resources may be attached to a network server. The other computers on the network that send requests to the server are referred to as clients or workstations. Network servers run a special program called the *server software* which controls computers on the network and *listens to client* requests to service them over the network. For example, a print server will give permission for a particular client to print documents on the network printer. Figure 1.2 shows a simple diagram representing a computer network that is controlled by a server.

**Remote communications**
In the present computing environment, computer engineers are faced with two basic problems.
1. Roaming of officers who by virtue of their work keep on covering long distances away from the workplace.
2. Access to the organization's information resources so that they can have up-to-date data or at least update the information servers with  the status quo in the field.

 Initially, the problem of roaming was addressed by the development of portable computers like laptops. But problem of access to the network's information server remained! However, both problems have been addressed by *remote communication.* Remote communication refers to the transmission of data signals between two communication devices located at different geographical locations. A computer that tries to access resources from another computer on the network is called a *remote client* while the computer being accessed is called a *remote host.* Remote communication has been made possible by use of wireless transmission media such as radio waves, microwave and satellite as will be discussed in details later.

It is through remote communications that people can be able to share ideas and pass messages over the Internet.

Therefore, remote communications give a lot of freedom to the network users which translates to more productivity. Imagine continuing to work from home just as if you were in your office.


**Distributed processing facilities**
Distributed processing refers to the act of running the same programs or databases on different computers which are on the same network. However, users will not know that the processing is distributed but will think that everything is taking place on computer. The output can then be transmitted to another computer or the central computer on an organisations network. Before the advent of distributed processing, many organisations had centralised systems of management. This meant that all the data and information

were sent from the *dumb terminal* (workstation with no processing power) for processing and storage in a central computer. It therefore followed that processing of data, release of information and decision making was centralised too.

However, with distributed processing, files reside on the user's computer rather than on a central computer. Branch offices in a large organization have their own servers that store data, information and other resources required for their daily operations. These servers would then periodically update the central computer.

This model of data processing has a number of advantages. These include:

1. The failure of the central computer does not affect the operations of the other terminals.
2. Processing load is shared equally hence no time wastage.

**Cost effectiveness**
Networks are cost effective in the organization. Although the initial purchase and lying down of network components may be expensive, the savings experienced and the value added to service delivery make them a ready choice for enterprising managers.

One good thing about a network is that it greatly increases the efficient use of scarce resources. Imagine a large organization that has stand alone computers only. In such a case, the management has to buy a printer for each computer. However, with a network, only one printer is sufficient. The same applies to other resources like fax machines, optical drives, files and applications.

It should also be noted that computer networks have enhanced daily communication by providing a paperless communication environment. Users can send electronic messages and mail to each other instead of having to bear the cost of stamp duty or delivery charges. On the same note, company executives may not need to travel across continents to hold meetings. They can hold electronic *video conferences* instead and save the fare.

**Reliability**
A computer network is reliable in two ways especially when communicating or accessing information:
1. Data can be transferred with minimum error from source to destination.
2. In case one computer breaks down, a user can still access data and information from the other computers using another computer on the network.

**Limitations of networking**
Although networking has many advantages it also offers many challenges that are associated with implementation and human factors. Some of the limitations and disadvantages of networking include *security issues, high initial installation cost, moral and cultural effects, spread of terrorism and drug trafficking and over reliance on networks* among others.

**Security issues**
Data and information held on a network is prone to more illegal access threats than if the computer was not on the network. For example, a stand alone computer may be accessed by only a few people at home or in the office environment. However, once the computer is connected to the network, especially the Internet, many people can access it not only

physically but also virtually over the network. Apart from this, when information is sent over the network from source to destination, it can be tapped or listened to by unauthorized parties.

Organisations find it very challenging to guard information systems from constant threats of illegal access. One of the common methods of data protection in a networked environment is *encryption.* This is the scrambling of information into a complex unintelligible form. Encrypted data cannot be understood by people who illegally access it unless they have the decryption key.

**High initial cost**

The initial cost of buying network hardware and software is very high. In fact, most institutions that have not set up their networks more often than not quote prohibitive cost as a limiting factor.

**Moral and cultural effects**

Large networks like the Internet have chat rooms and messaging services that may enable underage children to meet peers and adults on the *net* some of whom may have bad intentions. Access to pornographic and other negative material has also made the fight against social problems such as HIV/AIDS, bad sexual behaviour, drugs and substance abuse more complicated.

**Spread of terrorism and drug trafficking**

The Internet provides a rich recruitment ground for all types of illegal activities such as terrorism and drug trafficking. The easy flow of information from one place to another keeps even those who are on the wrong side of the law communicating easily. Terrorists and drug traffickers use information networks for their business communications. However, many countries have come up with methods of policing the Internet to try and break such syndicates.

**Over-reliance on networks**

Modem organisations have phased out most manual operations this means that all business processes and the society depend on computer networks. The disadvantage of this over reliance is that if by any chance the network fails or goes down, then many systems in the society can be brought to a halt! For instance, imagine the chaos if mobile phone services were to be abruptly brought to a halt. However, proper systems and network planning should be made to avoid such occurrences.

**Elements of networking**

A computer network is made up of several standard elements (components) which can be classified into three major categories namely:
1. Data communication media.
2. Communication devices.
3. Networking software.

**Data communication media**

A data signal cannot be sent from one place to another without a medium of communication. A data communication medium is a *pathway* used for carrying data and information from one point to another. The communication medium will more often than not dictate the type of signal that will be used to transmit a message. In essence, data communication media can be divided into two:
1. Communication using cable (bounded media)
2. Wireless communication (unbounded media)

**Communication using cables (bounded media)**
The main distinguishing characteristic of bounded media is that data signals are transmitted from the source to the destination through a *restricted pathway* such as through a cable. For example, if the cable is a copper conductor, the data signal which may be in form of an electrical signal is propagated through the cable from the source to the destination. Any radiation from the guided medium is regarded as *signal loss*.
There are several types of bounded transmission media but the most common ones are:
1. Two wire open lines cables.
2. Twisted pair cables.
3. Coaxial cables.
4. Fiber optic cables.

**Two wire open lines cables**
Two wire open lines cables are made up of two parallel copper wires separated by a plastic insulator they are used in telecommunication network to transmit voice signal e.g. the line running from a subscriber's house to the nearest telephone post.
Although the plastic insulator is meant to reduce inter-line interference called *crosstalk* their linear nature allows an electromagnetic field to build around them during heavy data transmission which may cause interference to the signal. The wires also capture environmental frequencies e.g. radio waves hence causing *noise* in the transmission channel. In data communications, the word **noise** refers to random unwanted signals picked up by the channel.

**Twisted pair cables**
A twisted pair cable is made up of two solid copper wire strands wound around each other in a double helix manner the winding of the wires is meant to reduce the development of an electromagnetic field around the two wires as they transmit data. These cables are mostly used to transmit both voice and data signals. The two common types of twisted pair cables are the unshielded twisted pair (UTP) and shielded twisted pair (STP) Unshielded twisted pair (UTP) cables do not have a shield that prevents electromagnetic interference (EMI) also called "**electric noise**" from the environment. The cable is therefore susceptible to noise and signal interference. Noise may come from lightening sparks, radio signal and even the radiations from spark plugs in motor vehicles. Unshielded twisted pair is therefore not suitable for environments that are electrically "noisy".
Shielded twisted pair (STP) is similar to unshielded twisted pair except that a braided shield is wrapped around the wires to shield or protect them from noise.

Twisted pair cables are categorised into five groups according to the type of data transmitted and maximum rate of transmission, as shown below.

**Table 1.1**

| Category | Suitable for transmitting | Speed (max. limit) |
|---|---|---|
| 1 | Voice | Less than 1Mbps |
| 2 | Data | 1 Mbps |
| 3 | Data | 16 Mbps |
| 4 | Data | 20 Mbps |
| 5 | Data | 100 Mbps |

1. Mbps means Megabits per second.
2. Today's networks are approaching speeds of Gigabits per second.
Most organisations today use category 5 twisted pair cables to set up their *local area networks*. Although twisted pair cables can support high data rates (bandwidth) of up to 100 Mbps, they suffer from attenuation. For every cable length of 90 m, a device for restoring the signal called a *"repeater"* is needed to amplify the signal.

The advantages of twisted pair cabling include:

1. Telephone systems use UTP which is present in most buildings. This means that it is easier to set up network media because connection is readily available.
2. Installation equipment is cheap and readily available.
3. It is cheap because of mass production for telephone use.
The disadvantages of twisted pair cabling include:
1. It suffers high attenuation.
2. It is sensitive to electromagnetic interference and eavesdropping.
3. It has low data transmission rates as compared to other cables.

**Coaxial cables**
A coaxial cable resembles the cable that is used to connect television antenna to a television set. This cable has a central copper core which may be of solid or stranded wires surrounded by a *dielectric material* (insulator). The dielectric material is then surrounded by a hollow mesh conductor which is covered by a shield making the cable more resistant to electromagnetic interference than the twisted pair cable.
The braid (or mesh conductor) is made of copper or aluminium and serves as the ground for the carrier wire. Together with the insulation and any foil shield, the braid shield protects the carrier wire from radio frequency interference (RFI) and electromagnetic interference (EMI). However, although the cable has better protection against electrical interference than the twisted pair cables, it has a moderate protection against magnetic interference. The diameter of the centre core or conductor determines the attenuation rate. The thinner the core, the higher the attenuation rate. Data is carried on the cable using *direct current* (dc).

Coaxial cables have bandwidths of up to 1 Gbps (Gigabits per second). Hence, they are installed in a network to form the *network backbone* (a link that connects two or more separate local area networks). A good example where this cables are used is connecting different networks between buildings and routing trunk calls in telecommunication companies. There are two types of coaxial cables:

1. Thin coaxial cable (Thinnet). It has one dielectric insulator
2. Thick coaxial cable (Thicknet). It has two dielectric insulators around the core and is thicker than the thinnet

The advantages of coaxial cables include:

1. They are very stable even under high loads.
2. They have a large bandwidth (up to I Gbps) compared to twisted pair.
3. They can carry voice, data and video signal simultaneously.
4. They are more resistant to radio and electromagnetic interference than twisted pair cables.

The disadvantages of coaxial cables include:

1. Thick coaxial cable is hard to work with.

2. Coaxial cables are relatively expensive to buy and to install as compared to twisted pair.

**Fiber optic cables**

This is one of the latest types of bounded transmission media to be developed. Instead of carrying or transmitting data signals using electronic signals, the fiber optic cable utilises light to transmit data from one point to another on the network. The electrical signals from the source are converted to light signals, and then propagated along the fiber optic cable. To convert an electric signal to light, you need a Light Emitting Diode (LED) at the transmitter. At the receiving end, a *photosensitive* device can be used to convert the light signals back to electric signals that can be processed by the computer.

The fiber optic cable is made up of the *core, cladding, buffer, strength members* and the *jacket.* .

*The core:* The core is the central part of the cable and is made of a hollow transparent plastic or glass.

*Cladding:* This is a single protective layer surrounding the core. It has some light bending characteristics in that, when the light tries to travel from the core to the cladding, it is redirected back to the core. This is why even if a fiber optic cable is bent into coils and a light signal is inserted at one end it will still be seen coming out from the other end.

*Buffer:* The buffer surrounds the cladding and its main function is to strengthen the cable.
*The jacket:* It is the outer covering of the cable.
Fiber optic cables are of two types namely:
1. Single mode fiber.
2. Multimode fiber.
The **single mode** fiber cable has a very narrow centre core the light in the cable can therefore take only one path through it. Because of this, it has a very low attenuation rate and is preferred for long distance transmission. It has a bandwidth of 50 Gbps which is higher than that of the twisted pair's 100 Mbps. Single mode fiber is very expensive and requires very careful handling during installation.

A **multimode fiber** has a thicker core than the single mode it allows several light rays to be fed in the cable at an angle. Because of multiple light signals navigating the cable at the same time, distortion of the signal is possible. Multimode cables have a high attenuation rate and are usually used for shorter distances than single mode.

The light signal travels through the core, through a process referred to as *total internal reflection.* The process that causes total internal reflection is called *refraction.* Refraction is the bending of light when it crosses the boundary of two mediums that have different density. When light signal is inserted into the cable, it tries to cross from the core to the cladding. The light is bent back into the core hence propagates along the length of the cable

The advantages *of* fiber optic cabling include:
1. It is immune to electromagnetic interference and eavesdropping.
2. It is fast and supports high bandwidth.
3. Large distance can be covered because it has low attenuation.

4. Can be used in hazardous places (highly flammable) because they do not generate electrical signal.
5. It is smaller and lighter than copper cable hence ideal for space limited situations.

The disadvantages *of* fiber optic cabling include:
1. Connectivity devices and the media are expensive.
2. Installation is difficult because the cable must be carefully handled.
3. It is relatively complex to configure.
4. A broken cable is difficult and expensive to repair.

**Wireless communication (unbounded media)**

Wireless or unbounded media, is a type *of* media that is used to transmit data from one point to another *without using physical connections.* In this case transmitting antenna and receiver aerial facilitate the communication. Examples *of* wireless transmission media include microwaves, radio waves, and infrared transmission all use different frequencies *of* the electromagnetic spectrum. All these waves travel at the speed of light.

**Microwave transmission**

Microwave frequencies range from about 3GHz to 40GHz on the electromagnetic spectrum. Due to their small wavelength, they easily release their energy in water as heat hence they are also used in making microwave ovens used as domestic kitchen appliances. However, in networking, microwaves are very suitable for *point to point* transmissions. This means that a signal is directed through a focused beam from transmitter to the receiver station.

**Satellite communication**

A satellite is a microwave relay station. The microwave earth stations have parabolic dishes with an antenna fixed on them in order to focus a narrow beam towards the satellite in space. A satellite transmission system has three main components:
1. *Transmitter earth station* that would set up an uplink to the satellite in order to transmit data. The uplink will have a unique frequency.
2. A *satellite* that is somewhere in an orbit that receives, amplifies and retransmits the signal to a receiving earth station via a *downlink* frequency that is different from that of the uplink so as to avoid interference with the uplink signal.
3. *Receiving earth station* that would receive the sent signal on the other side of the globe.

A communication satellite is usually launched into space about 36 000 km above the earth in such a manner that its speed will be relatively equal to the rotation speed of the earth. An observer on earth will therefore, see as if the satellite is stationary in space. These types of satellites are called *geostationary* satellites. They are convenient because the need to keep on moving the parabolic dish in a bid to track the line of sight is eliminated. A geostationary satellite offers a large constant line of sight to earth stations. The area on earth where the line of sight can easily be located is called the *satellites footprint.* The satellite transmits the signal to many recipient earth stations to form a *point to multipoint* transmission. In multipoint transmission the transmitted signal spreads out in all directions forming a cell of access radius.

The new trends in microwave transmission have seen the use of *very small aperture terminal (VSAT)* technology. This very small aperture terminal refers to a very small satellite dish used both in data, radio and TV communication. Many businesses are adopting this new technology because it enables direct access to satellite communication instead of having to go through the state owned or licensed satellite gateways.

The satellite produces strong signals that can be received by a satellite dish antenna of only about 2 metres in diameter. The signals are decoded using a decoder that is plugged directly to a television set or a computer.

**Radio communication**

Radio waves travel just like surface water waves, i.e. they are *omnidirectional.* This means that they start from a central point and spread outwards in all directions. As they travel outwards, their energy spreads outwards over the covered area. The waves are radiated into the atmosphere by a radio frequency antenna at constant velocity. Radio waves are not visible to the human eye. Radio waves are used in radio and television broadcasts. Data can also be transmitted over radio waves communication channels. For example, instead of laying telephone cables between two towns that are geographically separated, radiowave transmission can be used to connect the two towns. Radio waves can be of *high frequency, very high frequency* or *ultra-high frequency.*

The high frequency (HF) radio waves signal is propagated by directing it to the *ionosphere* of the earth. The ionosphere will reflect it back to the earth's surface and the receiver will pick the signal. Before the advent of satellite communication, high frequency radio was the only way of communication beyond the horizon such as communicating to a ship that is on the high seas or communication between continents. The biggest challenge of high frequency communication is the danger of signal interception by unauthorised parties.

Very high frequency (VHF) radio waves are transmitted along the earth's surface. Due to the curvature of the earth, the signal will most likely attenuate at the horizon. This means that repeater stations have to be placed strategically to maintain a line of sight in order to receive, amplify and propagate the signal from one area to another. This technology is popular for the hand held radio devices like "walkie-talkie" radios. The range of very high frequency is limited but it is preferred to high frequency where no major obstructions are encountered on the landscape. This is because with very high frequency, it is possible to make the wave to follow a narrower and more direct path to the receiver. To overcome the obstructions on the earth surface like mountains and buildings, repeater stations are built on raised areas.

Ultra high frequency (UHF) radio waves are like very high frequency when it comes to the *line of sight principle.* This means that there should be no barrier between the sending and the receiving aerial. However, they require smaller aerials. Notice that the television aerial for very high frequency is bigger than the one for ultra high frequency radio waves. This is because; ultra high frequency radio waves can be made to follow an even narrower and direct path to the receiver than very high frequency radio waves. Therefore ultra high frequency is popular for horizon limited broadcasts.

One of the latest radio transmission technologies is called *Bluetooth* technology. Bluetooth is a worldwide and short-range radio technology that enables people to use hand held communication devices such as cell phones and personal digital assistants to access the Internet. The main idea behind Bluetooth communication is to try and define one standard that will allow all personal communication devices regardless of their differences or size to be able to communicate with each other and through wireless technology. The main component in Bluetooth is a small *low power* two-way radio transceiver, small enough to be inserted in small devices. A network of bluetooth-enabled devices is called a *wireless personal area network (WPAN) or piconet.* This is because bluetooth networks are best suited for personal or hand held devices. This has made radio transmission to become very popular in mobile communication and Internet connectivity.

**Infrared transmission**

Infrared waves fall just below the visible light on the electromagnetic spectrum. Just like the radio waves, infrared waves are not visible to the human eye. Communication through this medium is achieved by having infrared transmitters and receivers *(transceivers).* Transceivers of infrared signals must be within a line of sight in the same room. This is because unlike radio signals, infrared signals cannot penetrate obstacles like walls. However, the signal can be reflected off surfaces like walls and ceiling until they reach their destination.

An example of an infrared device is the infrared transceiver on most mobile phones. Once activated, two people in the same room can send messages to each other using infrared technology on their mobiles without going through the mobile service provider hence avoid being charged.

In computer networking environment, the technology can be used to connect devices in the same room to each other without need for cables e.g. a computer to a printer. The computers infrared transceiver must maintain a line of sight with the one for the printer.

**Advantages and disadvantages of wireless communications**

Wireless communication offers numerous advantages that justify the cost of laying down the network. Some of the advantages are:

1. Wireless medium is flexible in operation as compared to bounded media i.e. devices can be moved around without losing access to the network.
2. Wireless networks can span large geographical areas easily.
3. Wireless communication can take place via satellite even in very remote areas that do not have high cost physical infrastructure like telephone lines.

Some of the disadvantages of wireless communications include:

1. It is relatively difficult to establish or configure.
2. The initial cost is very high.

**Communication devices**

Computers and transmission media require communication devices for the network to be fully operational. These devices are more or less used as interfaces or junctions between the *terminal devices.* Terminal equipments are devices at both ends of the communication link such as a computer. Some examples of data communication devices include *network interface cards (NIC), modems and codec's, hubs, bridges, repeaters, routers, gateways, switches* and *access points.*

**Network interface cards (NIC)**

Network interface cards (NIC) create a physical link between the computer and the transmission media. A network interface card is plugged into an empty expansion slot on the motherboard. However, most computer motherboards today come ready with an onboard network interface controller. The network interface cards have ports at the back in which the terminated end of a network cable can be plugged.

**Modems and codecs**

A modem is an important device in the world of communication. It converts a signal from digital to analog form for the purpose of transmission over the analog media, while a codec converts an analog signal to digital form for transmission via a digital medium. A modem can be *external,* an *add-on card* or built on the motherboard.

**Hubs**

A hub also called a concentrator is a component that connects computers on a network and is able to relay signals from one computer to another on the same network. A hub will usually connect networks that have a common *architecture* i.e. one that has the same set of communication software usually called *protocols.* Protocols are a set of rules that govern the communication between devices on a network. A hub transmits signals by broadcasting them to all the computers on the network. After the signal is broadcasted, the computer whose address is on the message picks the message from the network that is part of the broadcast domain. Some hubs called *intelligent hubs* are able to monitor the way computers are communicating on the network and keep the information in a small database of their own called a *management information base (MIB).* The network server can then use this information to fine-tune the network. *Intelligent hubs* can be able to manage a network by isolating computers that are not functioning properly. Several hubs can be connected together one after another to expand a network. However, this increases the broadcast range which may lead to *broadcast storms* on the network. The term broadcast storm refers to a condition where a network is overwhelmed with message broadcasts due to malfunctioning of network interface cards or hub related problems.

**Bridges**

This is a network device that selectively determines the appropriate network segment for which a message is meant for delivery through address filtering. Hence a bridge can divide a busy network into segments to reduce network traffic. The purpose of using a bridge therefore is to:

1. Extend the length and number of stations that a segment can support.

2. Reduce overall traffic flow by allowing broadcasts only in the destination segment of the network.

A bridge makes sure that packets that are not meant for a particular segment are not broadcast in that segment.

**Repeaters**

A repeater receives a signal from one segment of a network, cleans it to remove any distortion, boosts it and then sends it to another segment. Repeaters are the simplest way to expand a network because they broadcast the same message to other network segments. However, this is advisable due to broadcast storms that can develop. The repeater enables the network to eliminate attenuation problems.

**Routers**

The router interconnects different networks and directs the transfer of data packets from source to destination. Routing depends on network addresses. Each network has a unique identifier or address called the *network address.* Network addressing is enabled because of the use of a special internetworking protocol called the *Internet Protocol (IP).* Hence, the network address is usually called the *IP address.* All the computers on the same network have the same network address but different host numbers. The router receives a packet from another router on the *internet work* and checks the destinations network address. If the address is the same as the one on which the router is, it passes the data packet to the destination host by reading the host address otherwise the packet will be routed to the next network address. Some modem routing devices combine the functionality of a bridge and router. Such a device is called a *brouter.*

**Gateways**

A gateway is any device that can be configured to provide access to wide area networks or Internet. One such device is the router. Because of this reason most people confuse a gateway and a router. However a gateway may not be necessarily a router, it may be a computer configured to provide access the Internet. Figure 1.21 shows a logical diagram of a local area network connected to a wide area network via gateways.

**Switches**

A switch, unlike a hub forwards a packet directly to the address node without broadcasting. A node refers to data terminal equipment such as a workstation or computer on the network. The switch does this by connecting two nodes *point to point* as if they were linked by a direct cable between them. This reduces the broadcast problems on the networks. It is important to note that some hubs also incorporate the switching mechanisms. Such a hub is referred to as a *switching hub.*

Typically, switches are more expensive than hubs. This means that one switch may be used as a bridge to connect several hubs in order to reduce collision problems caused by broadcasts.

**Wireless communication devices**

For a long time, networks have been implemented using tangible transmission media like cables. However, as the cost of wireless technology goes down and the quality of service increases, it is becoming cost effective for companies and individuals to extend the capability of wired networks by integrating wireless segments into their communications. Some of the most common devices used in wireless communication include access points and the antenna.

**Access points (AP)**

The access point is one of the most common wireless network components  As its name suggests, it is an entry point into a bounded network for people who have wireless devices such as personal digital assistants (PDA's), laptops and computers with wireless links.

**Wireless antennae**

The access point needs to have antennas in order to detect signals in the surrounding. The waves may be radio waves, microwave or infrared waves in nature. In most cases, access points will have two antennas so that the one that receives the best signal at any particular time can be used.

**Personal computer memory card international association (PCMCIA) cards**

A personal computer memory card international association is an add-on card inserted into a device such as personal digital assistants or a laptop in order to enable wireless communication between the devices and a wired network server.

**Network software**

Computer networks have evolved from the simple linking of computers on a common transmission media to highly managed and optimised data and information transfer systems. This means that apart from data communications, the focus is now squarely on how best to utilise network resources. The issues of network security inter operatability and reliability have taken centre stage. Any network manager will be faced with the question of network load balancing and adopting best routing procedures.

All these tasks would be impossible if network software was not available. These software can be classified into two main groups namely:
1. Network operating systems.
2. Network protocols.

**Network operating systems**

These are operating systems specifically designed to optimise the networked computers ability to respond to service requests. Servers run on a network operating system. In addition to the functions of a normal operating system, this software performs the following network related functions:
1. Provides access to network resources e.g. printers and folders.
2. Enables nodes on the network to communicate with each other more efficiently.
3. Supports interprocess communication i.e. enables the various processes on the network to communicate with one another.
4. Respond to requests from application programs running on the network.
5. Supporting network services like network card drivers and protocols.
6. Implementing network security features.

In most cases, network operating systems are designed as multi-user operating systems that run the network server program. Once installed on the right hardware platform and configured as a server, the operating system will provide network management tools to network administrators. The administrator can use the tools to do the following:
1. Secure the network against unauthorised access.
2. Track network usage and keep a log of all the people who have used the network.
3. Ensure inter-operatability between various systems on the network.

4. Performance monitoring to ensure maximum throughput on the network.

Examples of network operating systems are Windows NT/2000/2003, UNIX, Linux and Novell Netware.

**NB:** Internetworking devices like routers also have operating systems of their own and hence they can be managed and configured for optimum performance. Note that routers are special purpose computers.

**Protocols**
Protocols are set rules and procedures that govern communication between two different devices or people. For example, a diplomat from a foreign country must adhere to the set of rules and procedures of communication when representing his country in the host country.

In computer networking, protocols are the rules and technical procedures that govern communication between different computers.

**How protocols work**
The data transmission process over the network has to be broken down into discrete systematic steps. At each step, a certain action takes place. Each step has its own rules and procedures as defined by the network protocols. The work of these protocols must be co-ordinated so that there are no conflicts or incomplete operations. This co-ordination is achieved through protocol layering. Network protocols are designed after the *open systems interconnection (OSI)* model. The open systems interconnection model is not a protocol as such but is meant to help designers to come up with high quality layered protocols. It has seven layers, each performing distinct functions as shown in Table 1.2.

**Table 1.2**

|   | Layer | Function |
|---|---|---|
| 7. | Application layer | User applications run here and generate requests for data transmission or open received Information. |
| 6. | Presentation layer | Adds formatting, display and encryption Information to the data being sent. |
| 5. | Session layer | Sets up data transmission sessions between two Communicating devices. |
| 4. | Transport layer | Manages data transfer over the network to ensure Reliability. |
| 3. | Network layer | Address information is added to the data packet And routed to destination. |

| 2. | Data link layer | Adds error checking information and prepares Data for going onto the physical connection. |
|---|---|---|
| 1. | Physical layer | The data packets are finally transmitted via the network card through the transmission media in form of bits |

Application protocols work at the highest layer of the OSI model. They provide services to application programs. An example of an application program is an e-mail editor program that enables composing or reading of e-mail messages. Examples of protocols at the application layer include:

1. Simple mail transfer protocol (SMTP) - An Internet protocol *for* transferring e-mails.
2. File transfer protocol (FTP) - An Internet protocol *for* file transfer.

3. Apple talk and apple share - Apple computers networking protocol suit.

Transport protocols ensure that data is passed between computers more reliably. Some examples include:

1. Transmission control protocol (TCP): This is responsible *for* delivery of sequenced data over the network.

2. Sequential packet exchange (SPX): This part of the Novell's internet work packet exchange/sequential packet exchange (IPX/SPX) *for* sequenced data.

3. NetBEUI: A local area network protocol *for* Microsoft and 1MB networks that establishes communication sessions between computers.

4. Apple transaction protocol (ATP): Apple computer's communication session and data transport protocol.

Network protocols provide link services. They handle addressing and routing information, error checking and retransmission of requests. Some examples of network layer protocols include:

1. Internet protocol (IP): It does packet forwarding and routing.
2. Internetwork packets exchange: *Netware's* protocol *for* packet forwarding and routing.

**Network topologies**

The term network topology refers to the way in which computers and other devices have been arranged or how data is passed *from* one computer to another in the network. Therefore network topology can be viewed in two ways namely *logical* and *physical* topology.

**Logical topology**

Logical topology also called *signal topology* deals with the way data passes *from* one device to the next on the network. Examples of logical topologies are *Ethernet* and *token ring*. This means that two networks with different physical layout may have the same logical topology.

**Ethernet topology**

In Ethernet topology, all computers listen to the network media and can only send data when none of the others is sending.

**Token ring topology**

In token ring topology, a special package for data called a *token* goes around the network and only the computer whose address is on the data held in the token will take up the token to read the data then release the token. The token can then be captured by another computer which needs to transmit data.

**Physical topology**

Physical topology refers to the physical layout or arrangement of components on the network. Examples of physical topologies include star, bus, ring, mesh and tree/hierarchical topology.

**Star topology**

In star topology, all devices are connected to a central hub. Nodes communicate across the network by passing data through the hub. When the hub receives data from a transmitting computer, it broadcasts the message to all the other nodes on the network. Until recently, the star topology was found mostly in minicomputer and mainframe environments. The topology consists typically of a system of terminals or personal computers, each connected to a central server.

The advantages of star topology include:

1. It allows centralisation of key networking resources like concentrators and servers.

2. It gives the network administrator a focal point for network management. When something goes wrong with the network, the administrator can troubleshoot it from one place, usually a wiring closet, but possibly from a remote management terminal.

3. Star networks are easy to configure.

The disadvantages of star topology include:

1. The star-based network is costly because it requires one complete cable per computer. Each workstation is connected to the central concentrator by its own dedicated line. In some star-based network technologies this line is coaxial cable that runs from an active hub to a workstation.

2. If the central hub fails, the entire network will be down.

3. Installing is time consuming because each node forms a segment of its own.

**Bus topology**

All devices are connected to a central cable called the bus or backbone as shown in Figure 1.26. The sharing of the transmission media (or bus) has several problems. Most importantly, it means that the cable can carry only one message at a time and each workstation on the network must be capable of knowing when it can and cannot transmit using this shared medium.

A *terminator* is attached to each end of the cable to avoid signals from bouncing back and forth on the cable causing signal distortion. As the data passes along the cable, each station checks whether the data is addressed to it. If the address matches the machines address, it receives the data otherwise it rejects it. The network addresses of computers on a network are called the *medium access control (MAC)* address.

The advantages of the bus topology are:
1. It is easy to install.

2. It is less costly. Does not require a complete cable length per computer.
The disadvantages of bus topology are:
1. A cable break in any section brings down the whole networks.

2. Troubleshooting a cable fault is difficult because the fault could be anywhere on the cable.

3. The bus topology limits the number of computers that can be connected to the cable because each computer is *listening* to the cable in order to transmit. This means that an increase in the number of computers results in an increased collision as machines compete for transmission.

**Ring topology**
In a ring topology, all devices are connected to one another in the shape of a closed loop each station is responsible for regenerating and retransmitting signals around the network to its neighbour. A *token* is used to exchange data from one station to another. A token can be viewed as an envelop or a bag where data is placed for transmission and carried around the network.
The advantages of ring topology are:
1. They use a short length cable.
2. Ring topology is simple to install.
The disadvantages of ring topology are:

1. Modification may be difficult because adding or removing a device can disrupt the entire network.
2. Troubleshooting can be difficult.
3. One device or media breakdown may affect the entire network.
However, this is not the case with *IBM token ring* where a device called *Multi Station Access Unit (MSA U)* is used for station bypass in the event a station fails.

**Mesh topology**
This is the most common type of topology used in wide area network where there are many paths between different locations. Devices are connected with many redundant interconnections between the nodes. In a true mesh topology every node has a connection to every other node in the network. This is a hybrid topology. Groups of star-configured networks are connected to a linear bus backbone

**Practical exercise**

**Setting up a peer-to-peer local area network**

This practical activity is a step by step guide on how to set up a simple local area network. The following are some of the requirements you need.

**Hardware requirements**
1. A computer running on any version of Microsoft Windows especially Windows 9x / 2000 / ME / Windows XP.
2. Network Interface card. Some computers may have it already installed onboard so that you do not have to purchase one.
3. A hub or a switch.
4. Transmission media preferably unshielded twisted pair category 5. 5. RJ45 connectors.

**Tools**
1. Crimping tool
2. Cable tester
3. Screw drivers.

**Installing a network card**
The network interface card acts as the physical interface or connection between the computer and a properly terminated transmission cable. As mentioned earlier, some motherboards come with on-board network interface cards hence you may not need to plug in a separate add-on card.

To physically install an add-on card:
1. Disconnect the computer from the power source.

2. Open the system unit and identify an empty expansion slot on the motherboard.

3. Insert the card and screw it into place. Some little force may be needed to push the card into place squarely. Make sure that all the conductor points of the card sink into the expansion slot. Avoid touching the golden conductor points and chips on the card with your bare hands.

NB: Some cards are slotted into Industry Standard Architecture (ISA) slots while others are designed for Peripheral Components Interconnect (PCI) slots. Make sure you install in the right slot and then screw into place.

4. Replace the casing then connect the computer to the power supply and boot it up. If you are using Microsoft Windows 9x and above, the computer will detect the new hardware because of the plug and play feature found in the operating system. It may install the protocols and device software needed for the proper operation of the network interface card automatically! If there is a problem of the card being detected, you may have to configure the card manually using software on a disk that comes with the card.

**Installing the drivers manually**

I. Click tart, Settings then, ControlPane1. In the Control Panel window double click the Network /Network Connections icon. A dialog box will be displayed. *(In some Windows versions you may have to double click the Network and Dial-up Connections icon found in the control panel then double-click the local area connection icon.)*

2. Click the configure button.

3. Click adapter/drivers and then click ADD. Follow the on screen instructions.

**Adding protocols**
1. Make sure the Network dialog box is open.
2. Click ADD then protocol
3. Click Microsoft, select TCP/IP and NetBEUI from the protocol list then ok
4. Click Apply

**Identifying your computer in a workgroup**
A workgroup is a collection of computers that are on the same network. To specify your computer and the name of the workgroup:

1. If you are using Windows 9x, click the identification tab from the Network dialog box. If you are using Windows Me, 2000 or XP. Identification *(Computer Name)* tab is located in system properties dialog box. Right click My computer, click Properties then click the computer name tab.
2. Type your computer name and the workgroup name. The computer name you give must be unique.

**Configuring transport control protocol/internet protocol (TCP/IP)**
In order to communicate with other computers, you need to install and configure a protocol. In our case let us use TCP/IP. To configure TCP/IP,

1. Select the TCP/IP Ethernet adapter from the list titled *The following network components are installed/ This connection uses the following items.*
2. Click the properties button then the Specify the IP address option,
3. Type in the IP address box an address such as 192.168.00.001. Each computer should have a unique IP address. Figure 1.32 shows a TCPI IP properties dialog box in Microsoft Windows XP.
4. Specify the *subnet mask.* Subnet masks are values that allow the router to distinguish the *network ID* from *host ID* portions of the IP address. If the IP address is examined by the subnet mask and found to be identical, the message is destined to a host on the same network otherwise it is routed to another network. Typically, subnet masks use the format 255 .x.x.x. In our case let us use a subnet mask such as 255.255.255.0.
5. Click APPLY then Ok   The computer will prompt you to restart in order for the changes to be effected.
6. Restart the computer

**Media preparation and connection**
In this practical, we are going to use twisted pair cabling technique because it has become almost the default method. This type of media uses a connector known as RJ45 to terminate the cable. RJ45 is attached to a UTP cable using crimping tool. To attach an RJ45 connector to a UTP cable, proceed as follows:
1. Cut a piece of cable of suitable length approximately 3 metres.

2. Strip off approximately a dimension centimeter of the cable sheath on both ends to expose the inner pairs.
3. Untwist the pairs.

4. Using the wiring diagram, place the wires in the correct order and trim the edges to make them even.

**Key**

1. Green striped 2. Green
3. Orange striped 4. Blue
5. Blue striped 6. Orange
7. Brown striped 8. Brown

5. Insert the wires into the RJ45 connector; plug it in their correct order and then push it into the crimping tool.
6. Squeeze the handles of the tool to make sure the wires are pierced and held tightly in the connector.
7. Repeat steps 5 and 6 at the other end of the cable. Your cable should now be terminated on both ends
8. You can then test the media for continuity and correct termination using the cable tester.

**Connecting the computers to the hub/switch**

It is now time to connect the computers together through the hub. To connect the computers:
1. Connect one end of the cable to the RJ45 port of the network card and the other end to one port in the hub. If the hub is powered, a LED will indicate the connection. Repeat all this process for all other computers that you wish to connect on the network.
2. To see if the networking is successful, right click the *Network Neighborhood/ My Network Places* on the desktop. If all the connected computers in the same workgroup can *"see"* one another then you have succeeded setting up a peer-to-peer network.
3. if not, you may decide to test the connection using the *PING* command. For example if you have two computers with the IP addresses 192.168.001.001 and 192.168.001. 028. To test the connection between the two, proceed as follows:
     (a) From the START, menu of the computer with IP address
192.168.001. 001, choose the RUN menu and type the command
PING 192.168.001. 028.
(b) Click, 0K.A connection failure will be displayed on the screen
*Sharing network resources*
If you have successfully installed the network, you can then start enjoying the benefits of networking by enabling resource sharing. For example if you are using Windows XP, you can share resources by enabling sharing and security as follows:
1. Open Windows Explorer.
2. From the explorer window, right click the drive folder or file you wish to share with others on the network then select sharing and security.
3. Click the **Sharing** tab then enable "**share this folder**".
4. Type in the share name and set other options as required.
5. Click 0.K.
**Network security**
Network security is like the security measures we implement in our homes. You do the best you can to protect yourself from intruders. Likewise in networking you should try to

protect your data and information from intruders. In networking there are several ways of enforcing security one of them is *share level* and the other is the *user level* security.

**Share level security**
Share level security is a sample network security used in peer to peer networks. The user can decide which resources to give for sharing. Most desktop operating system such as Window 9X provide such kind of security.

**User-level security**
User level security model is used on server based networks. A network administrator assigns accounts to users. This means that each user is provided with a unique name and password which he or she can use to access network resources. For more on user level security, read documentations on operating system such as Microsoft Windows NT 4.0/2000/2003, UNIX, Novell Netware, Linux Fedora etc.

# APPLICATION AREAS OF INFORMATION AND COMMUNICATION TECHNOLOGY (ICT)

*Chapter outline*

2.1 *Introduction*
2.2 *Application areas of information and communication technology*
2.3 *Field work report*

## Introduction
Computers play an important role in every aspect of our society today. Hardly does a day pass without one coming across a computer system that is used in offering services that were initially done manually.
 In this chapter, we shall look at how computers have been applied in the contemporary society to add value to the information systems of various organizations. An information system is a collection of specific human and machine efforts required to support the decision making process, data processing, information output and presentation.

## Application areas of information and communication technology
Information and communication technology (lCT) has been applied in various areas such as in the development of financial systems, retail systems, reservation systems, educational systems, communication systems, industrial systems, scientific and research systems, library systems, entertainment systems, transportation systems, home use, office expert systems, marketing, virtual reality systems and law enforcement systems.

## Financial systems
Financial systems enable organisations to manage their finances. They include:
1. Payroll systems.
2. Accounting systems.
3. Banking systems.

## Payroll systems
The primary purpose of this system is to process the accurate information of employees including gross pay, deductions and the net pay. Because money spent on human resource is one of the largest operating expenses of a business, a payroll system is also designed to produce several analysis reports e.g. a breakdown of payroll expenses against production/income of the company.

## Accounting systems
Accounting systems are popular in business management. There are six key business accounting activities/subsystems:
1. Customer order entry and billing
2. Inventory management
3. General ledger accounting
4. Accounts receivable
5. Accounts payable

**Customer orders entry and billing**
Customer orders entry and billing subsystem records incoming customer orders, authorises delivery of items or services ordered and produces invoices for customers who do not pay in advance or on cash basis.

**Inventory management**
Inventory management is used to keep track of the items in stock and help the management determine which items to reorder. This helps the management to have enough stock at all times to meet the needs of the customers.

General ledger **accounting**
General ledger accounting is used to keep track of how much a business makes and its worthiness by summarising the financial transactions. It produces reports on income, sources of income, expenses, and the net profit or loss earned. A summary report of these transactions is called a *balance sheet* and is usually generated at the end of an accounting period.

**Accounts receivable**
Accounts receivable system keeps track or records of the amount owed by each customer. This helps the management to make a follow-up by billing the customers for overdue payments.

**Accounts payable**
Accounts payable system keeps track of the amount the business owes others e.g. suppliers, tax organisations, transport e.t.c. Hence, it helps the management to produce cheques for payment of these amounts.

**Banking systems**
The banking industry was one of the earliest consumers of information and communication technology. The computerised banking services include:
1. Processing customer transactions.
2. Cheque clearing and processing.
3. Electronic funds transfer.
**Processing customer transactions**
Computers are used in banks to carry out financial transactions such as recording deposits, withdrawals and calculating interests on savings and loans. Such systems also generate reports on the current status of accounts. In most banks, these transactions are entered via terminals, which are connected, to a central computer for centralised processing. The tellers have revolutionised banking activity by offering 24 hour service to customers and more flexibility in cash deposits and withdrawals.

**Cheque clearing and processing**
Computerised cheques clearing and processing is made possible due to the special characters on cheques printed using ink containing magnetic particles. The characters identify the bank in which the cheque is drawn, the customer account number, the cheque

number and the amount of the cheque. Using a magnetic ink character reader, these details are automatically entered into a computer for cheque processing. Manual processing used to take lots of time but with computer systems, millions of cheques are processed every day hence improving efficiency in service delivery to customers.

**Electronic funds transfer (EFT)**
Electronic Funds Transfer (EFT) is the movement of money using information and communication technology. When a cash dispenser is used, the amount withdrawn by a customer is deducted from his/her account. Another example is when paying for goods and services using a credit card. Payment is transferred electronically from the customers account to the recipients account.

**Retail systems**
Computers are becoming more and more popular in retail stores such as supermarkets, distributor outlets etc. Computers are used in such stores for:
1. Stock control
2. Transactions handling at the electronic point of sale terminals (EPOS)

**Stock control**
A computerised stock control system enables a user to manage his/her stock more efficiently. This system is used to track what is in stock and what needs reordering so as to reduce the risk of under stocking or overstocking. Overstocking ties up valuable space and capital that could have been used for other valuable items. On the other hand under stocking causes customer dissatisfaction.

**Transactions handling at the electronic point of sale terminals**
An electronic point- of -sale (EPOS) is a computer terminal used in retail stores to input and output data at the point where sales are transacted e.g. at the supermarket checkout counter. An EPOS terminal has all facilities of a normal cash register, but with additional direct data capture devices, e.g. bar code reader, card reader, a monitor and a receipt printer. In such retail stores, goods are identified by means of bar codes. For each item, a record is stored in secondary storage medium containing: the item number, item name or description, quantity in stock and the price.
Transactions at the point of sale terminal may involve the following steps:
1. The bar code reader (wand) is passed over the items bar code. The bar code is automatically converted to the item number, e.g. 2160, which is read to the computer.
2. Using this number, the computer searches for the item with a corresponding number in the products database.
3. Once the record is found, its description and price lookup file is used for processing the sale.
The advantages of electronic point of sales terminal systems are:
1. Correct prices are used at the checkout counter.
2. Faster since the attendant does not have to enter details manually.

**Reservation systems**

Reservation systems are distributed networked systems that are used mainly to make bookings in areas such as airlines, hotels, car-rental, theatres etc. Bookings are made from a remote terminal connected to a centralised computer database. To access the database, a customer makes enquiries via the remote terminal connected to the central computer.

For example to make airline booking enquiries such as finding out the seats reservation a customer uses a remote terminal in the nearest booking office. The response is immediately available to the customer within a few seconds.

Such a computerised reservation system is referred to as *online enquiry* since an individual directly requests for information through a terminal from a central computer and receives an immediate response.

**Educational systems**

Initially most educational institutions used computers for administrative tasks such as compiling examinational reports, writing memos and accounting purposes. Computers are playing an increasingly important role in educational institutions in the following ways:

1. Computer aided instruction (CAI)
2. Computer aided learning (CAL)
3. Electronic learning (e-Learning)
4. Computer based simulation

**Computer aided instruction (CAI)**

Computer aided instruction refers to the use of a computer to learn, drill and practice particular educational principles. For example when learning a new concept in foreign language such as Japanese, the learner is presented with the explanation of the concept. The computer then presents questions from which the learner is to select the correct answer.

Some CAI programs present learning content in form of educational games, which makes learning more fun especially for young children. A good example is a typing tutor program. Figure 2.3 below is an onscreen illustration of a sample typing tutor program that teaches a person to learn typing skills.

**Computer aided learning (CAL)**

Another educational technique that uses computers is computer aided learning. Unlike computer aided instruction, which is meant to drill the learner, computer aided learning present's educational materials the way a teacher does in a classroom. For example, the program may pose a question and depending on the learner's performance, it may present new content or revisit the topic.

In order to make learning effective, most computer aided learning programs have clear graphical presentations such as video clips and voice for demonstrating or explaining difficult concepts.

**Electronic learning (e-Learning)**

In e-Learning, lessons and lectures are presented from a central site and the presentation is transmitted to remote conference terminals or displayed on TV screens. The learner can

also access learning material on the internet, sit for online examinations and receive results the same way. Learners therefore do not need to go physically to a college.

**Computer based simulation**

Computer based simulation refers to the science of representing the behavior of a real-life situation by using computerised models. Simulation has become very popular in learning and training institutions. For example, in distant or e-Learning, where a learner is not in physical contact with a trainer, simulation software can be used to provide the learner with clear illustrations about a certain concept or skill.

Simulation programs are mostly used in educational areas where practical skills have to be learnt like training drivers, pilots, engineers etc. have to be instructed using a virtual environment.


**Communication systems**

Communication refers to the distribution of information or data from one person or location to another. Effective and efficient data communication is achieved by use of high-speed electronic devices such as computers, cell-phones, radios and television. This integration of computerised electronic devices and telecommunication infrastructure for the purpose of communication is referred to as information and communication technology (lCT). Therefore ICT not only refers to computers but also all other devices that are used for effective and efficient communication. Examples of communication systems are:

1. Facsmile (Fax).
2. Radio.
3. Television set.
4. Video conferencing.
5. Telecommuting.
6. Internet.

**Facsmile (Fax)**

A facsmile machine, in short a *fax,* is a telecommunication device used to send documents via telephone lines. A document is placed in the machine, scanned and converted into analog form then transmitted over the telephone line. The receiving fax machine converts the analog data into the original softcopy and prints a hardcopy.

To send fax over the Internet, a special modem, called a *fax modem* is attached to the sending and receiving computers. This eliminates the need for a stand alone fax machine.


**Radio communication**

Computers can be used in radio broadcasting stations to do the following:

1. Record and manage radio programmes meant for broadcasting.
2. Manage the radio transmission and track performance. Most transmissions equipment are computerized for easy troubleshooting and operation.
3. Automate the running of the selected programmes.
4. Create slides, simulated objects and sound effects when preparing electronic and printed media advertisements.
5. Download information *from* Internet that can be used in preparing programmes such as international news.

**Television sets**

Television sets (TV) have become increasingly important in information and communication technology because they are much more available at homes and many places than computers. Data or information is transmitted via a TV channel the same way the channel is used to broadcast conversional TV programs. The most common types of data transmitted via TV include: *teletext (ceefax)* and *videotex (view data).*

**Teletext**
Teletext refers to a computerised service whereby news and other information are provided on television screens to subscribers. A TV is configured using a special add-on card or adapter. The subscriber can browse *for* information using a remote controlled device. However teletext is a one way communication (simplex) which means that the subscriber cannot communicate back to the service provider.

**Videotex (view data)**
Unlike teletext, videotex also known as view data is a two way communication service half duplex over a telephone line or cable television channel. A subscriber can interact with the service provider database and the information is displayed on a home TV screen. View data is used in reservation bookings, ordering *for* goods and services as well as sending electronic mails.

**Video conferencing**
Video conferencing refers to the use of computers, a digital video camera, audio capturing equipment and communication networks to enable people in different locations to *see* and *talk* to one another.
Each participant's computer is attached with a video camera (camcorder), speakers and a microphone. With such devices and appropriate communication software, a person can participate in a virtual conference room. In such a room, all participants can see each other on the computer screen as if they were seated in a real conference room.

Video conferencing communication is popular in TV broadcasting stations where a field reporter interacts with newscasters. It is also popular in organisations where top managers in different geographical locations hold meeting via the Internet or the organistions intranet.
**Telecommuting**
Telecommuting is a term used to refer to a situation where an employee works usually at home using a computer connected to the workplace network. Telecommuting takes advantage of the growing communication networks to reduce unnecessary travel to the place of work. This in turn translates to reduced travel expenses and less stress due to commuting inconveniences such as traffic jams.
**The Internet**
The Internet has become one of the most popular means of information transfer and efficient communication. Some of the services available on the Internet are:
1. World wide web (www).
2. Electronic mail (e-mail).

**World wide web (www)**

*World wide web* refers to a collection of web pages, which may be made up of text, images, animations, sounds and video held on web servers. One can access the information using a computer or any other communication device such as a mobile phone. However, for a mobile phone to be used to access the Internet, it must have the wireless application protocol (WAP). A computer connected to the Internet or a WAP-enabled mobile phone allows the user to access a wide range of information such as news, entertainment, banking, reservations, business news, e-mails among others.

**E-mail**
This is a very fast and efficient means of sending and receiving messages, data, files or graphics. Once you subscribe for Internet services through a service provider, you can send or receive e-mails to or from anyone connected to the Internet using a computer or a WAP-enabled cellular phone.

**Industrial system**
The application of computer technology in industrial or manufacturing processes has become one of the most effective methods of automated production. This has resulted in tremendous improvement in productivity.

Industrial plants such as motor vehicle manufacturers, chemical plants, refineries and mining plants use computer systems in a number of ways. Some include:
1. Computer aided design and manufacturing.
2. Simulation.
3. Process control.

**Computer aided design/computer aided manufacturing**
Computer aided design Computer aided manufacturing (CAD/CAM) is an integrated system that allows products that have been designed using design application Software, to be transmitted into an automated manufacturing system for the product to be manufactured as per the computer model. For example design of motor vehicle brake pads involves designing the model using computer aided design software then feeding it to an automated machine which engineers the required shape and dimensions as per the specifications. One application of computer aided manufacturing is the use of *robots* to carry out assembly line operations. A robot is a computer controlled device that emulates a human being in carrying out operations that would otherwise be hazardous, repetitive and boring to a human being. Such operations may include welding, lifting heavy objects; spray painting of vehicle bodies, removing red-hot materials from furnaces etc.
**Industrial simulation**
Simulation allows some activities that would otherwise be expensive and dangerous in real life situation to be put under test. For example, a car or plane crash test simulation is the use of a virtual model on the computer screen that attempts to represent the real situation or object. This enables the manufacturers identify the weaknesses of the real situation or object hence put the correct reinforcement to their designs. E.g. motor vehicle seat belts can be tested for their effectiveness in case of a car crash using a computer model. The general name of using computer models in such circumstances is known as *non destructive testing (NDT).*

**Process control**

Computerised process control refers to the use of a computer system to control an ongoing physical process especially in manufacturing. Such process controls may include regulating temperature, pressure, fluid flow etc. Computerised process control is mostly used in petroleum refineries, chemical plants and other manufacturing companies to manage machine intensive processes.

**Scientific and research systems**

Computers have a wide variety of applications in science, research and technology. Some of which are:
1. Weather forecasting.
2. Medical research.
3. Military and space exploration science.

**Weather forecasting**

Modern weather forecasting techniques have been automated using computerised systems; hence weather predictions are more accurate and reliable. Due to the large volume of data collected from rainfall, air pressure, humidity, temperature, wind speed and cloud cover, computers help in analysing, processing and predicting weather patterns using such data.

Another application of computers in weather forecasting is the use of *geographical information system (GIS)* and the *geographical positioning system (GPS).* This system represents geographical data in graphical form by positioning and superimposing it on the world map. Geographical information system is used to represent data on weather patterns in a clearer and coherent manner on a world map. Similarly, the path of storms can be accurately tracked and predicted. Such information is very important for the aviation industry and many other sectors of the economy.

**Medical research**

In health sciences, health professionals use computer technology for diagnosis, keeping patients' records, inventory control etc. Computers are now being used to control devices that help to care for the handicapped such as the deaf, blind, bed ridden etc. In some health institutions, a more specialised computer system referred to as an *expert system* may be in use. An expert system is an interactive system that generates conclusions from captured data by comparing it with a set of rules held in a database called a *knowledge base.* The system emulates the reasoning of a human expert in a *narrow field of specialisation.* Expert systems have been developed to help medical professionals diagnose illnesses more accurately in the absence of human experts.

**Military and space exploration science**

The dynamic growth in military, space science and exploration would not be a reality today were it not for computer technology. Space exploration and military research bodies such as America's national aeronautics and space administration (NASA) make extensive use of computer systems, for research, design, development and control of unmanned spaceships, aeroplanes and missiles.

### Library systems

Libraries use computerised systems for a number of tasks. Examples are:
1. Lending system
2. Inventory control system.
3. Cataloguing system.

### Lending system

The library lending system manages the issuance and return of borrowed reading materials. Books, magazines, journals, reports etc. are given unique identification numbers or codes. Once a member borrows a book, his/her details are recorded. When the book is returned the borrower's record is updated to reflect the new status.

### Inventory control

This involves use of computers to manage stock, which includes checking for books currently in the shelves and those on high demand for the purpose of adding more. Similarly, books that have become obsolete can be retired to the archives.

### Cataloguing

A catalogue is a collection of cards with information about each book or reference materials found in the library. These cards may be kept in a drawer sorted in alphabetic order either by title or author name. To enhance service delivery and efficiency, computerised cataloguing has replaced the manual cards catalogue. This electronic catalogue is updated constantly when new reference materials are acquired.

### Entertainment systems

The advancement in multimedia technology has produced computers that can be used in recreational and entertainment. Some application areas of computers in recreation and entertainment include:
1. Games
2. Music and video

### Games

Games have come a long way from the simple *solitaire* to modem simulated 3D games. Digital video disks (DVDs) and three-dimensional (3D) multimedia games are now possible on personal computers. There are computer games that simulate sports such as driving, war combat etc. such games gives the player maximum pleasure in a virtual environment on the screen.

Although some games can be played using other accessories e.g. on the TV screen using a game console, such games have been developed using computers.

### Music and video

Video compact discs (VCD) and digital video discs (DVD) have become a common feature in the entertainment industry.

In music industry, computers are used in recording, synthesizing, editing and adding special effects to music.

In video industry, computers are used to produce highly simulated and animated movies, generate scenes and actors. Some movies use a lot of computer generated images that make the movie interesting.

**Transportation systems**
Computers play an increasingly important role in transportation industry in areas such as:
1. Automobile traffic control
2. Air traffic control

**Automobile traffic control**
In busy towns where there are round about and road junctions, you will mostly find traffic control lights. These lights control both human and motor vehicle traffic using the three lighting system i.e. *green, red* and *amber.* These lights are either controlled using a small clock switch or a computer system. The clock switches the lights at regular intervals. However, some clock controllers are intelligent enough to vary the frequency of light change according to traffic direction and volume during rush hours. Computerised traffic light systems have sensor *pads* laid underneath the road which detect the pattern of the traffic flow. The collected data is sent to a computer system which detects and analyses the traffic flow and builds up a simulated image of the actual scene. Control signals can then be output to the traffic lights or motorists through their receiver devices to vary  the light timings or redirect traffic to less busy roads.

**Air traffic control**
Computers are used to monitor air traffic movement, take off and landing of crafts. This has helped minimise human control errors and mistakes I that could result from human controlled systems. The computer technology used to direct aircrafts to follow the shortest path between two locations is known as *geographical positioning system (GPS).*

**Shipping control**
Computers are widely used to control and guide the paths taken by spaceships and water vessels as they travel to distant lands. The geographical positioning system is also used in shipping control.

**Home use**
Because microcomputers are nowadays affordable, most people are using computers at home for preparing domestic budgets, entertainment, research and teaching children on educational concepts.

**Office expert systems**
This is an information system usually developed and installed in the office of a human expert or knowledge worker. A knowledge worker is a person in any field who is formally trained to apply a specific set of knowledge in his work. Such as a system is capable of simulating the decision making process and intelligent problem solution just like a human expert. It also has a set of rules that help it to make conclusions when some parameters are entered.

## Marketing

Without proper marketing, a business cannot survive in a competitive environment; hence computers are being used in a number of ways to enhance marketing. These include:
1. Electronic commerce or e-business
2. Electronic presentations
3. Advertising

## Electronic commerce/e-business

E-commerce is a new way of doing business where the transactions are carried out electronically without physical interaction between the seller and buyer. For example a customer may decide to buy an item through the Internet by visiting the supplier's web site, selecting the item and placing it in a virtual shopping tray. The website tracks the whole session as the customer chooses various items and calculates the total bill. Payment is then made through a cheque, credit card or through electronic funds transfer. Once the payment is made, the item is shipped to the customer.

This method of trade has enabled people to do business without much movement hence saving money and time.

## Electronic presentation

Using computers, marketing agents can create exciting presentations concerning the products of a business and present them to the audience using presentation software. Electronic presentation adds value to traditional marketing techniques because they are attractive.

## Advertising

Using simulation, presentation and animation software, it is possible to design catchy advert materials and video clips. Such materials can then be displayed on billboards, broadcasted over a television or placed on the Internet.

## Virtual or artificial reality

The term virtual reality (VR) or artificial reality refers to a condition in which a person becomes psychologically immersed in an artificial environment generated by a computer system. Other terms used instead of virtual reality are *cyberspace, virtual worlds* and *virtual environment.* To achieve this effect, the following interactive sensory equipment are used:
1. Head mounted display/headgear
2. Gloves
3. Body suit
4. Virtual reality software

## Head mounted display (HMD)/headgear

A headgear is made up of two tiny display screens and sound systems that channel images and sound from the source to the eyes and ears thus presenting a stereo three dimensional sound effect in the virtual world. The wearer of the headgear is able to look around in the virtual environment.

*A boom* is an alternative to the often-uncomfortable head gear. Screen, optical and sound systems are housed in a box. The user looks into the box through the two screens to see the virtual world.

**Gloves**

Gloves worn on the hands allow the user to navigate through the virtual world and interact with virtual objects. The gloves have sensors that collect data about the movement of the hands and relay the data into the system. They give the wearer a sense of touch in the virtual world.

**Body suit**

A body suit, worn during virtual reality session is made up of conductor wires wound in a rubber suit. The wires sense the body movement and relay the data into the virtual reality system which in turn adjusts the position of the user in the virtual reality world.

**Virtual reality software**

Virtual reality software such as body electric gives the wearer of the sensory devices an interactive virtual sensory experience that makes him/her feel as if he/she is in a real world. The software is responsible for simulation of all the aspects of the virtual reality world.

**Application of virtual reality**

Virtual reality is used to represent any three dimensional object or ideas that are either real or abstract.

Real objects include buildings, landscapes, underwater shipwrecks, spacecrafts, human anatomy, sculptures, crime scene reconstruction, solar system etc. For example, a house can be simulated before the actual building is physically set up. A client can be allowed to virtually move through the house, pull drawers and touch objects all in a computer generated environment

Other applications of virtual reality include entertainment, training in areas such as medicine, military, equipment operations, education, design evaluation, prototyping, simulation and assembly of sequences, assistance to the handicapped etc.

**Law enforcement systems**

Today, crime has become very sophisticated hence very difficult to deal with. Since immediate and accurate information is very crucial in crime detection, *biometric analysis* using computers is becoming a preferred tool in this area. Biometric analysis refers to the study, measurement and analysis of human biological characteristics. Biometric devices attached to a computer are used to identify people by recognising one or more specific attributes such as fingerprints, voice, lips, facial features like iris colour etc. Some of the devices that can be used here are video cameras and biometric scanners.

**Field work report**

Visit one of the information and communication technology (ICT) application areas discussed in this chapter and write a detailed report of about five pages on the use of computers in the area. The report should include the following:
1. Title page

2. Table of contents
3. Introduction
4. A detailed description of information and communication technology implementation in the area of field work study
5. Conclusion

## IMPACT OF INFORMATION AND COMMUNICATION TECHNOLOGY (ICT) ON SOCI ETY

*Chapter outline*

3.1 *Introduction*
3.2 *Issues resulting from the use of information and communication technology*
3.3 *Evolution of computer systems*

### Introduction
This era of information and communication technology (ICT) continues to influence our lifestyle both positively and negatively. This chapter seeks to explain some of the issues that result from the use of ICT in the society.

### Issues resulting from the use of ICT
The use of ICT offers a different set of opportunities and challenges in our society. Some of the effects of ICT in our society are:
1. Effects on employment.
2. Effects on automated production.
3. Issues of workers' health.
4. Cultural effects.
5. Breakthroughs in ICT.

### Effects on employment
The introductions of computers in the workplace have resulted in *creation of new jobs, replacement of computer illiterate workers* and *displacement of jobs* that were formerly manual.

### Job creation
ICT has introduced new employment opportunities that never existed before. The use of computers in financial institutions, reservation systems, educational institutions, communications etc. has created new job titles such as computer operators, programmers, network administrators, information technology or infof?1ation science managers, database administrators, software developers, system analysts etc.

### Job replacement
Since the introduction of ICT in workplaces, some clerical and repetitive tasks that required a large number of employees have been made redundant. Computer illiterate people have been replaced with those who have the desired computer skills. The question

in the mind of workers and managers is whether computers will in future take over all the work currently being done manually by human workers.

**Displacement**

Unlike in replacement where an employee may lose the job, in displacement an employee is moved to another place or department where computer skills are not required. For example, a clerk may end up being an office messenger if computers are introduced at the workplace and such a person is not willing to acquire new skills of using the computerised system.

However, to avoid losing competent employees, most employers organise in-service training for their employees on regular basis in order to help them keep up with the rapid changes in ICT.

**Automated production**

A number of manufacturing industries such as vehicle assembly plants, oil refineries and food processing companies are using computers to automate their processes with an aim of increasing production. Computer controlled robots and assembly lines are a common feature in manufacturing industries.

 The advantages of using automated production are:

   1. Increased efficiency due to the balancing of workload and production capacity.
   2. Improved customer service. Adequate and high quality goods are produced in time.
   3. Efficient utilisation of resources such as raw materials, personnel and equipment hence less operating expenses are incurred.

However, automated production has its disadvantages too. These are:

1. High initial cost of setting up 1an automated system. For example, the cost of buying one industrial robot is high compared to employing human resource.

2. Automated production may lead to unemployment in some areas that are labour intensive. For example, what would have been done by thirty people may be done by one person using a machine.

**Issues of workers' health**

The use of information and communication technology (ICT) and computers has some effect on our health. Some of the negative effects of ICT on our health include *repetitive strain injuries, eye strain* and *headaches, electromagnetic emissions* and *environmental issues.*

**Repetitive strain injuries (RSI)**

These are injuries resulting from wrist, hand, arm and muscle strain, tendonitis and neck strains due to forced repetitive movement e.g. when entering data using the keyboard. The cure for repetitive strain injuries is resting, sitting in a relaxed position and changing typing techniques.

**Eye strain and headaches**

Since computer users have their eyes at cross range with the monitor, there is danger of developing what is called computer vision syndrome (CYS). The syndrome is

characterised by eye strain, headaches, double vision and other problems caused by the improper use of the monitors. The solution to this problem is to use monitors with good resolution and fitted with an antiglare screen that filters excess light. A computer user at all times must adjust the brightness of the screen to the intensity that is comfortable to the eyes.

### Electromagnetic emissions
Electromagnetic field emissions are waves of electrical and magnetic energy that are emitted by current carrying conductors. Computer users are advised to use low emission devices in order to avoid exposing themselves to excess emissions.

### Environment issues
Some of the environmental effects of information and communication technology include energy consumption and radiation, pollution, paper consumption and disposal.

### Energy consumption and radiation
Initially computers consumed a lot of energy thereby generating a lot of heat and emitting electromagnetic radiations. However in recent years, the *Environmental Protection agency* (EPA) launched energy star policy to encourage minimal use of power by electronic devices. Electronic devices have to be energy star compliant to be recognised under this policy. You can tell whether your computer complies to EPA if it displays the star during boot up

### Environmental pollution
Information technology has also contributed to environmental pollution. For example, huge garbage dumps of dead computer parts, printers, ink toner cartridges, monitors and other computer accessories are disposed in landfills hence causing environmental pollution. There has been concern on the disposal of *Nickel - Cadmium* laptop batteries that contain toxic cadmium which when buried in a landfill can leak into underground water tables and catchments areas.

### Cultural effects
The rapid growth of information technology does not only provide us with different ways of working, playing and thinking but also presents challenges to our moral and cultural values. It is the moral standards that help in guiding human behavior. Information and communication technology has changed the way we talk, affected our privacy, human rights and integrity. For example Internet users are exposed to a form of communication called *flaming*. Flaming is writing on-line messages that use *derogatory, obscene* or of dirty language. Also through the Internet, one can view pornographic materials that affect moral values negatively. These free flows of immoral information have negatively influenced the behaviour of both the young and old in the society.
 Computer related crimes such as hacking, eavesdropping, piracy are on the increase. This has been accelerated by the *free for all Internets*. Therefore, a lot has to be done to improve on privacy and security of information.
To some extent, people with eroded integrity have used computers as a tool to accomplish their vices. Take for example where a person would use a computer to forge

certificates, passport and other documents. This means that the person is cheating and therefore his/her moral integrity has been compromised.

However, ICT has its advantages too especially where it has been used as a campaign platform against diseases like AIDS and drug abuse.

**Breakthroughs in information and communication technology**

As explained in the previous chapter, there has been a lot of breakthroughs in the fields of health care, education, communication, research, commerce, art and design, entertainment, transport since the inception of ICT . These breakthroughs have greatly changed our lifestyles such that it is hard to imagine how life would be today if information and communication technology is to be withdrawn.

**Evolution of computer systems**

The rapid evolution of computers and information technology has a lot of promise. It has always been fashionable for scholars and technologists to look out into the future and to try and predict the events of tomorrow. Future trends in information and communication technology will be characterised by:

1. Rapid evolution in computer hardware and software.
2. Artificial intelligence.
3. Expanded information superhighway.

**Rapid evolution in computer hardware and software**

Since the introduction of computers in the business world in the 1950s, a lot of technological improvements have been made both in hardware and software. The silicon revolution has seen rapid increase in microprocessor speeds and capabilities due to advanced research in the semi-conductor industry. Future trends will see reduction in size and cost of components but increase in capability. The capacity of computer memory is becoming larger and larger with reduced physical size and cost. Microprocessors of a thumb's size can now execute instructions in a trillionth of a second hence leading to emergence of smaller but smart devices.

**Artificial intelligence (AI)**

Artificial intelligence can be defined as a branch of computer science that is concerned with the development of machines that emulate humanlike qualities such as learning, reasoning, communicating, seeing and hearing. The idea of artificial intelligence developed from a need to develop computer programs that would even challenge human beings in playing games such as chess and scrabble! Computer scientists and engineers are still working hard and carrying out intensive research with the aim of coming up with smarter computers which can almost simulate human thinking and learning, instead of relying on static programmed instructions.

However artificial intelligence is still in its infancy stage and scientists are still working hard to make it a reality in the near future.

There are four main application areas of artificial intelligence namely:

1. Expert systems.
2. Natural language processing.
3. Artificial neural networks.
4. Robotics/perception systems.

**Expert systems**

This is software designed to make a computer operate at the level of a human expert in a specific narrow area of specialisation. Such software simulates the reasoning process of experts in certain well defined areas such as medical diagnosis, financial forecasting etc. An expert system consists of three components namely:

*Knowledge base:* This is the expert system's database of knowledge about a particular subject. It contains relevant facts, beliefs, assumptions and procedures for solving a particular problem.

*Inference engine:* This is the software that controls the search for knowledge in the knowledge base and produces conclusions. It takes the problem posed by the user and seeks to analyse it in order to arrive at a conclusion.

*User interface:* This is the display screen that enables the user interact with the system.

An example of an expert system is MYCIN developed at Stanford University, USA. MYCIN is used in diagnosis of blood and meningitis infections. Another application area of expert systems is in predicting mineral deposits in a particular geographical area by analysing composition of soil samples.

**Natural language processing**

Natural languages are ordinary human languages such as *Kiswahili, English, French* etc. The problem of natural languages is that they are ambiguous and may be interpreted differently by different people. For example the word 'sack' has two meanings i.e. "a type of bag" and "the act of dismissing a worker from gainful employment". Computer languages on the other hand are clearly defined.

*Natural language processing* is aimed at coming up with programming languages that would make computers recognise and understand natural languages, whether spoken or written. Currently there are voice recognition input devices and voice synthesisers are available but are limited to just a few vocabularies. However, before using them, the computer program must be trained to recognise the voice and the pronunciation of words by the user.

**Artificial neural networks**

The artificial neural network is the use of electronic devices and software to emulate the neurological structure of the human brain. The idea is to try and emulate the cognitive learning process of the human brain and how it recognises patterns. The human brain works by receiving signals from special sensory cells called *neurons.* When the neurons receive information, they either excite the cell to send a signal to the brain or not. Artificial neurodes in artificial networks work in similar manner by perceiving environmental stimuli and hence deciding whether to pass it on to the system or not. The essential attributes of artificial neural networks are:

1. The neurodes can be trained to distinguish between what constitutes a signal and what does not.

2. They are capable of recognising patterns in large amount of data that are too complex for the human brain. From these patterns, they can make predictions and point out anomalies. For example, in banking the pattern of credit card usage can be tracked over time to try and generalise spending patterns of individual card owners. In case of loss or theft, the bank can notice the change of spending pattern and conclude that the card is in

the wrong hands, hence take appropriate security measures even before loss of the card is reported.

**Robotics**

A robot is a computer controlled device that emulates a human being in carrying out tasks that would otherwise be dangerous and difficult. Although robots are being used in workplaces research is going on in order to come up with robots that will incorporate *perception systems.*

Perception systems are sensing devices that emulate the five common senses of a human being i.e. *sight, hearing, touch, smell* and *taste.* Such devices would operate under the control of a microprocessor. This development will give robots artificial senses. Such artificial senses include feeling the shape of an object, listening to ultrasound; detecting smell of a leaking gas or chemicals tasting food is quality and seeing using two miniature video cameras

**Expanded information superhighway**

Expanded information superhighway involves the integration of cabled and wireless technologies for the purpose of data and information transmission. In line with advancement in the other areas of information and communication technology, there is vast increase in throughput of various transmission media like fiber optic and wireless technologies. Scientists have demonstrated a fiber optic cable whose diameter is the size of a single strand of hair which is capable of carrying a trillion bit per second

Internet is growing tremendously causing what is generally referred to as a growth of the information superhighway to digital explosion or hurricane.

# CAREER OPPORTUNITIES IN INFORMATION AND COMMUNICATION TECHNOLOGY

*Chapter outline*

4.1 *Introduction*
4.2 *Description of career opportunities in information and communication technology*
4.3 *Further educational opportunities in information and communication technology*

## Introduction

The era of computers and automated information and communication technology has brought both blessings and disappointments in the workplace. Some people have acquired very well paying jobs while others have lost theirs. For example an ordinary typist has been replaced by one who can create documents using a computer. Many new jobs have been created in areas like banking, manufacturing, educational institutions, communication and other service industries.

## Description of career opportunities in the field of ICT

Information and communication technology (ICT) has created new job titles such as computer operators, computer technicians, system analysts, computer programmers, software engineers, computer engineers, information systems manager, data base administrator, computer trainer, website administrators, computer graphics designers and network administrators. This section explains some responsibilities of these professionals who are generally called *information technology workers.*

## Computer operator

Some of the responsibilities of a computer operator include:
1. Entering data into the computer for processing.
2. Keeping up-to-date records (log files) of all information processing activities.

## Computer technician

Given that computers require regular maintenance, upgrading as well as emergency repairs, demand for computer technicians continues to grow as more and more people computerise their workplaces and homes.

Some of the responsibilities of a computer technician are:
1. Troubleshooting computer hardware and software related problems.
2. Assembling and upgrading computers and their components.
3. Ensuring that all computer related accessories such as printers, modems, storage media and devices are in good working condition.
4. In developed countries, technicians help hardware engineers in designing and creating some computer components such as storage devices, motherboards etc.

## System analyst

This is a person who is responsible for analysing a company's needs or problems then designs and develops a computer based information system. A good system analyst is one who has at least the following attributes:

1. Good problem solving skills and creativity i.e. must have wide experience in solving problems.
2. Good communication skills: The analyst must be able to communicate clearly and precisely both in writing and in speech. He/she must be able to talk to different groups of people e.g. managers, operators, attendant and general public.
3. Must have business knowledge: The analyst must clearly understand the environment for which the system is being developed.
4. Technical knowledge: A system analyst must be well trained in relevant areas of computer science such as hardware, software and programming knowledge.
Some of the responsibilities of a system analyst include:
(a) Reviewing the current manual or redundant information system and making recommendations on how to replace it with a more efficient one.
(b) Working with programmers to construct and test the system.
(c) Coordinating training for users of the new system.

**Computer programmer**
Large organisations such as insurance companies, banks, manufacturing firms and government agencies hire programmers to work together with system analysts in order to:
1. Write in-house application programs or system programs.
2. Customise commercial application packages to suite the organisations needs.
3. Test, debug, install and maintain programs developed or customised for the organization.

**Software engineer**
A software engineer is one who is skilled in software development and technical operation of computer hardware. Some of the responsibilities of the software engineers are:
1. Developing system and application software.
2. Developing user and technical documentations for the new software.
3. Maintaining and updating the software to meet day-to-day requirements while overcoming challenges.

**Computer engineer**
Computer and electronic engineers are coming up with new and more efficient technologies in information and communication technology almost daily. Since computers are electronic devices, hardware designers must be good in electronic engineering in order to be able to:
1. Design and develop computer components such as storage devices, motherboards and other electronic components.
2. Determine the electrical power requirement of each computer component:
3. Re-engineer computer components to enhance its functionality and efficiency.
4. Design and develop engineering and manufacturing computer controlled devices such as robots.

**Information system manager**
The information system manager controls, plans, staffs, schedules and monitors all the activities of the ICT department in the organization. Using computerised management

information system (MIS), the manager can test the impact that an alternative course of action might have on the business.

Other responsibilities of an information system manager include:

1. making sure that all tasks in the IT department are done correctly and on time in order to support business planning, control and decision making processes.
2. Preparing budgets for the department.
3. Keeping the department inventory records up-to-date.
4. Managing the human resource within the department.

**Database administrator (DBA)**

The major purpose of computerising organisations or institutions is to store data in an organised way for easy access, retrieval and update. The organization requires a person who should be responsible for updating records in an information system database. For this reason, a database administrator is responsible for:

1. Designing and developing database applications for the organization.
2. Setting up security measures needed to control access to data and information.
3. Keeping the database up-to-date by adding new records, modifying or deleting unnecessary records.

**Computer trainer**

Due to the dynamic nature of computers and information technology, there is a high demand for qualified ICT trainers. Some of the responsibilities of an ICT trainer are:

1. Training people on how to use a computer and various application programs.
2. Developing training reference materials.
3. Guide learners on how to acquire knowledge through carrying out research.
4. Advising the learners on the best career opportunities in the broad field of ICT.
5. Preparing learners for ICT examinations.

**Web administrator/webmaster**

Internet is one of the areas of information and communication technology that has drawn the interest of most people. Thus people are able to exchange messages, search for information and do business through the Internet.

Business organisations, educational institutions and individuals put information on the Internet by developing websites. Most organisations hire the services of a web developer who is given the role of the company's web administrator also referred to as a webmaster. A web administrator is responsible for:

1. Developing and testing websites.
2. Maintaining, updating and modifying information on the web site to meet new demands by the users.
3. Monitoring the access and use of internet connection by enforcing security measures.
4. Downloading information needed by an organization or institution from Internet websites.

**Computer graphics designers and typesetters**

In publishing skilled graphics designers and typesetters are required in order to design graphical objects and professional publications. Such people may get employed in publishing houses to typeset books, newspapers and magazines.

**Self-employment**

Self employment can be achieved by using computers or other ICT devices such as mobile phones to start bureau services, Internet services, consultancy services and computer hardware and software vendor business.

**Network administrator**

A network administrator is a specialist whose responsibilities are to:

1. Set-up a computer network.
2. Maintain and enforce security measures on the network.
3. Monitor the use of network resources.
4. Maintain and troubleshoot network related problems.

**Computer sales representatives**

Computer sales representative should have good knowledge in information and communication technology. This would helps them to analyse customer needs and advice them accordingly. A good computer salesman needs to be *self confident, persuasive* and *proficient* in business communication.

**Further educational opportunities in ICT**

Most computer related educational opportunities offered at post-secondary level are relatively new and dynamic in nature compared to other disciplines. It is therefore difficult for most institutions that offer ICT courses to update their ICT curricula in order to accommodate these rapid changes. These changes also make it difficult for aspiring ICT professionals to identify the best career opportunities and training institutions. ICT courses are offered in the following tertiary institutions:

1. Universities
2. Polytechnics
3. Colleges

**Universities**

A university is considered as the highest institution in formal education. In most countries, universities are categorised into two major groups' namely *public* and *private* universities.

**Public universities**

Public universities are established by the state through the award of a charter and are run by a state appointed management team. However, current trends in educational management point to the fact that even state universities should be allowed to operate in an autonomous manner. Admission to such a university is controlled by either the state or a recognised body. However, most universities in developed countries do their own independent admissions.

**Private universities**

Private universities are self-sponsored institutions set up by individuals, churches or any other organization. Such universities are privately run and students' enrolment depends on whether the student is capable of sponsoring himself/herself. However, for these universities to operate they must be *registered* or *accredited* by the commission of higher education or any other quality assurance body that is recognised worldwide. Accreditation leads to public acceptance and confirmation evidenced by the grant of *charters* by the state or accrediting bodies.

Universities are authorised to offer approved diploma, undergraduate and postgraduate programmes. Some of the ICT related degree programs offered at university level courses include Bachelor of Science in computer science, Bachelor of Information Technology/Systems, Bachelor of Science in Computer Engineering etc.

**Research institutions**
Although for a long time universities have been considered as centers for research and excellence, other specialised research institutions that concentrate on narrow fields of study such as computer or ICT technology, agriculture and space science exist. There is a lot of research being undertaken in the field of computing such as artificial intelligence. It is possible to enroll in such institutions as a research trainee.

**Polytechnics**
These are institutions of higher learning that mostly offer diploma and certificate courses' in technical fields such as ICT, mechanics, food production etc. A polytechnic may also be accredited by a university or the state to offer degree programmes.
Some of the ICT courses offered at polytechnic level are diploma and certificate in computer studies, computer repair and assembly, computer operator, management information system etc.

**Colleges**
Just like the polytechnics, middle level colleges offer diploma, certificate and craft courses in many disciplines such as technical, ICT, teacher training, business management etc.
Most public and private colleges are now offering ICT related courses both at certificate and diploma level.
The most important consideration to make before you join a college to pursue an ICT course is:
1. Whether it offers ICT courses recognised both locally and internationally.
2. The cost of training with such an institution.

**DEVELOPING A PROJECT USING MICROSOFT ACCESS DATABASE**
*Chapter outline*
5.1 *Introduction*
5.2 *Preamble*
5.3 *Identification and definition of the problem*
5.4 *Fact-finding*
5.5 *System design phase*
5.6 *Constructing Bukuma information system*
5. 7 *Database security and startup options*
5.8 *Testing and implementing the system*
5.9 *Sample user manual*
5.10 *Project appendix*
5.11 *Bibliography*
**5.1**
**Introduction**
In this chapter, we undertake a case study entitled *Bukuma information system.* The objective of this case study is to help the student apply the system development

techniques learnt in Form 3. We shall address each step that is required in developing a working information system.

## 5.2 . Preamble

Due to your expertise and experience in system development, you have been hired to be the head of Information Technology (IT) at Bukuma Limited, a company that runs a supermarket. Your first task is to develop a computer based information system that would ensure that:

1. Stock control and monitoring is efficient and effective.
2. Customers' orders are processed accurately within the shortest time possible and invoices sent in time.
3. Purchase orders are processed accurately in time t~ avoid delays in items delivery.
4. Data entry screens or forms are easy to use hence eliminating data entry errors.
5. On-demand reports by the management are generated within the shortest time possible.
6. Communication between the branches is efficient.
7. Company data and information is secure from unauthorised users and only certain company employees can access certain reports.
8. The overall operating cost is reduced by at least 40%.

By the end of this case study, we shall have demonstrated how to:

I. Carry out the initial study.
2. Carry out fact finding.
3. Define system hardware and software requirements.
4. Design a system using system and program flowcharts.
5. Construct a system that would allow:
    (a) Inputting of data through forms.
    (b) Updating, modification, deletion of existing data.
    (c) Carrying out of input validation and integrity checks.
    (d) Search or filter specific records, query and retrieve specific records.
    (e) Generate various transaction reports.
    (f) Set up database security, menus and other startup options.
6. A sample user manual has been provided to help the student identify some components of a good user manual.

## Identification and definition of the problem

The problem at hand is to develop a computer based transaction processing system (TPS) that would capture and process data about business transactions. The system should also do data maintenance i.e.

provide for ability to update stored data. Some features of this system include:

I. Input data collected from transactions products, orders etc.
2. Output in the form of invoices, pay vouchers etc.
3. The system is also supposed to produce a variety of reports that are to be used for managerial purposes. Such reports include inventory levels, sales reports, payroll, expenses etc.

Reports produced by the system can be classified according to purpose. These are:
I. Summary reports - Shows totals and trends such as total sales by category.
2. Track stock levels and automatically alert the purchases department when restocking is necessary.
3. Produce monthly product sales and purchases reports.

In a nutshell, the following project charter outlines the objectives, preliminary investigation report and other pertinent issues that will be considered before embarking on system development:

Project charter for Bukuma **information system**

### BUKUMA DISTRIBUTORS LTD.
*lndustrial area, Funzi Road Box 30307, NairobiKenya*
*Phone:* 257- 020655147 *Fax: 02065551418*

*Computerised transaction*
*Processing and stock control system*
Project name: *Bukuma computerised information system*
Team leader: *Jane Okindia, System analyst*

**Project objectives**

The project development team will develop new computerised information system tl1at will support the operations of the company in order to realise the strategic vision for Bukuma products sales and delivery of customer services. It's anticipated that the new system will provide highly integrated processes and. services that will not only reach out directly to customers and suppliers but also increase internal operational efficiency.

Therefore, improvement to the current system can result in a number of benefits. These include:

1. Improving corporate profits by 10% through reduction of bouncing orders.
2. Ensuring improved customer services by efficiently managing stock levels.
3. Improved employee's morale due to better processing and operations management.
4. Improved internal decision support so that decisions are more reliable and made on time.
5. Support the competitive strategy of the business.

**Preliminary investigation**

preliminary investigation and feasibility study of the current manual system and the proposed was done through:

1. Studying the organisational chart.

2. Quantifying work output against performance criteria.
3. Observing the behaviour of the employees.
4. Listening to external feedback from vendors, customers and suppliers.

By going through the investigative process, the team discovered the following problems with the current manual system.

1. The constantly changing products presented to the market have created numerous internal inefficiencies and customer service problems.
2. Increased customer base and sales through aggressive advertising may overload the current system's ability to process transactions.
3. Unpaid orders have increased from 4%, only two years ago, to 12%. The current credit management system has to be improved.
4. Suppliers who have failed to deliver as per contracts have increased by 17% due to poor procurement procedures.

5. Competition from other companies threatens the survival of the company unless there is a change in management strategies.

6. Many orders are bouncing due to poor stock control. The orders that bounce are not given priority when new stock arrives.

7. The management is not exploiting the Internet as a marketing and service delivery channel.

**Scope of the system**

The proposed computerised system will support the following internal business functions:

1. Sales and customer order transaction processing.

2. Inventory control and procurement processing.

**Team vision**

The strategic information management team has come up with the following recommendations for the new system.

1. Adoption of automated data capture technology and methods e.g. using bar-coding as a means of capturing product stock records and sales, which is an automatic identification system currently being implemented in many modem business organisations.

2. Triple the order processing capacity of the unit by the end of fiscal year.

3. Reduce order response time by 50% by the end of fiscal year.

4. Rethink any underlying business processes, procedures and policies that have any visible impact on member satisfaction and complaints.

5. Provide improved marketing and promotion programs.

6. Provide improved follow-up mechanisms for orders and backorders.

**Feasibility of the proposed system**

The feasibility analysis of the proposed system centered on the following:

**Feasibility report**

1. Schedule: The system would take 9 months to develop.

2. The technology required to develop the new system is readily available in the market.

    .

3. The system users are happy with the proposal to develop the new system.

   *Cost benefit analysis*

   (a) Costs: The entire development and operational costs can be estimated as follows:

       (i) Development - Kshs 20 000 000
       (ii) Monthly operational costs - Kshs 1 000000
       (iii) Total lifetime of the new system - 5 years
            Total lifetime costs = 20 000 000 + (12 x 1 000 000) x 5
                          = Kshs 80 000 000

(b) Benefits:

    (i) Profit from increased sales per month - Kshs 100 000 000 (ii) Savings from introduction of paperless mail

                          Kshs 1 000 000

    (iii) Savings from reduced travelling costs - Kshs 20000000

Total monthly benefits.                    Kshs 121 000000

Total lifetime benefits = Kshs (121 000000 x 12 x 5) = Kshs 7 260 000 000

*Conclusion*

The development of the new system is cost effective and beneficial to the company because lifetime benefits greatly outweigh the costs.

**Team resolutions**
In order to develop the system within the shortest time possible, the team made the following resolutions:
1. The team will hold weekly status meetings, chaired by the project manager (system analyst). All project status meetings minutes and reports will be shared with management and all IT directors.
2. Team members will be communicating through e-mails, dialogue and written memos to keep in touch on project development.
**Conclusion**
This report is intended to help the management to make decisions about undertaking the project.

Although the system seems expensive it will contribute positively towards corporate objectives when implemented in the future. Its benefits will outdo the costs by billions of shillings throughout its operational lifetime.

Thanks.
Jane Okindia System analyst.

**Fact finding**

The management has responded and given the system development team an okay to start developing the information system. The next task now is
to discover user requirements of the new system through collection of facts. The members have been given the responsibility to carry out a detailed fact finding activity through the following:
1. Documentations study.
2. Interviews.
3. Observation.
4. Questionnaires.
**Documentions study**
A number of manual documents were analysed. These include products catalogue, invoices, purchase orders, sales reports etc.
**Interviews**
Various interviews were conducted which involved the management, employees in the company, customers and suppliers. For each of the interviewee an interview guide was used. Figure 5.1 shows a sample interview guide used with one of the staff at Bukuma distributors.

| Interviewee.name.' | Interviewer | |
|---|---|---|
| Date:. | | |
| Time: . | | |
| | | |
| Subject.; | | |
| | | |
| Time | Interviewer | Interviewee |

| Allocated | Question or Objective | Response | |
|---|---|---|---|
| I to 2 min. | Objective<br>Open the interview:<br>-introduce ourselves<br>.. Thank Mr.&&&for his valuable time<br>State the purpose of the interview- to obtain an existing<br>credit..checking.policies. | | |
| 5min | Question. I<br>What conditions determine whether a customer's order is approved for delivery?<br>Follow-up | | |
| 5inin | Question 2<br>What are the possible actions that might be taken once<br>These conditions have been evaluated?<br>Follow-up' | | |
| 3 min | Question3<br>How are customers notified when stock is unavailable<br>for their order?<br>Follow-1.Ip | | |
| Lmin | Question 4<br>After a new order is received, approximately how long<br>Does it take to process it and put the order under shipment? | | |
| lmin | Question5<br><br>Who are the individuals that perform the credit checks? Follow-up | | |
| 1 -3min | Question 6<br>May 1 please have permission to interview all the people<br>who carry out credit checking?<br>Follow-up<br>If so When would be the best time to meet with each of them? | | |
| 1 min | Objective<br>Conclude. The<br>interview:<br>Thank Mr. &&& for his cooperation and | | |

| | | |
|---|---|---|
| | assure him that<br>He will be receiving. a copy of what transpired during the interview. | |
| 21 min | Time allotted for base questions and objectives | |
| .9min | Time allotted for. follow-up questions and redirection | |
| 30min | Total time allocated for interview (2.00 p.m,to 3:00 p,m) | |

Fig,5.1: Sample interview guideline

**Questionnaires**
In our preliminary investigation of the business operations we decided to prepare some que.stionnaires that would help us seek some classified information without the respondent feeling threatened. Below is an extract of one of the questionnaires used.

BUKUMA DISTRIBUTORS INFORMATION SYSTEM

Date ..........,.......

.Introduction: The IT department is in the process of developing a new information system. Please, take a few minutes to fill in this questionnaire and return it to the IT office before date………..
.
Q I. How often do customer orders bounce due to lack of enough stock?
        0 Very often 0 Often 0 Not often 0 Not at all
Q2. After receiving an order, how long does it take to process it from reception to date of shipping?
        0 .1 hour () Several hours  () One day () Many days

**Fact finding summary and recommendation report**
As opposed to the preliminary investigation report which dwells on problems of the existing system from the general point of view, this report gives a more detailed analysis of the system and proposals for improving or overhauling it altogether. The following is a layout outline of the report.

*Detailed system analysis report for Bukuma distributors*
*Current system: Manual system*
*Proposed system: Computerised model*

 1. Executive summary (about 2 pages)
      (a) Recommendations
      (b) Summary of problems opportunities and alternatives
      (c) Brief statement of objectives

2. Background (about 2 pages)
      (a) Details of all the fact finding methods used e.g. interviews.

(b) Description analytical techniques used.

3. The current system (about 5 pages)
    Models of the current system in terms of:
    (a) Data entry techniques e.g. form.
    (b) Files and data storage methods and media.
    (c) Informatiol1processsingandmethods used.

4. Analysis Of the current system communication (about 5.10 pages)

    (a) Performance, problems, causes and opportunities.
    (b) Economic Problems, causes and opportunities
    (c) Security and control problems, causes and opportunities
    (d) Efficiency and service problems, causes and opportunities

5. Detailed recommendations (about 5-10 pages)
    (a) Reason for the current system improvement.
    (b) Limiting problems (recommendations).
    (c) Proposed implementation plan for the new system:
        (i) Scope and refinement.
        (ii) Master plan.
        (iii) Plan for the design phase.

6. Appendixes
    (a) System models.
    (b) Other appropriate documents.

**System design phase**
This is the most crucial system development phase. The design phase has been broken into two:
1. Preliminary design
2. Detailed design
**Preliminary design**
Preliminary design describes the functional capabilities of the proposed information system. There are many tools that can be used at this stage. However, the system flowchart tool was selected to design the system.
**System flowchart**
The system flowchart shows an overview of the functionality of Computerised system. Considering Bukuma distributors, the proper system required should achieve the following:

1. Process customer orders which may be in form of electronic messaging, post or personal visit.
2. Maintain the stock levels by automatically alerting the management when .the items go below the reorder level.
3. Produce various transaction documents like dispatch notes pay vouchers, various expenses and sales reports and invoices.
Figure 5.2 shows a system flowchart of the proposed system.
**Detailed design**
Once the general functionality of the system has been designed it is now possible to design detailed designs for various system functionalities. These include:

1. Output design.
2. Input design.
3. Files and data stores design.
4. Hardware and software requirements.

**Output design**

This design of both screen and printed output. The output requirements for Bukuma distributors system include: Picking lists, invoices, payment vouchers, inventories, sales reports. However in this design we shall only consider invoices, payment vouchers and sales reports.

**Invoices**

The sample invoice below is one of the reports that the system is expected to produce after delivery of goods to a customer. Notice that it is designed carefully to display all details necessary to seal a transaction.

<div align="center">

BUKUMADISTRIBUTORS LTD.

*Industrial area, Funzi Road Box 30307, Nairobi Kenya*

*Phone:257-020655147 Fax: 02065551418*

Invoice
</div>

Bill To:

Company name…………….                    Contact name …………….

Destination city………………..                 Postal code Sent via………………

Date due…………………                       Country……………….

| Order number | Customer name | Order date | Required date | Date shipped |
|---|---|---|---|---|
|  |  |  |  |  |
| Product name | Quantity | Unit price | Discount | Amount |
|  |  |  |  |  |
|  |  | Subtotal |  |  |
|  |  | Freight cost |  |  |
|  |  | Total |  |  |

Payment voucher

This is almost similar to an invoice only that it is used to authorise payments to the suppliers.

<div align="center">

BUKUMA DISTRIBUTORS *Industrial area, Funzi Road Box 30307, Nairobi Kenya*

*Phone: 257-020655147 Fax: 02065551418*
</div>

Voucher

Payment To:

Supplier name----------          Contact title------------

Postal address-----                Region----------

City------------                   Country-------

Sent via--------

| Purchase ID | Supplier name | Date ordered | Date required | Date received |
|---|---|---|---|---|
|  |  |  |  |  |
| Product ID | Quality delivered | Purchase price | Purchase discount | Amount |

| | | | | |
|---|---|---|---|---|
| | | Subtotal | | |
| | | Freight cost | | |
| | | Total | | |

Sales report

Sales report gives a summary of sales made with a period of time such as weekly, monthly or annually. Below is a sample sales report design.

BUKUMA DISTRIBUTORS

Product sales for the year Category name

| Order ID | Customer name | Product | Amount |
|---|---|---|---|
| | | | |
| | | Total sales | |

All other output reports were designed as per system requirements collected during the fact finding stage.

**Input design**

The quality of system input determines the quality of output. Well designed forms or screens should be effective, easy to use, attractive and consistent. The forms for data entry for Bukuma system should be clearly captioned and easy to use. Some examples of data entry forms

needed for this system are invoice processing form, products entry form, : customer entry form etc. Likewise all other entry forms should be appropriately designed according to the requirements collected.

**Inventory and products entry form**

Categories entry form is a compound form that should allow the user to enter or view both category and products in that category. This means that the products details should be a sub form in the categories main form. Below is the lay out of the categories and products entry sub form.

Category Details

Category ID ……………….

Category Name ……………..

Description…………………..

Products details subform

| Product ID | Product name | Quantity per unit | Price | Unit in stock |
|---|---|---|---|---|
| | | | | |
| | | | | |

**Customer entry form**

This is intended to be a columnar form with the following controls:

Customer ID          Phone

Company Name          Region

Contact Name          City

Contact Title          Country

Address

Since the fields for the customers are too many for one columnar form, they can be grouped into company information and personal information. The two categories will be implemented using a tab control form.

| *Company info tab* | *Personal info tab* |
|---|---|
| Employee ID | Address |
| Last Name | City |
| First Name | Country |
| Title | Date of Birth |
| Hire Date | Telephone |

**Invoice processing entry form**

This form is intended to be a compound form used to enter customer details in the main form and the items purchased in the products sub form.

*Bill To:*

 Customer ID …………………

Order number…………………

Contact name………………..

Title …………………

Country………………

   Destination name
   Date ordered
   Date required
   Date dispatched
   Freight cost

| Product name | Unit price | Quantity shipped | Discount | Amount |
|---|---|---|---|---|
|  |  |  |  |  |
|  |  |  |  |  |

**Pay voucher processing entry form**

Like the invoice processing entry form, pay voucher processing is also intended to be a compound form that allows the user to enter supplier's details in the main form and the items delivered in the products sub form.

The controls in the supplier's main form are:

| Company Name | Purchase Number |
|---|---|
| Contact Title | Freight charges |
| Phone | Date Ordered |
| Country | Date Received |

Products supplied sub form

| Product name | Unit price | Quantity received | Discount | Amount |
|---|---|---|---|---|
|  |  |  |  |  |
|  |  |  |  |  |

**Suppliers entry form**          .

Supplier's details entry form may be a two tab form with company and contact information tabs.

*Company Info tab*                                    Supplier 1D

Company Name                                      Address City
Contact Name                                      Region Postal Code
Contact Title                                     Country Phone Fax
*Contact tab*

**Transporter entry form**

Entry form for companies offering transport services to Bukuma may have the following controls:

Vehicle Number
Company Name
Postal Address
Phone

**Files and data stores design**

After designing the input and output, the last detailed design step is that of files or data store. The files and data store are considered the heart of any information system.

There are two methods of data storage in a computer namely *flat files and databases.*

**Flat files**

In flat files, records are stored in separate files each with particular details. The use of such separate files means that the same data is often stored in more than one place as illustrated by the tables below.

File A

| Product Number | Product Name | Quantity | Price |
|---|---|---|---|
|  |  |  |  |

File B

| Product Number | Product Name | Supplier ID | Supplier Name |
|---|---|---|---|
|  |  |  |  |

**Database systems**

A database is a centrally controlled store of data. It allows different users who share the database to have access to different data. This method of storage eliminates the validation problems of the flat file system.

In Bukuma Distributors Information System, the database approach is used. This will ensure that the following objectives are achieved:

1. Sharing of data among the users of the system.
2. Maintaining accurate and consistent data.
3. Availability of data required for current and future applications.
4. Giving users easy access to data.

**Designing tables /tiles structures**

The following points are considered before designing a file or a table structure:

1. The types of files to be constructed - is the file a master, transaction or report file?
2. Data access method in the file i.e. is it random, sequential or indexed sequential. .
3. The size of the files hence the storage media to be used.

Data structures allow the system analyst to produce a view of the elements that make up the data structure. In our system, the basic data structure that will be used to store data elements of the various entities is the record.

The initial data structure design that shows only "what" the records will contain e.g. Name, Address etc. is called the *logical design.* This design would then eventually be converted to the *physical design* which specifies how the various data elements in the record will be implemented such as

Product Name as string, Product _Number as integer etc.
Below is the logical view of some of the file structures that will be designed for the Bukuma information system.

| *Table/file structure* | *Elements* | |
|---|---|---|
| Inventory | **- Inventory number** | |
| | - Inventory name | |
| | - Description | |
| Products | - Product number | -Unit price |
| | -Product name | - Purchase price |
| | - Quantity/unit | - Quantity in stock |
| Customers | **-Customer number** | - Address |
| | -Company name | - City |
| | -Contact name | - Country |
| | -Contact title | |
| Supplier | -**Supplier number** | - Contact title |
| | -Company name | - Physical address |
| | -Contact name | |
| Purchase orders | **- Purchase number** | |
| | - Product purchased | |
| | - Quantity purchased | |
| Sales orders | **-Order number** | - Product ordered |
| | -Customer name | - Unit price |
| | -Order date | - Quantity |
| | - Required date | - Discount |
| Transporter | **-Transporter number** | -Physical address |
| | -Company name | - Postal address |
| | - Address | -Phone |

NB: The bolded attributes will be considered as the primary keys in the database. '

**Entity relationship diagram (E-R diagram)**
Some of the entities that may be used in constructing Bukuma distributor's information database are categories, products, customers, employees, orders suppliers, transporters and purchase orders. The first step is to construct the entity relationship diagram. Figure 5.3. below shows an example of E-R diagram for customers and the products ordered.
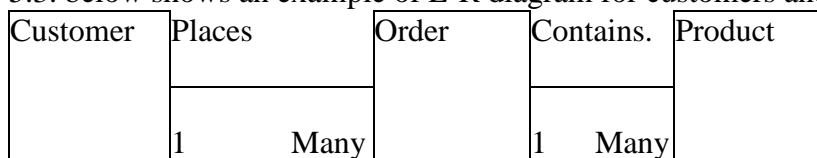
| Customer | Places | Order | Contains. | Product |
|---|---|---|---|---|
| | 1          Many | | 1      Many | |

Fig. 5.3: Entity relationship diagram

*Interpretation*

One customer may place several orders but each individual order can be placed by only one customer (one-to-many relationship). Each order placed by customers may contain many products. However, many products can be contained in one order.

## . Hardware and software requirements

After studying the detailed system design specifications and recommendations, the management of Bukuma decided to settle for a computer based system. This means that the development team must start looking for all the required hardware and software resources.

Hardware and software specialists in the team have already visited various suppliers in major towns and brought quotations and price lists for most

**Table 5.1**

|   | Hardware facility | Example | Estimated cost (Ksh) |
|---|---|---|---|
| 1 | Computer | IBM desktop Computer | Documents collected from various suppliers' Quotations. |
| 2 | Storage media | Optical disks, magnetic disks | |
| 3 | POS terminal equipments | Wand reader, magnetic card reader, bar code printer etc. | |
| 4 | Printers | Laser printer, Matrix printer | |
| 5 | Scanner | | |
| 6 | Others | | |

of the required resources. Table 5.1 below gives a sample summary of the hardware requirements recommendations for Bukuma Distributors information system.

Table 5.2 below gives a summary of the software requirements for Bukuma distributor's information system.

**Table** 5.2

|   | Software | Example | initial cost |
|---|---|---|---|
| I | GUI based Operating System | MS- Windows 9x, 2000, XP; Mac OS9, X etc. | |
| 2 | Application programs | MS-Office Suite, Lotus Suite, Corel Word perfect Suite | Documents collected from various suppliers' |
| 3 | Antivirus software | Norton, MacAfee, AVG. | Quotations. |

## Constructing Bukuma information system

Since relational databases store data in a series of two-dimensional tables, the first step in designing the information base is to design tables that are related to each other via primary and foreign keys. Throughout this section the following shorthand's will be encountered:

1. PK - Primary key
2. FK- Foreign key

Customer        Customer ID (PK),  Customer name……….

Sales order        Sales ID (PK), Customer ID (FK), ......
Product            Product ID (PK), Sales ID (FK), Inventory ID CFK) ......
Purchase order   purchase ID (PK), Inventory ID (FK), Supplier ID (FK).......
Supplier           Supplier ID (PK), Supplier name . . . . . .
Transporter       Transporter ID (PK), Supplier ID(FK) ......
Inventory         Inventory ID……….

These entities can be implemented in an entity relationship

**Setting up integrity constraints**

After setting up the database based on the entity relationship diagram, some integrity constraints need to be set in the database to enhance accuracy. Examples of constrains are lookup fields and data integrity constraints.

**Creating a lookup field**

A *lookup field* displays a list of acceptable values that may be entered into a field. This avoids the problem of wrong data entry in a field. It is recommended that all foreign keys be lookup fields.

To create a lookup field:

1. Display the table in design view.
2. Select lookup wizard in the data type column of the desired fields. 3. Complete the prompts in the lookup wizard.

Figure 5.5 below shows how to set up a lookup for the category field in the Product table.

When the table is displayed in data entry mode (datasheet fonn), you simply select from the list as shown in Figure 5.6 below.

**Data integrity constraints**

Data integrity constraints are rules that govern entering, changing and deletion of data and records in a database. There are several types of integrity constraints. Some of them are:

1. Entity integrity constraint.
2. Referential integrity.
3. Domain integrity.

Entity integrity

These are the rules that govern the composition of a primary key. A primary key cannot contain a null value, it must be unique. Null values are empty spaces in a field that have no data. Figure 5.7 below shows that the Customer ID field (which is the primary key) does not allow duplicates.

**Referential integrity**

Referential integrity governs the nature of records in a one-to-many relationships between tables in the database. All foreign keys in the child table must have a matching record in the parent table. Referential integrity is implemented in the following ways:

1. *Restricted database*- The system deletes or updates a parent record if there are no matching *child* records. A parent record is the one that has the primary key of the relationship while a child record is the one that has the foreign key of the relationship in the second table.

2. *Cascaded database*- Cascaded database will delete or update all matching child records when the parent record is deleted or updated. The cascade approach is better when changing records. For example if the customer ID changes, all foreign keys in the child records are updated as well. Figure 5.8 shows how to set up referential integrity between *customer* and *orders* table in Bukuma database.

Fig. 5.8: Setting referential integrity

**Domain integrity**
In databases, the term domain is used to refer to the acceptable range of values an attribute can have. This ensures that no field takes on a value outside the range of valid values. For example in the Purchase Orders table, the date of items received is always less than or equal to the current date $<=Now()$ as shown in the validation rule property box in Figure 5.9. Now() is a function that returns the current date.
Fig. 5.9: Setting domain values

**Constructing data entry and user-interface forms**
The main purpose of creating forms is to reduce data entry errors. The volume of data to be entered should be minimised and validation and integrity checks such as data type, domain and referential integrity are enforced.
This section examines creating graphical user interface (GDI) forms in Microsoft Access using the appropriate controls, macros and Visual Basic for Applications (VBA) code. Notice the code that is associated with each form and the objects on the form. In Microsoft Access most of these codes are generated by the wizard associated to each during the design. However, in some cases, general subroutines have to be written by the programmer. For the purpose of clarity, these forms are grouped into two main categories namely primary and advanced forms:
**Primary forms**
These are the forms primarily used to enter data into underlying tables. They include customers, categories, employees, products, suppliers, transport and employees details forms.
**Advanced forms**
These are more complex forms that are based on underlying queries and unbound controls. The forms provide the user with easy access to and manipulation of data in the underlying tables and other database objects.
**Creating the primary forms**

The main factors to be considered in creating primary forms are:
1. The general form properties e.g. record source that is, the underlying table.
2. Control properties for each of the objects.
3. Command buttons and their underlying event procedures and codes.

**Customers form**
It was designed as a columnar form as shown in Figure 5.10.

Fig. 5.10: Customers form
The form draws its data from the customers table. Apart from bound controls, the form has command buttons *Add Customers, Search Close,* and *Delete.* These buttons are brought to life by their underlying *event procedures.* The codes are generated using the command button wizard that automatically starts when you draw a command button on the form. Below are the code listings for each command button's event procedure.

*Option Compare Database*

*Private Sub CloseCustomers – Click( )*

*On Error Go To Err Close Customers Click*
   *DoCmd. Close*

*Exit  CloseCustomers Click:*
   *Exit Sub*

*Err Close Customers Click:*

   *MsgBox Err.Description*

   *Resume Exit CloseCustomers Click*

*End Sub*
*Private Sub deleterecord – Click( )*

*On Error Go To Err deleterecord Click*
                          *-*
   *DoCmd.DoMenuItem acFormBar, acEditMenu, 8,, acMenu Ver70*
   *DoCmd.DoMenuItem acFormBar, acEditMenu, 6,, acMenuVer70*

*Exit deleterecord Click:*

   *Exit Sub*

*Err deleterecord Click:*

*MsgBox Err.Description*


*Resume Exit deleterecord Click*


*End Sub*

*Private Sub addcustomer – Click()*

*On Error Go To Err addcustomer Click*

*DoCmd.GoToRecord" acNewRec*

*Exit addcustomer Click:*

*Exit Sub*

*Err addcustomer Click:*

*MsgBox Err.Description*
*Resume Exit addcustomer Click*
*End Sub*
*Private Sub SearchRecord - ClickO*

*On Error GoTo Err SearchRecord Click*

*Screen.PreviousControl.SetFocus*
*DoCmd.DoMenultem acFormBar, acEditMenu, 10,, acMenu Ver70*

*Exit SearchRecord Click:*

*Exit Sub*

*Err SearchRecord Click:*

*MsgBox Err.Description*

*Resume Exit SearchRecord Click*

*End Sub*
**Categories form**
The categories table has many products. Hence, the fonn has the products list subfonn which shows the items in each category as shown in Figure 5.11.



Fig. 5.11: Inventories form

The main form is a columnar form. It is populated with data from the categories table. It has command buttons *New Category, Search, close* and *Delete.* In this case, the categories are the same as the inventory ID.

The subform is a data sheet form embedded in the categories form. It gets its data from the products table.

**Products form**

This is a single columnar form as shown in Figure 5.12.

Fig. 5.12: Products form

The text box controls are populated with data from the products table. *Suppliers* and *Category* are lookup controls that source data from Supplier and Categories tables respectively. To operate the form, four command buttons used i.e. *New Record, Close* and *Delete.*

**Suppliers form**

The suppliers form is designed using the tab tool from the toolbox. Figure 5.13 shows an illustration of the form.

Fig. 5.13: Suppliers form

The form is populated with data from the suppliers table. However, apart from the already discussed form operation buttons for adding a new record, closing a form, searching and deleting records, there is an Open Products Form button, brought to life by the *OpenF orm* wizard. The OpenForm event procedure code is as listed below:

*Private Sub OpenProducts – Click()*

*On Error Go To Err - OpenProducts _Click*
*Dim stDocName As String*
*Dim stLinkCriteria As String*
*stDocName = "Products"*
*DoCmd.OpenForm stDocName,,, stLinkCriteria*

*Exit ₋OpenProducts _Click:*
*Exit Sub*
*Err₋OpenProducts _Click:*
*MsgBox Err.Description*
*Resume Exit - OpenProducts _Click*
*End Sub*

**Transporter form**

This is a single columnar form as shown in Figure 5.14.

Fig. 5.14: Transporters form

The form is populated with data from the transporter table. The four command buttons are *Add New, Delete and Close.*

**Creating advanced forms**

As stated earlier, these are the forms which draw data from underlying queries. This section not only analyses the *form properties* but also gives illustrations of the underlying queries in *design view* and any *event procedure* used to automate the forms and controls. The advanced forms are further classified into groups namely:

1. Data entry and manipulation forms.
2. User interface forms.

**Forms for data entry and manipulation**

These are the forms used for entering and manipulating data in the underlying query. These forms include the customers invoice and suppliers' pay voucher.

**Customers invoice data entry form**

This is a compound form that has the purchase orders subform contained within it as shown in Figure 5.15.

Fig. 5.15: Customer invoice form

The main form is a columnar form whose record source is *Customer Bills* query made from two tables, *Customers* and *Orders* as shown in Figure 5.16.

Fig. 5.16: Customer bills query

The customer details are automatically filled by selection from the lookup combo box of the customer control.

The sub form gets its data from the *order amount query.* The order amount query is designed using two tables, *products* and *order details* as shown in Figure 5.17.

Note that the query has a calculated field i.e. *Amount* that calculates the amount for each product ordered based on the *UnitPrice, Quality* and

Fig. 5.17: Order amount query

*Discount.* The expression for this field is:

*Amount: ccur([order details). [unit price]*[Quantity]* (1-[Discount]/ 100)* 100*

The subform has an event procedure for trapping data entry *errors.* This is tied to the *on error* event of the form properties. Since the user may forget to select a customer before entering products details in the main form section, the *on error* event procedure ensures that a customer is first selected before entering order details. A listing of on error event procedure is shown below.

*Private Sub Form_Error(DataErr As Integer, Response As Integer)*
*, Errors can occur if the user has not selected a customer for*
*, this order on the main form. If there is an error and Orders!BillTo is Null*

*, inform the user and cancel the entry made in the subform.*
*   If DataErr > 0 Then*
*    If IsNull(Me.Parent!CustomerID) Then*
*    MsgBox "Select a Customer to bill to before entering order details info. "*
*   RunCommand acCmdUndo*
*   Me.Parent!CustomerID.SetFocus*
*  Response = acDataErrContinue*
* Else*
* Response = acDataErrDisplay*
* End If*
*End If*
*End Sub*

The ProductID in the subform is a lookup control that enables the user to select an item from the dropdown list. This control also has an event procedure used to automatically fill the UnitPrice control from the products table once an item is selected. This minimises errors that may result from erroneous unit price entry. The code listing for the UnitPrice lookup event procedure as shown below.

*Private Sub ProductID – AfterUpdate()*
*On Error GoTo Err _ProductID - AfterUpdate*
* Dim strFilter As String*
* , Evaluate filter before it's passed to DLookup function.*
* strFilter = "ProductID = "& Me!ProductID*
* , Look up product's unit price and assign it to UnitPrice control.*
* Me!UnitPrice = DLookup("UnitPrice", "Products", strFilter)*
*Exit _ProductID - AfterUpdate:*
* Exit Sub*
*Err _ProductID - AfterUpdate:*
*MsgBox Err.Description*
*Resume Exit _ProductID - AfterUpdate*
*End Sub*

Command buttons that have been used include *Print Preview invoices, Print* and *Close.* Their underlying event procedures are similar to those generated in the other forms discussed earlier.

**Suppliers voucher details entry form**
This is almost similar in functionality to the customers' invoices entry form but it is intended to process payment vouchers for goods supplied to Bukuma. Figure 5.18 shows the voucher processing form.

Fig. 5.18: Payment voucher
The main form is a columnar form that derives its data from *Suppliers Delivery Note* query. This is created from two tables, *Suppliers* and *PurchaseOrders* tables. The

supplier details are automatically filled by selecting the supplier name from the lookup combo box of the Supplier control. Figure 5.19 shows the source query in design view.

Fig. 5.19: Suppliers delivery note query

The subform draws its records from an underlying query, *Products Purchased* shown in Figure 5.20.

Fig. 5.20: Purchase query

The *Total Puchase* is a calculated control with the expression:

*Total Purchase: Ccur[purchase Details].[Purchase Price]*{QuantityOrder]* ([Purchase Discountj)/l 00) * 100*

Just like in the customers' products ordered sub form, the product ID in the products purchased subform is a lookup control from which the user selects the product name. Once a product/item is selected, the Purchase Price is automatically filled with the purchase price from the products table using the lookup event procedure shown below:

*Private Sub ProductID – AfterUpdate( )*
*On Error Go To Err _ProductID _After Update*
 *Dim strFi/ter As String*
 *, Evaluate filter before it's passed to DLookup function.*
 *strFi/ter = "ProductID = "& Me!ProductID*
 *, Look up product's purchase price and assign it to PurchasePrice control.*
*Me!PurchasePrice = DLookup("PurchasePrice", "Products", strFilter)*

*Exit _ProductID - AfterUpdate:*
 *Exit Sub*
*Err _ProductID _AfterUpdate:*
*MsgBox Err.Description*
*Resume Exit _ProductID - AfterUpdate*
*End Sub*

Data validation and integrity checks have been enforced so that the pay voucher cannot be processed for a null or a non-existent supplier. This is achieved using the on error event shown in the listing below.

*Private Sub Form - Error(DataErr As Integer, Response As Integer)*
*, Errors can occur if the user has not selected a supplier for*
*, this order on the main form. If there is an error and PurchaseOrders!PaylTo is*
*Null , inform the user and cancel the entry made in the subform.*
  *If DataErr > 0 Then*
  *If IsNull(Me.Parent!SupplierID) Then*
  *MsgBox "Select a supplier to process the voucher for before entering pay details.''*
*RunCommand acCmdUndo*
*Me.Parent!SupplierID.SetFocus*

*Response = acDataErrContinue*
*Else*
*Response = acDataErrDisplay*
*EndIf*
*EndIf*
*End Sub*

The command buttons used to control the form are New Voucher, Print Voucher, and Close.

**User-interface forms**
These are forms that enable the user to access, manipulate, display and print other forms and reports. Two such forms used in Bukuma System are *sales report dialog* and the *main switchboard.*

**Sales report dialog form**
As shown in Figure 5.21 this form is mainly designed using unbound controls such as radio buttons, a text box and command buttons.

The three groups of controls are tied together using the code listing shown below.

Fig. 5.21 : Select report

*Option Compare Database' Use database order for string comparisons.*
*Option Explicit' Requires variables to be declared before they are used.*
*Sub PrintReports(PrintMode As Integer)*

*On Error GoTo Err-Preview-Click*
  *, This procedure used in Preview_Click and Print_Click Sub procedures.*
  *, Preview or print report selected in the ReportToPrint option group.*
  *, Then close the Print Sales Reports Dialog form.*
  *Dim strWhereCategory As String*
  *strWhereCategory = "CategoryName = Forms![Sales ReportsDialog]! SelectCategory"*
  *Select Case Me!ReportToPrint*
  *Case 1*
  *DoCmd.OpenReport "Products stock level", PrintMode*
  *Case 2*
  *DoCmd.OpenReport "Summary sales by date", PrintMode*
  *Case 3*
  *DoCmd.OpenReport "Sales by category summary", PrintMode*
  *Case 4*
  *IfIsNull(Forms![Sales Reports Dialog]!SelectCategory) Then*
  *DoCmd.OpenReport "Sales by Category", PrintMode*
  *Else*
  *DoCmd.OpenReport "Sales by Category", Print Mode, ,strWhereCategory*
  *End If*
*End Select*
*DoCmd.Close acForm, "Sales Reports Dialog"*
*Exit_Preview _Click:*
*Exit Sub*

*Err_Preview _Click:*

  *Resume Exit_Preview _Click End Sub Private Sub Cancel- Click() ,*
*This code created by Command Button Wizard.*

*On Error Go To Err Cancel Click*


          *, Close form.*
  *DoCmd. Close*

 *Exit Cancel Click:*


  *Exit Sub*

  *Err Cancel Click:*


  *MsgBox Err.Description*
  *Resume Exit - Cancel_Click*
*End Sub*
*Private Sub Preview – Click()*
*, Preview selected report. This procedure uses the PrintReports*
*, Sub procedure defined in (General) section of this module.*
     *PrintReports acPreview*
*End Sub*
*Private Sub Print – Click()*
*, Print selected report. This procedure uses the PrintReports*
*, Sub procedure defined in (General) section of this module.*
  *PrintReports acNormal*
  *End Sub*
*Private Sub ReportToPrint – AfterUpdate()*
*, Enable SelectCategory combo box if user selected Sales by Category*
*, report.*
  *Const conSalesByCategory = 4*
  *If MefReportToPrint. Value = conSalesByCategory Then*
*MefSelectCategory.Enabled = True*
  *Else*
    *MefSelectCategory.Enabled = False*
     *End If*
    *End Sub*

**Main form (Switchboard)**
The main form also referred to as the switchboard is the user-interface or main menu that is loaded when an application is started. The form mainly contains command buttons that enables the user to select the task to work on. Figure 5.22 shows the main form in design view used in Bukuma information system.

Fig. 5.22: Switchboard in design view
**Creating reports**
Reports present information to system users. These are the most visible components of a working system.
This section focuses on some of the reports expected from Bukuma information system. The main features to be highlighted in creation of reports are:
1. General report properties and data source.
2. Control properties, grouping and event procedures.
3. The report in design view.
4. Layout of report needed.
**Sales by category**
This is a comprehensive report that gives sales details for each product in each category group shown in Figure 5.23.

Fig. 5.23: A sample sales report
The report draws its data from *products sales* query. Figure 5.24 shows the query in design view.

Fig. 5.24: Product sales query in design view
The report has calculated controls for a number of items sold and total sales in each category whose expressions are:
Record count:
= *Summary for" & " " & [CategoryName] & " (" & Count(*) & " " & IIf(Count(*)= 1,* *"detail record", "detail records") & ")"*
Total sales: *Sum([ Amount])*
**Sales by category summary**
This is a compound report that has a chart subreport in it. The report gives summary total sales for each category both in tabular and graphical form as shown in Figure 5.25.

Fig. 5.25: Chart summarising sales by category
The graph shows that the most selling category is beverages followed by soaps. This report is meant for the management to decide which category of products sells more than the other.
The main report is populated with data from a select query, *category sales* summary shown in Figure 5.26.

Fig. 5.26: Category sales query design
**Summary sales by date**
On opening this report, the user is prompted to enter the beginning and ending date. Once the valid dates are entered, the sales for the duration are displayed as shown in Figure

Fig. 5.27: Yearly sales report

The record source for the report is the *products by years query*. The query has a compound criteria expression in the freight date field. The expression is:
*Is Not Null And Between [Beginning Date] And [Ending Date]*
**Purchases by category summary**
Just like the Sales summary, this is also a compound report that has a pie chart subreport in it. This report gives a summary of money spent on purchases.
 The main report is populated with data from a select query, *products purchased* shown in design view in Figure 5.28.

Fig. 5.28: Purchases query
**Products stock level**
The stock report is meant to help the management make orders in good time. Figure 5.29 shows the items currently in stock and indicates those that need to be reordered.

Fig. 5.29: Stock report
The report draws its data from product sales query. The report is grouped by category and the stock balance is obtained using a calculated control:
     *= ([units in stock] - (sum([Quantity])))*
While the reorder remark *Yes* or *No* is obtained using an if function:
*= Ilf((([UnitslnStock]-(Sum([ quantity])))<[ReorderLevel], "Yes", "No")*

**Invoice to customers**
This is a report sent to the customer showing detailed description of what is to be paid for, the total payment and the due date. Figure 5.30 shows a sample invoice to one of the customer's ofBukuma Distributors.

Fig. 5.30: Invoice sample report

The report draws its data from *invoice to customers* query. Figure 5.31 shows the source query in design view.

Fig. 5.31: Invoice query design

Calculated controls have also been used, these are as shown below:

Subtotal: = *Sum([amount])*

    Total:= *sum([amount])+ [freight]*

**Payment voucher**

This is similar in design to the invoice, only that it is meant for the processing of payments for the suppliers of Bukuma Distributors. Figure 5.32 shows a sample pay voucher report to one of the suppliers.

Fig. 5.32: Pay voucher report

The report draws its data from the *products purchased voucher* query. It also has an unbound image of the company logo inserted using the image tool, from the toolbox. Calculated controls have also been used as follows:

    Subtotal: = *Sum([Total Purchase])*

    Total:       = *sum([Total Purchase])+ [freightCost]*

**Products catalogue**

This is a document available to the customers and other interested persons who may want to know the items sold and the unit price of each. Figure

5.33 shows a page of a catalogue generated from Bukuma's information system.

Fig. 5.33: Products catalog

The report draws data from the products table.

NB: There are other reports that may be created in a real business environment but only a few have been considered. It is the responsibility of the learner to visit a computerised business organisation to learn more about the variety of reports used.

**Database security and startup options**

To protect the information system from unauthorised access, Microsoft Access database management software, provides a number of options. These includes:

1. Password protection.
2. User and group permissions.
3. User-level security.
4. Data encryption.

To set up any of these security options, click the Tools menu, point to security and then select the type of security you want to setup.

**Password protection**

This is the simplest security set-up that can be implemented using any Microsoft Windows operating system. A password to open or edit the database file is set for any user who wishes to do this action.

**User and group permissions**

Some operating systems like Windows New Technology (NT) lets an administrator assign permission to users on database objects such as queries, forms and reports. These permissions include opening and running the object, modifying etc.

The user and group accounts dialog box is used to assign accounts to the database users. However, this can only be done by a user who is a member of the Administrators group.

**User-level security**

This feature is used to assign permissions to users in order to limit user access to certain database objects. For example, the order entry clerk may not have access to payroll information. Figure 5.34 shows the log on dialog box used to log into Bukuma information system.

Fig. 5.34: Loging into an application

For more on setting up User Groups, Accounts and Permissions, read the online help of the Windows NT based operating systems.

**Data encryption**

If the database is to be used in a network or sent electronically, encryption secures the data from unauthorised access. Only the intended receipient can use the decryption key to read the message.          .

**Start up options**

The last step in developing a customised application is to specify the startup options. Figure 5.35 shows the startup settings for Bukuma information system.

Fig. 5.35: Setting up start up options

**Testing and implementing the system**

**Testing**

Individual system modules were tested using test data and found to work accurately and properly. Sample test data and error messages that were encountered due to invalid data entry are given in the appendix of this project report.

**Implementation**

This is the final stage in system development which involves putting the new system into use. The tasks during the implementation stage are:

1. System management - This involves installation, resource and staff allocation.

2. Staff training - This is done without interfering with the business operations.
3. Security control and contingency planning incase the system breaks down
4. Changing over from the old system to the new system using the most appropriate method.

Once the system has been installed and is running, the programming team must ensure that it is working as expected through a follow up evaluation. The evaluation report for Bukuma information system shows that apart from a few minor issues concerning the screen forms, the following issues have been addressed:
1. Out of stock problems have been addressed satisfactorily.
2. Stock transfer between warehouses is running smoothly.
3. Store managers, accounts clerks and order processing managers feel that they are in full control of the system.

The programming team has promised to address the minor emergent problems encountered during the system maintenance phase.

**Recommendation and conclusion**
The new system received recommendation from all sectors of the organisation after the first month of operation.
**Sample user manual**
Below is a sample of user manual aimed at helping the users ofBukuma information system.
**Introduction**
Bukuma information system is a computerised information system that enables users to process business transactions more efficiently and accurately.
With this system, you can prepare most of the documents that take a lot of time to prepare manually such as invoices, pay vouchers, sales reports, profit and loss accounts and many others.
**Loading the system** To load the program:

1. Click the Start button, point to programs then click Bukuma System. A logon dialog box shown in Figure 5.36 is displayed.

Fig. 5.36: Logon dialog box
2. Enter your user name and password and click OK. The system main menu such as the one shown in Figure 5.37 below appears.

Fig. 5.37: Main menu ,
**Menu descriptions**
Within the main menu are submenus that help the user to choose on the specific task to process. These submenus are grouped into two:
1. Details processing submenus.
2. Viewing transaction reports.

You activate a submenu by clicking on its button. Figure 5.38 shows the customers submenu.

Fig. 5.38: Customers submenu
**Description of submenu items**
**Customer's submenu**
 Once you click the customer's button, you will get the following items:
1. Customer entry and editing form.
2. Customer orders and invoice processing.
3. Preview and print invoices.
4. Preview and print a list Bukuma customers.
**Categories and Products**
Clicking this button displays categories submenu with the following options:
1. Entering and editing and categories and products details.
2. Preview products per category and invoices to customers.
**Suppliers**
This buttons displays the supplier's submenu with the options
1. Entering new editing the supplier details and products supplied.
2. Processing purchase details for items below reorder level.
3. Preview and print supplier's payments.
4. Preview and print a list of Bukuma suppliers.

**Viewing transaction reports submenus**
In this category, you activate a submenu by clicking on its button.
**Sales reports**
Clicking this button displays the sales dialog box from which you can select the report to preview or print.
**Purchase reports**
Click this button to preview purchases made for each purchase order.
**Preview catalogue**
This option is available to any authorised user who wants to preview or print the list of products available for sale to any interested client.
**Exiting from the program**
To exit the program, simply click the Exit button located at the bottom of the main menu.
**Troubleshooting data entry related errors**
Invalid and erroneous data entry results to error messages being prompted on the screen. Some of the error messages that you may encounter are:

*Error message:* The changes you requested to the table were not successful because they would create duplicate values in the index, primary key or relationship.
*Description:* You are trying to enter the same item twice.
*Solution:* Avoid double entry.

*Error message:* The field OrderDetails.ProductID cannot contain a null

value because the required property in the field is set to true. *Description:You* are trying to proceed to another record or field yet you have not selected the product name of the record in focus.

*Solution:* Select the product before proceeding to the next record. *Error message:* The value you entered isn't valid for this field. *Description:* You are trying to enter an invalid data type in the field. For example, you are entering text in a numeric field or an invalid date such as 46/34/2005

*Solution:* Enter the correct data type.

*Error message:* Select a customer to bill to before entering order details info.

*Description:* You are trying to enter order details before selecting a customer.

*Solution:* Select or enter the customer before entering order or invoice details.

Incase you may experience other data entry related problems, please consult the system administrator.

**Project appendix**

Below is a sample appendix of the project report.

**Test data used** in Bukumu information **system**

Although a variety of test data was used to test each operation of our system, we have given only two test data tables to emphasize the need to provide test data in system development. In real situation, you are expected to provide as many test data as possible to prove the functionality of your system.

**Inventory table**

**Table 5.3**

| Inventory | Inventory Name | Description |
|-----------|----------------|-------------|
| 1 | Beverages | Soda |
| 3 | Washing Powders | For Washing |
| 4 | Maize Flour | For Ugali |
| 5 | Daily Products | Milk, butte r, etc. |

**Order details query results**

**Table 5.4**

**Bibliography**

Below is a sample bibliography of the project report.

The bibliography shows a list of books and reference materials used in developing Bukuma information system.

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# DEVELOPING A PROJECT USING VISUAL BASIC PROGRAMMING LANGUAGE

## *Chapter outline*

6.1 *Introduction*

6.2 *Preamble*

6.3 *Problem recognition and definition*

6.4 *Developing algorithms*

6.5 *Developing the system in Visual Basic*

### Introduction

In this chapter, we shall undertake a case study entitled *A school canteen management system.* The objective of this case study is to help the students to apply the programming techniques learnt in Form 3

## Preamble

A school canteen operator sells confectionaries and toiletries to the students. The canteen operator requests you to develop a canteen management system that will accomplish the following:

1. Allow storage of stock records in a file.

2. Enable searching of a file to retrieve a particular record for editing and adding new stock.

3. Process sales transactions and calculate the total bill and change due to a customer.

4. Generate daily sales report showing all the items sold for a particular day.

## Problem recognition and definition

A careful analysis of the above scenario reveals that the system will need the following tasks:

1. Entering stock records and storing them in a file.

2. Searching for the stock file to retrieve records.

3. Processing of daily transactions.

4. Recording of any sale transactions in a transaction file.

5. Generating sales reports for a specified date.

### Developing algorithms

Before coding, the programmer needs to develop algorithms for each task. These algorithms will enable the programmer to develop the code for each of the processes.

### Algorithm for entering new stock records

The new stock module should enable the user of the system to continually enter new stock records in the file until he/she is through with the process. Therefore, the computer should request the user to key in records until the last item is entered. The following pseudocode extract can be used to represent the algorithm:

*Output "Enter a new item?" Enter "yes" or "no"*

*Input reply*

*While Reply <> No*

    *Output "Enter stock item details"*

    *Write to stock file*

    *Output "Are you through with entering the records Yes/No"*

    *Input Reply*

*loop*

*End While*

## Algorithm for searching for a record

This process will enable the user to access the records in a stock file and retrieve a particular record. The record search can be done as per the identification number of each record i.e. record ID. The search algorithm can be represented as follows:

*Begin*

*Enter the code of the record*

*Open stock file for reading*

*While Not end of file Begin*

    *If code entered = record itemcode Then*

    *Output record details*

    *Else*

    *Output 'Record not found'*

    *End if loop End while Close file End*

## Algorithm for processing sales

Sales processing requires that the stock file be opened in order to read details of the items bought. The sales module then calculates the amount of the sale and the change owed to the customer. The module should also update the quantity of the items in stock. The following algorithm will be used:

*Begin*

    *Retrieve item from stock file by record ID*

    *Specify quantity to be sold*

*Compute bill and customer change*

*Save transaction in sales file*
*END*

## Saving a sales transaction

After selling an item, the sales details must be stored in the system for future reference. In our case, the current transaction has to be stored in a file which we shall refer to as a *sales file.*

# Constructing the system in Visual Basic

Open Visual Basic and create a new project called *Canteen.vbp.* Create five forms in the project window i.e. Form1, Form2….Form5. To create a form, simply Click Project then Add Form command. Save the forms with the following names:

*Form Name*

Form I    UserInterface
Form2    AddNewStock
Form3    SellItem
Form4    SearchItem
Form5    SalesReport

Remember while saving that all Visual Basic forms have the extension .frm. After saving, change the Name property for each form in the properties window to start *withfrm* e.g. *frmCanteenManagementSystem* for Form 1. Change the captions for each form as you proceed through the project. At the end of this activity, the forms in your project should look as shown in Figure 6.1 in the Project Explorer window.

NB: Simply click the Project explorer icon to view this window. Alternatively, click View project Explorer on the menu.

It is now time to start placing objects on the forms and entering the code associated to each of the objects.

## Creating the user-interface form

1. Double click UserInterface.frm in the project explorer window and design it as shown in Figure 6.2.

NB: Change both the Name and caption properties of the command buttons as shown below:

| Control | Property | Setting |
|---------|----------|---------|
| Command 1 | Name | cmdAddNewStock |
| | Caption | Add New Stock Record |
| Command 2 | Name | cmdSellItem |
| | Caption | Sell Item |
| Command 3 | Name | cmdGenerateReport |
| | Caption | Generate Sales Report |
| Command 4 | Name | cmdEnd |
| | Caption | End Program |

2. The *File* menu on the form has only one command namely: Exit used to close the program when clicked.

To add this menu clicks the Menu Editor icon on the toolbar. Alternatively click, Tools then select: Menu Editor Command. Create the menu as shown in Figure 6.3 of the menu editor window:

3. To place the command buttons on the form, simply double click their icons on the toolbar.

Since this is the first form that the user will see when the project is run, the various controls are meant to help the user access other forms in the project.

## Adding code the "Canteen management system" form

This is the main form that has commands that enable the user to access other forms.

1. Click the File menu then command Exit. Notice that the code window for the Exit command opens on the screen. Type the word "End" in the body of the event procedure as shown below:

*Private Sub mnuExit – click()*
*End*
*End Sub*
This means that when the Exit command is clicked, the program will stop executing. Save and close this code window.

2. Double click the "Add New Stock Record" button and add the code below in the body of the event procedure as shown:

*Private Sub cmdAddNewStock- Click()*
*Load frmAddNewStock*
*frmAddNewStock Show*
*End Sub*

This code loads frmAddNewStock form and display it on the screen when the user clicks Add New Stock record command button.

3. Double click the "Sell Item" button and add the following code in the body of the event procedure as shown:

*Private Sub cmdSellItem – Click()*
*Load frmSellItem*
*frmSellItem.Show*
*End Sub*

4. Double click the "Generate Sales Report" button and add the following code in the body of the event procedure as shown:

*Private Sub cmdGenerateReport – Click()*
*Load frmDailySaleReport*
*frmDailySalesReport.Show*
*End Sub*

5. Double click the "End Program" button and add the following code in the body of the event procedure as shown:

*Private Sub cmdEnd – Click()*
*End*
*End Sub*

**Designing and adding code to the" Add New Stock to File" form**

Design your AddNewStock form to look like Figure 6.4 below:

6. Double click the "Click Here to Add New Stock Item" button and add the following code in the code window that appears. Ignore the line numbers.

1 *Private Type Item*
2     *ID As Integer*
3     *ItemName As String * 20*
4     *Q As Integer*
5     *CostPrice As Integer*
6     *SellPrice As Integer*
7 *End Type*

```
 8 Private Sub cmdAddStock- ClickO
 9 Dim ItemRecord As Item
10 Dim Old File As String
11 Dim Count As Integer
12 Dim Number As Integer, Reply As String
13 'CommonDialog 1. CancelError = True
14 'CommonDialog1.Filter = "Data file (*.dat)l*.dat"
15 'CommonDialog 1.ShowOpen
16 'Old File = CommonDialog1.FileName
17 Open "c:\Program FilesIMicrosoft Visual
     Studio I VB98 \ Old File. dat" For Random As #1 Len = Len (ItemRecord)
18 Reply = "No"
19 Do While Reply <> "Yes"
20 ItemRecord.ID = InputBox("Enter Record ID If","ItemRecord.ID ")
21 ItemRecord.ItemName = InputBox("Enter Record Name","ItemRecord.Name ")
22 ItemRecord.Q = InputBox("Enter Quantity","ItemRecord. Q")
23 ItemRecord.CostPrice = InputBox("Enter the Cost Price","ItemRecord. CostPrice")
24ItemRecord.SellPrice = InputBox("Enter the Selling Price","ItemRecord.SellPrice ")
25 Put # 1, , ItemRecord
26 Reply = InputBox("Are you through with record entry? Yes/ No", "Reply")
27 Loop
28 Close #1
29 EndSub
```

 **Explanations**
*Line* 1: Declares a user defined data type called Item. The data type is a record.
*Lines* 2 - 6: Declares the fields in the record.
*Line* 7: Ends the type declaration.
*Line* 8: Declares an event procedure or subroutine which is executed on clicking a button called *AddNewStockltem.* You double click this button in order to get the code window.
*Lines* 9 - 12: Variable declarations.
*Lines* 13 -16: Notice that they are commented off, hence the computer will not execute them. However, if they are not commented, they would display the Open dialog box when the button is clicked
*Line* 17: It opens a file called OldFile.dat stored on the disk. This is the file in which all stock records are kept. Notice that the full path to the file has to be specified. This eliminates the need for an Open dialog box. The whole statement should be on the same line.
*Lines* 18 - 19: It sets a looping condition that will stop only when the variable *Reply* has a value of "Yes". Each numbered statement should be on the same line.
*Lines 20 -* 24: Displays an input box on the screen which requests the user to input the various data elements of the record such as the ID, Name etc. Note the syntax of display a standard input box.
*Line* 25: It outputs a record to the file. The blank (, ,) ensures that the next record is written after the last *Put* operation. However if you want the record to be written to a

particular position in the file, then you can specify e.g. Put # 1 ,1, ItemRecord, which means write the record at position 1 in the file.

*Line* 27: It encloses all the code that will be repeatedly executed in the loop.

*Line* 28: Closes the file after writing to it.

*Line* 29: Ends the event procedure.

7. Double click the "Click Here to Update Existing Record" button and add the following code:

*Private Sub cmdUpdateRecord – Click( )*

   *Load frm UpdateRecordDetails*
  *frm UpdateRecordDetails, Show*
   *End Sub*
   Save the code and exit from the code window.

**Designing and adding code to sell Item form**

In the Project Explorer window, double click frmSellItem and design it as shown in Figure 6.5. Remember that this form is loaded by

Fig. 6.5: Sell item

clicking the *"Sell Item"* command button that you created in the user-interface form.

8. Design' a menu bar on the form with the following commands:

   (a) File
   .. .. Open
   …..Exit
(b) Transaction
   ….Save Transaction
   Enter the following code in the mnuOpen code window:
   *Private Type Item*
   *ItemID As Integer*
   *ItemName As String * 20*
   *Q As Integer*

*CostPrice As Integer*
*SellPrice As Integer*
*End Type*
*Private Sub mnuOpen – Cliek( )*
*Dim ItemReeord As Item, Quantity As String, Last As Integer*
*Dim Target As Integer, Current As Integer, First As Integer*
*CommonDialog* 1. *CaneelError = True*
*CommonDialog1.Filter = "Datafile (*.dat)/*.dat"*
*CommonDialog* 1.*ShowOpen*
*Old File = CommonDialog* 1.*FileName*
*Open "c: \Program Files \Microsoft Visual Studio \ VB98 \ Old File. dat"*
*For Random As #1 Len = Len(ItemRecord)*
*First = 1*

*Target = InputBox("Please Enter ItemID of Item to be sold", "Target"*
*Quantity = InputBox("How many units are you selling", "Quantity")*
*Last = LOF(1)/ Len (ItemRecord)*
*Do While First < = Last*
*Get #1, First, ItemRecord*
*Current = ItemRecord.ItemID*
*If (Current = Target) Then*
    *txtItemID. Text = ItemRecord.ItemID*
    *txtItemName. Text = ItemRecord.ItemName*
    *txtUnitPrice. Text = ItemRecord.SellPriee*
    *txtQuantitySold. Text = Quantity*
    *txtQuantityInStoek. Text = ItemRecord. Q - Quantity*
    *ItemRecord. Q = Int(txtQuantityInStoek.Text)*
*End If*
*First = First + 1*
*Loop*
*Close #1*
*End Sub*

**Explanation**

This code enables the user to open a file on the disk called OldFile.dat by selecting it in the open dialog box. The use can then select a particular record from the file by entering its identification number (ID).

To sell another item after the first, you need to search for it in the file again. You can add the *"Sell Next"* button on the form having the same code as the one for the mnuOpen command.

Add the following code to the mnuSave _Transaction command that enables the user to save the details in the transaction file called SaleFile.dat

*Private Type ItemSold*
  *ItemID As Integer ItemName As String * 20*
  *QSold As Integer*
  *Sell Price As Integer DateSold As String * 9*
  *Sale Value As Integer*
  *End Type*
  *Private Sub mnuSave - Transaction – Click()*
  *Dim Sale As ItemSold*
  *Dim First As Integer, Last As Integer*
  *Open "c:\Program FilesIMicrosoft Visual*
  *Studio \VB98 \SalesFile. dat" For Random As #2 Len = Len(Sale)*
  *Last = LOF(2) / Len (Sale)*
  *RecordNumber = Last + 1*
  *Sale.ItemID = Int(txtItemID. Text)*
  *Sale.ItemName = txtItemName. Text*
  *Sale. QSold = Int(txtQuantitySold. Text)*
  *Sale.SellPrice = Int(txtUnitPrice. Text)*
  *Sale.DateSold = txtTodaysDate. Text*
  *Sale. Sale Value = Val(txtBill. Text)*

```
    Put #2, RecordNumber, Sale
     Close #2
End Sub
```
Double click the *compute totals* button and then add the code listing below in its event procedure.
```
Private Sub cmdComputeTotals – Click()
   Dim Cashgiven As Integer, ItemRecord As Item
   txtBill. Text = txtQuantitySold * txtUnitPrice. Text
   Cashgiven = InputBox("How much money has the customer given", "Cashgiven")
   IblChange. Caption = Cashgiven - txtBill. Text
   Open "c: \Program FilesIMicrosoft Visual
   Studio\VB98\0IdFile.dat"
       For Random As #1 Len = Len(ItemRecord)
       ItemRecord.Q = Int(txtQuantityInStock.Text)
       Close #1
End Sub
```
Finally double click the "Cancel" button and then add the code listing below in its click event procedure
```
Private Sub cmdCancel- Click()
     Unload frmSellItem
End Sub
```
**Designing and adding code to controls on Search Item form**
This form lets the user add or edit the fields of an existing record in the stock file. For example, when you buy some more items, you enter the item quantity in the quantity control. Design the form as shown in Figure 6.6.

Fig. 6.6: Edit records form

Double click the button labelled *"Search"* and add the following code to it:
```
Private Type Item
     ItemID As Integer ItemName As String * 20
      Q As Integer
     CostPrice As Integer
      SellPrice As Integer
End Type
Private Sub cmdSearch – Click()
Dim ItemRecord As Item
Dim Target As Integer, Current As Integer
Dim RecordNumber As Integer, Stock Value As String
Open "c: \Program Files\Microsoft Visual Studio \VB98\OldFile. dat"
For Random As #1 Len = Len(ItemRecord)
First = 1
Target = Int(txtRecordId.Text)
Last = LOF(1) / Len (ItemRecord)
Do While First < = Last
```

*Get #1, First, ItemRecord*
*Current = ItemRecord.1temID*
*If (Current = Target) Then*
    *Label3.Caption = "Search successful: Now edit details and Click Save"*
    *txtName. Text = ItemRecord.1temName*
    *txtQuantity. Text = ItemRecord.Q*
    *txtCostPrice. Text = ItemRecord.Cost Price*
    *txtSellingPrice. Text = ItemRecord.SellPrice*
    *Stock Value = txtCostPrice. Text * txtQuantity.Text*
    *IblStockValue. Caption = Stock Value 'display total value of item in stock"*
    *End if*
    *First=First+1*
    *Loop*
    *Close #1*
    *End Sub*

**Explanation**

The code searches for a record whose ID is typed in the Record ID text box. After editing the retrieved record, the changes can be saved by clicking the *"Save"* button. Below is the code for save button:

*Private Sub cmdSave – Click()*
*Dim ItemRecord As Item, Stock Value As String*
*Open "c: \Program FilesIMicrosoft Visual Studio \ VB98\OldFile.dat"*
*For Random As #1 Len = Len(ltemRecord)*
*Target = Int(txtRecordID.Text)*
*First = 1 'first record in file is at position 1*
*Last = LOF(1) / Len (ItemRecord) 'length of file equals record length*
*Do While First <= Last*
    *Get #1, First, ItemRecord 'get the record that was edited*
    *Current = ItemRecord.ID*
    *If (Target = Current) Then 'search whole file for correct record*
        *ItemRecord.ID = Int(txtRecordID. Text)*
        *ItemRecord.ItemName = txtName. Text*
        *ItemRecord. Q = Int(txtQuantity. Text)*
        *ItemRecord. Cost Price = Int(txtCostPrice. Text) 'save fields as record*
        *ItemRecord.SellPrice = Int(txtSellingPrice. Text)*
        *Put #1, First, ItemRecord*
        *Stock Value = txtCostPrice. Text * txtQuantity. Text*
        *IblStockValue. Caption = Stock Value*
    *End If*
    *First = First + 1*
*Loop*
*Close #1*
*End Sub*
**Explanation**

The code takes the contents in the text boxes of the form and saves them as a record in the file. Code for the cancel button is

*Private Sub cmdCancel- Click()*
*Unload frmUpdateRecordDetails*
*End Sub*

**Designing and adding code to controls on Sales Report form**

This form is used for displaying the daily transactions when the user specifies a particular date in the fomart mm/dd/yyyy. Design the report interface as shown in Figure 6.7.

**Code for the sale report**

.Double click the "show report" button and add the following code that will search for all the items sold on a particular day and display them on the form:

*Private Type ItemSold*
 *ItemID As Integer*
 *ItemName As String * 20 QSold As Integer*
 *SellPrice As Integer DateSold As String * 9*
 *Sale Value As Integer*
End *Type*

*Private* Sub *cmdShowReport_Click(),*
Dim *Sale As ItemSold, Daysale As Integer*
*Open "c:\Program File&\Microsoft Visual*
*Studio\VB98\SalesFile.dat" For Random As #2 Len = Len(Sale)*
*First = 1*
*DaySale = 0*
Last = LOF(2) / Len *(Sale)*
*Target = txt Target Date. Text*
*Print ""*

*Do While First <= Last*
*Get #2, First, Sale*
*Current = Sale.DateSold*
*If (Current = Target) Then*
 *DaySale = DaySale + Sale. Sale Value*
 *Print ""*
 *Print Sale.ItemID, Sale.ItemName, Sale. QSold, Sale.SellPrice* Sale. QSold*
 *End If*
 *First = First + 1*
*Loop*
*Print ""*
*Print "Total sales/or", Target, "Are: Ksh, DaySale" Close* #2
*End Sub*

**Running the project**

To run the project click the Start button on the toolbar. Alternatively, click the Run then Start command on the menu. The user-interface screen comes on the screen as shown in Figure 6.8.

Before doing anything else, we need to create two files on drive C and enter all the records for the stock available. This program accesses the files in a folder called VB98 through the path:

c: \Program Files \Microsoft Visual Studio \ VB98

Open Microsoft Windows Notepad and save two blank files in the folder
VB98 having the names: *OldFile.dat* and *SalesFile.dat*

1. Click the "Add New StockRecord" button and add the following records to the file that will hold all stock. This should be the OldFile.dat that you created on drive C. Enter the following records:

| ID | Name | Quantity | Cost Price | Selling Price |
|-----|--------|----------|-----------|---------------|
| 100 | Bread | 120 | 25 | 30 |
| 200 | Milk | 50 | 20 | 40 |
| 300 | Jelly | 200 | 40 | 50 |
| 400 | Cake | 300 | 15 | 30 |
| 500 | Biscuit | 1000 | 10 | 20 |

Figures 6.9 (a) to (f) shows sample input boxes for an item for sale. After entering all the records, type Yes in the input box (f) to stop this process.

**Opening the stock file to sell an item**
Click the "sellitem"command to display the form in Figure 6.10.

Fig. 6.10: Click File - Open.
Click the open command. Open dialog box of figure 6.11 appears.
Locate for the file OldFile.dat and open it. Notice that you have to provide a record number so that when the file opens, the record requested for is displayed on the form.
Click the **compute totals** button. You will be prompted to state how much money the customer gives. This will compute the change due to the customer. Figure 6.12 shows a form with the amount payable and change due to the customer. The units in stock for the item sold also are updated automatically.
Save the transaction by clicking the "transaction" menu, then Save transaction command.
To sell another Item, click the *"Sell Next"* button

**Viewing a sales report**
Click the "generate Report" button. The *Daily Sales Report* appears. Enter the date of the transactions you want to view then click the show report button. All items sold on the particular date will be displayed as shown in Fig 6.13 below.