Topic 1 ▶ What is Human-Computer Interaction?

LEARNING OUTCOMES

At the end of this topic , you should be able to:

1. State the meaning and functionalities of Human-Computer Interaction;
2. Explain the contribution of other disciplines towards the human-computer interaction research field; and
3. Elaborate on the importance and contributions of the human-computer interaction field.

▶ INTRODUCTION

What do you understand about the meaning of interaction? Interaction refers to the process of communication that occurs between two entities at a specific time. When two people are conversing with each other, we can say that they are interacting. Interaction could also occur between three or more individuals or entities.

Another form of interaction that occurs without our realisation is the interaction with non-living devices, such as the copier machine, video recorder and computers. This direct interaction cannot be likened to oral interaction between two people who are conversing; instead it is in a form of operational reaction. For example, if we press the key 'Del' on the keyboard, the result is the deletion of a character or an item.

Figure 1.1: Photos of users interacting with the computer

The Human-Computer Interaction (HCI) is a field of research involving the development, evaluation and implementation of an interactive computer system that considers the surrounding factors, for human use. The computer system mentioned includes all hardware and software technologies whereas the system's users refer to humans in different environments such as the office, home, and school.

In this topic, we will discuss the entities involved and their duties and respective expectations in the interaction process. However, more emphasis is given to humans because it is easier getting humans to understand computers, than vice versa.

1.1 HISTORY AND EVOLUTION OF HCI

The initial term that was used to describe the interaction between computers and their users was "Man-Machine Interface". This term was introduced in the 1970s. The research included various types of machinery aids that were used by humans to complete their daily tasks, such as telecommunication tools like mobile phones and fax machines, household goods like washing machines and

microwave ovens, and the latest information technology tools like computers and PDAs. Most of the computer companies at the time used this research as their computer system's marketing strategy. In their opinion, if their company produced computer systems with more attractive interfaces, the volume of sales would definitely increase.

However, the researchers were more interested in researching the means and methods of using computers to increase the quality of work and life. Focus was given to the limitations of the users' capabilities in their interaction with computers. More attention was given to a number of issues that determined the success or failure of a computer system, such as training issues, work habits, organisational and management issues and health issues.

The term Human-Computer Interaction (HCI) was first used in the 1980s. This term is not merely used for the interface designs, but also for anything that is related to the interaction between humans and computers.

To obtain further information about the history and evolution of the Human-Computer Interaction (HCI), you can visit the following website:

- Chapter 2: Human-Computer Interaction {p.5}

  http://www.sigchi.org

- Stanford University Program in Human-Computer Interaction

  http://hci.stanford.edu

Try producing a brief summary about the history and evolution of Human-Computer Interaction (HCI) based on information from these websites.

1.2 ISSUES ON COMPUTER USABILITY

You go to a bank to deposit some money into your mother's account. The bank officer shows you a machine that allows you to perform this operation. This is the first time you are using such a service. Will you be able to use the machine without anyone's guidance or help? Is the interface designed to make your task easier?

The use of computers now has become crucial. Banks, supermarkets, schools, and even the management of mosques use computers to handle their daily tasks. Initially, there were many negative comments about computers, such as the difficulties in usage, lack of security and inefficiencies. This was probably because the pioneer computer users spent a longer time learning and familiarising themselves with the system. However, this is not the case now, as many people are getting more apt at using computers.

We cannot deny the existence of several types of software that inevitably confuse users. If users are not careful, they may end up wasting money buying software that is redundant. For example, the purchase of the latest and most sophisticated personal computer for home usage will be a waste if the computer is eventually only used for playing computer games.

In the past, computers were placed at specific corners at the supermarkets to provide necessary information to shoppers. These computers used touch screen technology that was very convenient for users. In your opinion, what sort of crucial information about the supermarket would be needed by the shoppers?

For additional reading material, you are encouraged to read the book that was authored by the famous computer software millionaire, Bill Gates, entitled "The Road Ahead" or the Bahasa Malaysia version translated by Dewan Bahasa dan Pustaka.

ACTIVITY 1.1

1. Explain the meaning of human-computer interaction.
2. Using a suitable example, elaborate on the difficulties of using a tool for the very first time.

1.3 HCI GOALS

The main goal of the Human-Computer Interaction is to produce a system that is easy and safe to be used, apart from being able to function well. This computer system should not just be easily usable, but also easily assembled, studied and maintained. Apart from that, the computer system should also be able to be operated accurately without any confusion to the users. Ideally, a minor mistake should not cause a major faulty situation in the system. All goals mentioned above are commonly known as the "usability goals".

The usability goals include the following aspects:

- The system should function optimally (factor of effectiveness).
- The system should function efficiently (factor of efficiency).
- The system should be able to be used securely (factor of secure-ability).
- The system should have the necessary utilities (factor of utility).
- The system should be easily learnt (factor of ability to learnability).
- The system usability should be easily memorised (factor of memorability).

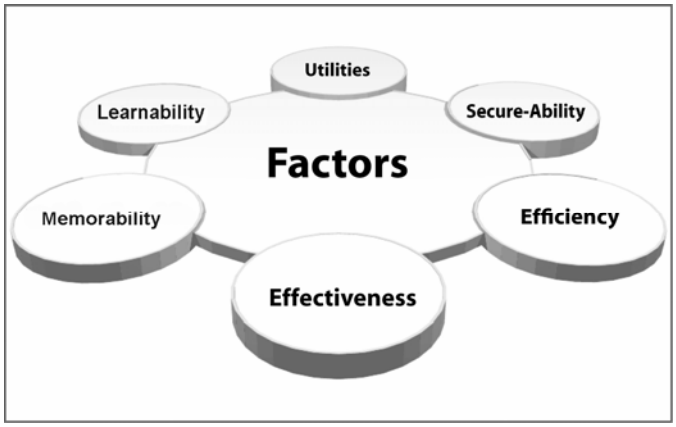

Figure 1.2

1.4 THE IMPORTANCE OF HCI

As stated beforehand, the research goal of the human-computer interaction is to produce a system that can be used easily and is secure. Do you realise the importance of such a system? It will be able to increase global productivity and the security of an organisation. Let us now look at the scenario below.

1.4.1 Productivity

In the past, you may have used a word processor called Word Perfect. Now, you are more likely to be using the latest word processor in the market, called Microsoft Word. This software is most definitely different from Word Perfect, especially in the usage of icons and instructions, among others. Chances are, you would have taken a longer time to learn this new software. Here, we see the importance of a good interface design. If the interface can be understood easily, then the Microsoft Word software would be also be easily learnt, used and managed. This would indirectly increase the productivity and quality of work.

1.4.2 Security

Computers have been used in the disciplines of aircraft, nuclear power plants, and aerospace control centres. These disciplines require an effective and accurate computer system for the general safety and welfare of others. Without proper interaction between the pilot and the computer system, the aircraft would become a dangerous mode of transportation. This also applies to nuclear power plants that are capable of wiping out the entire planet without proper interaction between the researchers and the power plant control system, which is a computer system.

ACTIVITY 1.2

1. Explain the goals of the Human-Computer Interaction research.
2. Explain the importance of the Human-Computer Interaction research.

1.5 THE RELATIONSHIP BETWEEN OTHER DISCIPLINES

HCI is a multi-disciplined field that depends on the development of other disciplines. The other disciplines that make an extensible contribution towards the development of HCI include computer science, ergonomics, psychology, engineering, artificial intelligence, language, art, sociology, anthropology, design, philosophy, and physiology. The relationship between these disciplines and HCI can be illustrated as Figure 1.3 below:

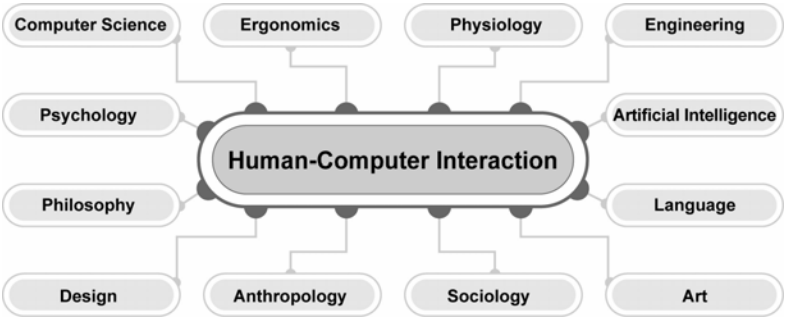

Figure 1.3: Relationship between HCI and Other Disciplines

In this topic, we will only discuss the four main disciplines, which are computer science, psychology, ergonomics, and engineering.

For the other disciplines, kindly refer to the topic entitled "Disciplines Contributing to HCI" in the book written by Jenny Preece *et al* called "The Human-Computer Interaction", or the topic entitled "The Relationship of HCI to Other Disciplines" in the book written by Christine Faulkner entitled "The Essence of Human-Computer Interaction".

1.5.1 Computer Science

Computer science is one of the disciplines that have experienced the most rapid technological changes. The technological developments include both software and hardware technologies. The hardware technology does not just include external computer designs, but also processing speed, memory size, processing accuracy and data transfer speed.

The development of computer accessories has also been equally as impressive. Computer software has experienced major changes from the perspective of interface concepts, interaction concepts, processing and accessing techniques, as well as data security. We can now find various types of software in the market.

Although an interface design is attractive due to its graphical decorations and animations, it can never function well if the processing time is slow. This case also applies to researchers who look for techniques to sketch graphical drawings that are able to reduce the usage of computer memory. These are all contributions of the computer science discipline towards HCI technology.

1.5.2 Ergonomics

HCI always takes into consideration the users opinions and views, as it emphasises on the comfort of users. Ergonomics is the field of research pertaining to the relationship between humans and their work environments. Its contributions are important during the design of different tools and hardware that are used for varying reasons, functions and situations. For example, the design of chairs used in the lecture hall differs from that of sofas at home. This also applies to normal users and disabled users, such as blind users and users with auditory disabilities.

ACTIVITY 1.3

In your opinion, what kind of input and output device is suitable for users who have vision disabilities?

1.5.3 Psychology

The psychology discipline focuses on the research of social structures and how computers can influence the work habits of an individual. There are four essential focuses on social psychology, which are:

- The influence of an individual on the behaviour and characteristics of another individual;
- The effects of a group of individuals on its members' characteristics and behaviours;
- The effects of the members on the activities and group structure; and
- The relationship between the structure and activities among various groups.

The psychology discipline also tries to understand human actions and mental processes to determine the limitations of users' abilities. This is to enable the design of suitable interfaces for different users. For example, the limitations of understanding are different between a five-year-old user and a twenty five-year-old user. The interface designer should be able to foresee how both these users would understand computer instructions. Therefore, a suitable interface for a five-year-old would be one that is simple and features interesting icons of cartoon pictures.

1.5.4 Engineering

The field of engineering contributes creative skills and knowledge to the process of producing hardware and tools that are both suitable and technologically advanced. As mentioned earlier, an effective interface does not merely depend on its design, but also on the processing speed. This is the contribution of engineering when combined with computer science.

We often browse the Internet to look for resources that can help us complete tasks given by our lecturers. At times, the process of downloading a document takes a long time. While studying computer networks or data communication, you may have learnt that the transfer of data from one computer host to another is via cable connection. The transfer that occurs within this physical connection

needs a reliable and speedy transport system. Without engineering, the transfer of documents or data via this physical cable would definitely take many days. In fact, it may even be quite impossible to achieve!

ACTIVITY 1.4

In the microcomputer technology that you often use, are you able to differentiate between the contributions of computer science and engineering?

ACTIVITY 1.5

1. In Human-Computer Interaction, the involvement of various fields is very crucial. These fields contribute substantially towards the field of HCI. List down these fields of knowledge. Choose two of these fields and give a brief elaboration.
2. Explain the differences between human-computer interaction and computer interface.

SUMMARY

- By now, you should be able to explain the nature of Human-Computer Interaction.
- The contribution from the various fields is very important, and the lack of these contributions would result in the breakdown of the Human-Computer Interaction.
- In Topic 2, we will discuss the relationship between the human factor and Human Computer-Interaction.

KEY TERMS

Human-computer interaction

Man-machine interface

Topic 2 ▶ Human Factor: Physical

LEARNING OUTCOMES

At the end of this topic, you should be able to:

1. Identify the abilities and limitations of human senses, such as sight, auditory and touch;
2. Explain the importance of the aspects of visualisation, auditory, and user touch; and
3. Identify the factors that need to be considered when designing an interface.

▶ INTRODUCTION

The Human-Computer Interaction (HCI) involves two main entities, that are the human entity and the computer entity. In this topic, we will discuss the relationship between the human factor and HCI. To help in designing a usable computer system, we need to understand the human aspects from the cognitive, social, and organisational perspectives.

Cognitive psychology will help us in designing a system interface by:

- Providing information on both acceptable and forbidden human actions;
- Identifying and explaining occurrences and sources for human problems; and
- Providing support by using toolkits and the method-modelling technique in designing an interface that is usable.

Social knowledge helps us in designing a system interface by:

- Providing information on usage context;
- Identifying and explaining the means of humans cooperation and the type of computer system that is required to support workplace cooperation; as well as
- Providing a social interaction framework as a basis for HCI.

The organisational knowledge helps us in designing a system interface by:

- Providing structural models and organisational processes; and
- Identifying problems that might hinder the optimal utilisation of a computer system; and
- Providing organisational processes to design and evaluate new technologies in work environments.

2.1 VISUALISATION PERCEPTIONS

Perception is the basics of interaction between computers and users. It is the initial notion of users about particular software upon seeing its display on the computer. Thus, users should be able to determine the type of information needed upon viewing. This initial notion is very crucial, as it can determine the interest or disinterest of a user in this software.

For instance, imagine yourself as a software developer who is interested in selling your product. In an exhibition, a customer visits your kiosk. During the demonstration session, you would able to determine if this customer were interested or disinterested in your software, just by looking at his facial expressions. If the customer were interested, he/she would definitely seek additional information about your software. As an interface designer, you must be able to understand how the perception theory can influence the design of an interface.

Now, to test your observatory skills, try looking at the picture in Figure 2.1. How many person(s) can you see in this picture?

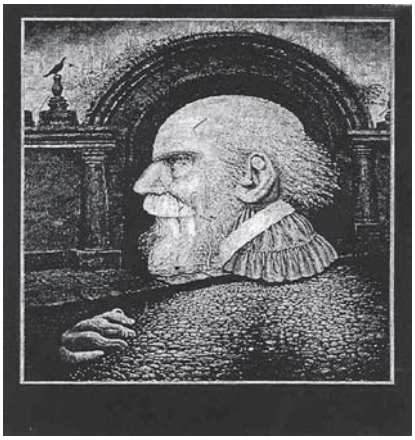

Figure 2.1: A visual perception picture

In a single glance, you will be able to see three people, but there are actually more than three people in the picture. Try finding the other six people.

For further explanations on visual perception topic, please refer to topic 4 "Perception and Representation" in the book entitled "Human-Computer Interaction", by Jenny Preece *et al*. Addison Wesley.

2.1.1 Vision

Visual perception uses eyesight as the intermediary object. This means that eyes play a very important role. The eye is the human organ for vision or sight, and requires extra care. You need to find out the various eye care methods, from the perspective of hygiene and diet, among others.

The light that enters the pupil has two main characteristics - intensity and colour. The objects that can be seen by the human eyes are a result of the brain's interpretation of these characteristics.

Refer to the website http://www.howstuffworks.com to view the structure of our eyes. Observe the position of the cornea, retina, rod, cone, and fovea. What are the functions of these components?

In designing a system interface, we should avoid the usage of representations that might confuse our vision, or better known as an optical illusion. Let us now look at Figure 2.2

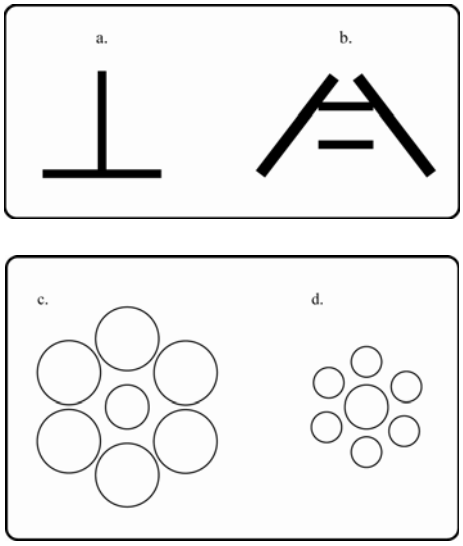

Figure 2.2: Optical illusion

In Figure 2.2 a, both lines used to form the alphabet 'T' have the same thickness as the two lines on the sides in Figure 2.2b. The middle line in Figure 2.2b causes our eyesight to perceive both lines on the sides to look thicker than the lines in Figure 2.2a.

Both the circles located in the middle of Figure 2.2c and 2.2d are the same size. Our vision is confused due to the presence of a number of different-sized circles.

All objects can be seen clearly if they are located exactly in front of our eyes. In this position, the reflection of light from these objects is well absorbed by our eyes. This also applies to light from the surrounding, where a person can see clearly in daylight, or in a place with sufficient lighting.

The area of our vision is measured by degrees. An optimal vision area lies in the range of 100-120 degrees. Let us now look at Figure 2.3.

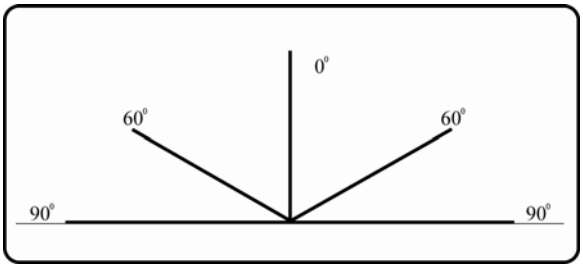

Figure 2.3: Area of vision

The area of vision is important in determining the size, arrangement and controls of the computer display. The extensive movement of our heads can tire our eyes as they have to frequently focus on a particular object. However, you should not sit idly in front of the computer without moving parts of your body. The workplace should always be comfortable by allowing movement and changes in activities. This is one the contributions of ergonomics towards the research in Human-Computer Interaction.

2.1.2 Colour and Brightness

Colour plays an important role in determining the identity and shape of an object, e.g. green is associated with the colour of the leaves, black with the colour of hair, and white with the colour of cotton. Colour is made up of three components:

- Hue
  Hue refers to the traceable distance of the colours waves. Hue consists of two parts of the colour, the primary colour and the secondary colour. There are three main colours in the primary hue, which are red, green and blue. Apart from these colours, all other colours, such as yellow, orange and purple are categorised as secondary hues. Secondary colours are produced from the combination of primary colours.

- Intensity
  The brightness of a colour is determined by the reflection of light from the colour, and this is called the measure of intensity. Intensity is a very subjective matter, and cannot be measured accurately. It can only be expressed as strong, mediocre or weak.

- Density
  The density of a colour is determined by the element of white in the particular colour. The levels of density include bright (light), dark (dense), and dull.

The background contrast also plays an important role in highlighting an object. A bright coloured object with an equally bright background would give a different projection compared to a dark coloured background. As you can see in Figure 2.4, the objects are displayed with different brightness and are placed on backgrounds of different brightness. In your opinion, which object is the brightest and clearest?

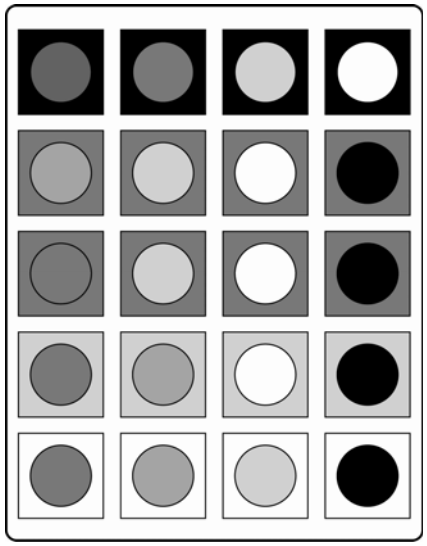

Figure 2.4: Effects of background light towards an object

Colour can also be categorised as 'hot' and 'cold'. Hot colours include red, orange and yellow, whereas cold colours include blue and green. Hot colours tire the eyes easily, whereas cold colours soothe and ease the mind.

Cold colours are best used in hospitals, because, psychologically, they help patients feel calmer. This indirectly helps patients in the treatment process. The use of green on the screens of the operation theatre is to neutralise the red colour of blood, which quickly tires the eyes of doctors or surgeons.

The phenomenon of being colour-blind is a situation where an individual is unable to differentiate between red and green. Thus, both these colours cannot be placed side by side. Due to this reason, the colours red and green are separated by the colour yellow on a traffic light.

All road users who are colour-blind will refer to the arrangement of colours as top colour, middle colour and bottom colour. The confusion about the difference between red and green occurs at all levels of intensities or densities of these colours. A user who is colour blind will never be able to see a warning sign that is coloured pink on a background of light green.

ACTIVITY 2.1

Explain the three components that form colours.

2.1.3 Graphical Representation in Interface

In designing an interface, a good graphic designer would consider certain characteristics when creating an interactive user-friendly environment. Based on your knowledge and experience, what do you think are these characteristics?

You already know that the interface on the computer display is the medium of interaction between humans and computers. A good interface design should have the following characteristics:

- The same objects are maintained, although at different levels;
- Every action should have a response or feedback;
- The interface has the ability to recover from mistakes; and
- The user has control over the interface.

When designing an interface, graphical representation is used to represent real objects on the computer display. These representations help users in developing expectations and understanding the functions of the representation. For example, in Figure 2.5, the representation for the '*save*' operation uses the picture of a diskette, while the magnifying glass icon represents the operation of enhancing the size of a document.

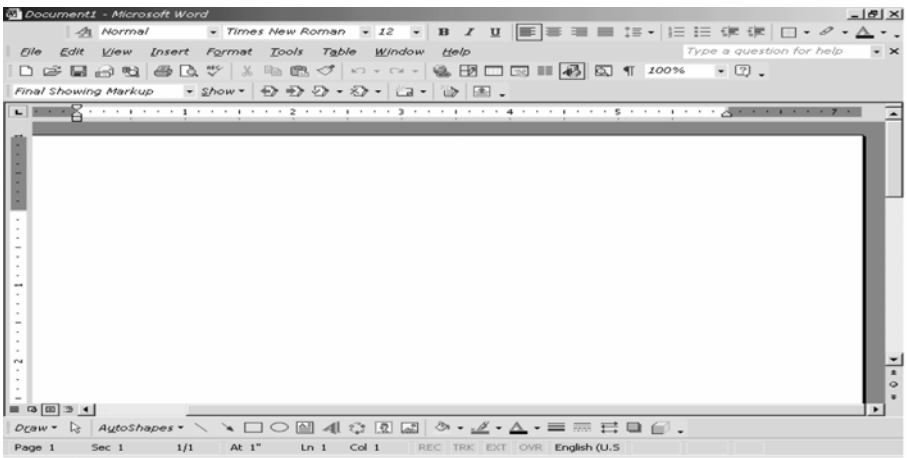

Figure 2.5: An example of a good interface that is easily understood

There are two kinds of pictorial representations - the 2D or two dimensional representation, and 3D or three-dimensional representation. The two dimensional representation is easier than the three dimensional representation. There are a number of tips for drawing a three dimensional representation, which are:

- Size illustrates the distance of same-sized objects from users. Kindly look at Figure 2.6a. The bigger circle seems closer compared to the smaller circle.

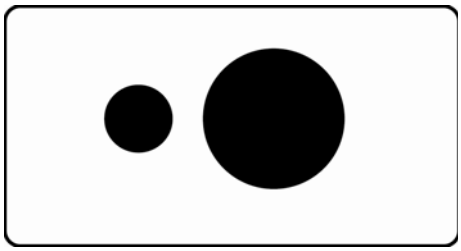

Figure 2.6a: Illustration depicts the bigger circle closer compared to the smaller circle

- Interposition or stacks illustrate an object as being in front compared to the object close to it. Observe Figure 2.6b. You will see the three balls arranged from back to front.

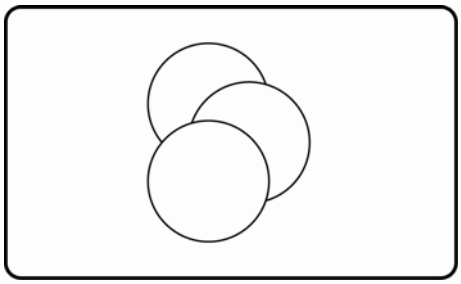

Figure 2.6b: The effects of interposition or stacks towards our vision

- The variation, clarity and brightness of the object's colour will be able to display the differences in distance as shown on Figure 2.6c. The object that is at a further distance appears vague with lesser clarity, and a greyish tint of brightness. The object with the shorter distance appears clear in shape, colour and structure.

Figure 2.6c: The effect of variation, clarity and brightness towards vision

- Shadows make an object seem real, as well as display the relative position of the object compared to other objects, as shown in Figure 2.6d.

Figure 2.6d: The effects of shadows on the position of an object

- The texture of smaller objects existing in larger groups will appear to be vague. Colour and shadows may be of some help. As we can see in Figure 2.6e, the rice in the sack appears as unrefined white powder.

Figure 2.6e: The effects of shadows on object texture

- In animation, we use object movements as an attraction factor. Supposing you are seated inside a car while enjoying the external view through the car window. The objects that are located furthest from your car would seem to be moving slower that objects located nearer to you. This case also applies during the animation of objects. The object located in front would move relatively faster than objects located behind the first object, as seen in Figure 2.6f.

Figure 2.6f: The effect of the distance of object in animation

- Stereoscopic refers to situations where an object is seen as if directed to a single point. Imagine yourself being on street lined with buildings on the left and right, as shown in Figure 2.6g. To you, the buildings and road would seem to converge towards a distant solitary point.

Figure 2.6g: Stereoscopic

2.2 SOUND AND AUDITORY SKILLS

Sound is normally used in computer systems to:

(i) Attract the attention of users;

(ii) Flash warnings; and

(iii) Respond to a certain action performed.

Examples of sounds are voices in conversation and music. Too much sound would only serve as a disturbance to users. Applications that are suited to use sounds as a form of reactive response are as stated below:

- Applications that use sound as a complementary factor of the standardised visual interface;
- Applications that need to be monitored and observed outside their display, such as industrial machines;
- Applications that involve process controls where continuous observation is required;
- Applications for users who are visually impaired;
- Sound is needed as data;
- Animation; and
- Computer games.

Sounds that are normally used as responses include music, scratches, beatings, and shrill and ringing sounds. All sounds that are used should have a distinct difference between one another, and should never be confusing to the user.

Sounds are ideally used to attract the attention of users because humans are more sensitive towards the auditory sense compared to the sense of sight. However, sounds can sometimes be stifling, and of great disturbance.

2.3 SENSE OF TOUCH

People who are visually impaired are normally more sensitive towards touch and auditory senses, as compared to normal people. The sense of touch is hardly used in interaction between humans and computers. The most sensitive part of a human body towards the sense of touch is the fingers.

ACTIVITY 2.2

List down two examples of devices or toolkits that use the auditory sense as forms of interaction.

Figure 2.7: Touch Screen

2.4 DESIGN CONSIDERATION

When designing an interface, the following should be taken into consideration:

- Choice and colour combination;
- Brightness and intensity of display;
- Response type; and
- Arrangement of the information on display;

2.4.1 Choice and Colour Combination

A normal human is only able to differentiate between 8-10 colours. In areas outside the visual focus, the eyes are more sensitive to the colour blue. Blue is suitable to be used as a background colour, especially for large sized displays. The eyes are less sensitive towards changes in blue compared to changes in the colour red. Red is more suitable for warnings, attracting attention or highlighting a particular situation, for example the existence of an error, as shown in Figure 2.8. The combination of red and blue easily tires the eyes because the spectrum of the waves differs greatly with each other. Hot colours such as red and yellow cause an object to appear closer, whereas cold colours such as blue and green cause an object to seem more distant, as shown on Figure 2.9.

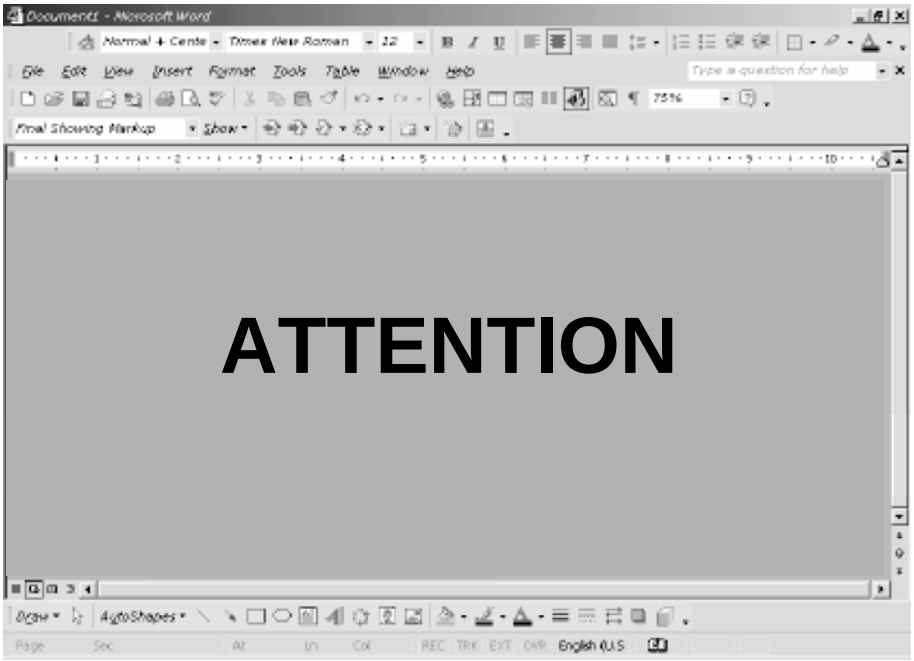

Figure 2.8: The combination of red and blue

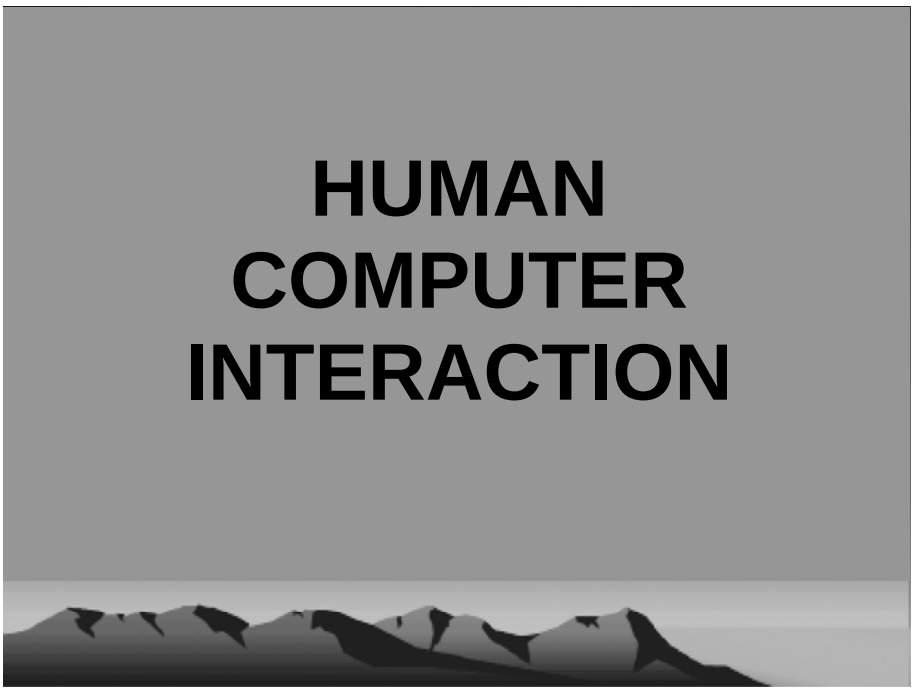

Figure 2.9: The combination of cold colours would make an object seem far

People who are colour-blind are unable to spot the difference between red and green. Thus, it is best to avoid the use of both these colours as display colours when designing an interface. Colour is also influenced by age and culture. Older people are less sensitive to the colour blue. The utilisation of a monochrome display that only uses the colours black and white does not need an interface with multi-colours. Here, the mere intensity of black plays an important role as shown in Figure 2.10. To attract the attention of users, other techniques can be utilised, such as sound, blinking lights and animations.

Figure 2.10: The utilisation of suitable monochrome colours for elderly people

Colour can be utilised in the design of an interface to highlight workspace divisions, or segmentation. You can probably use green as the background to indicate unfinished work, and white to indicate work that has already been evaluated. The accurate utilisation of colours on the interface display would reduce the time needed to look for information as users can easily spot the object, or required information.

Different task scopes can use different colours, as long as they are suitable. One example is a bank account's information management system that is used at the counters, as shown in Figure 2.11. This type of system does not require multiple colours which will only serve to tire the eyes of users who frequently glance at this screen on a daily basis.

Figure 2.11: Monochrome display that is normally used

Different colours can be used in computer games and multimedia presentations as shown in Figure 2.12. Similar to the utilisation of short-cut keys by skilful computer users, multiple colours can also be used to indicate different activities. However, this can also confuse new users.

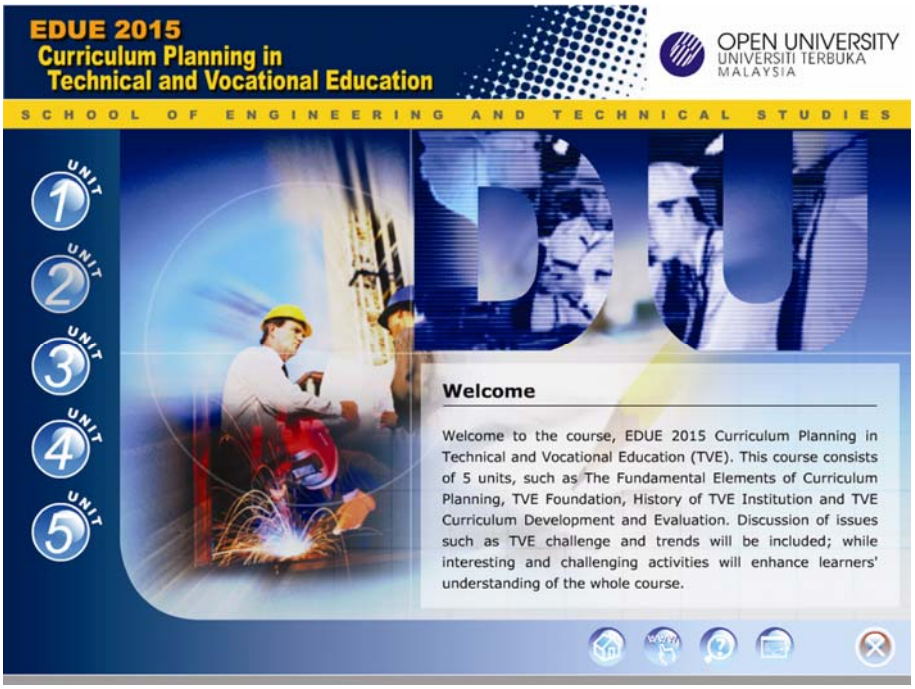

Figure 2.12: Colour diversifications in multimedia presentations

2.4.2 Brightness

A computer display that is too bright causes users to see glares of reflection as shown in Figure 2.13. The reflection is also clearer when it is beyond focus. The bigger the computer display, the clearer the scanning.

Figure 2.13: Examples of computer displays that are too bright

2.4.3 Type of Responses

Response is needed by users to determine the success or failure of an action. An example is the entry of data into the students' information system. If users have accidentally entered the wrong character in the date field, this error will be notified to the students, since date must always be a number. To ensure this, a suitable response is needed, such as ringing the bell to attract the attention of users or notifying users to input the correct date of birth into the field.

Responses are very important to prevent confusion among users, as inaccurate responses would cause users to repeat their mistakes. However, not many people like the utilisation of sound as error indicators, especially when the possibilities of making mistakes are higher, as this would cause the frequency of sound to increase.

2.5 INFORMATION ONSET DISPLAY

The arrangement of information on the interface's display is important to avoid frequent movement of eyes by users while searching for information. As we know, the frequent movement of eyes would cause the eyes to constantly refocus, and this action would easily tire the eyes.

The considerations for designing a system interface design are:

- Does not display too much information on screen.
- Does not display insufficient information on screen.
- Related information is gathered into a single group.
- Meaningful arrangement of information.
- Important information is placed at the main division.
- Less important information is placed at other divisions.
- Inactive divisions are hidden.

ACTIVITY 2.3

Elaborate on the four considerations in designing a system interface.

SUMMARY

- In this topic, you learnt the advantages and disadvantages of the human senses of vision, auditory and touch.
- You also studied the importance of the aspect of visualisation, and the user's sense of auditory and touch of users when interacting with computers.
- This knowledge can be used in designing a system interface.
- Apart from the human factor that involves physical aspects, mental aspects should also be considered when designing an interface. You will learn about mental aspects in Topic 3.

KEY TERMS

Brightness
Colour
Density
Hue
Intensity
Pictorial representation

Topic 3 ▶ Human Factor: Mental

LEARNING OUTCOMES

At the end of this topic, you should be able to:

1. Identify the abilities and limitations of the human memory;
2. Explain the mental model; and
3. Explain the learning process.

▶ INTRODUCTION

In Topic 2, you learnt about the abilities and limitations of the human senses of vision, auditory, and touch. The information obtained from these senses is redirected to the human mind to be processed, before the necessary actions are taken.

This topic will explain how this information is represented in the human memory. Some of this information is remembered for a long period of time, whereas other information is forgotten. How does this happen, and how can we overcome this? It is hoped that you will get these answers in the upcoming topic.

3.1 HUMAN MEMORY MODEL

Most computer applications involve too many steps or instructions that need to be both followed and remembered by users in order to complete a task. This definitely poses as a burden on the users' memory. The human memory has its limitations. Thus, to use our memory to the best of its ability, we need to understand and find ways to overcome its limitations.

The human memory is divided into three parts:

- Sensory memory
- Short-term or work memory
- Long-term memory

3.1.1 Sensory Memory

The sensory memory is the balancer that receives stimulus in the form of:

- Visual stimulus (*iconic*)
- Auditory stimulus (*echonic*)
- Touch stimulus (*haptic*)

Some of the information that has been received will be sent to the work memory for processing, whereas other information would just fade away. The selection of information is done through a process of careful observation. We will discuss in detail this observation in the following subtopics.

3.1.2 Work Memory / Short Term Memory

The work memory is the memory area that is used to process information received from the sensory memory. Its abilities are limited and it can only last for a very short period, approximately between two to three minutes. We can address the work memory as a "scrap paper" that merely stores information needed to process a task or information.

3.1.3 Long-Term Memory

Long-term memory is the memory area that is used to store information for a longer period. It does not have any limitations in storage load. This means that we will be able to remember a lot of information for a long period of time.

However, the "forgetfulness" phenomenon exists due to disturbance caused during the process of accessing the stored information. Sometimes, this phenomenon is influenced by human psychology, causing deliberate forgetfulness to take place.

The information stored in the long-term memory is normally in the state of inactiveness. Thus, it needs to be activated for easy and quick access. There are many existing theories on how information is stored in the human memory. We will discuss these theories in the upcoming sections.

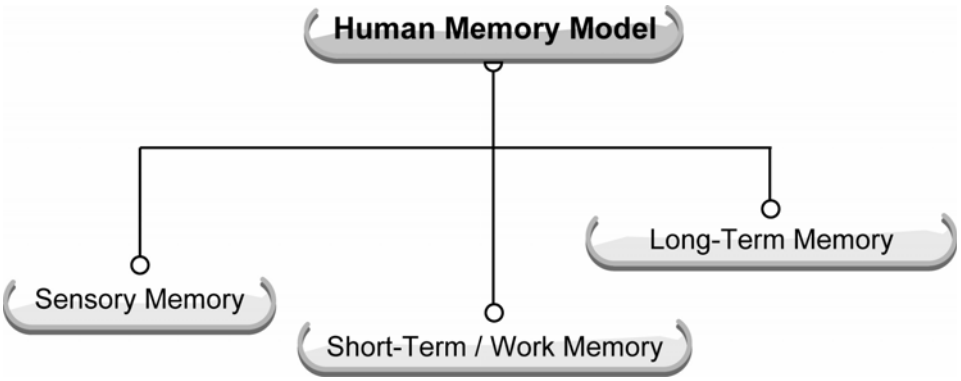

Figure 3.1: Mind-map of human memory model

3.2 MEMORY LIMITATIONS

The human memory has limitations in storage periods. This is one of the causes of the 'forgetfulness' phenomenon. Nevertheless, there exists a number of approaches that can be used to ease our process of remembering, such as:

- Chunking technique – breaking a statement is into several meaningful pieces or 'chunks'.
- List arrangement techniques.
- Thought-centralising techniques

3.2.1 Chunking

The memory theory of 7 ± 2 *'chunks'* was introduced by George Miller in 1956. According to Miller, humans are only capable of remembering 5 to 9 units of *'chunks'* at any one point of time.

'*Chunks'* are a single unit or group of meaningful information. For example:

- The digit – 012620450 is easier to be remembered if it is divided into a few parts to become 012-620-450;
- The word "collect" is easier remembered than "colltce";
- The sentence "This book is red in colour" is easier to be remembered compared to "This red-in-colour book";

ACTIVITY 3.1

Explain the problems of the human memory limitations and steps to overcome them.

You can refer to the title "*The problem with the Magical Number 7 plus or Minus 2*" in the book "**Interaction Design**" by Jenny Preece, Helen Sharp and Yvonne Rogers, 2002, John Wiley and Sons.

3.2.2 The Effects of Primacy, Recency

ACTIVITY 3.2

You are given a list of items to be bought. Try memorising this list of items in one minute, then rewrite this list without referring to the original. The items are brown sugar, rice, cooking oil, coffee, condensed milk, Milo, flour, instant noodles, Nescafe, Tom Yam Extract, soup, and a can of cooking gas. Now, close this book and try to rewrite this list.

Well, try again with this next list. 1kg of brown sugar, 10kg of *Super Jasmine Siamese Rice*, 1.5kg of *Seri Murni* Cooking Oil, *Kapal Api* brand of coffee, 5 tins of F&N condensed milk, 1kg of Milo Tin, *Adabi* soup, and a 14kg Petronas gas tank.

Which of these lists is easier to be accurately remembered?

When memorising a list of information (words), the primacy and recency effects make it easier for the information to be memorised and remembered.

The '*primacy*' effect.

- This is the effect of information being located at the beginning of a list.
- The information or word that exists at the beginning of a list is easier to remember because humans normally start the process of memorising from the beginning of the list.

The '*recency*' effect

- This is the effect of information being located at the end of a list.
- The information that is located at the end of the list is much easier to be remembered because of its existence in the work memory.

The '*closure*' effect

- This is the phenomenon of relaxing our concentration upon the completion of a given task.
- It is important to reduce the burden of the human memory.
- The user can forget all information that was needed to complete the first task, and start focusing their concentration and memory on the second task, which would be the newer task.

We must consider all three effects mentioned above in the process when designing the interface of a new computer system. In any interface, the response to mark or certify the success or completion of a particular task is very important.

3.2.3 Centralisation of Observation

The centralisation of thoughts on a single subject rather than a number of simultaneous subjects is more effective, especially by discarding all unnecessary entities.

Divided attention occurs when humans try to concentrate their thoughts on more than one subject at one time. Normally, attention is divided only between two matters.

The process of dividing attention would be successful if one of those tasks was an automated task that did not require any form of control. For example, consider someone who is chatting while walking. These are two actions that are being done simultaneously, as the process of walking does not require any form of control because it happens automatically.
However, actions that require attention, such as chatting and reading, cannot be done simultaneously, although there are some tasks that can be done automatically after much practice, such as chatting while driving a car.

A good interface is able to help users centralise their thoughts on a single task at any one point of time. All other subjects are categorised as secondary tasks that have to be controlled by the computer system. However, the computer system will only shift its attention if there are other tasks that require more attention from users. Sound can be used as an interesting approach to attract the attention of users because sound attracts more attention compared to images.

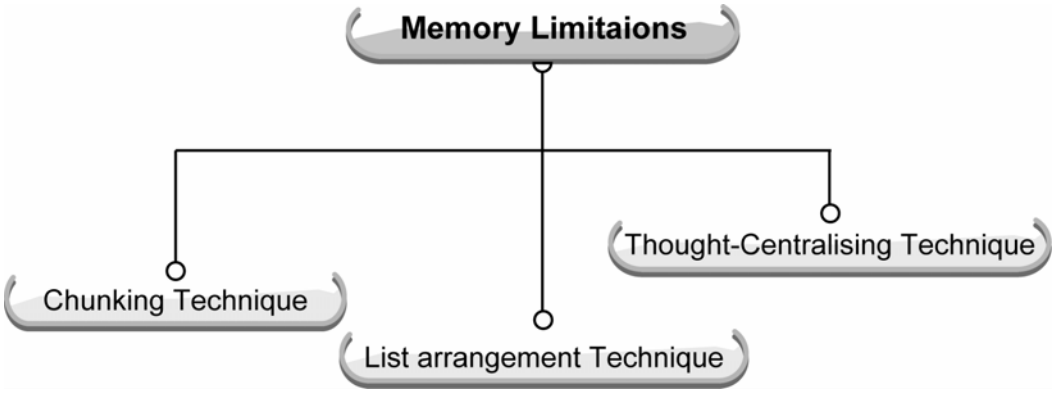

Figure 3.2: Mind-map of Memory Limitation

3.3 MENTAL INDUSTRIAL RELATIONS PERSPECTIVES

In the human memory, knowledge is arranged in a very systematic and structured manner. Knowledge is stored in three forms of representations:

- **Analogical representation,** that is, representation in the form of images such as an apple. When the word apple is mentioned, the image that crosses the mind is the shape of the apple, and not the colour or taste.
- **Statement Representation,** that is, representation in the form of a statement.
- **Distributed Representation,** that is, representation in the form of nodes that are connected to a network.

3.3.1 Mental Model

- This is a behavioural and characteristic model of a system that was developed by humans based on their individual understanding.
- It is built dynamically. It is very important to predict the system's characteristics and responses before executing a task.
- It may be imperfect, unstable, confusing and influenced by beliefs and not scientific facts.
- It is not the same as a real model, and this may cause mistakes to happen.

Mistakes during the usage of a system can occur because of two issues:

- The development of an incorrect mental model; and
- Changes in the tasks that are normally executed.

There are two kinds of mental models:

(a) **Structured Type**

- It describes how a system or device tool functions structurally.
- It is used to predict system responses due to user actions.
- It is normally not required when using toolkits that are utilised daily.
- It is difficult to be used, but easy to be expanded.

- For example, a mechanic needs to understand the structured model of a car whereas a driver does not need to know this.

(b) **Functional Type**

- It describes how to use a system or a toolkit.
- It is developed based on the similar systems' domain knowledge.
- It cannot be used to answer unpredictable questions because it only focuses on specific tasks.
- It depends on context and is easily usable, yet tough to be expanded.
- For example: A calculator that is easily usable.

An interface needs to be developed in order to help users produce/ form a mental model of the related aspects of a system.

ACTIVITY 3.3

Compare and differentiate two types of mental models.

3.4 LEARNING PROCESS

The success of the system depends on the depth of difficulty that is faced by users to study and use the system. Learning is a complex process, thus a good system needs to help users in the process of learning. It is normally assumed that users are able to learn everything from documentations and guidance books. But, in reality, not many users refer to these guide books or documents.

The findings from the research of Mack.*et.al* (1984) about the problems faced by users in the process of learning a new system were:

- Learning is a tough process. Users take a long time to learn, and are easily disappointed and always blame themselves for their slow learning ability.
- Users to not have sufficient basic knowledge, and do not understand the jargons used.
- Users make their own assumptions and 'ad-hoc' interpretations. Users normally make the wrong assumptions.
- Users utilise their previously gained knowledge.

- Users do not read and follow instructions well.
- Problems are interrelated to one another.
- Interface features that are not clearly defined draw confusing responses.
- The guide books provided are not helpful. Users do not know what to look for because the help provided is too general.

For example, when learning the word processing system, users try to relate this with the experience of using a typewriter. However, there are many differences between these two learning processes, among them the usage of backspace.

Novice or new users refer to inexperienced users using a lot of existing analogy and knowledge when utilising the new system. Through the process of continuous learning, anyone can be more skilful. A good interface design should be able to help novice users to be skilful in a short span of time.

ACTIVITY 3.4

Mack.*et.al* (1984) conducted s research on the problems faced by users in learning a new computer system. Explain the problems faced by users.

SUMMARY

- Previously gained knowledge always helps users in the process of learning a new system.
- This newly gained knowledge greatly aids the learning of upcoming systems.
- This topic is important because it allows you to understand the way users think and learn.
- This information can then help you to design a system that is able to help users to easily use a system.
- In Topic 4, you will learn about the social aspects of communication.

KEY TERMS

Auditory stimulus
Chunks
Closure effect
Primary effect
Recency effect
Touch stimulus
Visual stimilus

Topic 4 ▶ Social Aspect

LEARNING OUTCOMES

At the end of this topic, you should be able to:

1. Explain human communication and the problems faced during communication;
2. Explain the importance of the social aspect in our daily lives; and
3. Differentiate between cognitive analysis and social aspects.

▶ INTRODUCTION

In the previous topic, you studied the cognitive aspects of an individual during the process of communication. In this topic, the social aspects involved in the process of communication will be explained in detail.

4.1 FACE-TO-FACE COMMUNICATION

From the perspective of technology development, face–to-face communication is the most basic and primitive communication method. Usually, communication involves the interaction between two or more parties at one time. The communication between two parties is the simplest mode of communication. In fact, it is also easy to determine whose turn it is to speak, as one person would be listening while the other is speaking.

However, in face-to-face communication, you would not be merely listening to his/her voice, but would also be able to watch the individual's facial expressions, voice intonations, back channelling ('uhh', 'ummm' sounds), body orientation and some of their body language. From this observation, you would be able to

guess if that individual is comfortable/uncomfortable with the communication session that is being conducted.

Communication that involves more than two parties is more complex, and this complexity increases when the number of involved parties increases. In this situation, the problem that arises is the effectiveness of the communication, due to the existence of multiple conversation queues at one time.

In a formal gathering such as a meeting, the rules would be preset where a chairman will control the discussion being conducted. This form of control does not occur during an informal gathering. The conversation turns can overlap and many two-party communication groups may also exist at the same time.

Currently, there are many systems of technology that support the social interaction process. An example is the telephone that is used for communication between two parties. Other devices such as telephone conferences, video conferences and email can also be used to support interaction between various parties.

4.1.1 The Effects of Transition

When the communication era moved from primitive communication method to the computer technology method, what actually changed was the media of communication and not the methods of communication. For example, we always speak on the mobile phone with the inclination that our friend is standing in front of us. Without realising it, our hands would automatically move to indicate some form of action that cannot be seen by our friend.

This is also the case during face-to-face communication where we try to determine the best distance for effective communication. If we want to converse about confidential matters, we stand closer to our friends to ensure that only he/she is able to grasp the information. On the contrary, for matters that are non-confidential, we are not too concerned about the distance.

This action has become a norm that is beyond our control, so much so, that during a video conference, we would try to determine the distance between ourselves and our friends instead of ourselves and the camera.

4.1.2 Eye-Contact Unitary Perspective

Eye-contact is a language of the eye that never betrays our true feelings. By looking at the students, a teacher would be able to know if that particular student is concentrating in the class, or not. Eye-contact is widely used during the

usability evaluation process (we will study this in topic 3). With the latest technology, videos are able to record the eye movements (or eye-contact) of any individual, and this can be clearly seen on the observer's display to determine if the users are feeling confused, bored, etc.

4.1.3 Body Language

The use of body language in face-to-face communication is to show reaction or response during interaction. This reaction can be positive or negative. Normally, body language occurs on par with eye-contact.

4.1.4 Turns

Conversation turns does not adhere to any standardised rules. As mentioned earlier, the communication between two parties has simple turns of conversation, but this is not the case during communication between multiple parties. As all parties are able to converse simultaneously, the environment would become very noisy causing the lack of concentration among the individuals. On the contrary, if only one person speaks at a time, communication would be very effective as the other people involved in the conversation would be listening attentively. This case also applies to telephone and video conference, where there should be a preset rule to ensure that at any one point of time, only one person is speaking.

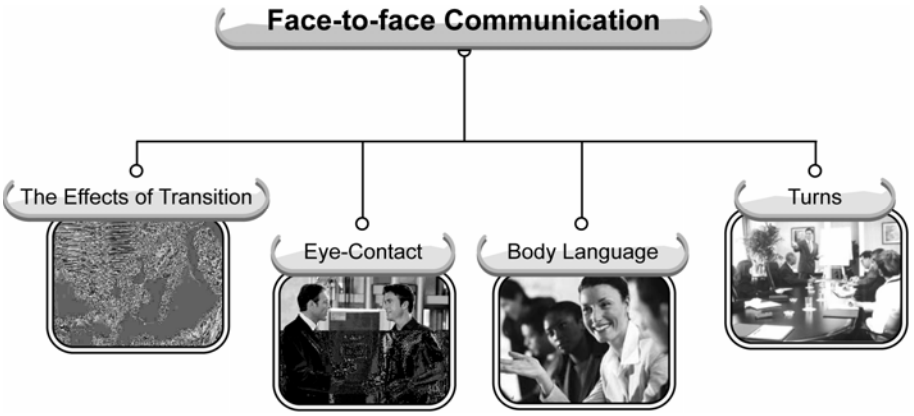

Figure 4.1: Face-to-face communication

ACTIVITY 4.1

Compare and differentiate communication between two parties and among multiple parties.

4.2 CONVERSATION

Conversation is always referred to as interaction or communication between two parties, but in actuality, it covers a wider context, ranging from informal telephone conversations to formal interrogation sessions in courthouses.

4.2.1 Context

All conversations solely depend on their context. With prior knowledge of the situation and social relationship of the participants in the conversation, it would be difficult to understand the contents of the conversation.

The context of a conversation can be divided into two types:

- **Internal Context,** which depends on previous conversations.
- **External Context,** which depends on what is happening during the conversation.

4.2.2 Focus and Topics

Each of the participants in a conversation should focus on the topic of conversation. The process of focusing is very important in achieving a conclusion at the end of the conversation, even if there is no following action.

4.2.3 Back Channels and Distortions

One of the main causes of communication distortions is due to the lack of focus on the discussion topic as well as participants who are unable to understand the message being delivered. Normally, these distortions are expressed in the form of back-channels or facial expressions, such as a confused look or wrinkling of the forehead. However, humans are smart enough to handle this problem, by repeating their statements to ensure understanding.

4.2.4 Understanding

To achieve a mutual agreement in a communication, both the process of focusing and understanding are equally important. All parties involved in the communication should be able to understand what is being said and being explained by the other parties. As an example, refer to the excerpt of a conversation below. This conversation is via telephone between a five-year-old child and an officer from the 911 emergency division unit (excerpt from a television series).

Child : I'm looking for my house but I can't seem to find it!
911 : Where are you now?
Child : At the telephone booth.
911 : Do you see any shops or houses?
Child : There are many houses but there are no shops.
911 : What coloured clothes are you wearing?
Child : Green, Red, White, Blue.

In your opinion, did the child understand the questions posed by the officer? If you are the officer, would you trust the child? Would you be able to find the child?

4.2.5 Analysis

Having understood the contents of the conversation between your and you, you would then try to analyse his/her words and decide on the next step of action. If your friend had said "I'm hungry…Have you eaten?" you would have understood that your friend was inviting you for a meal. Your friend did not directly ask you out for a meal, but he implicitly mentioned his hunger. If you had answered "No, I have not eaten", most definitely your friend's next statement would have been "Shall we go and eat?" The second statement was to strengthen the first statement. This time, he/she was directly asking you out.

For further reading about the analysis of conversation, kindly refer to the topic "Speech Act Theory", page 524 of the book "Human-Computer Interaction", written by Alan Dix *et.al.*, 1998 Pearson Education.

4.3 TEXT-BASED COMMUNICATION

Group-based asynchronous communications are normally conducted in text forms. Text-based communication varies from face-to-face communication in terms of how the meaning is delivered. Face-to-face communication is a combination of voice intonation, facial expressions, back channels, and a number of body languages. These characteristics do not exist in text based communication.

There are four types of group-based textual communication, which are:

1. **Discrete communication** refers to direct messages such as email, which merely involves the relationship with the previous message. At times, there are chain messages that revolve around the same topic.
2. **Linear communication** refers to attachments.

- **Non-linear communication** refers to messages that are connected from one to another using hypertext.
- **Semi communication** refers to a message that has been arranged into two parts. The topic of discussion refers to one of these parts.

Look at page 529, refer to the *York Conferencer* system interface picture as an example of semi-textual communication, in the book entitled "Human-Computer Interaction", by Alan Dix.et.al,1998, Pearson Education.

The text communication participants should make their statements as clear and complete as possible as text communication does not have characteristics such as voice intonation, facial expressions, back channelling, and body language. The usage of back-channels can also be included, but the effects will not be the same as it is with voice communication. Look at the example of an email message below:

>>What is your contribution towards your religion, race, and country?
>> Because of you, Malaysia. Happy Independence Day!!!!!
>
> I do not want to beat my chest any longer.
>
ishhhh … is it too much?

The symbol '>' indicates the reference to the previous statement. How do we make the sound for "isshhh" and what is the meaning of it? This is an example of the linear textual communication because the topic of discussion is attached in the conversation.

There are also some writers who use symbols to express the way they feel (anger, sadness, confusion, etc.) such as:

:-) ☺ indicates liking
:-(☹ indicates anger, and sadness

ACTIVITY 4.2

What are the limitations of textual communication compared to face-to-face voice communication? Please elaborate on your answer.

4.4 ORGANISATIONAL ISSUES

When designing a system to support group communication in an organisation, there is a number of issues that need to be taken into consideration. Among them are:

- Determining the users and the individuals who benefit from the developed system. The users may not be receiving the benefits. For example, the Personal Organiser system is used by the company secretary but the benefits are gained by the company head.
- Are they used optimally? An example is the usage of a video conference. If many users are silent, the usage is not cost-worthy. Thus, all users are encouraged to voice out their opinions.
- The problems during its initial stages of use. The introduction phase is the toughest phase as most people would not be brave enough to use the system and would rather wait and watch its implementation. They would only start using it once the system is stable. For example, mobile phones that have now become a necessity for everyone.
- Varying objectives of individuals in an organisation.
- Change of management, share holders, etc.
- Workers that do not have a fixed position in an organisation.
- Determining the workflow between individuals of an organisation.

SUMMARY

- The social aspect equally contributes towards development of technology especially in group work.
- Upon understanding these aspects, it is hoped that you will be able to make due consideration during the process of designing the system.

KEY TERMS

Back Channels
Body langguage
Conversation
Distortions
Eye-contact
Face-to-face communication
Turns

Topic 5 ▶ Input Technology

LEARNING OUTCOMES

At the end of this topic, you should be able to:

1. Explain the characteristics, strengths and weaknesses of existing input devices;
2. Apply your understanding of user characteristics, work, and the environment when choosing the most suitable device and technique; and
3. Analyse the effects of the latest input technology on the design of a system.

▶ INTRODUCTION

The input technology refers to the technology and tools or devices that are used to transform data type provided by users to data type that can be processed by the computer. Examples of input devices that are usually used are the keyboard, mouse, joy stick, and track balls.

As we earlier, a good system should be safe, effective, efficient, and comfortable for usage. To ensure this, the selection of technology to be used in the interaction between humans and computers should be done carefully, as the input device used may not always be suitable to the existing physical conditions or physiology of users. A simple example of this scenario is that of a shopkeeper having an injury to his right hand. He would have difficulties is using the keyboard to key-in the transaction of his business as he is only able to use his left hand.

Table 5.1 below illustrates the four factors that may influence the suitability of certain input devices used by the system.

Table 5.1: The Four Factors that Influence Suitability of Input Devices

Factors		Examples
1.	The physiological and psychological characteristics of users.	An individual who is visually impaired is unable to use the normal keyboard or mouse.
2.	Training and skills of users.	An individual who does not have any experience in using the joystick may face difficulties in using it.
3.	Implementation of tasks.	Drawing cartoon characters using a mouse is not as suitable as using a stylus pen.
4.	Work and its environment.	A mobile phone user who wants to call his friend via voice recognition is unable to do so due to a noisy environment.

Thus, before selecting an appropriate device, it is important to reconsider all the four factors mentioned above.

Each input device that exists in the current computer systems has its respective criteria that vary from one another, where one criterion might be suitable for some situations but not for another. To address this problem, this topicwill discuss the strengths and weaknesses of the input devices mentioned above. From this discussion, you should be able to choose a suitable device for the system that you have planned to develop.

5.1 HCI GOALS

The keyboard is one of the earliest devices used in computer systems. There are many variations of keyboards that have been produced over the years, differing in design and key arrangements. Each of these variations depends on some specific purpose. Let us now look at the variations of these keyboards.

5.1.1 QWERTY Keyboard

This design was developed by Scholes in the year 1874, to be used on mechanical typewriting machines. By using a hinge, each key on the typewriter was connected to a subsequent alphabet mould. When the key was pressed, the hinge would hit the alphabet mould onto a carbon cloth. This action would then form

the alphabet on the paper. Unfortunately, this design caused the overlapping of keys when neighbouring keys were hit nearly simultaneously and quickly, as well as caused these keys to get entangled with one another.

The design that was suggested by Scholes was meant to reduce the incidence of overlapping keys. The alphabets that are frequently used were placed further from each other. For example, the alphabets 's', 't', and 'h' frequently exist in the English language. Thus, the alphabet 't' was placed on a different row from alphabet 's' and 'h', whereas 's' was placed three keys away from 'h'

Figure 5.1: An example of the QWERTY keyboard

This keyboard was also called the 'QWERTY' keyboard based on the arrangement of alphabets on the left side of the keyboard, on the first row. This design is used on electric typewriting machines and computer keyboards until today.

Although the 'QWERTY' keyboard extensively uses the English word pattern, why do you think we use the same keyboard design in Malaysia?

5.1.2 DVORAK Keyboard

The keyboard created by Dvorak was believed to have a better design compared to the 'qwerty' keyboard. This keyboard was patented in 1932, and was said to be able to increase the speed of typing. It was based on the following principals:

(i) The frequency of using each alphabet, pattern, or sequence of alphabet in the English language. The alphabet that was most frequently used was placed in the middle row as the position of the fingers would enable quick access to this row.

(ii) All vowels and consonants that are frequently used were placed in the middle row as 70% of the alphabets used were placed on this row.

(iii) The intermittent use of the left and right fingers. Thus, on the second row, the vowels were placed on the left and consonants on the right.

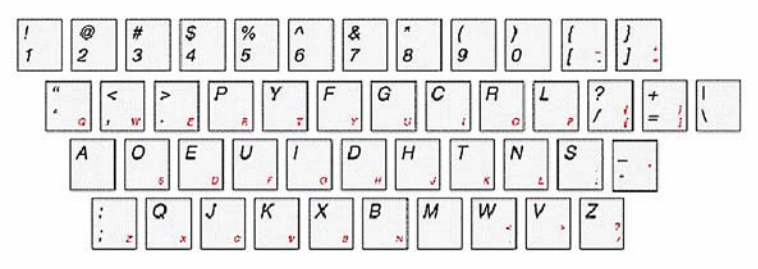

Figure 5.2: An example of the DVORAK keyboard

Apart from having the ability aid quick typing, this keyboard was also able to reduce finger movements, consequently reducing the feeling of tiredness from the fingers. Subsequently, this also helped increase the accuracy in typing.

Although the DVORAK keyboard could increase the speed of typing, its commercialisation was less successful. This was because the use of the QWERTY keyboard had expanded so widely that the shift in technology was quite impossible to be implemented. Most parties were hesitant to invest a large sum of money to train their employees, and purchase the new keyboard.

However, it did not mean that the efforts and research that had been done to increase the efficiency of the machine and computer usage just went to waste. The most important consideration was the ability to understand human and technological factors that might influence the success of a product.

5.1.3 Chord Keyboard

The Chord keyboard differed from all other existing keyboards, because it only had (4/5) keys. An alphabet was formed by simultaneously hitting on one or more keys.

Strengths:
The small size of the keyboard made it conveniently portable, and it could be used single-handedly. Thus, it did not require a big space for storage and during use.

Weaknesses:
The user's hands would tire easily compared to using other keyboards because of the need to hit a number of keys simultaneously to produce an alphabet, subsequently causing the process of typing to become slower.

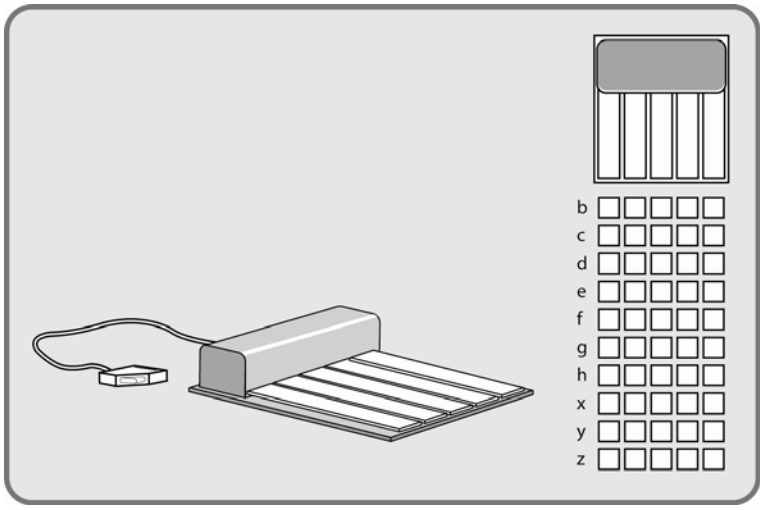

Figure 5.3: An example of the Chord Keyboard

5.1.4 Other Keyboards

There are a number of other keyboard designs, such as:

(a) **Alphabetic Keyboard**

- Arrangement of keys based on the sequence of letters from A to Z.
- Intended to help inexperienced users with their typing exercises.

  However, research showed the time difference between the 'QWERTY' keyboard and this keyboard was not very significant.

(b) **Natural and Ergonomics keyboards**

- Considers the characteristics of the tool based on ergonomics experts.
- Curved shape of the keyboard is said to support the positioning of users' fingers.
- There is also a location for users to keep their wrists below the keyboard.

The characteristics of natural and ergonomics keyboards are meant to reduce the effects of strain on our wrists as well as repetitive-strain injuries.

Figure 5.4: An example of the Natural Microsoft keyboard

5.1.5 Special Keyboards

Apart from being used for alphabets and symbols, a number of special keys on the keyboard are also used for formatting purposes. For example, the keys 'ENTER', 'CAPS LOCK', and 'NUM LOCK' are designed to be of a bigger size compared to other keys to enable them to be distinguished from other alphanumeric keys. Some keys also have lights to display their status on the keyboard.

There are two kinds of numeric key arrangement designs. In the first design, the numbers are arranged in the ascending order, as designed on telephones where the numbers 1-2-3 are on the first row. In the second design, the numbers are arranged in the ascending order as designed on a calculator, where the numbers 7-8-9 are on the first row. Research conducted proves that the first design is better than the second design. However, the key arrangements on the keyboard are based on the calculator.

There are other keys that are designed to perform special functions as well. The labels for these keys begin with the letter 'F' followed by different numbers, such as F1, F2 and so on. These keys enable users to complete their tasks in a speedier manner. These can also be arranged in different layouts, among them are in the form of 1 X 12 (all in a single line), 3 X 4, and 2 X 5.

The cursor on the screen can be moved using the arrow keys on the keyboard. There are four arrow keys that represent four types of movements - upwards, downwards, to the left and to the right. There are various arrangements and displays of these arrow keys, where some are in the form of T while others in horizontal positions. These variations can be viewed in Figure 5.5 below:

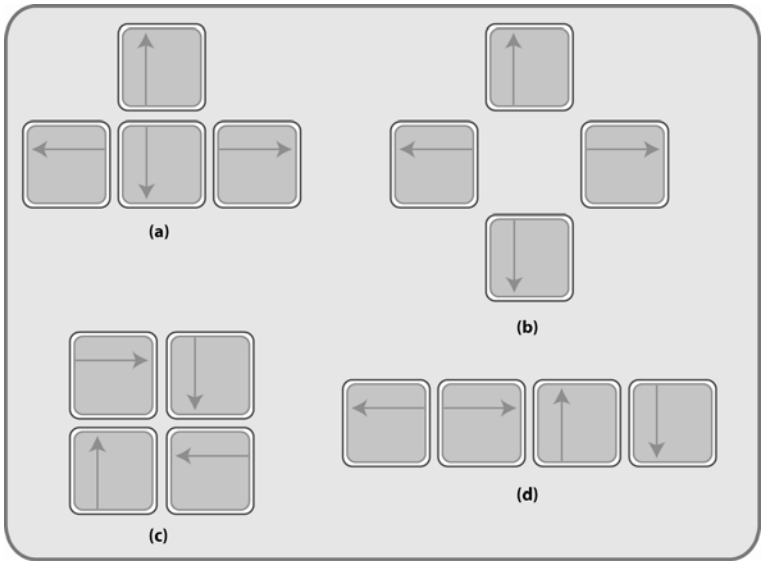

Figure 5.5: An example of the arrow key arrangements

The most popular design is in the shape of a 'T' (Figure (a)), because users do not have to move their fingers too far from one another. The arrow key that is placed in the middle is the central key, where users merely have to move their fingers around this central key to access the surrounding arrow keys. The second design (Figure (b)) is found to be more suitable for new users who are inexperienced in the usage of keyboards. The arrangements are in line with the movements, and this enables users to choose the appropriate keys quickly.

Apart from the arrangements of these keys, the texture of the keys' surface also influences its usability. In earlier designs of the keyboard, the surfaces of the keys were more slippery than it is on the current ones. These changes were made to avoid the effects of reflection as well as to prevent the users' fingers from slipping off the keyboard.

An important factor in ensuring the quality and accuracy of user input is the response that is given by the device upon input. If you had the opportunity to use the initial IBM keyboards, you would have noticed its differences compared to current keyboards. The current keyboards are more supple when pressed, and produce a soft 'click' sound as a form of response. On the contrary, the earlier keyboards produced by IBM were not as flexible, with a smoother surface where users had to press the keys with more force due to the hardness. At times, users had to press the same keys repetitively to ensure that the input was received by the computer. Additionally, there was a lack of response from the keyboard to acknowledge input from users.

However, these older IBM keyboards were more durable than the existing keyboards. Thus, there may be a possibility of these keyboards still being used in environments that require their characteristics.

ACTIVITY 5.1

Explain the purpose of using the 'QWERTY' keyboard design compared to other designs.

5.2 INPUT DEVICES

The display activity is one of the most important aspects in the interaction between humans and current computer systems. Users are able to view and manipulate the items that are displayed on the screen by using the input devices. The following subtopics discuss a number of input devices that are currently being used. Among the most popular input devices are the mouse, joy stick, and track balls.

5.2.1 Mouse

The mouse is a small sized device that can be held within the palms of a user. There are two types of mouse:

(a) Mechanical Mouse

- Normally contains a small heavy ball that is placed inside its housing.
- When the mouse is moved on a surface, the ball inside it rolls.
- The spinning of the ball is traced by the roller which interprets the changes in directions and distances between each spin into vertical or horizontal movements.
- This information is sent to the computer, which then controls the cursor movements on the screen.
- Any movement of the mouse is reflected on the screen.

(b) Optical Mouse

- Requires a special pad with a metallic grid pattern on its surface.
- The light that is produced from the bottom of the mouse is reflected by the metallic grid pattern, which will interpret the information to the x and y coordinates.

There are two kinds of actions that can be performed with the mouse - the single-click and double-click. The type of operation performed depends on the number of existing buttons on the mouse. Some mouses have a single button, like those used on Macintosh machines, while others have two buttons as used on personal computers, or three buttons as used on Sun work stations.

Figure 5.6: An example of a group of mouses with 1, 2 and 3 buttons.

Apart from the mouses that are operated by hands, there are also mouses that can be operated by legs. In this case, the position of the cursor depends on the location of the mouse that is being pressed. If the left-side of the mouse is pressed, the cursor would move to the left; if the top-side of the mouse is pressed, the cursor would move to the top. However, this device is rarely found due to the difficulty in using it..

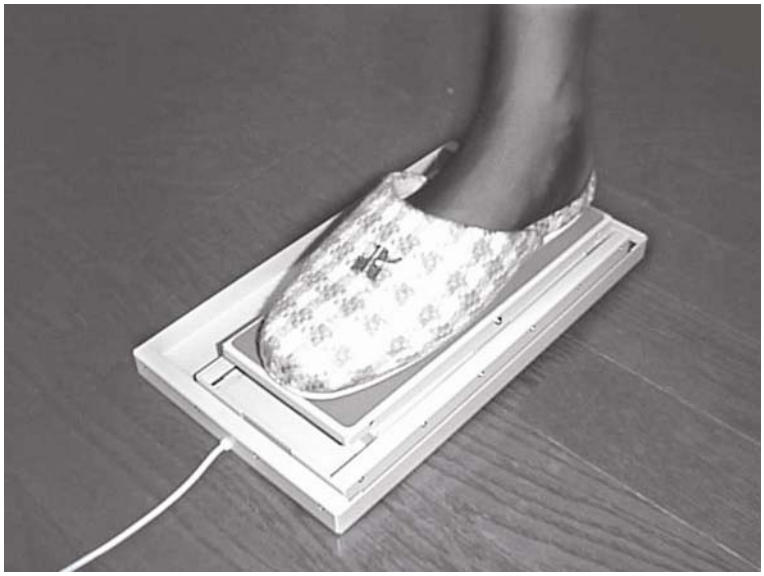

Figure 5.7: An example of a foot-mouse

5.2.2 Joystick

The joystick consists of a box with a lever protruding upwards which can be held by the hands. To move the cursor on the screen, users have to move the lever to the front (upwards cursor), to the bottom (downwards cursor), to the left and to the right.

Figure 5.8: A sample of the joystick

The joystick is a durable apparatus, and it is suitable to be used for computer games.

5.2.3 Touch Screen

ACTIVITY 5.2

Imagine this scenario. You have been required to develop a kiosk machine that can be used to send emails. This machine is to be placed at the Kuala Lumpur International Airport (KLIA) for public use. What is the most suited input device, and how would users utilise this device to send their email?

The touch screen enables users to point and select the appropriate objects on the screen. Input is received by sensing the presence of users' fingers, or stylus, on the screen.

The use of touch screens enables simple and speedy interaction. Touch screens are also intuitive, making it suited for use by the public. This is the reason for the extensive use of touch screens at kiosk machines or ticket purchasing machines. An example is the Putra-LRT ticket purchasing machine.
However, touch screens have a number of disadvantages, such as:

- Fingers tend to leave traces of oil on the screen.
- It is very tiresome for the hands. If users are required to raise their hands and point to a screen that is positioned vertically for a long period of time, they would most certainly feel tired. Ideally, the touch screen should be placed at a 15 degree incline from the horizontal line, and not placed vertically. To enable users to touch the screen, touch screens should also be placed at a distance of one meter away from the users. A shorter distance may be too close for comfort.
- The unsuitability of selecting objects of a smaller size compared to the size of the users' fingers. Thus, is unsuitable for use in high accuracy tasks, such as drawing.

However, technological developments have enabled research to be conducted in producing high-precision touch screens. These touch-screens are still unpopular in the market due to their costliness.

5.2.4 Light Pen

The light pen uses the same principals as the touch screen, where users are able to point and select the appropriate objects from the screen. The only difference lies in the sensory of the device or tool that is being used to point and select the appropriate objects, in this case, a light pen.

Figure 5.9: An example of the light pen

The light pen is connected to the screen via a cable. The presence of the light pen is sensed by the light that is reflected off the pen. This reflection is sensed by the phosphor layer on the screen. Thus, the light pen is able to point to the accuracy of a single pixel unit. Compared to the touch screen, the light pen is more appropriate for use in tasks that require high degrees of precision, such as drawing and selecting small-sized objects.

However, the light pen has its set of disadvantages, which are:

- The selection process on the screen can be tiring to the users. To avoid this problem, a suitable screen position should be taken into consideration.
- Easily damaged and lost.
- The activity of pointing to the screen may cause a part of the screen to be obstructed from view. This applies to both the touch screen as well as light pens. It may cause difficulties especially when carefully selecting an object or during quick movements. Thus, the light pen can only be used for tasks that do not require a lot of selections to be made.

5.2.5 Track Balls

A track ball can be likened to an overturned mouse. The heavy ball is placed at the top of the housing. The physical shape of the track ball enables it to be placed on the keyboard, such as those placed on current notebooks.

Figure 5.10: An example of a track ball

To move the cursor, the users have to rotate the ball. This rotation is sensed and interpreted into *x* and *y* coordinates on the screen. Compared to the mouse, the track ball requires a separate button to enable users to click and make their selections.

The track balls exist in many different sizes and shapes. Some are as big as a golf ball, whereas others are shaped as buttons as small as 7mm. Track balls are compact input devices suitable to be used on small-sized computers such as notebooks.

However, its usage may be limited because of operations that involve lengthy long distance movements.

ACTIVITY 5.3

Explain three disadvantages of using the touch screen.

5.3 INPUT DEVICES IN 3D DISPLAY DEVICES

A 3-Dimensional environment requires more complex interaction and exploration techniques compared to a 2-Dimensional environment. The movement in a 3-Dimensional environment could require up to six degrees of movement. Thus, the device that is used should also be suited for this situation.

The virtual reality environment is an example of the 3-Dimensional environment. Among the input devices that are used as an interaction medium between the users and environment are data gloves and virtual reality helmets.

5.3.1 Data Gloves

Data gloves are made from Lycra fabric that contains fibre-optical stripes along the length of each finger. These fibre-optical stripes trace the curves between the joints of each finger. When the fingers are bent, the fibre-optical stripes will also bend and this information will be sent to two sensory devices at the end of the glove. This device also senses the rotation of wrists. A combination of both these information is interpreted into a 3-Dimensional position.

Figure 5.11: An example of the data glove

The data glove is easy to use, and is very beneficial because it is able to produce a large 3-Dimensional environment in a very short span of time (10 pieces of information from the angle of the bent joint coupled with 50 wrist rotation degrees per second). This device has high potential in gesture-recognition technology and sign language interpretation.

5.3.2 Virtual Reality Helmet

The virtual reality helmet has two main functions:

- Displays a 3-Dimensional environment to the users, and
- Enables the tracking of head movements.

This information about the movement of the users' head is related to the output that is produced by the helmet. A different perspective of view would be displayed to the users, depending on the direction of the head movement.

Figure 5.12: An example of the virtual reality helmet

5.4 DEVELOPMENTS IN INPUT

You would have noticed by now that all input devices discussed require the visual abilities of users. This would mean that users with visual impairments would find it quite impossible to use these devices. As a solution to this issue, we will now discuss a number of alternative devices that does not solely depend on visual abilities.

5.4.1 Voice Recognition

Voice recognition technology would be very beneficial if it were made a reality. However, its implementation has been very difficult to date. Among the problems faced are:

(a) Noisy backgrounds.

- Voice recognition technology should be able to differentiate between voice instructions and background noises.
- With the existing technological limitations, the implementation of this process has not been successful. Thus, this technique is only suitable for use in a quiet environment. This indirectly limits the usage of this technique to certain applications.

(b) Inability to identify languages of different accents.

(c) Only systems that do not involve sensitive data can use this technique. This is because safety and confidentiality of the information have to be taken into consideration.

(d) From a normal user's perspective, the process of giving instructions using voice requires a lot of mental effort compared to using hand-and-eye coordination.

However, this technology could still be used as an alternative in special situations that do not allow the usage of the keyboard as an input device. Examples are the telephony information system and application and the system that is used by users who are visually impaired.

5.4.2 Handwriting Recognition

Writing is an activity normally done by the users. Thus, interacting with computers by using handwriting is an interesting idea and approach.

However, there are a number of limitations in using this technique, such as the difficulty faced by the computers in recognising handwriting due to the different shapes and styles of each individual. The important information that can be used to identify the alphabets that have been written is not in the shape of the alphabet itself, but in the strokes of the alphabet. For example, when writing the letter 'O', we start from the upper middle area and move downwards along a curve in an anti-clockwise movement.

This means that online recognition of handwriting is easier compared to recognising handwriting that has been written on a paper. These online recognition techniques have already been popularised in pocket computers or Personal Digital Assistants (PDA) that act as a notebook, diary, and address book. A stylus pen is sometimes provided to enable users to write. It is suitable to be used with this device because its limitation in size does not permit its usage on keyboards.

ACTIVITY 5.4

Give suggestions of input technologies that can be used as suitable interaction mediums for users who are visually impaired, and give supporting statements for your suggestions.

SUMMARY

- You have already been exposed to the different kinds of input devices that are used in the interaction between humans and computers.
- Each of these devices has its advantages and disadvantages, thus only certain devices can be used in particular situations.
- It is hoped that with the knowledge that you have gained, you would be able to select the most suitable device that can be used for the system that is going to be developed.

KEY TERMS

Chord Keyboard
DVORAK Keyboard
Input Devices
QWERTY Keyboard

Topic 6 ▶ Output Technology

LEARNING OUTCOMES

At the end of this topic, you should be able to:

1. Explain the characteristics, strengths and weaknesses of the different output devices;
2. Apply you understanding about user, work and environment's characteristics in choosing a suitable technique and device, and
3. Analyse the effects of the current output technology on the design of a system.

▶ INTRODUCTION

In this topic, you will learn about the output technology. It discusses the technology and device that is responsible to convert electronic information into another form that can be understood by humans using both visual and sound.

This topic also mentions that the ability of users to process and understand information that is illustrated depends on the quality and accuracy of the method used in presenting this information. The two types of outputs that will be discussed in this topic are visual output and sound output.

6.1 VIDEO DISPLAY UNIT

The quality of a visual output largely depends on the output device that is being used. The main visual output used is the Visual Display Unit, or better known as VDU, that encompasses many different types of technologies.

6.1.1 Cathode Radiation Tube (CRT)

The VDU that uses this technology is very popular in computers as well as television monitors. It consists of a tube that contains an electron radiator that radiates electron flow to a phosphor-coated screen. The particles of phosphor that is hit by the electron radiation will normally shine. The combination of this shining phosphor will shape the image that is going to be displayed.

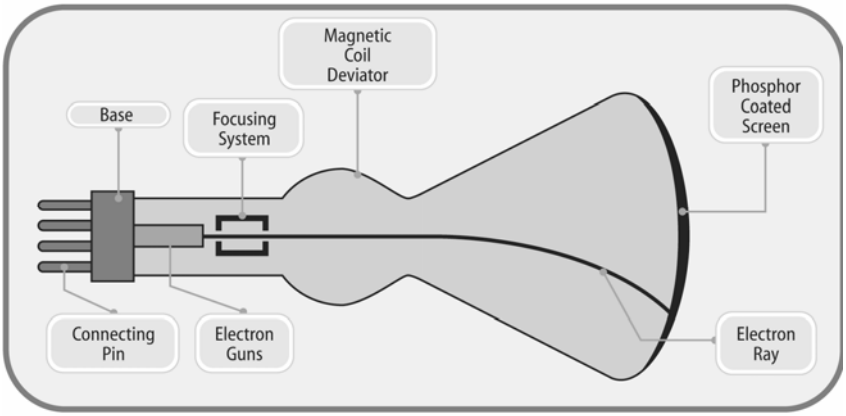

Figure 6.1: Design of the Cathode Radiation Tube (CRT)
Source: Hearn and Baker, 1997

There are two techniques that can be used to radiate electrons onto the Cathode Ray Tube (CRT):

(a) **Raster Scan Technique**

- The electron ray is scanned from left to right, starting from the top to the bottom before moving on to the next row.
- The image on screen has to be refreshed by repeating the same process to ensure its onscreen stability. This is because phosphor ray will gradually become dull after a period of time.
- The image is refreshed with the exact scan around 30-70 times per second (30-70 Hz).

Due to this process of refreshing, some twinkling of lights can be seen on the screen. There are three ways to avoid these unwanted effects:

(i) Increase the refresh rates.

(ii) Perform the scanning process alternately. For example, the even-numbered lines are scanned before all odd-numbered lines.

(iii) Use phosphor capable of radiating for a longer period. However, this technique is unsuitable for animation as it is capable of causing the smear effect.

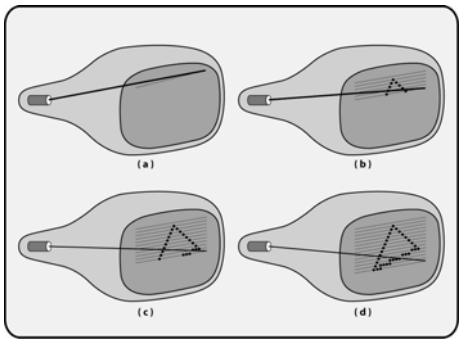

Figure 6.2: Raster Scan Technique
Source: Hearn and Baker, 1997

(b) **Random Scan Technique**

In the random scan display, the electron's ray is aimed directly at the portion of screen that displays the image. Thus, the electron ray does not have to be aimed at the portion of the screen that does not display any images. A sharper image can be produced by a moderate rate of refreshing the screen. However, this scan is limited to images made up of lines and is unsuitable for producing complex images, such as 3D objects.

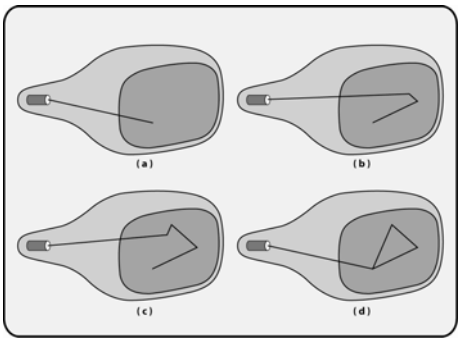

Figure 6.3: Random Scan Technique
Source: Hearn & Baker, 1997

If you are interested in learning more about CRT technology, kindly refer to Chapter 2, "Overview of Graphics system" in the book titled *Computer Graphics* by Hearn and Baker, Prentice Hall, 1997.

Users staring at a CRT display for an extensive period or in a less-suitable environment can suffer adverse effects. After a few hours, their eyes would feel tired and their vision would be blurred.

The following methods can help reduce these negative effects:

1. Users should not sit too close to the screen.
2. Users are not encouraged to use small-sized writing.
3. Users are discouraged from looking at the screen for a long period of time.
4. Users should use computers at areas with sufficient lighting, as insufficient lighting would burden the eyes.
5. Users should not place computers facing windows as light that is too bright can cause glares to the eyes.

6.1.2 Flat Screen Display

There are many different types of flat screen monitors in the market right now. These include the plasma panel, the electro luminescent thin film display, and the Liquid Crystal Display (LCD). All the displays mentioned *consist of* a basic structure of *two glass plates* with a built-in carbon ribbon that acts as an electric conductor. Each of these glass panels varies from one another depending on the different materials existing between these glass panels, as summarised in the Table 6.1 below:

Table 6.1: Features of the Different Glass Plates

	Display	Material between two glass plates	Effects
1.	Plasma Panel Display	A mixture of gas, including neon gas.	When the flow of electric current is directed to the carbon ribbons, the existing gas molecules would break into particles of electron plasma and lights of ion.
2.	Electroluminescent Thin-Film Display	A layer of phosphor in between two glass plates.	• The flow of electric current that is directed to the conductor ribbons will cause the phosphor particles on this layer to shine and produce the required image. • The process of producing a coloured image is very difficult as it requires a high source of power.
3.	Liquid Display	Crystal molecules that flow like liquid.	• When the flow of electric current is directed to the conductor ribbons, the molecules move in the direction of the ribbon. As the conductor ribbos on each side are arranged horizontally and vertically, these molecules would be moving in the middle. As a result, the light that flows through these molecules is reflected, causing the light to be displayed. • It is normally used on small scaled computer systems, and is robust as a notebook computer. • The resolution produced is low as the size of the crystal molecules is big. However, technological developments have led to increase in resolution. The current LCD resolution ranges from 640 X 480 until 768 X 1024.

One of the benefits of the flat screen display is its size. Compared to the CRT display that contains electron guns, the flat screen display is much lighter. The twinkling effects that are produced on CRT displays due to the process of refreshing the screen does not occur in the flat screen display. Despite that, the CRT display is still popular and is extensively used in laptops and portable computers despite its high cost. The plasma panel and LCD are becoming more popular in the production of television displays.

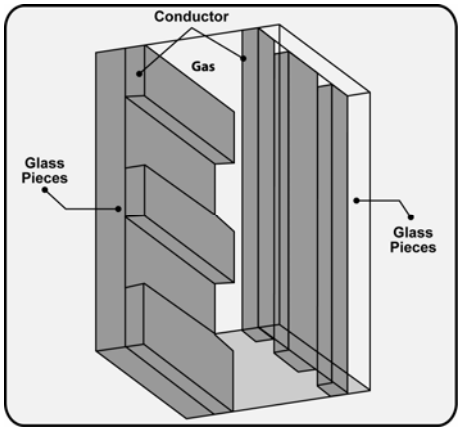

Figure 6.4: Plasma Panel Design
Source: Hearn and Baker, 1777

6.1.3 3D Display

When the image produced by a CRT display is reflected by a special and flexible vibrating mirror, a hologram-like 3D object is produced outside the screen. This image can be seen from various angles, similar to viewing a physical object. The process of producing this image is illustrated in Figure 6.5.

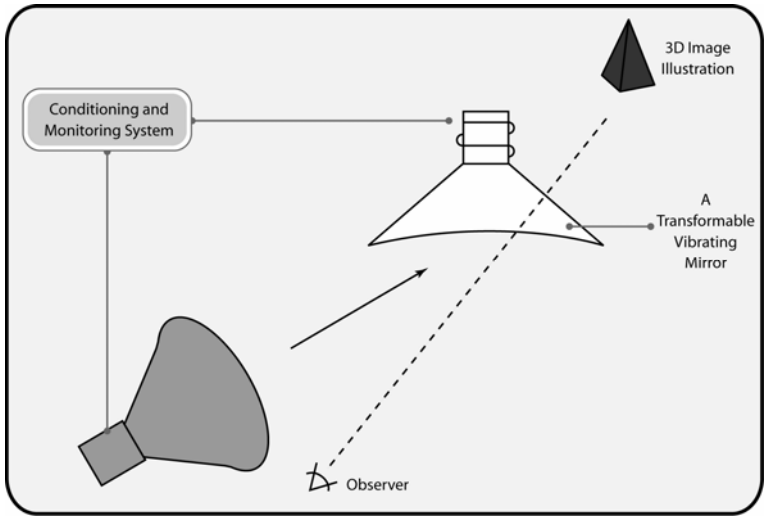

Figure 6.5: 3D Display system utilising a vibrating mirror
Source: Hearn and Baker, 1997

6.1.4 Stereoscopic and Virtual Reality System

The stereoscopic technique does not produce a **true 3D image; instead it creates a 3D effect on a 2D image**. The 2D image that is displayed will resemble a 3D object.

This effect is produced by providing two different angles of views to each of the users' eyes. When the views are simultaneously seen by both eyes, they merge into a single image that would seem to possess depth.

The stereoscopic view is one of the components of the virtual reality system. In this system, the user is present in the scene and interacts with the environment. A headset is used to display the stereoscopic view to the user and a 3D input device, such as the data glove, is used to manipulate objects in the environment. Figure 6.6 shows a user who is interacting in a virtual reality system. Take note of the tools being worn by him.

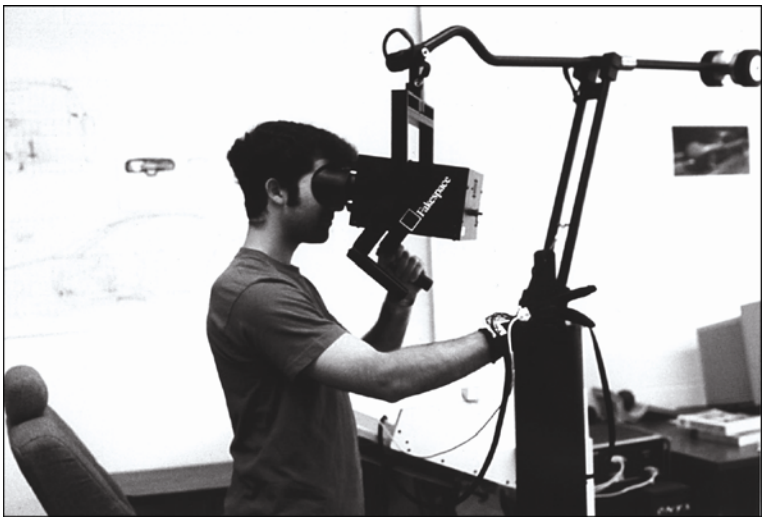

Figure 6.6: Interaction in a virtual reality environment

ACTIVITY 6.1

Explain the strength and weaknesses of using the LCD display when compared to the CRT display.

6.2 SOUND OUTPUT

Sound output is mostly used to issue warning notifications as well as used as a form of response. As we have discussed in Unit 1, there are three kinds of sounds used in a computer system - the conversational voice, music and natural sounds. Let us now at the technology used to produce these sounds.

6.2.1 Conversation

The utilisation of conversational sound has long been of interest to system designers. However, many computer systems have not used this approach due to the limitations that will be discussed later.

Voice or conversation can be produced using two methods:

(a) Concatenation

- Combines digitally recorded alphabets, words, and phrases.
- This recording is then replayed using computer controls.
- New sentences are formed by rearranging words or phrases that have been recorded using required arrangements.
- Example: Automatic Telephone Operator System

This method has two weaknesses:

- The sentence or word produced does not have a smooth flow and may be inappropriate at times.
- The number of words that can be produced using this technique is limited. Normally each application can produce less than 200 words, causing limited usage of this method.

(b) Synthesis by Rule

- Utilises words and sentences that have been fully synthesised using phonemic rules and rules based on the context of a sentence or phrase.
- Phoneme is the smallest unit of sound. An example is the sound produced by 'sh' and 'm'.
- If a phoneme in a word is changed, the meaning of the word may also differ. For example, the words 'line' and 'fine'. What distinguishes these words is the first phoneme.
- Produces more words and conversational sounds compared to the concatenation method. For example, on cameras, vending machines, and children's toys.

6.2.2 Natural Sound and Music

There are no specific techniques or methods that are used to produce these sounds, except for digital audio recording. Before being utilised in a computer system, this recording is edited, cut and combined to customise it for the application that will be using it.

ACTIVITY 6.2

Why does the synthesis by rule method produce more words than the concatenation method?

SUMMARY

- In this topic, you were exposed to a number of output devices and technologies that are used to produce visual and auditory output.
- The strengths and weaknesses of the devices or technology used were also discussed.
- Thus, it is hoped that you will be able to select or suggest a suitable device and technology for the system that is going to be developed.

KEY TERMS

Concatenation

Raster Scan Technique

Random Scan Teachnique

Sythesis by Rule

Topic 7 ▶ Conceptual Models and Interaction Styles

LEARNING OUTCOMES

At the end of this topic, you should be able to:

1. Explain the meaning of the conceptual model as well as its role in designing interaction styles;
2. Elaborate on the approaches of direct manipulation, including its advantages and disadvantages; and
3. Make a comparison between the six interaction styles and their suitability to different types of users i.e. novice, occasional, and talented/skilful.

▶ INTRODUCTION

In this topic, we will discuss conceptual models and the interaction styles that exist between humans and computers. The conceptual model provides some initial ideas about the characteristics and usability of the system. This enables the system to be specifically designed. As a systems developer, you need to ensure that the conceptual model is well understood by the users in order for them to construct an appropriate mental model. Do you still remember what a mental model mean? If you do not, kindly refer to Topic 2 to refresh your understanding of this concept.

In developing an interactive system, the developer should be able to construct a respective conceptual model. This topic will teach us the methods of delivering the conceptual model to the users.

Upon designing this conceptual model, you would then need to select an appropriate method or interaction style that is suitable for this system. This topic will also expose you to a number of interaction styles that are normally used as well as all issues related to these styles, to ensure the suitability of the interaction style for the conceptual model of the system.

7.1 CONCEPTUAL MODEL

The definition of the conceptual model:

> A model that provides users with a brief and simple explanation about the system that has been proposed, in the form of ideas and concepts related to the abilities and characteristics of the system, and how users interact with the system.

For your information, this kind of representation cannot be documented; rather, it is a conceptual illustration in the minds of system users, designers, and developers. For an example, imagine a normal VCR. To record any program, you know that pressing the 'REC' button will start the recording and pressing the 'STOP' button will stop the recording. This case also applies to cassette players, where you need to press the 'PLAY' button to play the cassette, and it would only stop when you press the 'STOP' button. From this experience, you will understand that you need to give some specific instruction to the player. In this case, the instruction is pressing the appropriate button on the VCR to enable it to fulfill the task required. This is the concept known as the conceptual model of the system. In this case, the conceptual model has been used to give instructions to the machine. There will be more explanations on conceptual models in the upcoming chapters.

The conceptual model of a system is determined by the designers and developers of the system. An effective conceptual model can be utilised by users to understand the characteristics and abilities of the system, and ensure appropriate user interaction with the system. Thus, it is the developers' task to think of a suitable conceptual model that is able to fulfil the needs of users.

There are two general conceptual model categories that are used: the activity-based conceptual model and the object-based conceptual model.

7.1.1 Activity-Based Conceptual Model

This model is based on the communication activity between users and the computers. The communication activity mentioned can be classified into four types:

(a) Giving Instructions

(b) Conversation

(c) Manipulation and navigation

(d) Exploration

This means that the product or system may use a combination of different communication activities when interacting with users.

(a) **Giving Instructions**

A system that uses the 'Giving Instructions' conceptual model will only respond when users input instructions. For example:

- The VCR, a product that uses the conceptual model discussed above.
- The UNIX and DOS operating systems and software, as well as systems that use selection menus.

Although the examples above use different approaches when giving instructions, the concept used remains the same, where users give task-based instructions to systems, and in return, the system completes these tasks.

In the UNIX and DOS operating systems, users need to type an instruction or a set of instructions on the *prompt* for a task to be completed.

For example, the instruction 'dir' below is used to list down all files and folders that exist in the hard disk directory of the D drive.

D:\>dir

In most Windows-based software, there is a list of options on a menu, located at the top of the screen display. In the category of 'File' under that menu, there are a number of choices - create a new document, open an existing document, and store a document as a file, among others. To perform a task, users need to select an appropriate instruction to be implemented by the system.

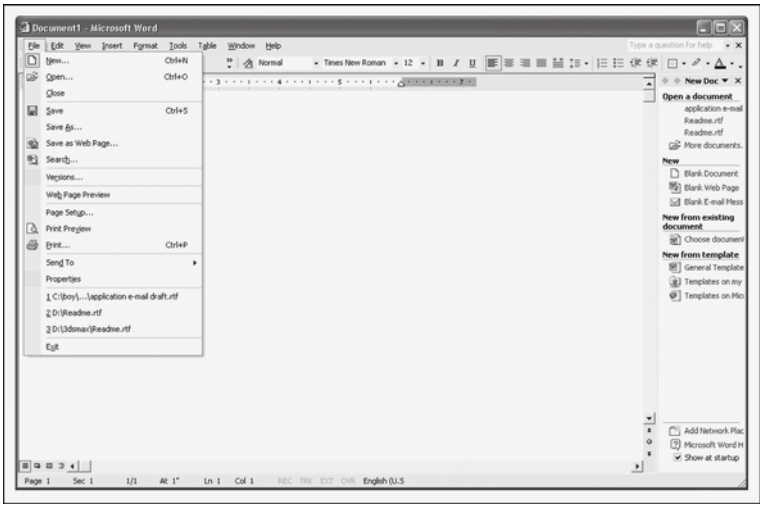

Figure 7.1: A screen shot of the Microsoft Word 2002 Interface (copyright© Microsoft Corporation 1983-2001

As shown in Figure 7.1, users need to select 'Open' to instruct the software to open an existing document.

One of the benefits of using the 'Giving Instructions' conceptual model is the level of efficiency provided in the process of interaction. It is most suitable for repetitive actions, when using more than one object as well as for diversity in instructions. Look at the sample of DOS instruction below:

D:\> dir
D:\> dir *.doc

The first DOS instruction is to list down all the different types of files and folders that exist in the particular directory, and the second DOS instruction is to further list down all the Microsoft Word document files that only end with the '.doc' extension. If you have had previous experience using the UNIX or LINUX operating systems, you would surely have come across these different variations of DOS instructions.

(b) **Conversation**

All systems that utilise the conceptual models are designed to function in a similar manner to how humans communicate with other individuals via conversations. Thus, the systems would function as a conversation partner to users by answering all the questions, and prompt users with some necessary questions to guide them in obtaining more information from their questions.

These conceptual models have been found to be most useful in applications that function to search for specific information, or applications that support discussions on important issues. Some examples of such applications include advisory systems, help facilities, and the search engines.

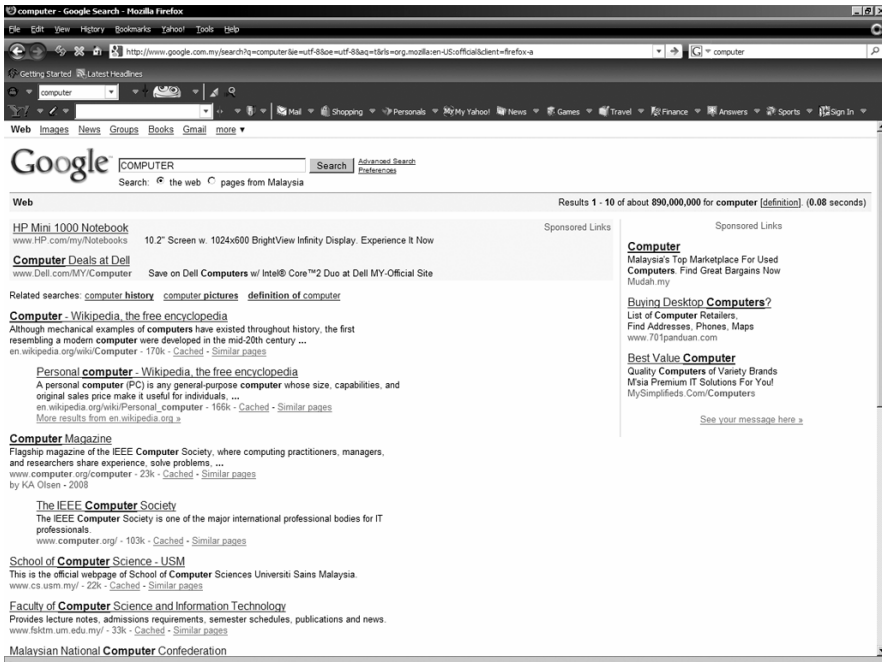

Figure 7.2: A screen shot of Google search engine interface

As displayed in Figure 7.2 above, a user intends to search for some related information, but has mistyped the spelling of the word. Although the search engine would display the search results for the word 'computr', it would also pose the question 'Did you mean: computer' on the screen, to validate the accuracy of user's search request.

There are many types of conversations supported by the systems. Some systems use voice recognition to select an item from a menu, such as systems used by operators of automatic telephones, sophisticated systems that involve the processing of natural languages, as well as systems that respond to user queries. Some examples include ticket reservation systems, banking systems, search engines and aid systems.

Strengths:

- Easy for novice users to interact with the system. As conversing is a daily activity of humans, they will be able to adapt easily to this approach when interacting with the system.

Weaknesses:

- Confusion may arise due to system complications. For example, a search engine that is unable to answer questions which are expected by users. Look at the example below.

Figure 7.3: A screen shot of 'Ask Jeeves for Kids' Website (© 1996-2009Ask Jeeves)

Figure 7.3 above displays the response of a search engine to the question on the number of legs on a centipede. As the engine is unable to provide the best answer to this question, it suggests more questions to be typed by the user. Although the keywords in the user's question and the system's questions are similar (*legs* and *centipede*), the system's questions cannot be used to look for the required information.

ACTIVITY 7.1

What are the other system issues related to the conversation-based conceptual model? Guide: *Automatic telephone operator system.*

(c) Navigation and Manipulation

The manipulation and navigation oriented conceptual model elaborates on object manipulation and virtual space exploration by using the users' knowledge to perform these tasks in the real world. For example, virtual objects can be manipulated through moving, selecting, opening and closing them. The Windows Operating System is an example of a system that uses this conceptual model.

One of the important branches of this approach is the direct manipulation approach.

(d) Exploration

The exploration oriented conceptual model is based on enabling users to explore and search for information by using their knowledge of exploring existing media such as books, magazines, TV, radio, libraries and pamphlets. When an individual visits the tourism office, book shop, or dentist, he/she is able to look for necessary information of pamphlets. These individuals would only continue reading if they find a piece of information that captures their interest. Some of the applications that use this conceptual model are CD-ROMs, web pages, portals, and e-commerce pages.

7.1.2 Object Oriented Model

This model uses a special object to illustrate the characteristics and methods of using the system. An example of the object oriented conceptual model is the spreadsheet. Spreadsheets use ledger papers to illustrate their characteristics and actions. Thus, users who are familiar with ledger books would be able to use the spreadsheet.

7.1.3 Interface Metaphors

A metaphor is a method of explaining a new concept in a simple or familiar manner to the users. An interface metaphor is a metaphor that is used in a systems interface. In a simplified manner, an interface metaphor generally illustrates how users interact with the system, specifically illustrating each interface component in the system. These interface components may be new to the users, but they share some similarities with the other physical entities in the real world. These physical entities may be more familiar to users.

An example of a good interface metaphor is the *recycle bin* in the Windows environment. The *recycle bin* is a metaphor based on a physical entity that is the dustbin. In the real world, the dustbin is used as a location to keep all materials

that are unwanted by users. The same concept is used in the Windows environment, where all files to be destroyed are sent to the '*recycle bin*'.

The '*desktop*' and '*spreadsheet*' can also be categorised as metaphors. The '*desktop*' uses the concept of being '*on the table*'. In the real world, all materials frequently used are placed on the table / desk. Some examples are files, documents, and stationery. The *desktop* metaphor is used to enable users who are familiar to such physical work environments to be comfortable with the operating system in use. The interface metaphor can also be a combination of a familiar concept and a brand new concept. An example is by placing an electronic file on an icon that represents the printer on the *desktop*, which causes this file to be printed.

The interface metaphor has been proven to be a concept that has successfully helped users in understanding and utilising a system. Metaphors are used to map existing knowledge, that users are familiar with, into knowledge that is unfamiliar or has not been obtained by users. This is to enable users to understand and learn a new domain.

You can further your reading about conceptual models and metaphors in Chapter 2, 'Understanding and Conceptualising Interaction', of the book *Interaction Design Beyond Human-Computer Interaction* by Preece, Rogers, and Sharp, John Wiley and Sons, 2002.

7.1.4 Direct Manipulation

Direct Manipulation is an example of a conceptual model that is based on navigation and manipulation. Due to its extensive usage in most operating systems and software, direct manipulation appears as an interaction style. This style, together with other interaction styles (such as menus and question-answer dialogues), is extensively used in the Windows environment. In fact, it has become one of the main elements of this operating system.

According to Ben Shneiderman (1993), the man who created this term, a direct manipulation interface must have the following three basic characteristics:

- Objects and action operations that are visually represented.
- Action and response that are fast, revertible, and can be viewed in layers.
- Implementation of instructions that uses action and manipulation on the object.

Most software using this approach represent objects as icons on the interface. Any manipulation process on these objects can be clearly viewed by the users. For example, when users want to copy a document file into another folder, they have to drag the file into the destination folder, and the movement of the file in the direction of the cursor can be seen on the screen. This is what is meant by fast action and response viewed in different phases. This action can also be reverted. An example is when users want to transfer the file back to its original location; the same process can be seen in phases, on the screen.

The direct manipulation approach is very popular due to the following advantages:

- Helps new users to quickly learn the basic functions.
- Occasional system users can easily remember the steps to perform certain operations.
- Seldom displays error messages, as the results of actions can be clearly viewed.
- Users can immediately see the results of their actions.
- Users feel comfortable in using the system.
- Users feel that they are in control of the system, and not vice versa.

Apple Computer Inc. was the first organisation to design an operating system that uses the direct manipulation approach, making it the main mode of interaction.

This approach is closely related to the concept of WYSIWSG (What You See Is What You Get) and GUI (Graphical User Interface). The WYSIWSG concept was created from the awareness of the importance of word-processing software in illustrating the actual preview of how an electronic document would appear when printed on paper. This means that users get a clear illustration of the document that will be produced during its electronic preparation. In doing so, they are able to correct any errors, or change a document format that is not suitable for printing.

A graphical-user-interface or GUI is an interface concept that uses graphical representation. This concept was introduced as an alternative to the text-based interface that was used in the older computer systems. GUI is the base for the direct manipulation approach. Without GUI, this approach can never be implemented.

However, visual representation is not necessarily always better than text representation. Among the problems that arise are:

1. Sometimes, graphical representation requires more space. Thus, to be able to see all elements that are on display, users may need to scroll up and down the screen. This indirectly increases the burden upon users, and at times slows down the task at hand. Research was conducted to compare the effectiveness of a graph and table in displaying business data. From the research, it was found that in a situation where the graphics were too big or when searching for detailed information, the usage of tables was more effective than plotted graphs.
2. Users need to learn the meaning of each visually-represented component or icon being used. A graphical icon may be more meaningful to a system designer compared to a new system user. Thus, this new user may need more time to learn the use of this icon.
3. Visual representation may give a different portrayal from what was meant to be displayed. Users may be able to identify the analogy that is being used in the symbol, but may be mistaken in concluding the actions that can be performed by the icon. This problem can be solved by testing the symbols, objects and icons that are used on the interface before they are used as an end product.
4. Some users consider the use of a mouse to point at an icon a slower process compared to typing a related instruction for the same task. An example is when typing a mathematical statement. An experienced user would have memorised the keys that need to be typed to produce a mathematical symbol. Thus, this user may consider it a slower process to point the mouse at the necessary icons each time he/she wants to produce a related mathematical symbol. This problem can be solved by using shortcuts which specify a key or combination of keys as an alternative to implement a certain task. For example, to store a newly typed document, the user can point to the diskette icon that symbolises the process of storing a file. Another alternative is the simultaneously press the 'Ctrl' and 'S' key together. This method may be more popular amongst skilled users as they need not remove their hands from the keyboard.

The direct manipulation usage approach is the basis of interaction between users and virtual reality systems. You would have already studied the technology that supports this interaction in topic 1 and 2.

A detailed discussion and examples of the use of the direct manipulation approach can be obtained from Chapter 6,'Direct Manipulations and Virtual Environments' of the *Designing the User Interface Strategies for Effective Human-Computer Interaction* book, by Shneiderman, Addison-Wesley, 1998.

ACTIVITY 7.2

1. What is the relationship between the conceptual model and mental model?
2. Explain the advantages of using the direct manipulation approach.

7.2 INTERACTION STYLES

This subtopic discusses the interaction styles that are extensively used in the current software interfaces.

7.2.1 Instruction Language

The instruction language was one of the earliest interaction styles used. It was usually used by technical experts who wanted speedy access to the system's functionalities. This style was popular in the UNIX and LINUX operating systems. In order to implement a task, the user needs to type a specific instruction.

The instruction language is very powerful because it enables direct access to the functions of the system. It allows the process of combining a number of instructions for the purpose of data manipulation. The instruction language is also very flexible because it may have multiple choices or parameters with varied characteristics that are simultaneously applied to various objects at the same time. This makes it best utilised for repetitive tasks.

However, the fact that the instruction language is based on specific formats and instructions makes it difficult to be learned and utilised for the very first time. Each time around, the instructions need to be remembered, and no clues are provided to enable users to identify the instructions that implement a task. Thus, it is more suitable to be used by expert users rather than novice users.

7.2.2 Menu

In a menu-based interface, a set of selections is displayed to users. Users can then choose between using the mouse and typing the numeric keys or alphabets.

As all the available selection functions can be viewed, users only need to identify the functions that need to be executed rather than having to remember all instructions.

Normally, the items on a menu are arranged hierarchically. The required selection is not placed on the top hierarchy, so users need to depend on prompts that are provided to the group as well as the names that are used in the hierarchy.

The most basic menu used in previous systems is the text-based menu. In this menu, each choice is accompanied by a number. Users can make a selection by moving the cursor to the arrow keys, or entering the provided number of the selected menu.

With the emergence of GUI, many types of menus can be used:

(a) Pull-down menu

(b) Pop-up menu

(c) Tear-off menu

(d) Walking or cascade menu

(a) **Pull-down menu**

- The most widely used menu.
- The items that are inserted in the pull-down menu represent the tasks or utilities that are usually used by users.
- The items are categorised based on their respective duties. To select an item, users need to choose the category name of the menu beforehand. Only then will the items in the category be displayed.
- An example of a pull-down menu is illustrated in Figure 7.4.

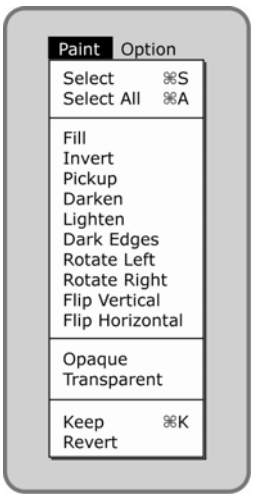

Figure 7.4: An example of the 'pull-down' menu in Macintosh OS

(b) **Pop-up menu**

- Normally used for selections or tasks that are rarely utilised.
- Only displayed upon the request of users.
- Example: when users click the right button on the mouse, the pop-up menu will appear.

(c) **Tear-off menu**

- Normally used for selections of colours and patterns which are used in graphics software.
- Unlike other menus, the tear-off menu can be moved to other locations on the screen. This is to avoid other parts of the monitor screen to be blocked by this menu.
- This function is very useful in graphics software because it enables users to utilise the entire screen. It also enables users to choose all selections on the menu without having to open the menu each time around.
- Example is as shown in Figure 7.5.

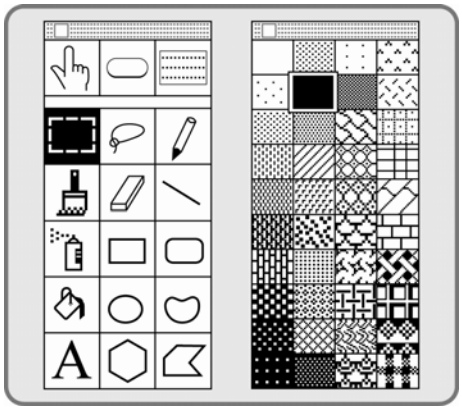

Figure 7.5: An example of the 'tear-off' menu

(d) **Walking or cascade menu**

- A pull-down menu that contains many sub-menus within it.
- These sub-menus can be seen by selecting the categories that contain them.
- The example is illustrated in Figure 7.6.

The advantage of this menu is that users do not need to remember instructions, as they are able to select from the menu. This situation is also ideal for novice users. The menu also ensures the systematic implementation of a task or process.

However, it also has its set of disadvantages. Among them is the fact that experts users will take a longer time using the menu compared to using shortcut keys. By selecting from the menu, the users' activity is merely limited to the provided selections. This does not provide flexibility to skilled users who need more varieties of tasks to be implemented.

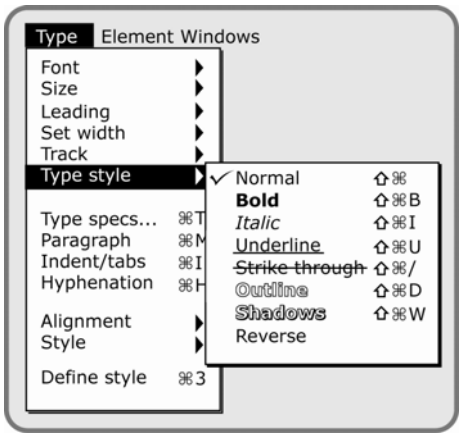

Figure 7.6: An example of Cascading Menu

7.2.3 Natural Language

In the cases that have been mentioned above, users may face problems in remembering instructions, or may get 'lost' amongst the hierarchical tree's menus. Thus, a more suitable solution to this problem would be the usage of the natural language, where the instructions given are in the form of words used in everyday language.

The technique and technology used for natural language processing are still being researched. Although the idea of using natural language is very interesting, the confusion or ambiguity of this language may cause some difficulty to the computer interpreting it.

The ambiguity in natural language can exist in its syntax, the structure, the language phrase used, or the meaning of the word being used. The meaning of a word, for example, is always dependent on the context it is being used.

Due to the problems mentioned above, it will be some time before an interface using the natural language as an interaction style and communication can be designed on a computer system.

7.2.4 Forms

This style was initially used extensively in helping data entry clerks. These clerks did not need a long time to learn the system, as this interaction style was similar to the physical designs that they had been using previously.
Nowadays, this interaction style is widely used in information retrieval applications. Users are provided with a display that resembles a paper form, with spaces that are to be filled with text typed in by users. Users can input all categories of data simultaneously, where the sequence of input is disregarded.

However, a default input is needed to help novice users and to quicken the process for skilled users. A 'default' is data that have been preset and proposed by the system. The 'default' is determined based the answers or choices the systems developers feel are most commonly provided by users.

To ensure the validity of data that is entered by the user, input examination needs to be conducted for each step of entry. In the case of an error, a notification message will be provided to the users to ensure immediate correction. At times, these corrections are automatically done by the system.

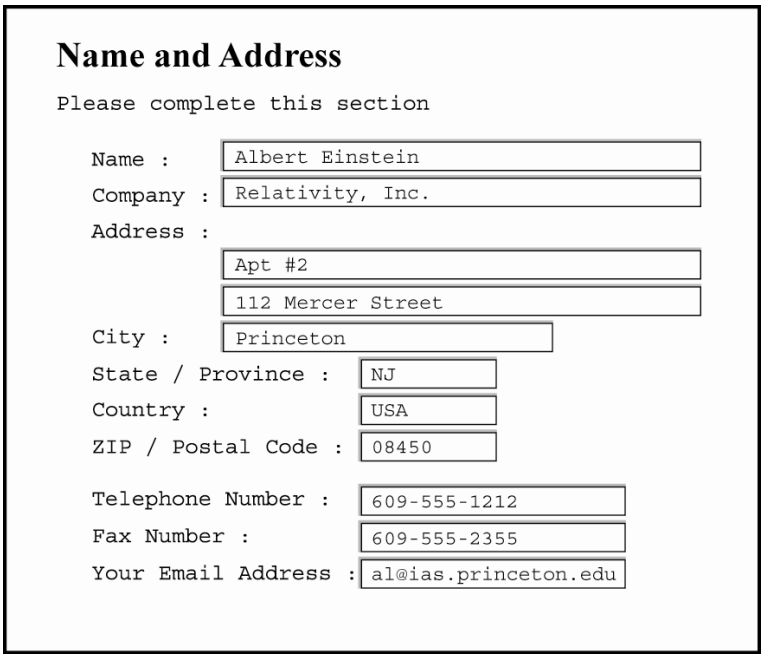

Figure 7.7: An Example of form

7.2.5 Question and Answer Dialogue

The question and answer dialogue is a simple mechanism for the input receiving process. The user is usually given a series of questions, and each answer would be in the form of a 'yes/no' response or a set of answers. In this way, the interaction between the users and system can be implemented step by step.

These interfaces are easy to learn and use, but have limitations in their power and capabilities. Thus, they are more suitable for use in smaller domains, and for novice and casual users.

The question-answer session is usually used in situations where users are not allowed to make many choices, or in critical conditions. An example is during the occurrence of an error, as illustrated in Figure 7.8 below.

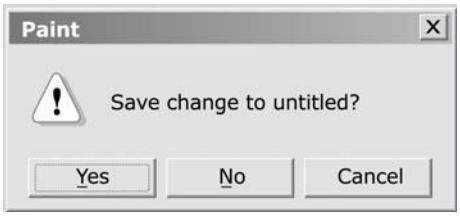

Figure 7.8: An example of a question-answer dialogue

The question-answer dialogue also needs a default to help novice users in making selections, similar to the form-based interaction style, as the question provided by the system may not be understood by the users, or the users may be unsure when selecting the appropriate answer. With the existence of 'default', users merely follow the selection suggested by the system.

7.2.6 WIMP Interface

The WIMP interface of Windows System is a style based on direct manipulation and the GUI concept. It contains a number of interface components known as the 'widgets', that consist of (W)indows, (I)cons, (M)enu and (P)ointers. The combinations mentioned above form the WIMP Interface.

ACTIVITY 7.3

Why must the default be prepared in the form-filling and question-answer dialogue approach?

7.3 SCREEN LAYOUT AND DESIGN

A screen layout and design may consist of many different types of interaction styles. In this subtopic, we will learn about the different interaction styles that are combined and used on the screen displays. The use of these interaction styles depends on the functions that are required.

7.3.1 Information Presentation

The presentation of information on the screen depends on the following matters:

(a) The type of information, consisting of text, digits, maps or tables.

(b) The technology that can be used to present this information, such as technology using normal displays, graphic displays as well as virtual reality.

(c) The objective of presenting the information or the manner in which the information will be used.

In order to support the many different tasks of users, the information should be presented in a diversified and interactive manner. For example, as illustrated in Figure 7.9 below, if users want to look for a particular email from a particular person, they could arrange the email based on sender's name in alphabetical order, by clicking on the 'From' title and if users want to view the latest message, they can click on the 'Received' title. This action will rearrange the messages based on the latest date.

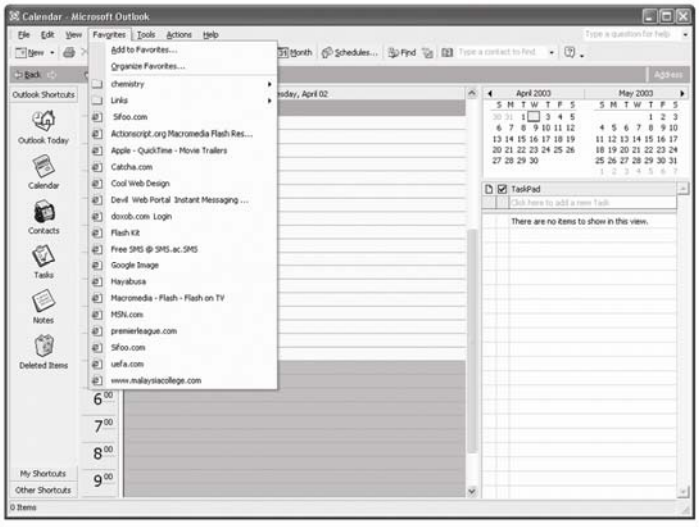

Figure 7.9: A screen shot of the Microsoft Outlook
(copyright © Microsoft Corporation 1983-2001)

As mentioned earlier, visual representation is not always suitable for every situation. Over-using graphics could also cause some negative effects from the perspective of the system's usability. An example is the over-use of colours. This issue was discussed in detail in Topic1. When choosing a colour, it is very important to give due consideration to users who are colour blind, the contrast between the background and text or image that is meant to be highlighted, the suitability of the colour used, and the importance of the information.

The alignment of items on a list is also an important consideration. To enable comfortable reading from left to right, the items should be aligned on the left. However, digits are usually aligned on the right, or with decimal points. This is because the columns on the list reflect the magnitude or value of the particular digit. Thus, it would be easier for users to look for the biggest or smallest value from the list.

7.3.2 Information Entry

The form-filling technique is the information style that is usually used as the method of information entry. A form usually has a combination of spaces to be filled and items to be selected by users, as well as information to be presented to the users. However, this method has several drawbacks, which were discussed previously in the subtopic of information presentation. Again, the process of alignment is a very important matter to be taken into consideration. It has become a norm for text boxes to appear unaligned on forms due to the uneven length of field names. This requires alignment to the right, alternatively, smaller font sizes or the placement of labels on the upper or left corner of the text boxes can be used.

Thus, a clear and logical layout is very important to ensure proper information presentation and entry.

7.3.3 Requirements and Aesthetic Values

You should bear in mind that an attractive interface may not necessarily mean a good interface, although, ideally a good interface should always be designed to look attractive. This is because an attractive interface would increase user satisfaction, and this indirectly increases their productivity.

However, beauty and requirement may not always go hand in hand. An example would be the posters and multimedia systems. Ideally, any background colour should always have a softer contrast to enable the foreground writing to appear clear and legible. Unfortunately, in most cases, the background is always designed to look more sophisticated and attractive. The results are always impressive, but lack functionality.

In any event, the careful use of the aesthetic concept always helps to increase understanding in users.

7.3.4 Discovering What is Needed

Some of the elements or items on an interface carry passive characteristics, where they are only able to provide information, whereas other elements have active characteristics, by enabling actions to be taken upon them.

For example, a label that is written beside the text box will only be able to inform users about the name of the box. Nothing will occur if users place the cursor in the box, and click on the mouse. On the contrary, an underlined text or button on a screen is an active characteristic. If users were to place their cursors upon this button and click on the mouse, some form of action would take place.

One of the main shortcomings of an interface is the unclear distinction of functionalities of elements in an interface. Due to this, many organisations have standards for their interfaces to enable elements to be differentiated from one another.

7.3.5 Localisation/Internationalisation

You have probably been frequently using the Microsoft Word software to prepare reports or documents in Bahasa Malaysia. During the preparation of these reports, have you ever faced difficulties due to the conflict of language between the software and your report? An example is the use of the spell check utility. This software feature is specific to the English language, and you would have to make selections based on American English or British English.

The latest version of Microsoft Word comes with an automatically built-in spell check functionality. Any mistakes you make will be auto-corrected by the system. Have you ever experienced this situation?

Localisation or Internationalisation is the process of customising the software to be used in different cultures and languages. In this process, the words that are used in the software are changed to the target language. Most software use database sources for this process of customisation. The database source consists of a number of databases, where each database uses a different language. Each word used in this software is referred to a particular number. When the software is customised to a certain language, the associated numbers are used to refer to the related words in the database source.

The change of language is just one of the issues in the process of localisation. There are also a number of other issues, such as the direction of the flow of

reading depending on the different races and culture, and the use of symbols that may reflect different meanings, as well as many other issues that have yet to be discussed. In conclusion, as a systems developer, you should be able to identify all the possible issues and make efforts to design a system that has the most ideal interface.

ACTIVITY 7.4

Why do we have to give due consideration to the aesthetic values of an interface?

SUMMARY

- You have already been exposed to the metaphor concept and conceptual models, which are actually tools to explain the characteristics and behaviours of a system that is being developed.
- You have also been exposed to the various interaction styles that have been and are still being used in current software interfaces.
- In relation to these, it is hoped that you will have the capability to select the interaction style ideal to the conceptual model that is being formed as well as be able to handle all related interaction issues.
- In the next topic, you will learn about the Windows System, which is an interaction style used extensively in current software and applications.

KEY TERMS

Conceptual model	Internationalisation
Direct manipulation	Localisation
Instructional language	Natural language
Interface metaphors	Object oriented model

Topic 8 ▶ The Windows System

LEARNING OUTCOMES

At the end of this topic, you should be able to:

1. Identify the four important elements in the Windows System;
2. Understand the importance and consider the design of each of the above elements; and
3. Understand the Windows Management process and its effects on users.

▶ INTRODUCTION

In this topic we will study in detail the interaction style that is currently being used extensively in many software and applications. It is none other than the Windows System.

The main shortcoming of the Windows Systems is the need for users to be able to refer to various sources in a short span of time. If the size of the display used is big, then a number of Windows can be opened and displayed simultaneously, but the visibility and frequent movement of the eyes could pose as a serious problem. On the other hand, if the size of the display is small, then the size of the displayed Window would be too small to accommodate the accurate context of the information.

It is indeed a challenge for the designer to be able to provide sufficient information with enhanced flexibility apart from reducing the management activities, compact displays due to too many windows popping-up, and the constant movement of eyes and head.

The management of Windows is related to the interface, and not to specific tasks implemented by users. Thus, if the task of managing Windows could be reduced, users would be able to complete their tasks in a shorter time period.
system that you have planned to develop.

8.1 ELEMENTS OF THE WINDOWS SYSTEM

The Windows System is also known as the WIMP, which is formed from the combination of basic elements that are the (W)indows, (I)cons, (M)enu, and (P)ointers. These elements are also called 'widgets'. Since menus have already been discussed in Topic 7, we will not discuss them here.

8.1.1 Windows

The definition of a window is:

> "A square space that contains software application or document files. Windows can be opened, closed, moved, and its size modified. You can open a number of windows at the same time, minimise windows to an icon, and maximise windows until they fit into the entire display."
>
> (MS Windows 3.0 Users Guide)

Windows are used to split the display space into a number of virtual displays. This enables a number of operations to be executed or data to be displayed simultaneously.

Each window can be moved, its size changed as well as have a number of other activities implemented on it. The information contained within a window can also be manipulated and moved. All the above mentioned activities will be discussed in subtopic 4.2.

Each window also contains basic interface objects that are able to support all activities or operations conducted on it. These interface objects include the title, frame, border and scroll bar.

Title

Most windows have titles on their upper left or mid sections, lower mid section or a tab that extends from the window. A tab on a window is useful for identification by users, especially in a compact Windows environment.

To save space, the designer may invent a window that does not have a title. The title bar may change colour/shading to indicate the active window. When the window is closed, it will only be represented by an icon.

Frame or Border

It is used to differentiate between the space inside the window and space on the desktop. Some applications utilise the 3D approach by displaying shadows at the bottom section of the window.

Scroll Bar

The size of the window is relatively small compared to the information displayed. Thus, a suitable mechanism is needed to move the window's display in order to view any hidden information. This can be achieved by moving the display to the right, left, up or down using the Scroll Bar.

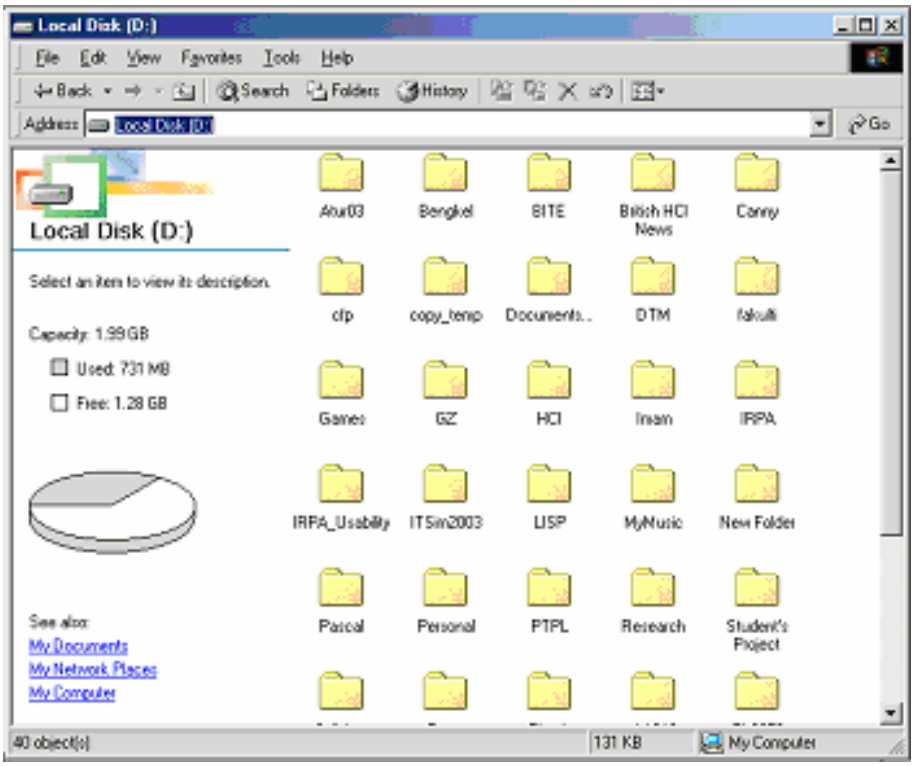

Figure 8.1: An example of a Window on the Windows 2000 system

Most scroll bars contain arrows or scroll boxes that can be clicked by users to move the window's display. An important characteristic of a good scroll bar is the smooth flow of the arrow when it is continuously pressed. Users should also able to go to a specific destination in the document by dragging the scroll box to the intended destination.

The response from the scroll box is crucial to capture the user's confidence as well as ensure accuracy of the operation. One of the approaches is by using the scroll box in proportion with the location of document being viewed. For example, if the scroll box is located at the end of the scroll bar, it means that the user is at the end of the document.

8.1.2 Icon

An icon is a symbol or image that is used to illustrate an object, concept, operation or utility that is being used in a system. For example:

- The recycle bin illustrates the concept of disposing a document or object in a system; and
- The scissors illustrates the operation of cutting a selected section.

An icon can also be used as a symbol to represent a window that has been minimised.

The main objective of using an icon is to save space. This is to enable more explanations of concepts, operations, or utilities to be presented in a simplified manner rather than using sentences or words.

The idea of using an icon is nothing new. In fact, it has been extensively used in printing media, notice boards in buildings, and maps. An important point to remember is that the icon should accurately illustrate the message being delivered, as its failure may cause confusion in the users, and influencing the usability of software.

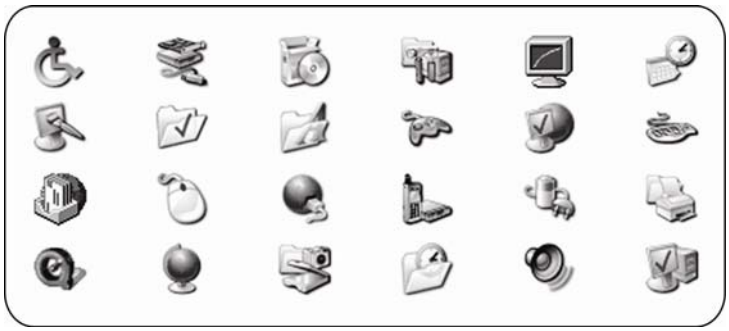

Figure 8.2: Examples of various different icons

8.1.3 Pointer Cursors

A cursor is an active icon. It is used as an indicator to a specific location and to indicate a mode. The pointer cursor is a very important element in WIMP as the interaction style used in the WIMP heavily depends on the process of pointing and selecting an item or element, such as an icon.

Users normally point to the items of an interface by using the mouse or a number of other input devices, such as the joystick or track balls. The movement of these devices is illustrated on the screen using these pointer cursors.

There are many types of pointer cursors provided by the current computer systems. Different shapes of pointer cursors are used to differentiate the modes. For example:

- Arrows indicate a normal mode.
- Crosshair indicates a mode to draw lines.
- Hourglasses indicate a system that is busy reading a file.

A pointer cursor does not physically differ from an icon, but has a hot spot, which is a location on the screen where it is pointing to. Each pointer cursor has different hot spots, depending on its shape, where some are shaped as arrows and located at the upper left corner and others on the upper right corner. However, there are some cursors that have vague hot spots that make it difficult for users to click on a smaller space. Thus, when designing a pointer cursor, you must ensure that the icon that is used to indicate should have a clear hot spot.

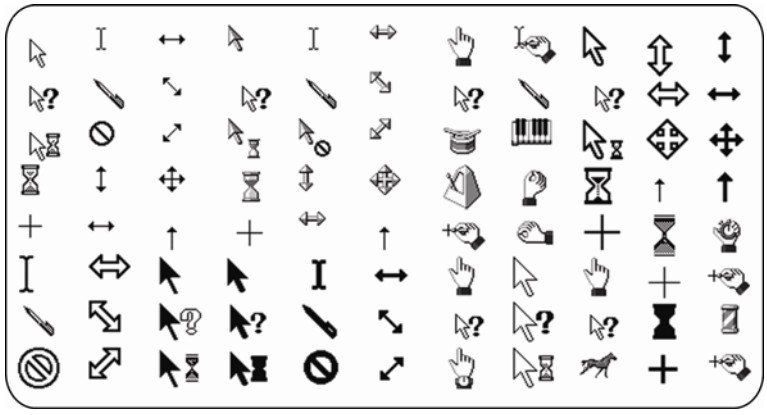

Figure 8.3: Examples of different types of pointer cursors

8.1.4 Other Elements

(a) **Buttons**

Buttons represent an area that can be selected by users upon clicking on it. The button is normally accompanied by a word or icon that indicates it functionality or purpose.

There are three kinds of buttons that are normally used in interfaces:

- Check buttons are used to make more than one selection.
- Radio buttons are used to make a selection from a number of provided selections.
- Toggle buttons are used to indicate if an item has been selected or not.

Examples of these buttons are illustrated in the following figure.

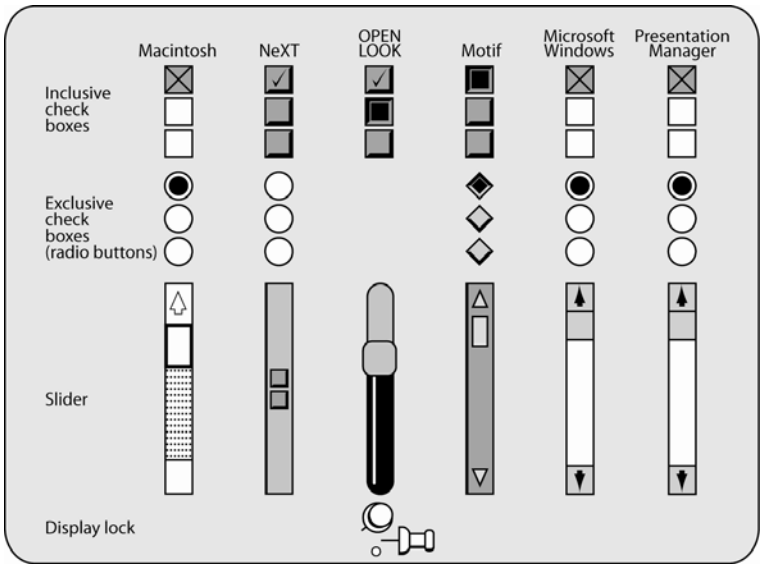

Figure 8.4: Examples of different kinds of buttons

(b) **Toolbar**

A toolbar is a collection of utilities frequently used by the software. These utilities are normally represented by small sized buttons that contain icons to represent their functions. In most interfaces, this list of buttons can be customised based on the users' requirements.

The figure below displays an example of a toolbar that exists in the Microsoft Word software.

Figure 8.5: The toolbar on Microsoft Word (copyright © Microsoft Corporation)

(c) **Dialogue Box**
The dialogue box in WIMP is normally used:

- To capture the attention of users towards an important information. Example: error messages or warnings to avoid the occurrence of an error.
- For interaction between the system and users when a specific task within a bigger task has been completed.

Example: the operation of naming and storing the files at a certain location.

The completion of the actions and the disappearance of the dialogue box indicate the completion of the operation.

ACTIVITIES 8.1

1. Briefly elaborate on the four important elements and functions of the Windows System.
2. Why is it necessary to conduct a detailed research on the design of the icon to be used in the interface?

8.2 MULTIPLE WINDOW SYSTEM

One of the most important features of the Windows System is that it enables users to open multiple Windows simultaneously. With this feature, users are able to refer to various resources, thus speeding up their tasks as well as completing multiple tasks at the same time. There are many approaches that can be used to support this feature. In the following subtopic, we will discuss the methods that can be used.

8.2.1 Multiple Display

During their course of work, stock brokers or process monitoring operators utilise more than one display screen. By using this method, they would be able to view all the required information. However, the eyes would be forced to view in-between displays, causing a delay in their movement. With the Windows System,

this problem can be overcome by using more screen displays with higher resolutions.

8.2.2 Interchangeable Displays

One of the alternatives to using multiple windows is by utilising a number of interchangeable displays that can be swiftly switched, either automatically or manually by users. This strategy is quite useful, but can become a difficult task for the users. To control this interchangeability, users need to know:

- Their locations;
- The instructions used;
- How to plan the procedures that would lead them to the targeted display; and
- How to implement this plan.

This interchangeable display can be controlled by users, provided they have sufficient knowledge in controlling these displays. On the other hand, the automatically controlled interchangeable display can be utilised in public areas as means of providing information, like in an airport. However, the cost and space required for a fast and automatic interchangeable display is higher compared to the cost and space required to display the arrival and departure information on 12-18 screens.

8.2.3 Dividing the Display

Most word processors allow users to split their displays into one of more sections. This enables users to view different parts of the document in a single display. This feature can be found on earlier text-based systems such as eMacs, WordPerfect, MS Word, and IBM PC, among others.

The display can be split both horizontally and vertically. It is a simple approach resembling the multiple windows display, but provides more features compared to the Windows system.

8.2.4 Tile Arrangement

Displays arranged horizontally or vertically are examples of tile arrangement. This idea is drawn from the concept of fixing floor tiles. The floor space is filled with pieces of square tiles and the arrangement of tiles does not overlap with one another. This is also the case for displays on a computer screen, where the border of one display does not overlap with another.

In this approach, the modification of the size and location of windows is very important in ensuring each new window that is opened does not overlap on an existing window. The best strategy for this approach is as follows: The first window is opened to its maximum size without overlapping the existing toolbar. When a subsequent window is opened, the earlier Window will be divided into equal horizontal and vertical displays to provide sufficient space for the second window. This process repeats for all subsequent windows opened.

When one of these windows is closed, the screen would be modified again to best fit the free space. This may maximise a window that has already been opened, by reversing the process described above.

There are some software that use a modified version of this approach. For example, the Xerox Star arranges opened windows without filling all the available space on screen. The first window opened fills the left portion of the screen, meaning the right space would be empty. When a second window is opened, the previous window is split into two sections to accommodate the second window below it. Up to this moment, the right space is still left free. The same scenario repeats when the third screen is opened. Now, each screen opened accommodates one third of the left section of the screen. Only upon opening the fourth screen will the right section be filled. The size of the fourth window is equivalent to the size of the first window before all subsequent windows were opened. The process that occurred on the left screen will now repeat on the right when the fifth and sixth screens are opened.

8.2.5 Maximising and Minimising Windows

To support the requirement of users to temporarily maximise and minimise windows, certain software provide the capability to maximise the window to the full screen, and later minimise it to its original size. This technique is normally used by software utilised for slide displays. This feature that enables all slides to be displayed simultaneously in a single display is known as the ‘thumbnail’, where each thumbnail can be expanded.

8.2.6 Windows Overlap

The most popular strategy currently being used is the ability of windows to overlap one another without a specific style of arrangement. These windows can be freely moved by users. If the window is moved beyond the screen display, only the section of the window that within the screen will be displayed. This strategy is widely used in SmallTalk, Apple Lisa, Apple Macintosh, and in a number of the latest Microsoft software.

The advantage of this approach is the system is able to execute multiple tasks at the same time. For example, while using the word processor, the users are also able to send email and use the calculator. The users can open a new window, execute a new task and then return to the initial window without having to restart it. However, this approach may hide some necessary information as well as increase the users' burden of managing these windows.

8.2.7 Cascade Arrangement

In this approach, the windows are arranged sequentially from the top left to the bottom left of the screen. The first window is higher and moved to the left compared to the second window. This is to ensure that a substantial section of each window opened is visible to the users.

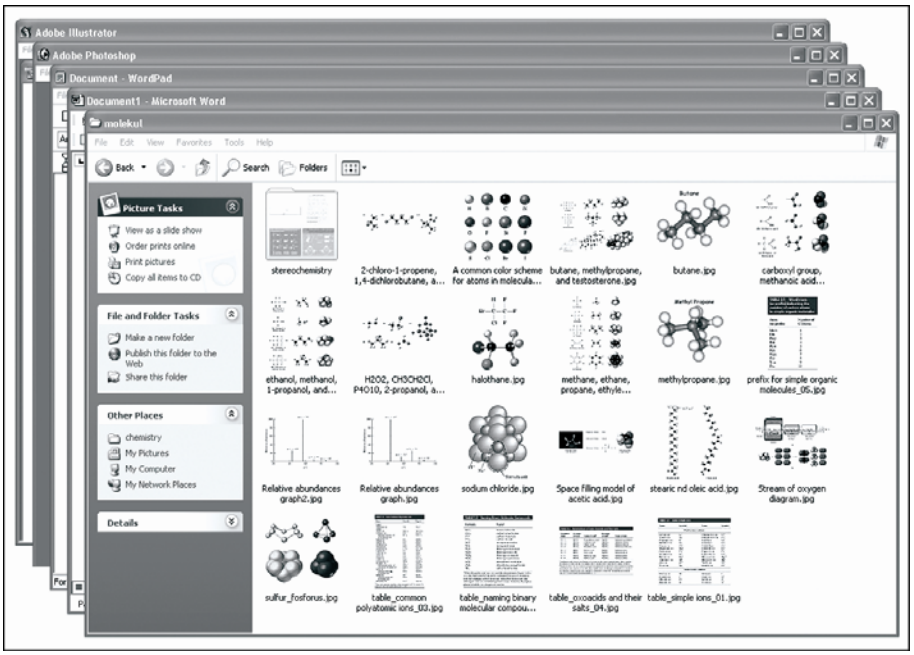

Figure 8.6: An example of windows that have been cascaded

Some systems automatically cascade the windows, whereas others allow users to select the cascade arrangement from a menu. Research has proven that users are able to answer questions more swiftly when using the cascade arrangement for the windows compared to using a single window at a time.

ACTIVITY 8.2

What is meant by the 'tile' arrangement of the windows?

8.3 WINDOW MANAGEMENT

As mentioned previously, users are required to manage windows when using the Windows system. The following subtopic will discuss each window management technique as well as variations in the existing software.

8.3.1 Opening Windows

A window can be opened from an icon or a text menu list by writing instructions, selecting menus, using voice instructions or double clicking the mouse button.

The icon used to represent a window comes in many sizes, ranging from 0.5 – 3.0 cm^2

8.3.2 Choosing the Window Location

Most systems determine the size and location of the prospective windows based on the size and location of the current windows. However, opening a new window closer to the current focus would be a better method in determining the size of windows. This is to ensure minimum eye movement when users shift their vision between the previous and newly opened windows. It is also important to ensure that the new location should be distant enough to prevent the newly opened window from disturbing the current focus.

8.3.3 Closing Windows

A window usually has a small icon on the top left or right corner, which functions to close it. Users can also close the window by selecting the 'close' item on the 'pull-down' menu that is located at the top left corner of each window.

8.3.4 Changing the Size of Windows

There are many different ways of changing the size of windows that are used in various software. Macintosh, for example, allows the size of window to be changed only from the right corner angle. In other software such as MS Windows, OSF/Motive and OS/2, the size of windows can be be changed from every angle. Some systems are able to automatically change the size of windows. The maximum and minimum size of windows may also vary from one system to another. Some systems allow changes of up to 1 x 2cm, whereas others set the minimum size at 4 x 6cm. However, most systems set the maximum size of the window to the size of screen display.

8.3.5 Moving Windows

There are many existing approaches for this operation. Xerox STAR and MS Windows 1.0 contain the 'Move' item on the menu. Users need to select this item by placing the cursor on the necessary location and clicking the mouse to move the window to its destination. On the other hand, the Macintosh system utilises the title bar as its holder, and users are allowed to drag the window outline to the required destination. Some systems allow the entire window to be dragged to its targeted destination.

8.3.6 Activation of Windows

If a system allows for the overlapping of its windows, there should be a mechanism to activate the movement of windows located from the background to the foreground. There are many different ways to perform this activity. Users can select a window's title from the menu list, select the 'Top' operation that is featured on each window, and click on any visible section of the window. In X Windows, for example, users merely have to move their cursor to the visible section of a window and this window will immediately be activated.

ACTIVITY 8.3

1. What is the method used in X Windows to activate a window?
2. Why does the Windows system need to provide the facilities for managing windows?

SUMMARY

- You have already been exposed to the different.
- In this topic, we discussed the elements of the Windows system as well as the issues related to the system.
- You have seen how different approaches and solution methodologies are used in different systems or environments.
- You can use this knowledge to design the interface of your upcoming system.

KEY TERMS

Icon
Multiple window system
Pointer cursor
Window
Window management

Topic 9 ▶ What is a User-Centred Design?

LEARNING OUTCOMES

At the end of this topic, you should be able to:

1. Elaborate on the importance of user interference in the process of system development;
2. Explain the three basic principles of the user-centred design as well as each of its importance; and
3. Identify the main characteristics of each life cycle model and the design approaches that are being discussed.

▶ INTRODUCTION

Software that is complex and sophisticated would usually require the expertise of a group of systems developers. To ensure the production of high quality software, the process of software development should be systematically done using specific methods. Experts in the field of software engineering conduct research on these methods and other elements related to the development of high quality software.

According to a number of researches conducted, it was discovered that most software were produced had usability problems and were difficult to be maintained. This finding encouraged HCI researchers to continue investigating

and identifying the strengths and weaknesses of the existing system development methods that could be have been the source of these problems.

In this topic, we will look at a number of methods or traditional system development approaches that have been used in software development, and compare them with one another.

9.1 WHY ARE SYSTEMS DIFFICULT TO BE USED?

We should be aware that the interface a vital element that relates users to the system in use. Thus, the problems that are faced by users when utilising the system may be related to the system's interface.

As previously mentioned in Topic 2, a developer's conceptual model should be in the same inclination as the users' mental model. Apart from this, you have also been exposed to a number of approaches that can be utilised to ensure both these models are compatible with one another. Nevertheless, a number of differences may cause difficulties in using the system. Among these differences are:

- The elements that seem important to users may differ from what is important to developers. Developers always emphasise on system characteristics and are prone to develop a system that is elegant, sophisticated and complex, whereas users give more emphasis to the features provided by the system that help them complete their task in a shorter period of time.
- Developers tend to make inaccurate assumptions about users. For example, developers often assume that users are able to understand all the information displayed on the screen, but this may not always be the case.
- Many developers do not use the developed system, as an end-product, and may not give proper attention to human social aspects such as psychology. Thus, they are unable to understand or predict the possible problems that may be faced by users.
- Users often act unpredictably, possess habits or characteristics that cannot be changed, are suspicious of the system and sometimes have the notion that they may disrupt or cause system malfunctions, whereas developers assume that users have the same perspective as themselves.

The most important factor that can assure the success of a particular software or product is user satisfaction. In other words, we should always give importance to the views of the users and be sensitive towards their problems. Thus, the field of HCI always emphasises the importance of cooperation between users and developers during the development stage. This may reduce the incompatibility problems mentioned above. This concept of cooperation between users and

developers has become one of the main principles in developing a user-centred design.

Prior to discussing the user-centred design, it is important that we have an understanding of the system development life cycle, which comprises the activities and phases involved throughout the process of developing software or a system.

ACTIVITY 9.1

Why do developers have to give importance to the social aspects of humans, such as psychology?

9.2 SYSTEM DEVELOPMENT LIFE CYCLE (SDLC) IN SOFTWARE ENGINEERING

Software engineering explores all systematic methods that can be utilised to develop software. There are many types of SDLC models that have been proposed in software engineering. Here, we will look at three traditional models - the Waterfall Model, the Spiral model, and the Rapid Application Development (RAD) model.

9.2.1 The Waterfall Model

The Waterfall model was the earliest life cycle model to be introduced. There are several phases of system development in this life cycle. These development phases are implemented in a linear manner. For example, the design process can only begin upon the completion of the requirement specification phase. This model can be illustrated as in Figure 9.1. In short, all processes in each phase are shown in Table 9.1

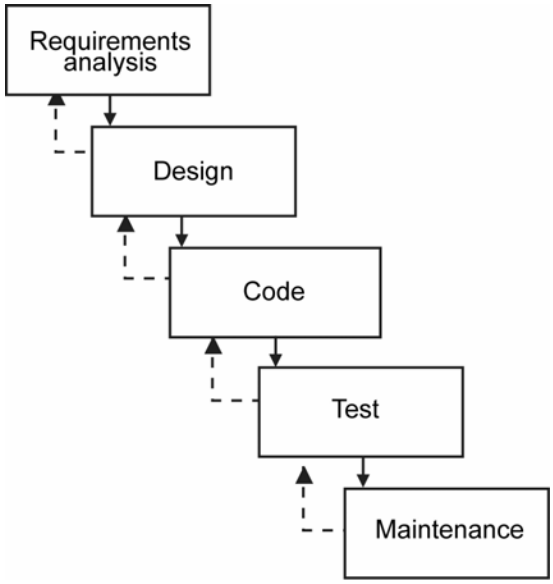

Figure 9.1: The Waterfall Lifecycle Model

Table 9.1: The System Development Phase in the Waterfall Model

Phase		Steps of Process
1.	Requirement Specifications	• The designer and customer discuss to identify the utilities that need to be featured in the new system.
2.	Architectural Design	• The designer develops utilities that have been identified. • Certain techniques are used to formulate the results of the requirement specifications of this architectural design.
3.	Detailed Design	• The system is divided into a number of components or units. • Each component or unit is designed separately with specific details, and may be designed by different designers.
4.	Coding and testing unit	• The programmer codes or implements the design based on the respective units and later tests the code.
5.	Integration and testing	• The components or units are recombined, and testing is conducted on the entire system.
6.	Maintenance	• Error correction, updates, and system improvisations conducted on the entire system.

A number of system weaknesses that have been identified are:

- System requirements that often change due to rapid development in the business and information technology environments after the completion of system development and testing. Additionally, users always fail to highlight their exact requirements at the beginning stages. Thus, a good life cycle should be able to support this repetitive process, through consistently checking the system requirements throughout development, and customise when necessary.
- The shortcomings during the process of maintenance. Research has found that the longest life span of software is determined during the maintenance phase. Usually, the group of developers would always be dismissed once the product has been developed. This causes difficulties for the process of maintenance.

9.2.2 The Spiral Model

The Spiral model was first introduced in 1988. There are two main characteristics that distinguish this model from the Waterfall model, which are risk analysis and prototype development. Kindly refer to the following illustration:

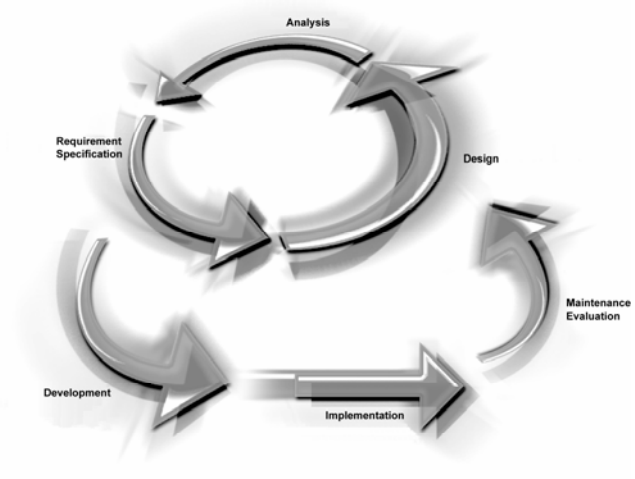

Figure 9.2: Spiral Model

This model allows for ideas and improvements to be continuously monitored and evaluated during the development process. Each circle represents a repetition, and each repetition involves a different activity, except risk analysis and prototype development.

Although this model uses the concept of continuous repetition, enforcement is given towards the risks that are overcome during the process of developing the system, and not the functionalities and utilities that are provided by the system. The latest version of the Spiral model is known as the Spiral WinWin model, and has entered the negotiation phase between the developers and stakeholders. This phase is expected to ensure the satisfaction of both the developers and users of the system for the products that have been produced.

9.2.3 The RAD Approach

In the 1990s, a new approach was introduced, called Rapid Applications Development or RAD. By considering user opinions, RAD attempts to reduce the effects of the changes in user needs during the development of a system.

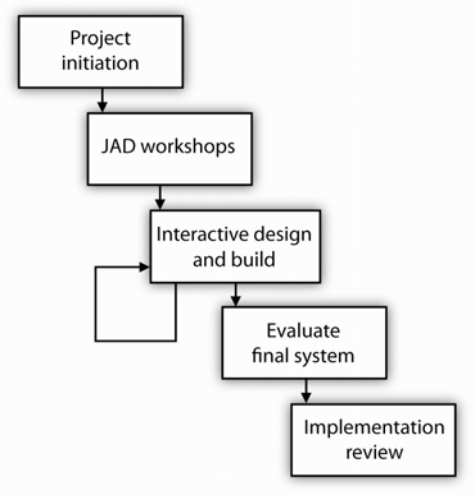

Figure 9.3: RAD lifecycle model

The two main characteristics of the RAD model are:

- A shorter life span of SDLC. Usually, the time span for system development is limited to six months. At the end of this period, a portion of the system should have been completed. To ensure this, bigger projects are normally divided into smaller subprojects that can be developed in different stages.
- Conducting Joint Application Development (JAD) workshops. In these workshops, users and developers jointly discuss system requirement issues and make decisions on requirement specifications. The representatives from each stakeholder group will be involved in these workshops to ensure that the views of all parties who are directly or indirectly involved in the process of development are given due consideration.

ACTIVITY 9.2

What are the main weaknesses of the Waterfall and Spiral models compared to RAD?

9.3 THE BASIC PRINCIPLES OF A USER-CENTRED DESIGN

The three main principles of the user-centred design or UCD are:

- Users are given attention from the beginning of the development;
- User response to the system prototype is measured empirically; and
- Iterative repetition occurs in the SDLC.

Each principle will be discussed in detail in the following subtopics.

9.3.1 Focus on Users

In the UCD approach, it is important for developers to know prospective users, as well as understand their needs. This is achieved by studying their cognitive characteristics and attitudes. This is by observing the manner in how users perform their tasks, studying these natural tasks and involving users in the development process.

This principle can be divided into a number of specialised principles:

- Consider user tasks and goals as the driving force behind the development process. In the UCD approach, the question that needs to be answered is not "How can we apply this technology", but "What is the best technology that can be utilised to support the users' tasks and goals?".
- Study user behaviour, context of use and the system that is being designed to support these elements. The knowledge on how users implement these tasks is also important. By understanding these aspects, we can obtain information about their priorities, preferences and intentions.
- Study user characteristics when designing the system. Usually, we tend to blame ourselves for the arising technological mishaps. But as humans, we are prone to making mistakes because of the physical and cognitive limitations. The product or system that is being designed should be able to minimise the mistakes effects of human limitations and weaknesses.
- Consider user views, from the first phase until the final phase of system development. There are many phases of user involvement in system

development. Under any course, developers should always have high regards for user views and opinions.

- Base all decisions made on the design on context of the user, nature of work, and environment. This does not necessarily mean that users are actively involved in the process of making decisions. As long as developers are aware of the importance of considering user interests and welfare, this principle can always be implemented.

9.3.2 Prototype Development

Prototype development is the phase of developing the interactive version of the system being created. The prototype is passed to users for testing and evaluation. The response from users should be measured empirically and the results interpreted and analysed for further system improvements.

The development of prototypes can be executed in stages. During the initial development stages, the users' abilities and reactions are measured using scenarios and manuals. In the next stage, users interact with prototypes and simulations that are more complete compared to previous scenarios and manuals. This process continues until the developer is satisfied with the system's design. This process will be further discussed in upcoming topics.

9.3.3 Repetition

When problems are encountered during the user-testing phase, the prototype would be improvised and further tests and observations are conducted to confirm the benefits of this improvisation. In other words, the process of designing and developing the system is an iterative process, where the cycle of 'design-test-measure-redesign' phase is repeated if necessary.

9.3.4 Case Study: Olympic Messaging System

The development of the Olympic Messaging System or OMS is an example of the user-centred design approach. The OMS was developed to provide athletes and all personnel who involved in the 1984 Los Angeles Olympics with the facility of voice message transmission. A number of kiosks installed using this system was placed in the surroundings of the Olympic Village. This enabled athletes to send and receive voice messages among themselves. Additionally, users around the world were also able to send congratulatory voice messages and words of encouragement to the athletes and officials of this event.

We will now look at the manner in which this successful system was developed, as well as the approaches that were used for this process. After performing a number of initial analyses on the system's requirements, the user interface

scenario was prepared, printed and evaluated. Figure 9.3 (a) and (b) below show examples of this scenario.

Caller:	(calling 213-888-888)
Operator:	Irish National Olympic Committee. Can I help you?
Caller:	I want to leave a message for my son, Michael.
Operator:	Is he from Ireland?
Caller:	Yes.
Operator:	How do you spell his name?
Caller:	K-E-L-L-Y
Operator:	Thank you. Please hold for about 30 seconds while I connect you to the Olympic Messaging System. Are you ready?
Caller:	Yes
OMS:	When you have completed your message, hang up and it will be automatically sent to Michael Kelly. Begin talking when you are ready.
Caller:	'Michael, your mother and will be hoping you'

Figure 9.4(a): A scenario of a father leaving a voice message

You:	(call 740-4560)
OMS:	Olympic message system. Please keypress your three-letter Olympic country code.
You:	U S A
OMS:	United Stated. Etats-Unis. Please Keypress your last name.
OMS:	J O N E
You:	John Jones.
OMS:	Please keypress your password.
You:	405
OMS:	New message sent by Message Center. 'John, good luck in your face. Dad.' End of message. Press 1. listen again; 2, leave a message; 3, hang up.
You:	3.
OMS:	Good-bye.

Figure 9.4(b): Scenario of a user listening to a voice message

This scenario was evaluated by designers, management groups and prospective users. As a result of this evaluation, a number of system functionalities were customised while some were disposed.

Apart from this, a brief user guide explaining the system's behaviour was also written and tested by athletes, their friends and family members. This guide was iteratively developed and approximately 200 versions were produced before the actual guide was approved.

Before the authentic system was produced, a simulation was created and tested by the users. One of the issues highlighted in the testing was the need for an 'undo' and 'backup' key to enable users to revert back to their point of mistake. An example of a mistake was when users incorrectly entered the country code.

Several other methods were also used to gather the required information from targeted users. These methods included visiting the Olympic village, demonstrating the initial system, interviewing users involved in the sports, and discussions with former athletes who were also the system's designers. A system prototype was then produced and tested by different groups of users. As a result of this test, several design modifications were made, and the system was then retested.

A number of other methods were also used to obtain user opinions about the heights and design of the existing kiosks by using kiosk prototypes. This included the use of the 'try-to-destroy-it' test to encourage users to crash the system. This tested the durability of the system.

This case study is presented to explain on how the three basic principles of the user-centred design were used as the basis for designing and developing a system.

ACTIVITY 9.3

Provide a specific explanation on the three basic principles of the UCD design.

9.4 USER-CENTRED LIFE CYCLE MODEL

There are a number of SDLC models produced based on the user-centred design approach. The following subtopics will discuss these models in detail.

9.4.1 The Simple Model

The relationship between the activities of the SDLC models is illustrated in Figure 9.4 below:

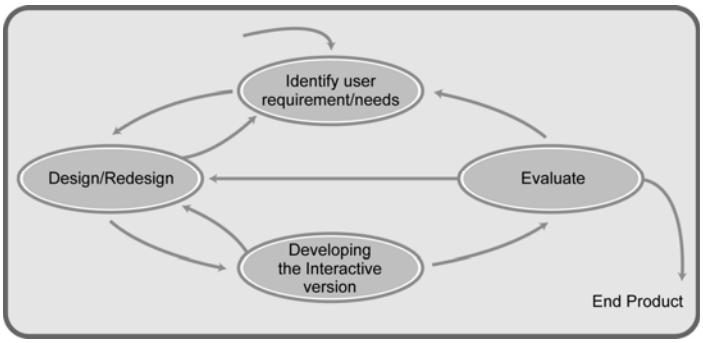

Figure 9.5: The Simple Model
Source: Preece, 2002

The Simple model enforces the concept of repetition and focuses on the users. Most projects begin with the task of identifying user requirements. Subsequently, several design alternatives are generated to ensure that the identified requirements are fulfilled. The interactive version is then designed and evaluated. Based on the response from the evaluation, the developers may need to re-identify the system requirements or move forward to the design phase. A number of alternative designs may be expanded after this process.

9.4.2 Star Model

The Star model was created as a result of the empirical studies on how designers handle HCI issues and problems. This model was proposed by Hartson and Hix in 1989 as an alternative to the Waterfall model.

From the empirical study that was conducted, researchers identified two modes of developer activities: analytic and synthetic. The characteristics of these modes are summarised in Table 9.2. However, they discovered that it was a norm for system developers to frequently switch between different modes.

Table 9.2: Characteristics of Modes

Characteristics of Modes	
Analytic	**Synthetic**
• Up-down	• Down-up
• Judicial Organisation	• Free thinking
• Formal	• Creative and Ad-Hoc
• The production of a system begins from the system's view towards the user's view.	• The production of a system starts from the user's view towards the system's view.

Unlike the Waterfall model, the Star model does not emphasise on the sequence in activities. All the activities are closely related to one another and you can move from one activity to another provided that an evaluation is conducted before the commencement of the intended activity. Refer to the following Figure 9.5.

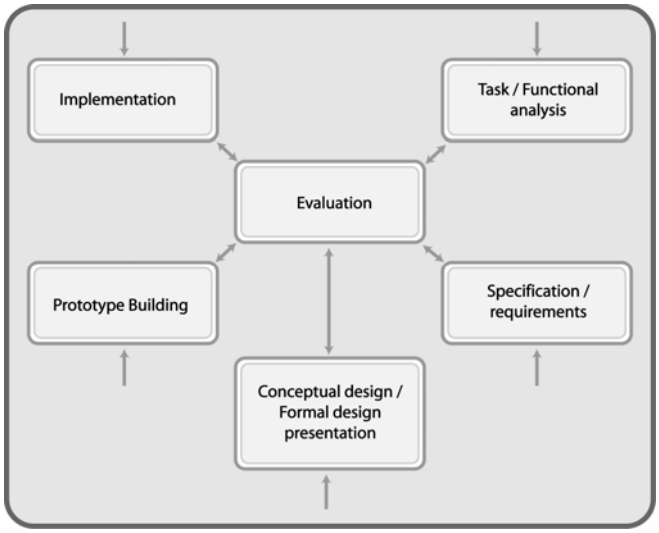

Figure 9.6: The Star Model
Source: Preece, 2002

The process of evaluation is an important activity in this model. After the implementation of each activity, the results should be evaluated. Thus, a project may begin with the process of information gathering and evaluation of the existing system before advancing to the next step.

9.4.3 Usability-Engineering Model

This model was proposed by Deborah Mayhew in 1999, and provides the space and explanation on how the evaluation of usability can be implemented. This activity is incorporated into the traditional SDLC, making it very useful for inexperienced developers in enduring the usability test. This model also combines the rapid prototyping approach and the object oriented software engineering method.

The usability-engineering model involves three main activities: requirement analysis, design development/testing and installation. In observing Figure 9.6, you will notice that the life cycle of this model resembles the Simple model's design, but is designed in detail. It involves the phases of identifying requirements, design, evaluation and prototype development, and uses style guides as a mechanism to infuse and ensure that the usability goals are achieved in this project. According to Mayhew, a number of steps in this model can be disregarded in the case of it getting too complex to be implemented.

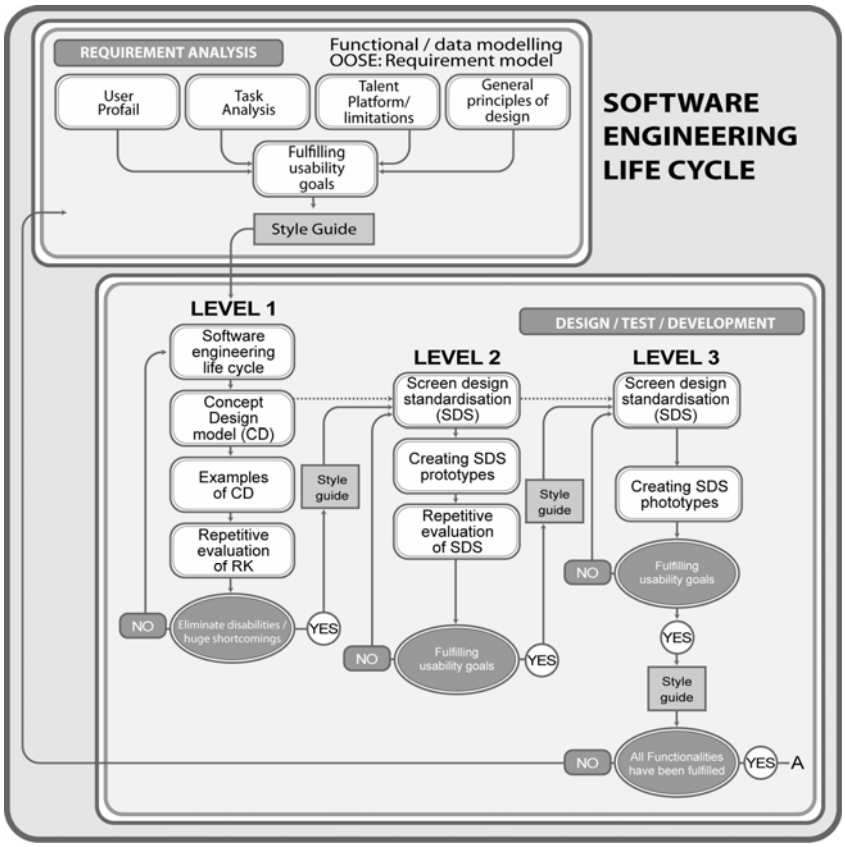

Figure 9.7: Software Engineering Model
Source: Preece, 2002

ACTIVITY 9.4

Explain the main difference between the Star model and all other existing models.

9.5 PARTICIPATORY DESIGN

The Participatory design greatly resembles the UCD model. The participatory design is a philosophy that encompasses the entire SDLC cycle. This design is a workplace design that involves users both as research material and as members of the system design or developers' team. In this case, the users are actively working in the process of designing the system, and are no longer the designers monitoring the outsiders.

The rationale of this approach is that the system users are usually the experts in the context of the job, and any design is most effective in the context of work if these experts are allowed to contribute towards the designing of the prospective system.

The participatory design has three specific characteristics, which are:

- This design intends to improvise tasks and work environments by introducing a proposed design. This causes the design to be work-oriented compared to being system oriented.
- The collaboration or active cooperation provided by users enables them to continuously contribute towards the design throughout the development of the system.
- The iterative approach enables the design to be evaluated and improvised at each level.

The participatory design uses a number of techniques or methods to help deliver information between users and designers. The summaries of the techniques used are illustrated in Table 9.3.

Table 9.3: The techniques used in the Participatory Design

Techniques		Characteristics
1.	Brainstorming	• Involves all users. It is carried out informally and not too rigid. • All information is recorded without prejudice. • This session can produce many ideas, and the process of filtering to select an idea uses a different technique.
2.	Storyboard	• Explains: - Potential designs and effects that can influence this design. - Daily activities of users.
3.	Workshops	• Receives more detailed information and presents a focused view of design. • Users and designers keep questioning each other to understand the context of the design from different perspectives. • The designer question users about the working environment of the prospective design, whereas users question designers on the existing technological abilities.
4.	Paper and pencil exercise.	• Enables design to be analysed and tried by sketches of the model on papers. • Simple and cheap; suitable to be used at the initial stages of system development.

SUMMARY

- User satisfaction is a very important consideration in ensuring the success of a product. Thus, user views should be taken into consideration when designing a system.
- By studying the three life cycle models which are the Waterfall model, Spiral model and RAD approach, you are now aware the approaches that have been used to develop a system or software.
- The three basic principles of the user-centred design are the focus on users from the initial stages of system design, the empirical measurement of the users' response towards the system prototype, and the occurrence of iterative repetitions in the system development life cycle.

- The traditional approach has its weaknesses, where user involvement makes the system difficult to be used.
- Several new approaches such as the Simple model, Star model and the Usability Engineering model have been discussed above.

KEY TERMS

RAD approach
Simple model
Spiral model
Star model
System development life cycle
Usability- engineering model
Waterfall model

Topic 10 ▶ System and User Requirement Analysis

LEARNING OUTCOMES

At the end of this topic, you should be able to:

1. Identify the meaning of 'user';
2. Explain the five types of system requirements;
3. Identify the five techniques for gathering data; and
4. Identify the three techniques of interpretation and data analysis that focus on users.

▶ INTRODUCTION

As you have learnt in the previous topics, the process of system development consists of several phases or basic levels. These phases would always exist despite the use of various other designs and approaches. The only difference lies in the enforcement of usage, sequence and several additional phases. The basic phases mentioned above include the phases of requirement specification, design, coding and implementation, and testing and maintenance.

However, in this course, we will not discuss the details of each phase, but concentrate on phases that focus on the user-centred design. One of the most important phases which acts as the starting point for the process of software development is the phase of requirement specification. In this phase the system requirements, especially user needs, are determined and documented as the requirement specifications of the system, and used as a reference throughout the development of the system.

In this topic, we will also discuss all the different requirements of the specification, as well as techniques used to gather all the neccesary information and interpret them.

10.1 USER REQUIREMENTS

One of the most important goals of designing an interactive system is to optimise the interaction between users and the products created. Thus, the end product should always support the requirements and needs of its users, as well as always be able to provide all the necessary features that would speed up and improvise the users' tasks. Thus, as developers, we should be able to identify individuals whom we could refer to in order to obtain information on the system and user requirements.

10.1.1 Who are the Users?

When we mention the word 'users', we always refer to the prospective users of the system and the end-product that is going to be produced. In reality, there are several interpretations of 'users'. Apart from users who will be directly interacting with the system, better known as end-users, users also encompass individuals who are involved in system testing, making decisions to purchase a system as well as those who are competing to use this new system.

Eason (1987) identified three groups of users - primary, secondary and tertiary users, as summarised in Table 10.1

Table 10.1: Three Groups of Users

User Groups		Characteristics
1.	Primary	• Frequently use the system that was produced.
2.	Secondary	• Rarely use the system, or use a mediator when using the system.
3.	Tertiary	• Accept the effects or consequences of new emerging systems. • Influence the purchase or production of the new systems or products.

Tertiary users are also known as stakeholders. The definition of stakeholders is:

"Individuals or organisations that experience the effects or consequences from the system, as well as those who are directly or indirectly involved in determining the system's requirements". (Kotonya and Sommerville, 1998).

These users can also be classified based on their expertise and frequency of using the systems. Based on this classification, there are three types of users. The type of user plays an important role in determining the system's requirement specifications and design. Each user has different needs compared to others, and a good system should be able to consider all the different types of users, as explained in Table 10.2.

Table 10.2: Three Types of Users

	Type of User	The Required System
1.	**Novice Users** • New and inexperienced users.	• Guides users in implementing their tasks by providing one instruction at a time. • Prepares more responses and 'closures' to enable users to feel their progress when using the system. • If this is nott enforced, the novice users may feel abandoned and wary of the system.
2.	**Casual Users** • Able to complete their tasks without much help from the system. • Use the system once in a while.	• Possess a consistent structure to enable users to make accurate predictions and assumptions about the system. • Possess efficient help facilities and documentation to enable users to make detailed references, or when they have forgotten information about the system.
3.	**Expert Users** • Rarely need guidance from the system as they are able to remember all the necessary details. • Emphasises methods to implement tasks as quickly as possible with minimum error. Thus, these users prefer using shortcuts.	• Has the mechanism to control and correct mistakes made by expert users, including serious mistakes.

10.1.2 What is Meant by User Requirements?

It is not easy to determine what is required by users. We will not be able to obtain this information by merely asking users 'what do you need?'. This is because users are usually unaware of the capabilities of the system. On the contrary, to gather the necessary information, we need to address the following issues beforehand:

- Understand the characteristics and strengths of users;
- Be aware of the goals that they intend to achieve or implement;
- Undertand the means used to achieve these goals; and
- Study the possibility of achieving the goals more effectively by using various other utilities.

In the previous units, we discussed how the characteristics and abilities of users can influence the system's design. For example:

- The size of the user's hand can influence the size and position of an input button.
- The height of a user can influence the design and location of a kiosk machine.

If a product turns out to be a new invention or innovation, it may be difficult for us to identify its users and the tasks that utilise this product. For example, when the microwave oven was invented, none of the users could be questioned or were involved during its development, and there were no related tasks that could be analysed. The designer was prone to design the product based on his/her preferences, but it may not have been suitable for the targeted users. The best approach to solving this matter would be to understand that the users' nature in utilising an existing product may be the same as for the prospective product. Another example is that prior to the introduction of the mobile phone, analysis of user tasks could not be conducted. However, with the existence of fixed telephones, the initial analysis could be conducted on the methods of usage. Apart from making calls, it was discovered that users had to frequently refer to the numbers they wanted to call, take messages during the absence of the recipient, and retrieve the last caller's number. With these characteristics in mind, the mobile phone was designed to support these additional features.

ACTIVITY 10.1

Give a simple explanation about the three groups of users.

10.2 SYSTEM REQUIREMENTS

System requirements refer to the specifications of what could be done with a prospective product, as well as how these actions could be carried out. One of the goals of this activity is to specify the system's needs and clear all confusion as much as possible. For example, the requirement of a website is to be able to download an item is less than five seconds.

10.2.1 Functional Requirements?

There are two types of requirements that have been identified in software engineering:

- Functional requirement – to highlight what is to be done by the system.
- Non-functional requirement – to highlight the limitations during the development of the system.

An example of such a system would be the word processing software.

- Functional Requirements
  - the need to support different formats and styles.

- Non-Functional Requirements
  - should be able to be implemented on different platforms such as PC, Mac and UNIX machine.
  - this software should be completed within six months.

In an interactive system development, these non-functional requirements are important elements that influence the product design. The non-functional requirements can be divided into several parts:

- Data requirements;
- Environmental requirements;
- User requirements or need; and
- Usability requirements.

The elements will be discussed in the following subtopics.

10.2.2 Data Requirements?

Data requirements revolve around the type of data, its volatility, size, endurance and persistence, and accuracy as well as the value of the data required. All interactive devices should be capable of handling the specified data. For example, if the system that is being developed is supposed to operate a stock management application domain, the data specified should be up to date and accurate, as there may be a possibility for this data to consistently change periodically. In individual banking domains, data have to be precise and be able to last for a number of months or years. The data are very valuable and may be large in size.

10.2.3 Environmental Requirements?

The specification for environment requirements or the context of use refers to the condition in which the interactive product will operate. The four environmental aspects that need to be considered in estimating the requirement specifications are:

Physical Environment

Example:

- The estimated amount of light, noise, and dust during the operation of the product.
- Do users have to wear protective apparel such as gloves and helmet which would influence the selection of style and technology used in interaction?
- How constricted is the environment?
- An example of an aspect that needs consideration: an ATM machine that operates in an open space. Thus, using voice technology to interact with customers would be a problem.

Social Environment

- Issues relating to collaboration and coordination have to be analysed and researched in the context of the current system development.
- An example of consideration: should data be shared? If necessary, is the sharing synchronous, where all users are able to display data at the same time?

Organisation Environment

Example:

- What is the level of user support?
- How easily can it be achieved?

- Will utilities and training resources be provided?

Technical Environment
Example:

- What is the technology that is used or suitable to be used to implement the product?
- Will technological limitations influence the product efficiency?

10.2.4 User Requirements?

User requirements or needs revolve around the characteristics of the targeted group. In the previous units, we touched on the importance of the relationship between of the users' talents and skills and these aspects during the specification of user requirements.

Additionally, a user may be a novice (new to the system), casual (frequently uses the system) or an expert user. The different levels of users have already been discussed in the previous topics.

The collection of information on the different attributes and characteristics of users can be called the user profile. Each tool or prospective system being developed may contain different user profiles.

10.2.5 Usability Requirements?

The usability requirements define the usability goals and measures related to a product. In previous topics, we discussed the usability testing implemented in a system development life cycle (SDLC). In the user-centred life cycle, usability has to be pre-determined during the initial stages of system development. Usability requirements have to utilised to track the progress of each level of system development.

There are a number of usability goals that need to be achieved. Among them are:

- Effectiveness;
- Efficiency;
- Utility;
- Learnability; and
- Memorability;

It is indeed difficult for us to quantitatively measure the qualities of these principles, but it is important to stress the importance of each of these qualities.

ACTIVITY 10.2

Explain the five types of system requirements.

10.3 DATA COLLECTION

We will now look at the methods to determine and obtain the previously discussed requirements. The main reason for gathering data is to ensure a sufficient, relevant and appropriate collection of data to produce a set of sensible requirement specifications. Although a set of requirement specifications has been pre-determined, this process is used to expand the specifications as well as validate its accuracy.

There are a number of basic data gathering techniques. However, these techniques can be expanded and combined in many other ways to collect more useful information. These techniques include interviews, questionnaires, focus groups and workshops, observations and documentation studies. Some techniques, such as interviews, require more active participation from the stakeholders, whereas techniques such as documentation studies do not require the involvement of stakeholders.

10.3.1 Questionnaires

Most of us are probably used to the questionnaire technique. It consists of a series of questions that have been designed to obtain specific information from the respondent. In this technique, we are considered the stakeholders. The questions can be designed in different forms; some require simple 'YES/NO' answers, others require users to select from multiple choices of answer or to provide specific answers. At times, questionnaires may also be sent via email or be published on websites. However most of us receive questionnaires on papers and these questionnaires are mainly managed from a distance, thus respondents do not have anyone to help them answer the questions or explain the questions to them.

A questionnaire that is carefully planned can be used to obtain specific answers from a large number of respondents, especially from groups of individuals located at different places that cannot be visited by the researcher. The questionnaire technique is usually used together with other techniques. For

example, the information obtained from an interview is usually supported by sending questionnaires containing the same questions to different stakeholders for verification.

10.3.2 Interviews

Interviews are data collection techniques where users ask various questions to obtain the necessary information. An interview is usually conducted face-to-face with the respondent. However, many organisations these days spend large sums of money to interview clients via telephones. This is to find out if the clients are satisfied or dissatisfied with the services provided. If respondents are interviewed at their homes or office, it may be easier for them to talk about their activities by presenting the necessary artefacts to the interviewer. An example would be the of downloading an email, where users may not be able to remember this issue if interviewed while at another location.

An interview can be classified into three types, depending on how the interviewer adjusts the questions based on a set of questions provided. This is depicted in Table 10.3 below:

Table 10.3: Types of Interviews

	Type of Interview	Characteristics
1.	Structured	• The interviewer usually conducts by reading the questions that have been prepared, without many changes to the structure and words to ensure consistency throughout the interview.
2.	Semi-structured	• The interviewer may make some changes to the question to obtain more detailed information.
3.	Unstructured	• The interviewer may prepare their own set of questions, but these questions must revolve around the topic or information of interest.

In the requirement specification phase, interviewing is a good technique of encouraging the respondents to discuss related issues, and the unstructured technique is usually used to simulate an appropriate scenario. However, an interview can take a long time and it may get tedious for the researcher to meet all the required respondents.

10.3.3 Focus Groups and Workshops

An interview is usually conducted on a one-to–one basis, and this only generates a perspective of the individual's view. As an alternative or validation, cumulative opinions can be obtained by meeting a number of stakeholders in a single session of focus groups or workshops.

The session can be conducted in a very structured manner by using a set of related topics for discussion, but it can also be conducted in an unstructured manner. The latter would require a facilitator to control the flow of the discussion, and ensure the discussions do not divert from the original topic. If you recall, in the participatory design, workshops are one of the techniques used to enable users to contribute and work together with the designers.

In order to produce the requirement specifications, a good focus group or workshop would obtain different consensus or views and differing opinions. From the social point of view, this would enable stakeholders to meet the designers, and be able to openly voice their opinions and views. It is not unusual for a stake holder's opinion to differ from a designer, although they are both probably working in the same environment.

For a session to be structured, the potential participants should be carefully selected. It is easy for some individuals to dominate a discussion, especially if they carry a status, control, or influences that are higher compared to other participants. Thus, it is better to use facilitators in comprising such individuals to ensure the comfort of all parties involved in the discussion.

10.3.4 Observation

An individual may sometimes find it difficult to accurately explain his/her actions or means of completing a task. Thus, it is impossible for a developer to obtain all the necessary information from the stakeholder by only using a single method. Scenarios and props can be used to help users give more accurate information, although obtaining best opinions can done through observations.

Observation enables systems developers to spend more time with stakeholders who are performing their daily tasks in an authentic environment. One of the developers would be beside the stakeholder, asking questions (but not too many) and observing the actions in the actual context. This is a valuable method of obtaining information about the tasks of the stakeholder. This technique can also be used to complete the information obtained from other techniques.

The methods of observing users may differ from one observer to another. The observer could be directly involved as a member of the stakeholders by

performing all their daily tasks, or be indirectly involved in observing the stakeholders.

Apart from collecting information details, observation can also be used to gather information related to the context of usage. The context and environment in which the system is being used provide important information to generate the requirement specifications. However, the process of observation requires more time and commitment from the systems designers, and may also produce too much data for analysis.

10.3.5 Documentation

Procedures and regulations are usually written in a manual or document, and these resources are sufficient for obtaining data about the rules or steps involved in a task or activity. However, these documents should not be used as the main source of data as the daily tasks could increase and be modified to ensure the smooth and practical flow of the procedure.

Other forms of documents that can be studied include journals or work logs written by stakeholders while performing their daily tasks.

In determining the requirement specifications, studying documentations is a good technique in ensuring the designer obtains enough background information to execute a task. This technique does not take up much of the stakeholder's time, a limitation that can affect other techniques.

Table 10.4: Overview of Data-gathering Techniques Used in the Requirements Activity

Technique	Good for	Kind of data	Advantages	Diadvantages
Questionnaires	Answering spesific questions	Quantitative And qualitative data	Can reach many people with low resource	The design is crucial. Response rate may be low. Responses may not be what you want.
Interviews	Exploring issues	Some quantitative but mostly qualitative data.	Interviewer can guide interviewee if necessary. Encourages contact between developers and users.	Time consuming. Artificial environment may intimidate interviewee.
Focus groups and workshops	Collecting multiple viewpoints	Some quantitative but mostly qualitative data.	Highlights areas of consensus and confilct. Encourages contact between developers and users.	Possiblity of dominant characters
Naturalistic observation	Understanding context of user activity.	Qualitative	Observing actual work gives insight that other techniques can't give	Very time consuming. Huge amounts of data.
Studying documentation	Learning about procedures, regulations and standards.	Quantitative	No time commitment from users required	Day-to-day working will differ from documented procedures.

ACTIVITY 10.3

Compare and differentiate all the techniques of data collection based on suitability, advantages and disadvantages. Summarise your answer into a table.

10.4 DATA ANALYSIS AND INTERPRETATION

The required data that are gathered should be interpreted and analysed as soon as possible.

There are many different techniques that can be used to interpret and analyse the data that have been gathered, depending on the requirements. For example, a data flow diagram is used to analyse the functional needs of the system, while the entity relationship diagram is used to analyse data needs. We will not discuss these techniques in this course as they will be covered in other courses.

As far as this course is concerned, we will focus on the interpretation and data analysis techniques pertaining to the users. Thus, the discussions would centre on techniques for understanding users and their tasks. These techniques include scenarios, use case, and hierarchical task analysis.

10.4.1 Scenario

A scenario is an informal narrative explanation. It explains the activities and tasks of users in the form of a story and allows discussions and exploration from the perspective of context and requirement. However, scenarios do not provide a clear narration on the software usage and technological support utilised to implement the task.

This approach uses commonly used words and terms that are understood by stakeholders. This enables the stakeholders to be directly involved in the system's development. The interpretation of data into a scenario by stakeholders is actually the first step in determining the system's requirement specifications.

The following example is a scenario produced by a book catalogue service user in a library:

Say I am in the midst of looking for a book that has been written by A.Samad Said. I do not remember the title, but I know that the book was published in 1998. In the catalogue system, I enter the user keyword. After my keyword is validated, I am given a choice of performing a search based on the author's name or published year. However, I do not have the choice of using a combination of both options. I then perform a search using the author's name. After 30 seconds, the screen displays a message stating that no list exists with that name, but returns a list of books written by authors with a similar name. After scanning the list, I discover that I made some mistakes when keying-in the name. I had entered A. Samad Saad and not A.Samad Said. I then select the item I want from the list, and the screen displays the location of the book.

If you observe the example above, there are several issues that can be highlighted:

- The importance of accurately entering the author's name.
- User dissatisfaction of having to input keyword.
- Unflexible search methods.
- The advantages of displaying information close to the search query, especially when the query is unclear or contains a mistake.

The four issues highlighted above are suggestions of elements that need to be considered during the development of a new system.

Scenarios are usually the results of interviews or workshops, and can be used to further explain user goals. It is not a technique that encompasses the entire system's requirements, but provides space to obtain certain ideas or views from users.

Now, look at the following scenario that depicts an individual using a smart phone with wireless technology.

A businessman is travelling from Kuala Lumpur to Paris. During his journey, he is nearly caught in a traffic jam. Fortunately, he is able to avoid the traffic jam because of the warning tone notification from his Smart Phone accompanied by a message about an accident that has occurred on the route that he usually takes to Kuala Lumpur International Airport (KLIA).

Upon arriving at the airport, his Smart Phone is able to track his current location and transmit a message to the check-in counter to notify that he will be checking-in soon. Thus, an employee of the airline service collects his luggage for registration and transports it to the aircraft. After registering at the check-in counter, the display on his Smart Phone indicates that his flight would be

departing as scheduled, together with a map to the departure gate. On the way to the departure gate, the businessman download sall the related tourist information as well as the itinerary during his visit to Paris.

Upon boarding the flight, he immediately reads all the information that has been downloaded, and learns that his favourite opera performance would be held in Paris. He immediately reserves ticket for the performance, by using his credit card information on the Smart Phone. The Smart phone has additional security features that avoid the duplication of credit card information.

The Smart Phone stores the information on the opera booking as well as some email that have been typed by the businessman. As soon as he disembarks from the flight, his Smart Phone automatically establishes a connection to send all his email. Upon leaving the airport, his Smart Phone then displays the map showing the direction to the hotel.

ACTIVITY 10.4

From the scenario above, can you identify the additional features in a Smart Phone, compared to the mobile phone?

10.4.2 Use Case

The Use Case is another technique that focuses on user goals. It mainly enforces the interaction between the users' and the system, as compared to the scenario technique that enforces the users' tasks.

The Use Case is usually in relation to an actor, and the actor is always a user of the system. The Use Case would normally record information on user goals based on the context of system usage. Each Use Case technique contains two actions:

Normal Action

- The analyst's or designer's assumption about the steps usually be taken by users to implement a task.
- It is placed at the top of the Use Case.

Alternative Action

- Other actions that can be taken in order to implement the same tasks.
- It is placed after the normal action.

The following example is a Use Case of an administrator who is planning a meeting for the employees of his faculty by utilising a calendar application that can be shared by all the faculty's members:

Normal Action:

1. The user decides to plan a conference.
2. The system instructs the user to input the names of all members who are required to attend this conference.
3. The user types the name list.
4. The system validates the name list.
5. The system instructs the user to enter the limitations of the conference.
6. The user enters the limitations of the meeting.
7. The system looks for the best date on the calendar that fulfils the limitations.
8. The system displays all possible dates for the meeting.
9. The user selects the most suitable date.
10. The system notes the appointment on the calendar.
11. The system generates an email to all the names on the list, notifying the recipients about the appointment.

Alternative action:

5. If the name list is invalid:
   - 5.1 The system displays the error message.
   - 5.2 The system returns to step 2.

8. If none of the dates is suitable:
   - 8.1 The system displays an appropriate message.
   - 8.2 The system returns to step 5.

Note the numbers that are used in the alternative actions. In the case where the 5th step of the normal action is not implemented, the 5th step in the alternative action would be implemented. This also applies for step 8.

The Use Case technique is illustrated in Figure 10.1 below:

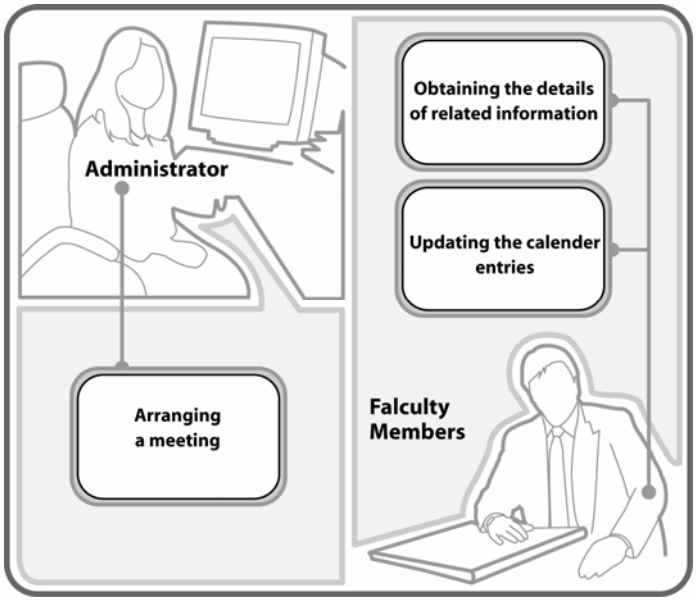

Figure 10.1: An example of a use case
Source: Preece, 2002

10.4.3 Task Analysis

The task analysis technique is used to study an existing situation, and not for illustrating a new system or tool. It is used to analyse the rationale of user actions:

- What do they intend to achieve?
- Why do they intend to achieve it?
- How do they intend to achieve it?

The information obtained from this technique is used as the basis to produce the new requirement specifications and design new tasks.

The task analysis includes research conducted on the cognitive process and detailed physical actions. The mostly widely used variety of this technique is the hierarchical task analysis that we will discuss in the following section.

(a) **Hierarchical Task Analysis**
The Hierarchical Task Analysis or HTA was designed for the purpose of usage training. It involves the process of splitting a task into subtasks, and subtasks to subsequent subtasks and so on. These subtasks are then gathered as a plan that contains specifications on how the tasks can be implemented in actual situations.

Try considering a catalogue service system and the task to be implemented is borrowing books. This task can be split to more tasks such as accessing library catalogues, searching for names, titles and issues and any information related to the location of the book, going to the correct rack to obtain the book (if it exists) and taking it to the counter.

The HTA below shows how these tasks are split and related to each other:

0. To borrow a book from the library
    1. Go to the library
    2. Look for the required book
        - 2.1 Access the library's catalogue
        - 2.2 Access the search screen
        - 2.3 Enter the search characteristics
        - 2.4 Identify the required book
        - 2.5 Note the location
    3. Go to the correct rack to collect the book
    4. Collect the book and take it to the counter

Plan 0: do steps 1-3-4. If the book is not at the rack, proceed with steps 2-3-4.

Plan 2: do steps 2.1-2.4-2.5. If the book cannot be identified, do steps 2.2-2.3-2.4-2.5.

Observe how the numbering is used in this technique. The plan explains how the subtasks contained within the related steps are implemented. For example, the 2nd plan explains the sequence of steps from subtask 2.1 to subtask 2.5. The first step does not have a plan because it is not split into any subtasks.

The HTA technique is illustrated in Figure 10.2.

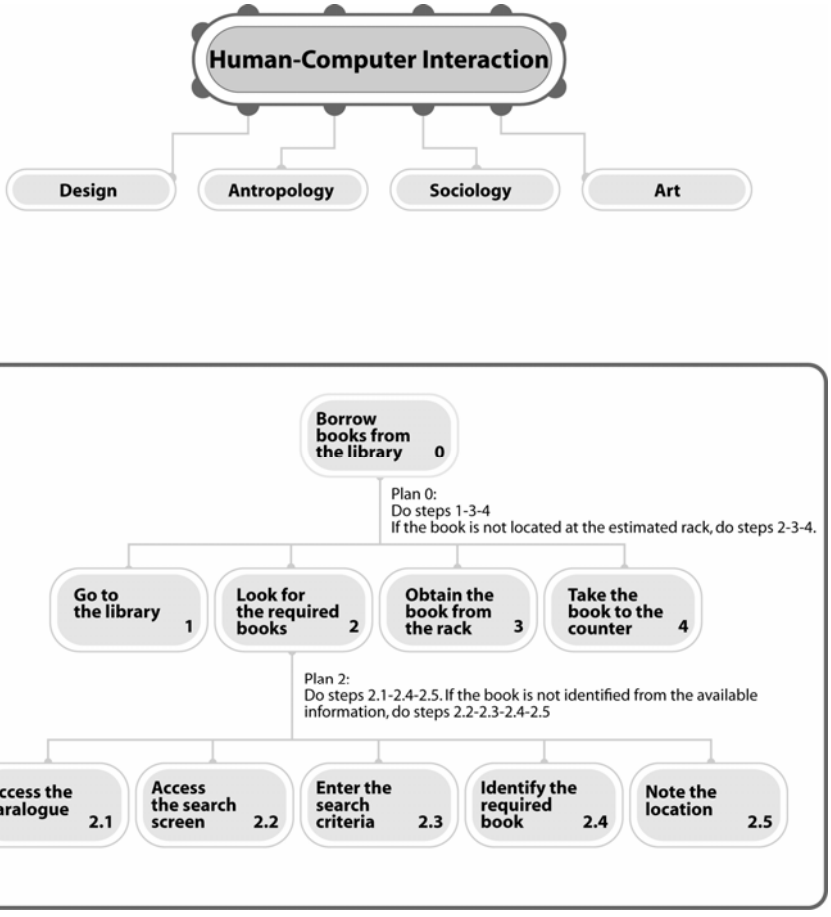

Figure 10.2: An example of the hierarchical task analysis fiure
Source: Preece, 2002

ACTIVITY 10.5

What are the three techniques that can be used to interpret and analyse users and their tasks? Explain the techniques that are suitable for analysing current systems, and illustrate the upcoming system.

SUMMARY

- This topic has dicussed how the system requirement analysis phase can be implemented by using the available techniques . Emphasis is given to user profiles, data gathering techniques and data interpretation techniques.

- There are a number of existing user interpretations, such users who use a completed system (or better known as end-users), end-user managers, system testers, purchase decision makers, and users utilising competitor systems.
- The three types of users are the novice users, casual users and expert/frequent users.
- System requirements refer to specification statements about what has been done or will be done on a product that is going to be produced, and how this action is done.
- There are five types of system requirements - functional requirements, data requirements, environmental requirements, user requirements and usability requirements.
- To obtain system requirements, it is important to gather sufficient data. The five techniques of gathering data are through questionaires, interviews, focus groups or workshops, observation and documentations.
- The gathered data need to be interpreted and analysed based on different needs. The three kinds of data interpretation and analysis techniques that focus on users are scenarios, Use Case, and hierarchical task analysis.

KEY TERMS

Data requirements
End-users
Enviromental requirements
Functional requirements
Requirement analysis
Usability requirements
User requirements

Topic 11 Prototype Development

LEARNING OUTCOMES

At the end of this topic, you should be able to:

1. Explain the importance of prototyping in the development of a system based on the user-centred design method; and
2. Analyse the four approaches or techniques that are used in developing prototypes.

▶ INTRODUCTION

The development of prototypes is one of the main principles of the user-centred design. In this topic, we will take a closer look at how this activity is implemented.

11.1 Prototype Development

The activity of designing a prototype commences as soon as a set of system specifications is produced. There are two types of prototype designs:

- Conceptual Design – related to the conceptual model development that revolves around the capability and functionality of the product.
- Physical Design – related to the menu structures and displays, icons, and graphics that are utilised on the interface.

The design is produced by an iterative software life cycle process that requires evaluation by users.

To enable users to effectively evaluate a design, it is necessary for the designers to provide an interactive version of the product. During the initial stages of system development, this interactive version can be produced by using manila cardboards and papers. However, in the following levels where the system design becomes more advanced, it is more ideal to use an interactive version that resembles the end product. These interactive versions are what we call 'prototypes'.

It is commonly known that users are unsure of their needs but, once familiarised with a product, are quick in identifying the shortcomings in a system. Upon gathering information on user work practices and views regarding what can and cannot be done by the system, we should then implement our proposal to develop an ideal prototype, and later reproduce it in different versions. The more repetitions done, the better the product would be.

11.1.1 What is a Prototype?

When you hear the term 'prototype', you may imagine an object that resembles the model of a building or bridge, or software that contain many bugs and frequently crash. However, a prototype can also be a paper, electronic photo or video simulation of a specific task.

A prototype could have many versions, and is used to illustrate software. It can be designed in the simplest form, such as storyboards on papers, on in a more complex form such as near-complete software. A prototype enables interaction with stakeholders by illustrating the characteristics of the system. This interaction is intended to help obtain information and experience of using the software in an authentic environment, whilst exploring the imaginations of users.

For example, when the Palm Pilot idea was taking shape, the inventor of the product, Jeff Hawkins, initially carved the precise size and form of his idea onto a piece of wood. He often carried this wood, and behaved as if it were a real tool for him to input information. This helped him visualise the scenario in which he owned the product. Although this scenario may seem strange to some people, it is actually an example of the simplest prototype that enabled Hawkins to achieve his goals.

In conclusion, a prototype is a representation of a product being designed which enables user interaction as well as allows them to understand its suitability.

11.1.2 What is the Need for Prototype Development?

Prototypes are useful tools for designers to discuss their ideas with stakeholders. It becomes a communication medium between the systems developers and is very suitable and effective to be used by developers as a test platform for their ideas.

The prototype provides the answers for all arising questions apart from helping designers to make selections based on different alternatives. A number of reasons for prototype development are listed below:

- Tests the technical feasibility of a system.
- Explains vague and ambiguous requirement specifications.
- Determines if a design's approach is compatible with the development of other parts of the system.

The designer influences the type of prototype being developed. For example, if the designer is trying to identify methods in which the users would implement a set of tasks, and to determine if the tools developed would be able to support these tasks, the prototype being developed should be paper based.

ACTIVITY 11.1

Explain the meaning of prototype.

11.2 APPROACHES TO PROTOTYPE DEVELOPMENT

There are various methods that can be used in developing prototypes, where some prototypes can be developed faster, at different stages, and in evolutions. The following subtopics discuss each of these methods.

11.2.1 Fast and Disposable Prototypes

Prototypes developed using this technique are not stored, but disposed as soon as the testing and evaluation phases have been completed. It is only meant to test certain aspects of the system. Usually, this prototype is used to obtain more detailed information about the system's requirements. Figure 11.1 below illustrates the procedures and processes involved in the development of this prototype.

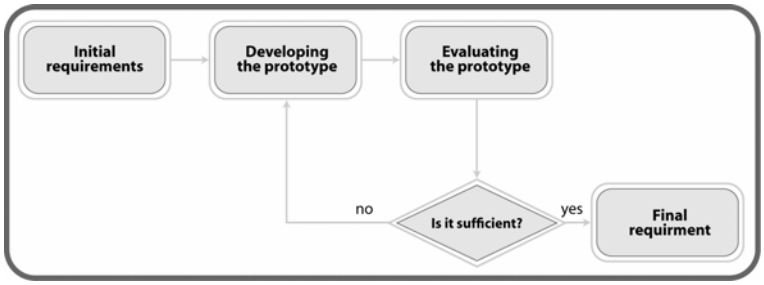

Figure 11.1: The development of the disposable prototype

11.2.2 Layered Prototype

In this approach, the system is divided into a number of smaller components. Each of these components is individually and independently developed as prototypes. The final product is launched as a series of a product, where each launch may consist of different components. This process can be illustrated as in Figure 11.2.

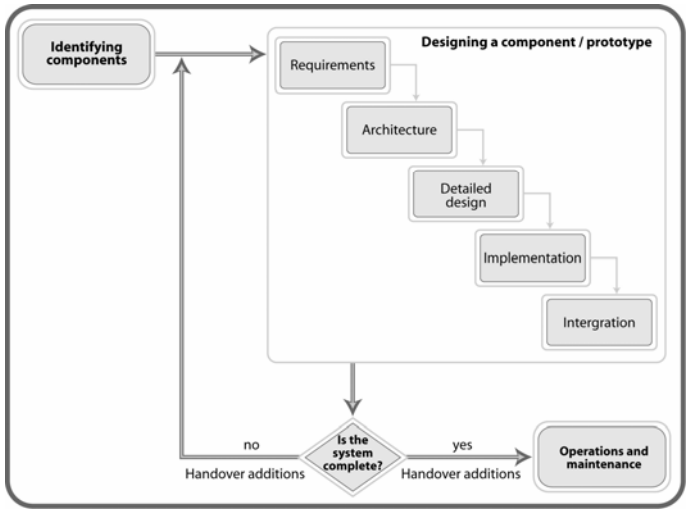

Figure 11.2: Layered Prototype Development
Source: Dix 1998

If you notice, the prototype developed using this approach is not disposed, but used as a basis for the final designs of components in a system.

11.2.3 Evolution Prototype

The evolution prototype refers to an evolutionary approach towards system development, beginning from a prototype with limited functions, and expanding to the final product. Just as the layered prototype, the evolution prototype is not

disposed, but used as a basis for designing the final product. This process is illustrated in Figure 11.3.

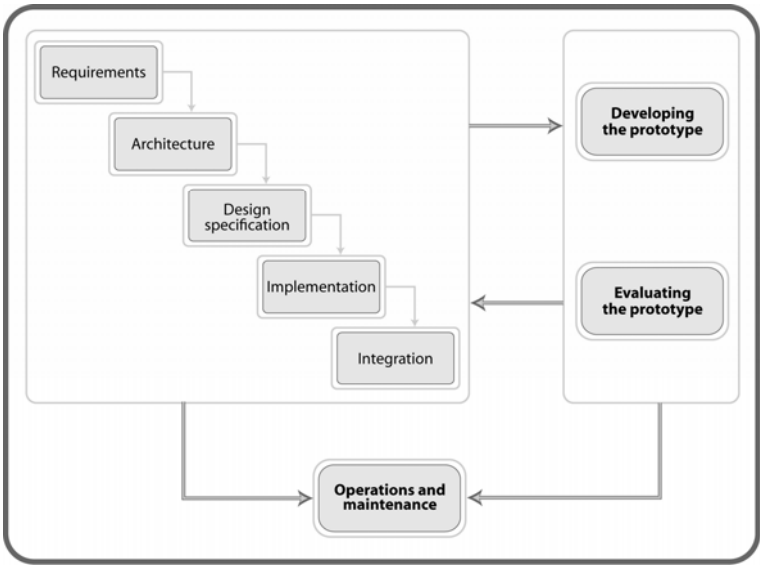

Figure 11.3: The evolution prototype development
Source: Dix 1998

ACTIVITY 11.2

Explain the differences among the fast and disposable prototype, evolution prototype, and layered prototype.

11.3 TECHNIQUES FOR DEVELOPING THE FAST AND DISPOSABLE PROTOTYPE

We will now look at a number of techniques that can be used to develop the fast and disposable prototype.

11.3.1 Storyboard and Sketches

The drafting of storyboards is an example of a prototype that is usually used in this scenario. A storyboard contains a series of sketches that illustrate how users implement tasks by using the tools that are being developed. It may consist of a series of screen sketches for GUI-based software, or sketches that illustrate how users utilise the tools. When used together with the scenario, a storyboard can

provide more specific information to ensure appropriate interaction between stakeholders and the prototype. Sketches are also widely used to produce icons or symbols in upcoming GUIs.

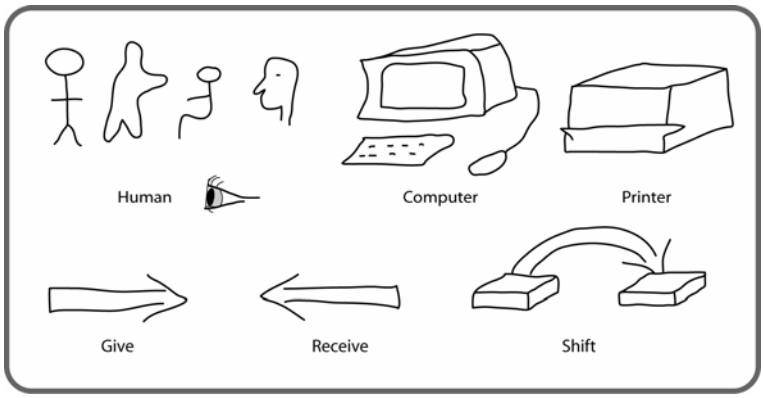

Figure 11.4: An example of a sketch
Source: Preece 2002

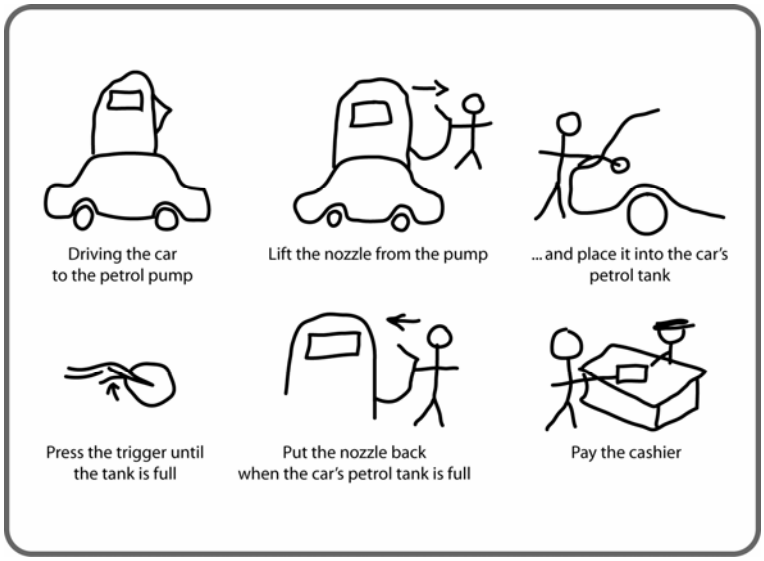

Figure 11.5: An example of a storyboard

11.3.2 Index Cards

Prototypes using index cards are mostly used for developing websites. Each index card represents a screen display or element on an interface. In user evaluations, the user can pretend to surf the internet while observing each index card arrangement.

11.3.3 Computer Simulations

Another technique of developing a prototype is based on simulation or animation that illustrates the flow of a system. These kinds of prototypes are usually produced by using specific software as toolkits. Among the software that can be used are HyperCard and Visual Basic. By using this software, sample screens can be produced and interrelated to observe the process flow from one screen to another screen or element of the system. Users are also able to improve their interaction with the interfaces.

However, this simulation-based prototype does not have to necessarily support all the functionalities of the prospective system. Just as other prototypes, it is merely used to test certain aspects of the system.

11.3.4 Wizard of OZ

In this technique, users use the computer and are given the impression they are using software that have already been developed. However, the user's computer is actually connected to another computer that is being used by the software designer. Each time the user interacts with the software prototype, the designer responds to the user, yet giving the user the impression of receiving a response from the software.

11.3.5 Chauffeured Prototype

This involves users who observe a designer testing the system prototype. This technique differs from other techniques, in that users do not interact with the system, but only observe how the system is used to implement a task. This technique can be used to validate the sequence of actions involved in implementing a task. However, this technique is rarely used as it goes against user evaluation principles, where users interact directly with the prototype or system.

ACTIVITY 11.3

What are the techniques that can be used to produce the disposable prototypes?

11.4 PROTOTYPING FIDELITY

As you have read in subtopic 3.2, prototypes can be classified based on the approaches used during its development. The prototypes can also be classified based on their similarities with the final product. Prototypes can be divided into low-fidelity prototypes and high-fidelity prototypes. The following subtopic will discuss each of these prototypes.

11.4.1 Low-fidelity Prototypes

Low-fidelity prototypes are quite different from the final products. For example, the prototype does not use the same materials as the final product. For example, the prototype might use paper and manila cardboards as opposed to steel and electronic displays in the final product. The wood used as a prototype for the Palm Pilot is an example of a low-fidelity prototype.

Low-fidelity prototypes are very useful because they are simple, cheap and easily used. This means that the prototype can be easily customised into alternative designs that can be tested and tried. This is a very important factor during the initial phases of development. One example is during the conceptual design. The prototype used to analyse and test ideas should be flexible and easily modifiable. Low-fidelity prototypes are not created with the intention of storing and integrating them with the final product, but merely for the purpose of trials and research.

11.4.2 High-fidelity Prototypes

High-fidelity prototypes utilise materials that are used in the final products. Thus, they have similar characteristics with the final product. A system prototype that is developed with Visual basic, for example, would be more accurate compared to screen sketches on a paper.

To produce high-fidelity prototypes, you would need software such as Macromedia Director, Visual Basic and SmallTalk. These software contain powerful prototyping toolkits that enable easy development of prototypes.

However, this technique has a number of weaknesses that cause researchers to discourage its usage. Among the problems of this prototype are:

- It takes a longer period of time to be produced.
- Evaluators would usually concentrate their criticism on external aspects that are related to the prototypes toolkits, rather than focusing on the contents of the prototype.

- Developers are usually reluctant to make modifications on a prototype that had been designed previously in the past.
- Prototypes that utilise software may lead to overly-optimistic expectations.
- Even with the existence of a small error, the process of evaluation or testing would be halted.

High-fidelity prototypes are useful as they provide ideas to users and test the technical issues of the system. However, the use of low accuracy prototypes to study and explore all issues that are related to its contents and structure should be encouraged.

ACTIVITY 11.4

Differentiate the strengths and weaknesses of the low-fidelity and high-fidelity prototypes.

SUMMARY

- This topic discussed the different types of prototypes as well as techniques used in their development.
- The prototype is a trial version that illustrates software, such as a storyboard on a paper or on software that are nearly complete.
- Prototypes are developed in order to test the technical feasibilities of an idea, explain unclear requirement specifications and examine if the approach of a design is suitable for the development of other parts of the software.
- There are many types of prototypes that can be developed for the purpose of evaluation, and the prototype that is most suitable depends on its' purpose and when it was developed.
- The four techniques or approaches in the development of prototypes are the fast and disposable prototypes, layered prototype, evolution prototype and fidelity prototype.
- In the fast and disposable approach, the five techniques that can be used are the storyboard and sketches, index cards, computer simulations, Wizard of Oz, and chauffeured prototype.
- Prototypes can also be classified based on accuracy and resemblance to the final product. The two classifications of prototypes are the low-fidelity prototypes and the high-fidelity prototypes.

KEY TERMS

Evolution prototypes
Fast/Disposable prototypes
Fidelity prototypes
High-fidelity prototypes
Layered prototypes
Low-fidelity prototypes
Prototypes