Course Overview

INTRODUCTION

Welcome to CHC401 Human Computer Interactive which is one of the required courses for the Master of Education (MEd) programme. The course assumes no previous knowledge and experience in educational research but you are encouraged to tap into your experiences as a teacher, instructor, lecturer or trainer and relate them to the concepts and principles discussed.

COURSE AUDIENCE

CHC401 is a core subject for all students who intent to do MEd. Thus, student should be able to thoroughly understand the chapters covered in this course before pursuing to higher level of finance subjects.

STUDY SCHEDULE

The student should accumulate 120 hours for this course. Table 1 shows the approximation of study time that the students should allocate during a semester.

ACTIVITIES	HOURS
Understanding the course content, initial discussion and problem solving	70
Attending tutorial sessions	10
Online Discussions	5
Completion of Assignment	25
Revision	10
Total	**120**

OBJECTIVES OF THE COURSE

By the end of this course, you should be able to:

1. Explain the importance of Human Computer Interaction and the relationship of HCI with other fields.
2. Analyze any suitable technologies that can be apply with HCI; and
3. Apply the principles and techniques that related with the design, prototype development and judgement in developing a system.

AIM OF THE COURSE

The main aim of the course is to provide you with a foundation on the principles and practices of educational research and its application in the design of a research project.

COURSE SYNOPSIS

The course begins with discussion of the research process followed by techniques in writing a review of literature. Both quantitative and qualitative research methods are examined. Among the quantitative methods emphasised are experimental research designs

and the survey method. Various kinds of experimental research designs are introduced together with the procedure for conducting a survey. The design and development of instruments and issues relating to reliability and validity are discussed.

The qualitative and quantitative approaches are compared in terms of objectives, data collection methods and techniques of data analysis. Data collection methods such as observation, interviews and documents are discussed. This is followed by an examination of data analysis methods with emphasis on coding and reporting of qualitative data. The final part of the course focuses on the writing of the research proposal.

COURSE CHAPTERS

To enable you to achieve the FIVE objectives of the course, CHC401 is divided into 10 chapters. Specific objectives are stated at the start of each chapter indicating what you should be able to do after completing the chapter.

CHAPTER 1 Interface and Cognitive Science's Perspective

Our main focused in this chapter is to introduce the HCI, their goals and the importance of HCI in our life and its relationship with other fields.

CHAPTER 2 Human Information Processing

This chapter is about how the human can process the information given to them. This chapter will describe about the stage memory model, mental model, physical model, social model and also ergonomics. In addition, we also explained the implication of HCI.

CHAPTER 3 Human Computer Interaction and Technology

Currently, technology has become the most important medium in our life. In this chapter, we explained how HCI and technology can be merging together. This chapter is focusing on input technology, output technology and etc.

CHAPTER 4 Technology in Interaction

The chapter presents different types of weak designs, true experiments and quasi-experiments. Focus is on the reasons for using a particular design and the ethics involved in experiments using human subjects.

CHAPTER 5 Design Evaluations & Methodology

Our main focused in this chapter is the principles of applicability, the user-centered design and user's requirement.

CHAPTER 6 Types of Design

This chapter is about three types of design; conceptual design, functional design and dialogue design.

CHAPTER 7 Prototypes

In this chapter we described the goals and importance. We also explained about techniques of prototypes and the prototype equipments.

CHAPTER 8 Evaluations

This chapter introduced the function of evaluations and the evaluation techniques.

CHAPTER 9 User Requirement Analysis

We described the documentation requirement, its approaches and the minimalist instruction.

CHAPTER 10 Rules & Regulations

In the last chapter, we give some tips, the rules and regulation of the interface and several case studies based on HCI.

REFERENCES

R. Slavin (2006). Educational Research in an Age of Accountability. Boston: Allyn & Bacon.

M. Gall & J. Gall (2006). Educational Research: An Introduction (8th Edition). Allyn & Bacon

J. McMillan & J. Wergin (2005). Understanding and Evaluating Educational Research. Prentice Hall.

D. Hittleman & A. Simon (2005). Interpreting Educational Research (4th Edition). Prentice Hall.

Bechhofer, F. (2000). Principles of Research Design in the Social Science. London: Routledge. *Chapter 1: Fundamentals* [available at eBrary].

Mitchell, M. and Jolley, J. Research Design Explained (1988). New York: Holt, Rinehart and Winston. *Chapter 2: Generating the research hypothesis.* 14-36.

W. Borg & M. Borg, (1988), Educational Research: An Introduction. New York: *Longman. Chapter 3: The research problem, research plan and pilot study*. 71-106.

Kerlinger, F. (1990). Foundations of Behavioural Research. New York: Allyn and Bacon. *Chapter 3: Constructs, variables and definitions*. 28-46.

Problem formulation, W. K. Trochim,
http://www.socialresearchmethods.net/kb/probform.htm

Defining the research problem. Andrea Chan, Language and Learning Unit, 1998.
http://www2.fhs.usyd.edu.au/well/knowbase/defresp.htm

The Research Question Outline. Mary Mikijanis and Dee Thom,
http://kancrn.kckps.k12.ks.us/guide/question.html

EVALUATION

Course evaluation consists of two components that are the ongoing evaluation and the final examination. In order to obtain a good score and grade in this course, students need to take each component of the course evaluation seriously.

1. **Final Exam** - 40%
2. **Coursework** - 60%
   Coursework assessment is based on the following methods which may vary with subject:
   - Assignment 1
   - Assignment 2

CHAPTER 1

Interfaces & Cognitive Sciences Perspective

LEARNING OUTCOMES

By the end of this chapter, you should be able to:

1. Define Human Computer Interaction (HCI) ;
2. Explain the meaning human-computer-interaction ;
3. Identify the importance of HCI ; and
4. Describe the contribution of other fields to HCI.

INTRODUCTION

Let us begin by watching a video clip below to give an idea about the Human Computer Interaction (HCI):

Source: http://www.youtube.com/watch?v=ukYBAa89kT0

Do you ever wonder what makes some websites easier to use than others, or why some people manage to master new navigation systems faster while others struggle to learn? Do you know why users get lost in electronic space or find it difficult to communicate with others through the medium of technology?

These questions are just some of the driving forces behind research in the developing field of Human Computer Interaction. Human computer interaction was first introduced in the 1970's as Man-machine Interface. The research about Man-machine Interface includes all computerised machines used in human's life. For instance, telecommunication devices such as hand phones, facsimiles, washing machine, microwave, computer, and personal digital assistant (PDA). At that time, most computer industries were using the research in Man-machine Interface as their marketing strategy. They believed that the company profit would be increased if the interfaces were more attractive and user friendly. In this chapter, we will explain the basic information about Human Computer Interaction involved in our life.

1.1 HUMAN COMPUTER INTERACTION (HCI)

Human Computer Interaction (HCI) is a term that you may or may not have heard. So let's explore what it is, and what role it can play in your website development.

According to Jenny Preece (1994)

> "Human-computer interaction is a discipline concerned with the design, evaluation and implementation of interactive computing systems for human use and with the study of major phenomena surrounding them."
>
> "The study of relationships between people and computers/computer mediated information. The design, development and evaluation of models, systems, techniques and applications from a human-centered perspective."

As its name implies, HCI consists of three parts; user, computer, and the ways they work together:

(a) The User

When we talk about HCI, we don't necessarily imagine a single user with a desktop computer. The term "user" may mean an individual user, a group of users working together, or maybe even a series of users in an organisation, each involved with some part of the job or development. The user is whoever tries to get the job done using the technology. An appreciation of the way people's sensory systems (sight, hearing, touch) relay information is vital to designing a first-class product.

For example, display layouts should accommodate the fact that people can be sidetracked by the smallest movement in the outer (peripheral) part of their visual fields, so only important areas should be specified by moving or blinking visuals. And of course, people like designs that grab their attention. Designers must decide how to make products attractive without distracting users from their tasks.

(b) The Computer

When we talk about the computer, we're referring to any technology ranging from desktop computers, to large scale computer systems -- even a process control system or an embedded system could be classed as the computer. For example, if we were discussing the design of a Website, then the Website itself would be referred to as "the computer".

(c) The Interaction

There are clear differences between humans and machines (as shown in Figure 1.1).

Figure 1.1: Interaction between human and computer

In spite of these, HCI attempts to ensure that they both get on with each other and interact successfully. In order to achieve a usable Website, you need to apply what you know about humans and computers, and consult with likely users throughout the design process. You need to find a reasonable balance between what can be done within the schedule and budget, and what would be ideal for your users. Figure 1.2 shows the overall relationship of HCI.

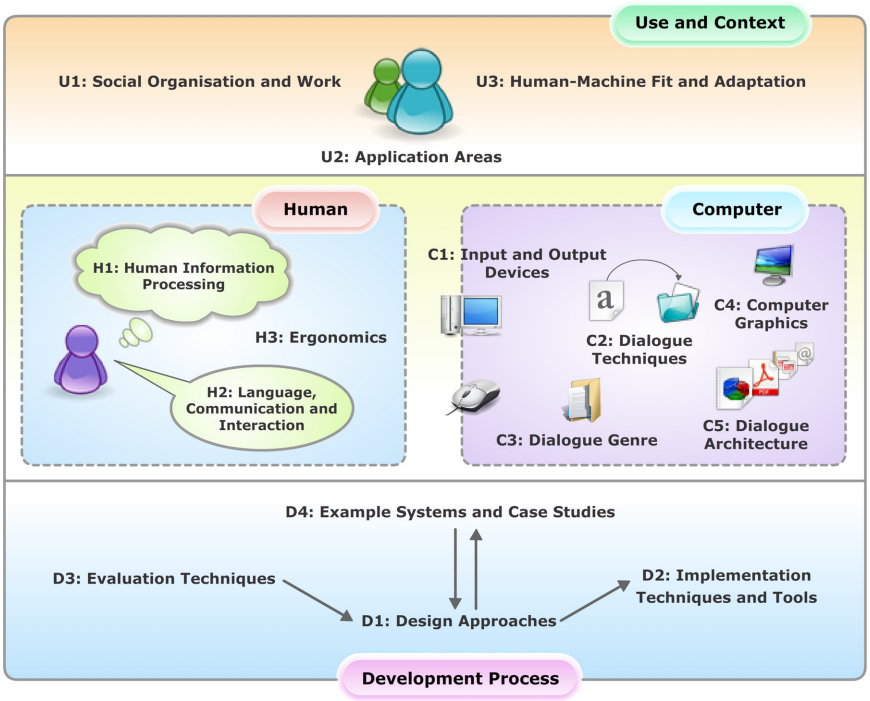


Figure 1.2: Human-computer interaction

SELF-CHECK

1. What is Human Computer Interaction (HCI)?
2. Currently, Maybank, CIMB and other banks have such an understandable interface for us to use the automatic teller machine (ATM) cash deposit or cheque deposit machine. If you are the first time user, can you use it without any help? Do you think the interface can help you lots? Give the reasons.

1.2 THE GOALS OF HUMAN COMPUTER INTERACTION

The goals of HCI are to produce usable, safe, and functional systems. In order to produce computer systems with good usability, developers must attempt to:

(a) understand the factors that determine how people use technology.
(b) develop tools and techniques to enable building suitable systems.
(c) achieve efficient, effective, and safe interaction.

The underlying theme of HCI is the belief that people that use the computer system should come first. Their needs, capabilities, and preferences for conducting various tasks should direct developers in the way they design the systems. People should not have to change the way they use a system in order to fit in with it. Instead, the system should be designed to match their requirements.

The same goals can be applied to Website development. Websites should be usable and safe, as well as functional, so that users can perform the task at hand without any obvious problems or usability errors.

1.3 BASIC PRINCIPLES OF HUMAN COMPUTER INTERACTION

There are several principles that are related to the HCI. The principles include the requirement analysis, conceptual proposal, prototyping, development, and launch and housekeeping as shown in Figure 1.3.

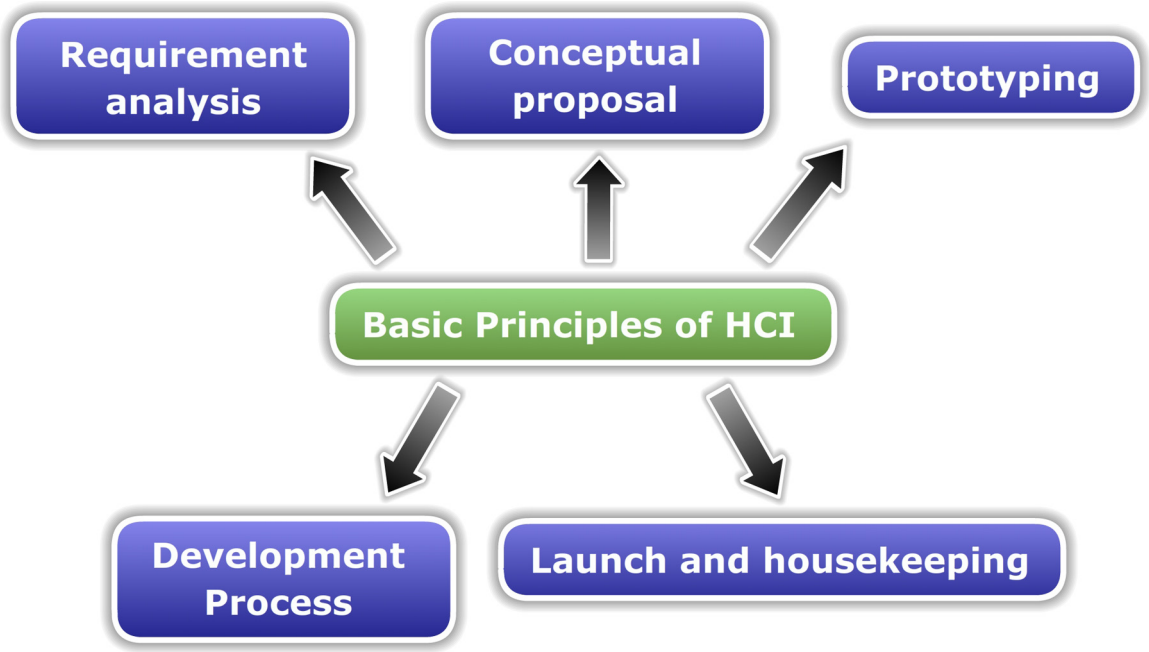


Figure 1.3: Principles of HCI

Table 1.1 below explains each of the Human Computer Interaction principles.

Table 1.1: Human Computer Interaction Principles

HCI Principles	Description
(a) Requirements Analysis	• Establish the goals for the Website from the standpoint of the user and the business. • Agree on the users' needs and aim for usability requirements. • Appraise existing versions of the Website (if any). • Carry out an analysis of the competition. • Complete discussions with potential users and questionnaires.
(b) Conceptual Proposal	• Outline site design and architecture at an abstract level. • Perform a task analysis to identify essential features.
(c) Prototyping	• Create visual representations (mock ups) or interactive representations (prototypes) of the Website. • Evaluate usability using a proven method. • Using the results, create more mock ups or improve the prototypes. • Repeat this process until the design and usability goals are met.
(d) Development	• Create the final product. • Evaluate functionality through testing, quality assurance, usability testing, and field testing. • Use the evaluation results to improve the product. • Repeat this process until the business goals are met.
(e) Launch and Housekeeping	• Launch the Website. • Maintain and tweak with user feedback (housekeeping). • Use the feedback to create new requirements, and begin major design improvements (system iteration).

1.4 FACTORS IN HUMAN COMPUTER INTERACTION

There are a large number of factors that should be considered in the analysis and design of a system using HCI principles. Many of these factors interact with each other, making the analysis even more complex. The main factors are listed in Figure 1.4 below:

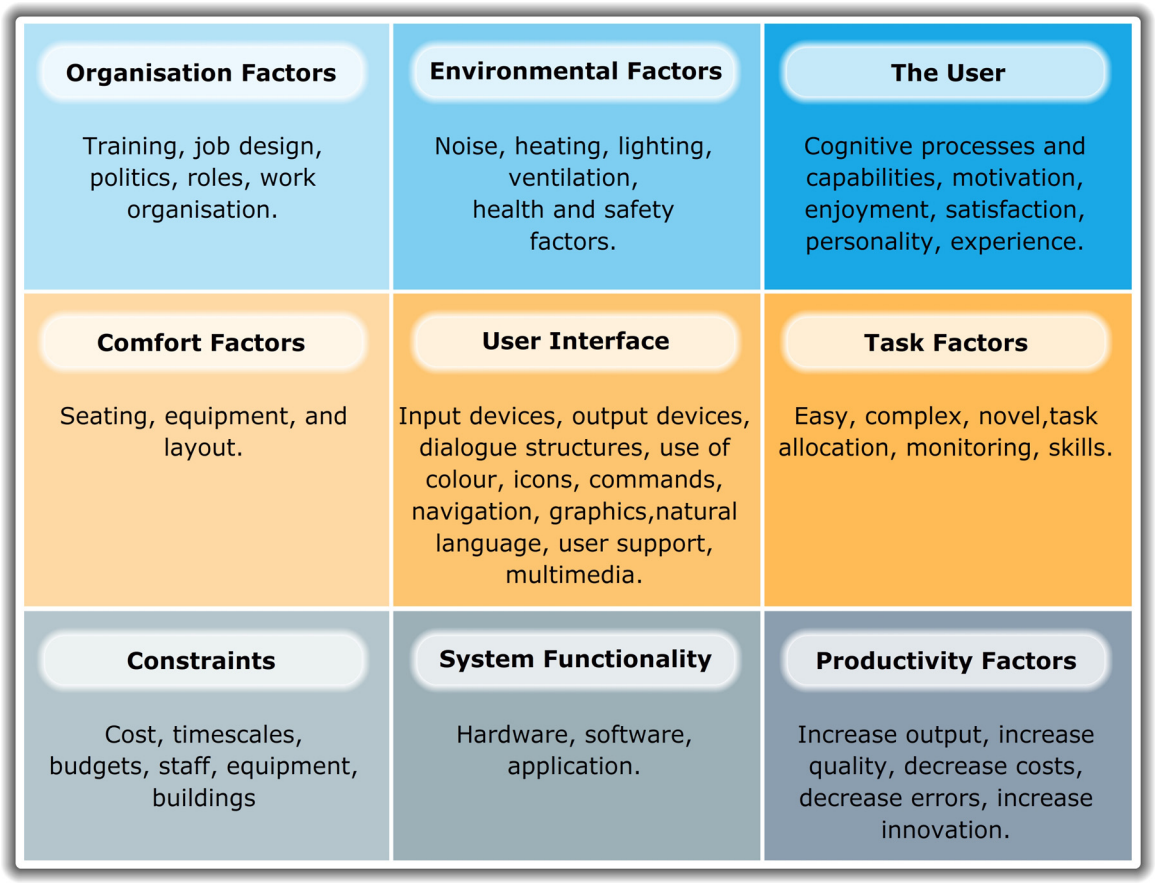


Figure 1.4: Factors in Human Computer Interaction

1.5 CONTRIBUTION OF OTHER FIELDS TO HUMAN COMPUTER INTERACTION

There are many disciplines that can be related to Human Computer Interaction (HCI) to facilitate interaction between human and computer. Figure 1.5 shows the disciplines that are related to the HCI. All of these disciplines contribute to develop the future of HCI technologies. The disciplines are computer science, engineering, linguistics, ergonomics and human factors, Artificial Intelligence, social and organisational psychology, sociology, anthropology, cognitive psychology, philosophy, and design.

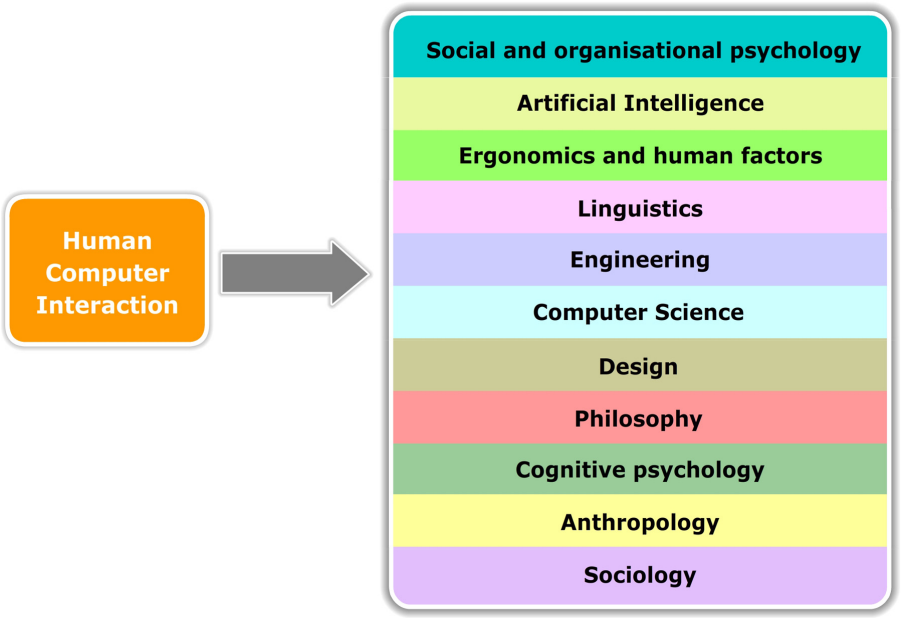


Figure 1.5: Disciplines that contributes to Human Computer Interaction

1.5.1 Computer Science

The discipline of computer science gives lots of contribution to Human Computer Interaction.

Computer science provides knowledge about the capability of technology and gives ideas on how the technology can potentially be used by human. There are methodologies, programming languages, and models that have been created by computer scientists. These elements help to improve the design, development, and maintenance of a system. The design of object oriented, 4th and 5th generation language make the process of developing program for the system easier and understandable.

These generation programming languages are used to design the system because they are more oriented towards problem solving and system engineering. The 5th generation language incorporates artificial intelligence to help solve human problem. Computer scientists also design User Interface Management System and User Interface Design Environments as the applications that facilitate efficient website development and high quality interfaces design. The models and tools for system development these days help to improve the functionalities and interfaces of the system.

Prototyping model is one of the models of system development that enables developers to try out their ideas with users and get feedback from users. Nowadays, there are some efforts to improve the theoretical development such as system architecture, abstractions, and notations by analysing the design of HCI within the system. The

concepts of reuse and reverse engineering are being applied to assist the adaptation of HCI design to the higher level. Visualisation plays the important role in HCI because it helps to interact human with the computer, for example, the usage of sophisticated graphics in virtual reality system.

1.5.2 Cognitive Psychology

Psychology is an academic and applied discipline involving the scientific study of human behavior and mental processes. Discipline of psychology is being applied to computer science so that the computer scientists can build a model of human information processing. Every action of human beings such as seeing, tasting, touching, and feeling can be categorised as information processing.

In the early 20th century, the study of human actions as information processes came from "human factors" at work that began as an effort to improve the efficiency in workplace. This discipline is potentially relevant to the ways in which users will behave in the course of interacting with a computer.

For example, the problem that children face when interacting with computers and in understanding the command languages that appear. In this case, the interfaces of computer should have more graphics such as icons and cartoons for the computer to interact with the children. But there are many concepts such as input and output, memory, processing, and resources that are still being questioned concerning the limitations and capabilities of the computer.

WEB-SITE

This video clip below is about the world's first computer specially designed for children aged from 3 to 12. With unique features of the computer, such as interchangeable interface and various plug-in keys, children can play games and connect to the internet safe and secure. This is also an innovative and effective learning tool for schools.

HCI incorporates cognitive psychology using a variety of techniques that are:

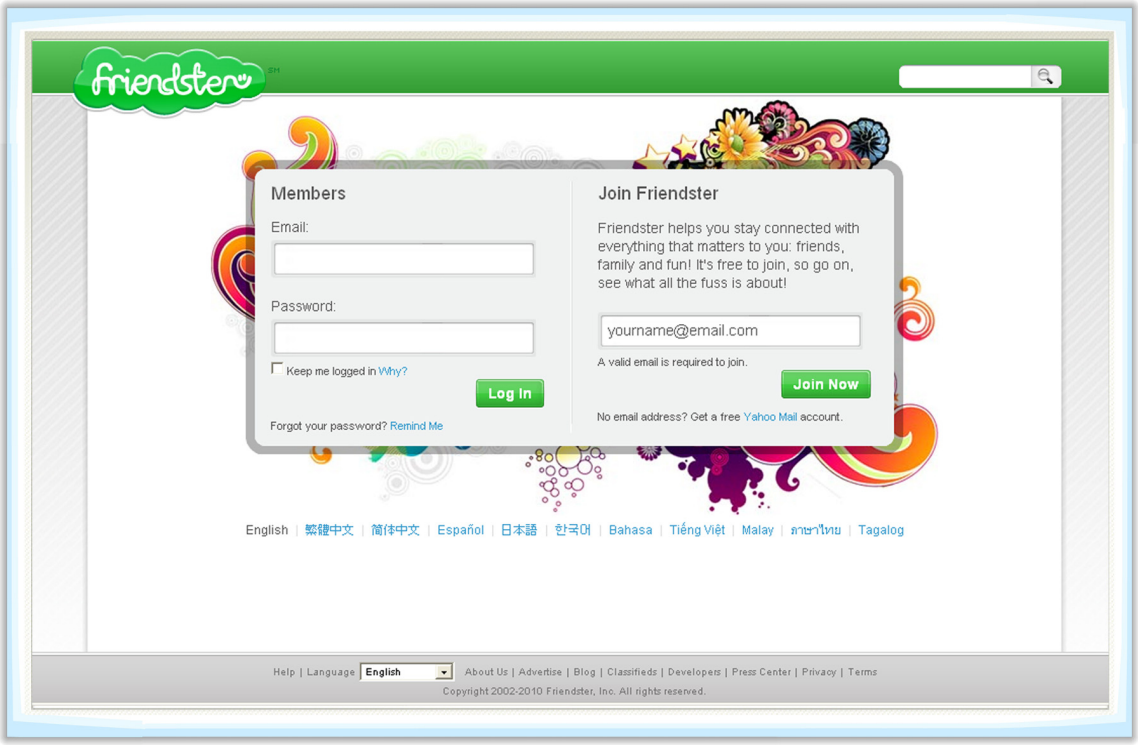
(a) the use of models to predict human performance,
(b) developing guidelines, and
(c) the use of empirical methods for testing computer systems.

1.5.3 Social Psychology

Social psychology is the study of people in social context based on the nature of human behavior. There are four core concerns of social psychology identified by Vaske and Grantham (1990):

(a) the influence of one individual on another person's attitude and behaviour;
(b) the impact of a group on its members' attitudes and behaviour;
(c) the impact of a member on a group's activities and structure; and
(d) the relationship between the structure and activities of different groups.

Generally in HCI, social psychology is applied by understanding the social aspects of both system design and implementation. Social psychology is important to HCI research because it highlights the importance of social interactions when people are involved in tasks. The role of social psychology is to inform the designers about social structures and how the introduction of computer will influence the working practices in term of human natural behaviors and social environments.



For instance, some people may be connected by work and others by friendship or casual acquaintance. Social networks should also be considered when designing an application that is created for the purpose of bringing people together. For example, the applications such as friendster.com, facebook.com, and myspace.com (as shown in Figure 1.6) in which the purposes are to build the online community and to reunite old friends.

Figure 1.6: Examples of social network application

1.5.4 Organisational Psychology

Organisational psychology can be defined as a collection of interacting and interdependent individuals who work toward common goals and whose relationship are determined according to certain structure (Duncan, 1978). However, organisational psychology is also related with the relationships between groups of individuals within a business and organisation.

In HCI, organisational psychology offers knowledge of businesses and institutions that can be used to understand the impact of computer systems upon these organisations. For

example, in a large organisation like university administration, computer is an important component for university operations. It manages the student and staff information and also controls the power of the administration building. Besides that, organisational psychology also involves understanding the structure and function of organisations in terms of authority, size, complexity, efficiency and effectiveness of information flow, technology, working practices, work environment, and social context.

1.5.5 Ergonomics or human factors

Ergonomics is the discipline in which tools are designed to fit user's needs and various factors are defined for different tasks, equipment, information, and domestic environment to suit the user's capacities and capabilities. Ergonomics grew out of the experiences during the Second World War, when it was necessary to design machines to suit their human operators.

Ergonomics contribute a lot in HCI and ergonomists play an important role in designing and evaluating various kinds of human factors in order to make users compatible. For example, ergonomics discipline is applied in a situation when a postman is using an in-car GPS navigation system to deliver item. Ergonomics in term of human computer interaction is the specification of conceptualised knowledge as the representations of the processes required by users to interact with the computer to perform work safely, effectively, efficiently and reliably as well as to make task easier. Ergonomists contribute to design human-machine interfaces and cognitive artifacts so that human performance is sustained in work environments. There is an application called Smart Shopping Tool (as shown in Figure 1.7) to help visually impaired people to go shopping at a shopping center. This application is installed in a PDA and used to scan RFID to get the information about products.

Figure 1.7: Blind people using Smart Shopping Tool
Source: http://www.jacobsschool.ucsd.edu/pulse/fall2006/images/Pg11Belongievisualimpaired.jpg

ACTIVITY

In your opinion, what are the best devices that should be used by the visually impaired users for input and output of information?

1.5.6 Linguistics

Linguistics is the scientific study of language (Lyons, 1970). The role of linguistics to HCI is to understand the structure (syntax) and meaning (semantics) that are important in developing natural languages interfaces. It helps to understand how individuals and groups interact with computers in natural environments.

Linguistics discipline is sometimes viewed as one of the disciplines that are related to Artificial Intelligence. There is a term called computational linguistics that investigates machine recognition and the production of human language. For example, speech recognition is one of the best technologies that use linguistics to support interaction between human and computer. Speech recognition helps to recognise the speech from user and produce appropriate responses in an interactive mode within a defined topic. Techniques from computational linguistics have contributed to improve HCI and have proven useful for analysis of the language.

Crime SMS Investigation (CSMSI), as shown in Figure 1.8 is an application that uses language identification of SMS text tool. It is developed to detect the potential criminal activities based on the text messages sent through mobile phone.

Figure 1.8: CSMSI interface

1.5.7 Artificial Intelligence

Artificial Intelligence (AI) is a technology that designs intelligent computer programs by simulating different aspects of intelligent human behavior. Research in artificial intelligence spans multiple disciplines, and can certainly delve into the metaphysical. AI seeks to define and understand intelligence, interweaving roles, and importance of memory, emotion, knowledge, perception and so on to create intelligent systems. The use of AI theory and methods in HCI will make the intelligent interface that interacts with the user. For example, the use of production rules that have been applied to HCI in connection with expert system.

There is another definition that states: "Artificial Intelligence is the study of mental faculties through the use of computational models" (Charniak & McDermott). From the definition, this approach provides the understanding of the use of computational models that offer many workable and interesting methods for representing processes and structures. As it is, AI offers two things to the study of HCI:

(a) a variety of computational models for representing the user, as means to test these models; and
(b) the possibility of intelligent systems for use in HCI.

The relationship between AI and HCI is mainly about the users' needs. This relationship is also about how the intelligent agents interact with users to make easy navigation and to reduce the difficult tasks that arise when users use the computer systems.

Now, let us watch a short video clip related to Artificial Intelligence.

Artificial Intelligence: Thinking Big

Source: http://www.youtube.com/watch?v=eq-AHmD8xz0

1.5.8 Philosophy, Sociology and Anthropology

These three disciplines are in soft sciences perspective and they also contribute to HCI. Traditionally, all of these disciplines have not been directly involved in the design of computer systems. But the fast development of Information Technology and technology transfer make all these disciplines participate to fullfill user's needs. The major concerns when applying these disciplines to HCI are the implications of the introduction of IT to society. Recently, attempts are being made to apply methods from social sciences to the design and evaluation of systems.

Philosophy is the study of general problems concerning matters such as existence, knowledge, truth, beauty, justice, validity, mind, and language while sociology is the scientific study of society and human behavior.

Sociology is also to interpret human behavior using theories on how to understand human behavior. This is achieved using scientific methods of research. The sociology approach to bureaucracy and social role appears particularly relevant to the processes of system design and implementation.

Anthropology is the study of humanity and has origins in the natural sciences. Anthropology does have contribution in HCI in which anthropologists can play their role to rethink the notion of social context where technology is used. The role of ethnography within HCI has been used to understand the social context, the routines of users' workday, practical management, and organisation.

There are many reasons for applying social science method of analysis to HCI. There is one application of social science methods that has been used to characterise computer supported cooperative writing (CSCW), which this application concerns with sharing software and hardware among groups of people working together. The aim of this application is to design tools and ways of working which optimise the shared technology so that users or those who are affected can obtain maximum benefit.

1.5.9 Engineering and Design

Engineering is the discipline and profession that applies science and relies heavily on model building and empirical testing. There are many aspects of engineering that influence HCI, especially on the interface and system development through software engineering. Software engineering is concerned about the development of new methods for producing software. The new things in software engineering such as new programming language and programming techniques are not only more cost effective but also usable and hence more saleable computer systems.

Design is the discipline that contributes creative skills and knowledge to engineering process. In HCI, design influences the application of engineering on HCI. One of the popular examples of design is graphic-design. Graphic design has influenced the way HCI is designed, for example, the new Microsoft Window Vista (as shown in Figure 1.9) that uses more graphics for its interface design. In software engineering, design is very important to make sure the system is not just attractive but also comfortable and easy to use.

Figure 1.9: Interface of Windows Vista

SUMMARY

1. Human-computer interaction (HCI) is a discipline concerned with the design, evaluation and implementation of interactive computing systems for human use and with the study of major phenomena surrounding them.
2. HCI consists of three parts; user, computer, and the ways they work together.
3. The goals of HCI are to produce usable, safe, and functional systems. In order to produce computer systems with good usability, developers must attempt to:
   (a) understand the factors that determine how people use technology;
   (b) develop tools and techniques to enable building suitable systems; and
   (c) achieve efficient, effective, and safe interaction.
4. The basic principles of HCI include the requirement analysis, conceptual proposal, prototyping, development, and launch and housekeeping.
5. The factors that should be considered in the analysis and design of a system using HCI principles include:
   (a) Organisation Factors
   (b) Environmental Factors
   (c) The User
   (d) Comfort Factors
   (e) User Interface
   (f) Task Factors
   (g) Constraints
   (h) Productivity Factors
6. The disciplines that are related and contribute to develop the future of HCI technologies are computer science, engineering, linguistics, ergonomics and human factors, Artificial Intelligence, social and organisational psychology, sociology, anthropology, cognitive psychology, philosophy, and design.

REFERENCES

Jenny Preece, Y. Rogers, H. Sharp, D. Benyon, S. Holland, T. Carey, (1994), Human-Computer Interaction, Addison Wesley

CHAPTER 2 Human Information Processing

LEARNING OUTCOMES

By the end of this chapter, you should be able to:

1. Explain how human process information in the memory;
2. Identify your stages in the series of mind processes;
3. Identify three aspects of human information processing;
4. Describe the three well-known theories related to human information processing; and
5. Explain what mental models are.

INTRODUCTION

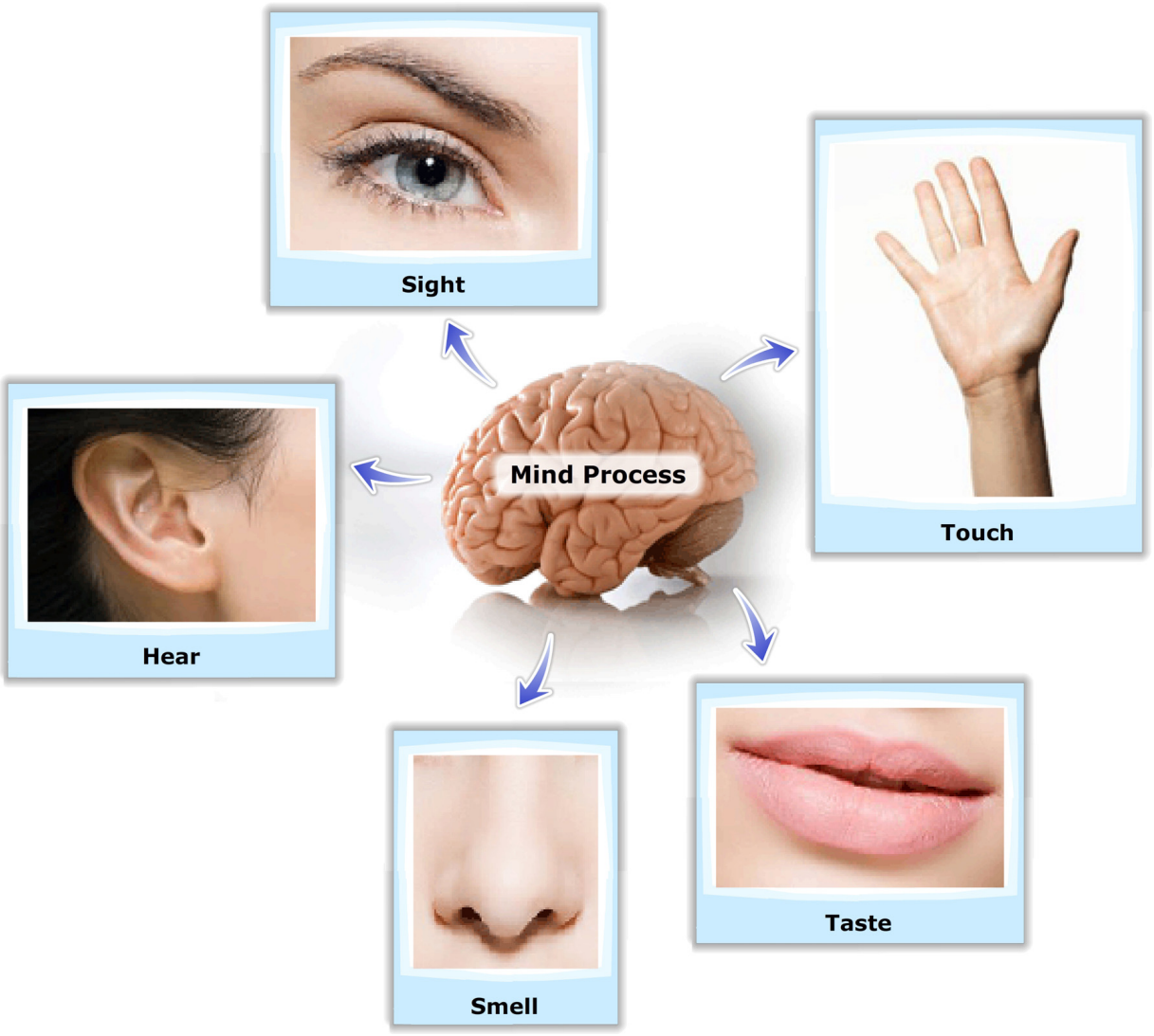
During the 1960s and 1970s, there is a work in cognitive psychology to characterise humans as information processors. This work involves all the five senses: sight, hearing, touch, smell and taste.

Human Biology: The Five Senses

We use our eyes, ears, nose, mouth and skin to pick up information from the world with receptors that translate the information into electrical and chemical signals that our brains can interpret.

Source: http://videos.howstuffworks.com/hsw/11825-human-biology-the-five-senses-video.htm
As we can see from the video clip above, from all of these sense actions there is information which the mind process. The connection between sense action as information and mind process is shown below:

As we can see from the video clip above, from all of these sense actions there is information which the mind process. The connection between sense action as information and mind process is shown as follows:



This chapter will explain how humans process information in the memory, which involved series of ordered processing stages. The chapter also discusses on implications of human information processing as well as mental modes information.

2.1 THE FOUR STAGES IN THE SERIES OF MIND PROCESSES

The basic idea of Human Information Processing (HIP) was that information enters and exits through a series of ordered processing stages (Lindsay and Norman, 1977).

Figure 2.1 summarised the series of ordered processing stages.

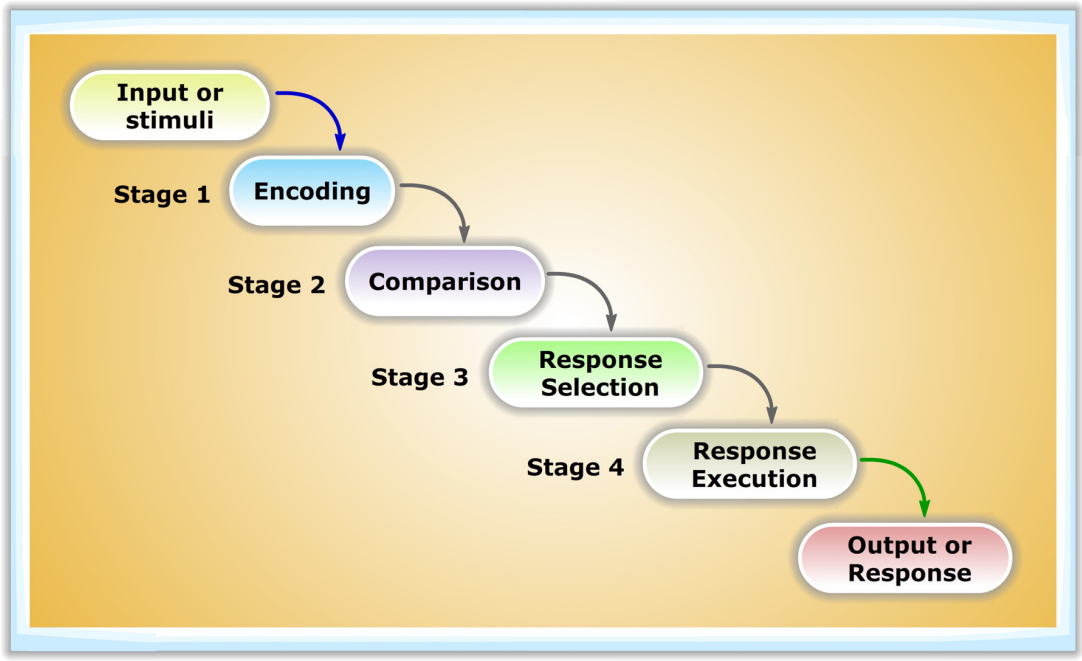


Figure 2.1: Series of ordered processing stages

From Figure 2.1, we can see there are four stages in the series of mind processes, as shown in Figure 2.2 below.

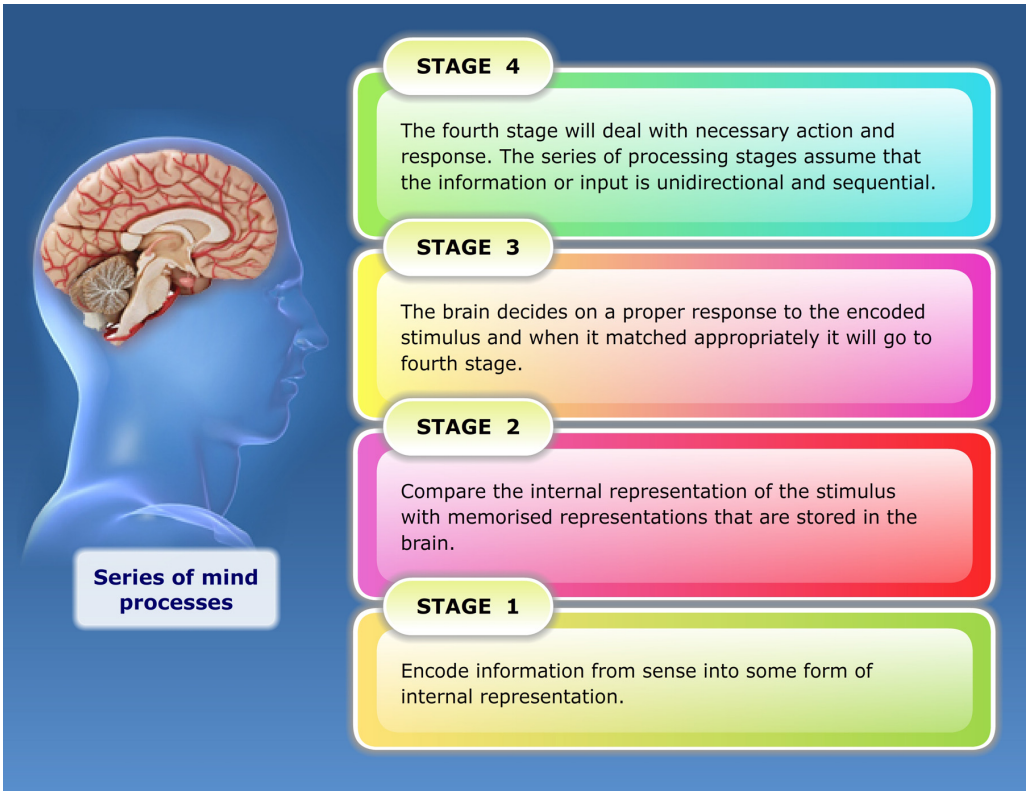
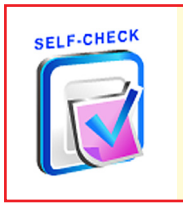


Figure 2.2: The four stages of the series of mind processes

Every stage needs an amount of time for thought and it all depends on the complexity of the operations.



Used the concept of information processing analysis, get the list of your friend address house and determine the house address of a friend.

2.2 THREE ASPECTS OF HUMAN INFORMATION PROCESSING

When talking about Human Information Processing (HIP), the first thing in our head is the concept of human brain processes to make response and action based on the information or input. In Human Computer Interaction (HCI), HIP is being applied to make easier interaction between human and computer.

Today, HCI faced a lot of data such as visual, auditory etc. So, the used of HIP concept in a new era of technology will suit human usage based on factors such as efficiency, effectiveness, safety, utilities, ease of learn and memorable. There are 3 aspects of HIP that should be applied to HCI, as follows:

2.2.1 Mental

Mental aspect is an important role in HCI. However, before we go deeply into the mental aspect, we should know the important things in a human mind. There are three types of knowledge that are represented in memory such as analogical, propositional and distributed (refer Table 2.1). These three aspects can be classified into cognitive processing. For mental aspect, human use both images and propositions in thinking and problem solving.

Table 2.1: The three types of knowledge represented in memory

Representations	Description
Analogical	Picture-like images. For example image of a car.
Propositional	Abstract and language-like statements that make assertions. For example, a statement like "The book is on the chair".
Distributed Networks	Networks of nodes where knowledge is implicit in the connections between nodes.

In mental models concepts, there are many ways in psychological theorising and HCI research. Mental models are used to make predictions about external or internal event before taking an action. They are also constructed when a human mind is required to make an inference or prediction about a particular state or situation.

There are two types of mental models that user used when interacting with devices. There can be categorised as structural and functional model. Table 2.2 below indicates the two categories in detail:

Table 2.2: The two categories of mental models

Structural Model	Functional Model
• A **structural model** in human mind internally recognises the structure of how the device or system works in memory	• **Functional model** internalised procedural knowledge about how to use the device or system.
• Can be simply defined as 'how it works'.	• Can be simply defined as 'how to use it'.
• The structural model is used to predict a system response from user response.	• The functional model is used to solve certain tasks and problems based on knowledge that is similar to domain system.
• The example for structural model is the architecture of computer that can interact with a user. The user does not need to think about the architecture of the computer but the computer architecture does need to think about it.	• The use of a calculator to help with daily computations and money transactions is an example of a functional model. 

Differentiate structural and functional model.

In HCI, mental aspect is a very important part as this is where the process that makes the user remembers the steps in using the system or devices, takes place. This is because the success of the system or devices depends on the difficulty that the user faced in learning to use the system or devices. This part is called the learning process. A manual explains how the system or device works, but users

sometime do not read the manual. In this new computer era, Keyboards have replaced typewriters for typing purposes. But there are differences between a keyboard and a typewriter such as backspace function, print screen function and so on.

Figure 2.3: The keyboard (right) has replaced typewriter (left) for typing purposes

2.2.2 Physical

In physical aspect, there are several considerations to be taken to make good HCI in applications. They are visual, sound, touch and design. These perceptions will make for easy interaction with the computer. They will influence users' first impression towards the software when using it for first time.

In visual perception, there are the factors that influence understanding of the visual. They are sight, color and graphics representation in interfaces. There are many versions of interfaces in every system or software, for example the e-learning portal for primary school students. The interfaces in e-learning portal for primary school students should have more graphics such as cartoons and animations. Color for interfaces also must be attractive and colorful in order for the students to have good interaction with the portal system. Figure 2.4 shows one example of e-learning portal for primary school students.

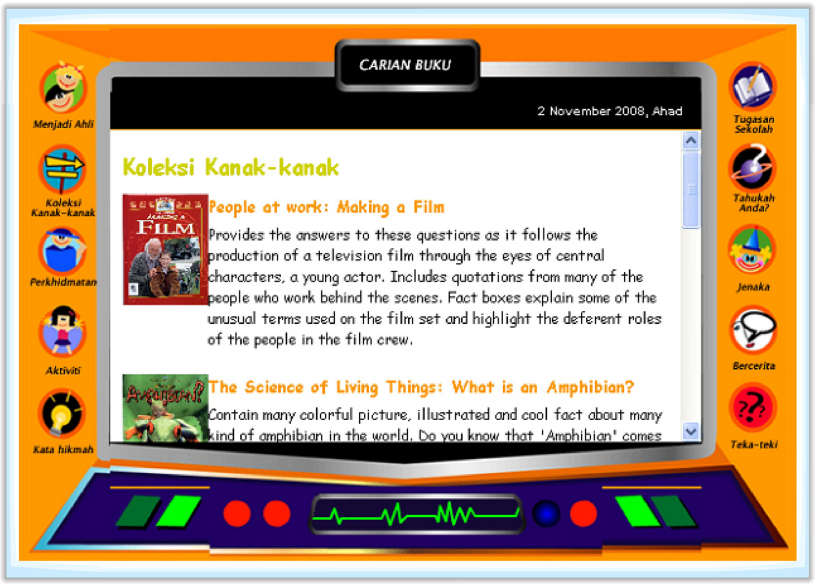


Figure 2.4: E-learning portal for primary school student

SELF-CHECK

Figure 2.5 below shows the interface for library portal for youth, can you identify the differences between Figure 2.4 and Figure 2.5?

Figure 2.5: Library portal for youth

Sound perception is commonly used in computer systems to attract, give warning or notice and give feedback to the users. Examples of sound that are commonly used in HCI are speech and music. If there is too much music in the system to interact with user, it can become uncomfortable for the users. There is a high technology application that used sound for security purpose. One example of an application that uses sound as data is speech recognition. The usage of sound can be used for computer games, animations, blind users etc.

Skin is the biggest sense at the human body especially at the fingertips. Touch becomes one of the popular concepts to be applied in new era of high technology applications. There are high technology applications of touch concept, such as Personal Digital Assistant (PDA), mobile phone, smart card, thumbprint reader and others.

Figure 2.6 below illustrates the smart card and thumbprint reader.

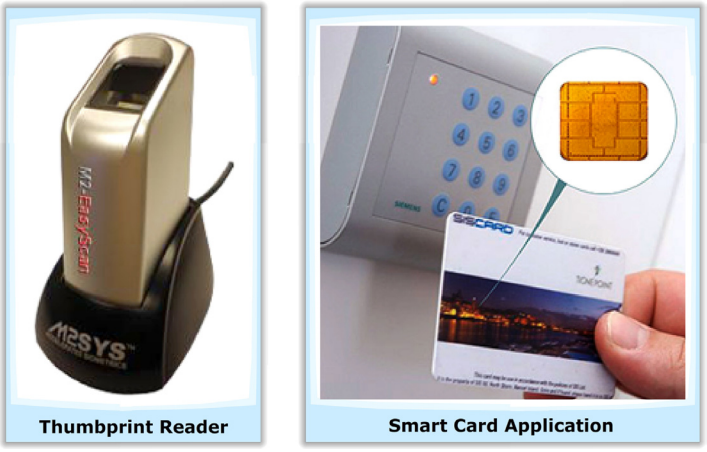


Figure 2.6: Examples of a thumbprint reader (left) and a smart card application (right)

Every system developer should think of the design that is best suited to the user. A good design of interface lets the user know how to use the system properly. In designing interfaces for the system, there are several factors that should be taken seriously by the system developers:

(a) Choices and combination of colors The choices and combination of color makes the interface more attractive.
(b) Brightness and intensity of interface.
(c) Forms of feedback.
(d) The arrangement of information at interface.

SELF-CHECK

Try to figure out other applications or hardware that used physical factor to interact with user.

2.2.3 Social

The way we communicate and interact with other people or community is called social. In cyberspace, there are many applications that used the social concepts to make interaction with other people. The social concept also is being applied to the applications, so that the users can interact with each other. The researchers in areas of discipline such as sociologists, linguists, anthropologists, philosophers and social psychologists have contributed theoretical framework with which to study the patterns and structures the social concept in HCI. The aim of applying social aspect is to facilitate more efficient interactions between people.

For example, the usage of Yahoo Messenger application, the user can interact with their friends that use the same application in a different way. The way of communicating using this application is called online chatting, but there are 3 types of online chatting such as asynchronous text-based talk tool, computer to computer conferencing and video conferencing using web cam.

For example, Figure 2.7 below shows us one way to communicate with your friends in Yahoo Messenger. The user needs to type the words to the chat window and send the message to friend directly. The ways of this communications called typing.

Figure 2.7: The example of communication online chatting via typing

Yahoo Messenger has successfully implanted the social aspect to make the user comfortable when using it. One of the examples that we can see is the usage of icons. In Figure 2.7, we can see there are many types of icons that represent someone's mood. When chatting to your friends and you want to tell that you are in good mood, you can use the smile icon to picture it.

Microsoft also improved their Microsoft Office application such as functions and interfaces to make them user friendly and comfortable to the user. In Figure 2.8 we can see the menu and options that can be viewed as an icon so that the Microsoft Word can be more interactive and easy to navigate. There are other applications that use text based on graphic to make the user interact with the computer. Social aspects of HCI focus primarily on communicative and interactive processes. The usage of graphic technique is to make it easier for the user to interact with the computer.

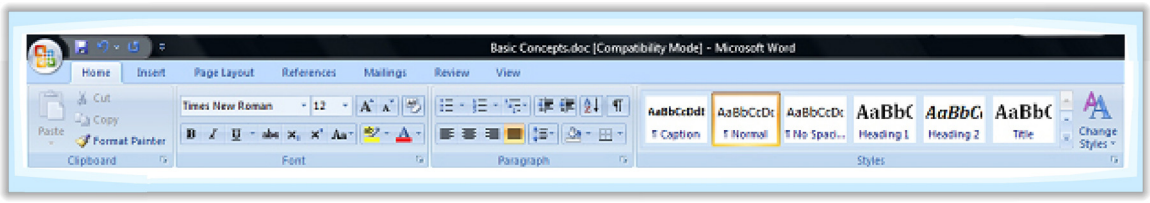


Figure 2.8: The example of Microsoft Word menu

2.2 HUMAN INFORMATION PROCESSING - BRIEF OVERVIEW

In the psychology part, the main approach is how we process and store the information in our memories. There are three well known theories related to this topic, which can be categorised as shown in Figure 2.9 below:

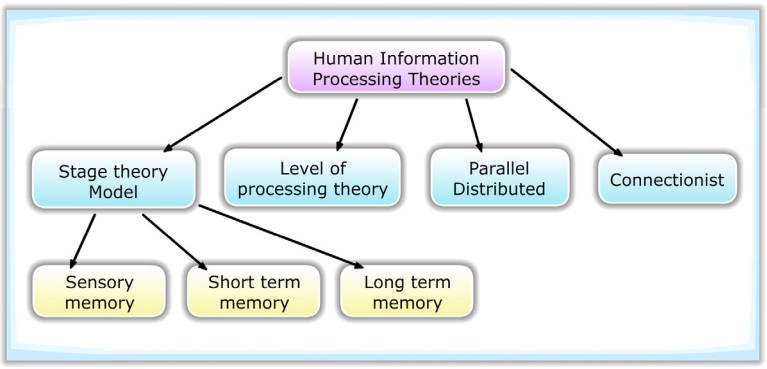


Figure 2.9: The three categories of Human Information Processing theories

2.3.1 Stage Theory Model

This model is divided into three stages (as shown in Figure 2.10). In order to store the information for later use, our brain needs to pass the information through all three stages. Information stored in long-term memory is eternal. However, if we do not pass the information to this final stage, we will not be able to remember it after a short period.

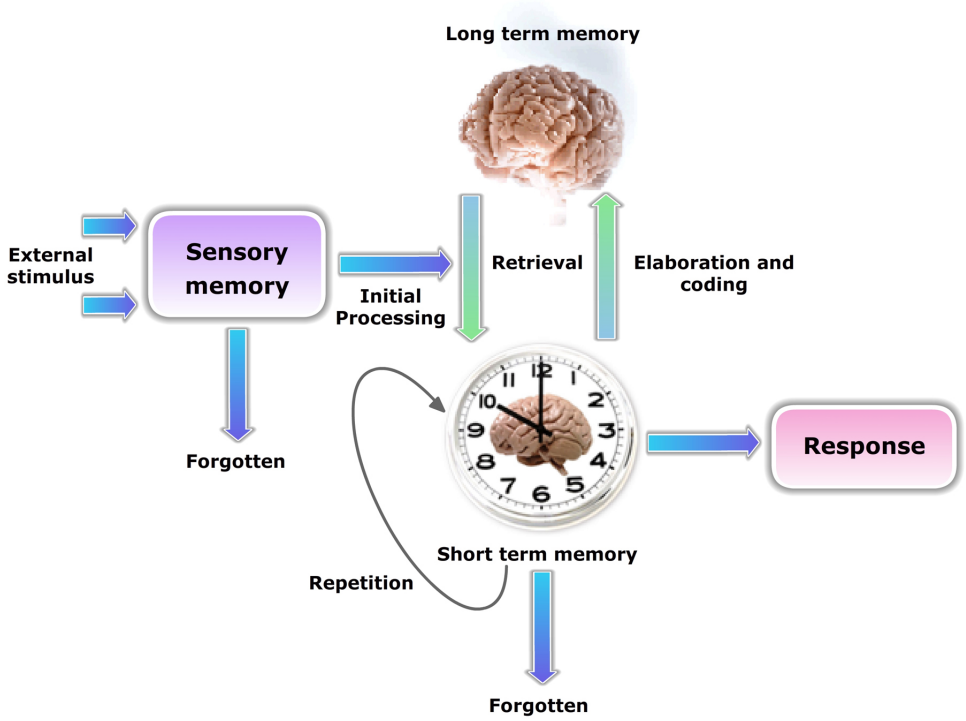


Figure 2.10: Memory Model

(a) **Sensory memory**

This is an initial stage of the process. To process information, we should find it first. In the computer example, we can think of it as the initial input stage to the CPU. In order to write the information to the hard disk, it needs to be entered using the input devices. In our body, our input devices are the five senses of our nervous system. This memory is very short and lasts only for a temporary period. We have a tendency to forget everything we get from these senses, unless we change our focus and attention immediately to inputs coming from our sensors.

(b) **Short term memory**

This stage is also known as working memory. It relates to what we are thinking about at any given moment in time. It temporarily stores and manages information that is required to carry out complex thinking tasks such as learning, reasoning and comprehension. Short term memory is also involved in the selection, initiation and termination of information processing function like encoding, storing and retrieving data.

"one-three-eight-six" and "two-four-nine-zero" How do you remember these numbers?

(c) **Long term memory**

"A system for permanently storing, managing, and retrieving information for later use. Items of information stored as long-term memory may be available for a lifetime."

Long term memory can be stored for a long time and permanently in our memory. Sigmund Freud divided long term memory into two parts:

- **Preconscious**
  Preconscious is knowledge in our permanent memory. In order to reach there the information needs to be recalled; however the knowledge is reachable using normal methods.
- **Unconscious**
  This is where we obtain the knowledge, however we are not aware that we know it. In order to find it, we need to have detailed methods like hypnosis. We are unable to reach this knowledge on our own methods.

2.3.2 Mental model in HCI

Several theories exist relating different models of users, designers and systems. They proposed four basic models that affect the way users interact with a system:

(a) **User's model of the system**
The model that is constructed by the users through their interactions with the target system.

(b) **System's model of the user**
This model is constructed inside the system as it runs through different sources of information such as profiles, user settings, logs, and even errors.

(c) **Conceptual model**
An accurate and consistent representation of the target system held by the designer or an expert user.

(d) **Designer's model of the user's model**
This model is constructed before the system exists by looking at similar systems or prototype or by cognitive models or task analysis.

Several factors influence the way these models are built and maintained. On the users' side are: their physical and sensory abilities, their previous experience dealing with similar systems, their domain knowledge and finally ergonomics and environments in which users live.

On the designers' side, the need is to influence the user's model to perceive the conceptual model underlying the relevant aspects of the system. This can be accomplished using metaphor, graphics, icons, language, documentations and tutorials. It is important that all these materials collaborate together to encourage the same model.

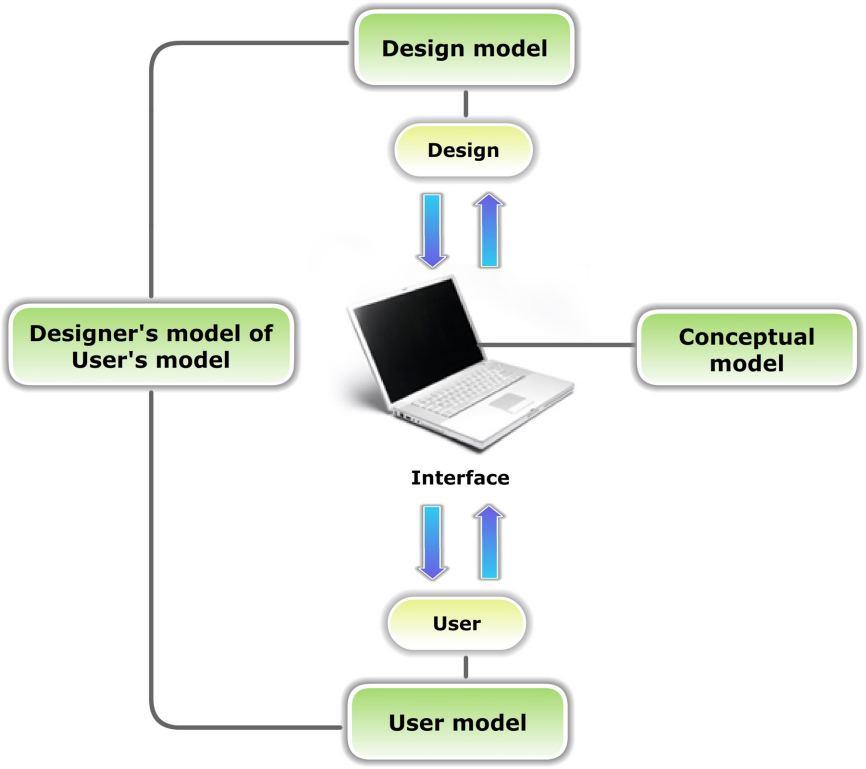


Figure 2.11: Mental model in HCI

2.3.4 Social Aspects

Social aspects is about to explain how people relate to each other and/or with the surrounding environment. With the wider use of current technology, the way we communicate with each other become more relevant for HCI. From the human perspective, technology needs to be designed in a way that supports the cooperative behavior.

Sociability becomes as important as usability when designing interfaces for collaborative/communicative technologies. Social and cultural theories can help

define new areas and give new perspectives to HCI research. Social and cultural theories are very broad topics to discuss in a paper of this scope, so instead of specific details, this paper attempts to give a general picture of the type of research that is important to the HCI community. Many of these topics warrant full descriptions (or books) to understand the impact, so in addition to the general overview, the reader is encouraged to investigate the theories further by looking at the links and references.

SUMMARY

1. People receive, process, and respond accordingly to information many times each day. This sort of processing of information is essentially a conceptual model (or mental model) of how things in our surrounding environment work.
2. This chapter gives us an explanation about the five senses that humans have. Through this senses, we can understand how the interaction between human and computer can be done.
3. Human information processing is one of the main aspects that are involved in this study. Lately, our environment is also affected by the implication of Human Computer Interaction.

REFERENCES

Jenny Preece, Human-Computer Interaction, Addison Wesley

Open University Malaysia, Interaksi Manusia Komputer

http://www.medterms.com/script/main/art.asp?articlekey=7142

http://klcitylib.dbkl.gov.my/

CHAPTER 3

Human Computer Interaction and Technology

LEARNING OUTCOMES

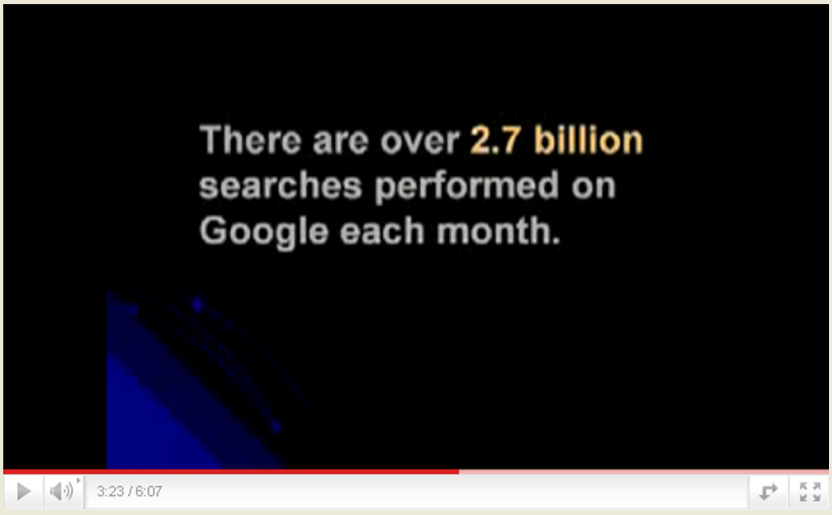
By the end of this chapter, you should be able to:

1. Explain the features, weakness, and advantages for every types of input and output devices;
2. Describes the users characteristics, work and environment for selecting devices and suitable techniques, and;
3. Identify the effects of the current and latest input and output technology for designing systems.

INTRODUCTION

Did you know that technology has given huge impact towards the development of human race? Watch a video clip below to know the answer:

Technology and the Human Race



Source: http://www.youtube.com/watch?v=L2DGI59jOF0

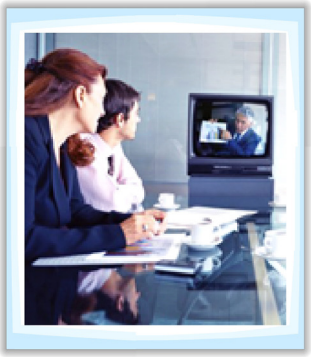
Human beings are very subjective, highly variable, and unpredictable creatures. This is of the constant changes in their life such as mood, motivation, emotion, having prejudices and fears, making errors, and misjudgements. Humans are also capable to identify and act rapidly in response to external stimuli, solve problems, create masterpieces, and organise their actions. With all these capabilities, humans can do many things such as developing high technology applications, acting in films, building airplanes, etc.

Today, humans are one of the main factors that should be considered by system designers. System designers should understand more of human aspects in computing so that they will develop more usable, useful and joyful systems. The system must be developed to fulfill human needs and provide great functionalities by considering how human act and react in different situations.

Today, technology helps human to complete their jobs or tasks in easier way. Computer is one of the high technology machines that introduce more flexibility and power. For example, desktop computer can do multiple works and indirectly change the nature of human work from complex to routine. Every office must have at least two computers so that the staffs can complete all their tasks. Since technology is a part of human life, every system developer or designer must have good understanding of human psychological process. This will ensure that all the designed systems suit

users' capabilities and concern with their gender, age, culture, educational background, and physical abilities and disabilities.





In this chapter, we will explain how the combination of the knowledge of human psychology and technology will contribute to Human Computer Interaction (HCI). In addition, we will also introduce the technology of input and output devices and their interaction styles.

3.1 THE INPUT TECHNOLOGY

Every input device in computer systems nowadays has their own criteria, maybe for certain situations. To suit all the criteria, we must know and overcome the factors before we select the input devices. Table 3.1 shows four factors that can influence suitability of devices.

Table 3.1: Four Factors that Influence Suitability of Devices

Factors	Example
1. Physiological character and user psychology	How blind people surf the Internet?
2. Training and user skill	Train new staff on how to use the computer system.
3. Task to be completed	Using a stylus pen for drawing cartoon is better than using a mouse.
4. Work and environment	User cannot use video call in a noisy environment

In terms of physiological character and user psychology factor, let us see how technology can help the blind and visually-impaired to surf the web:

Discovery Tech: The Blind Surf the Web

Source: http://videos.howstuffworks.com/discovery/33293-discovery-tech-the-blind-surf-the-web-video.htm

3.1.1 Keyboard

Keyboard is a very important input device in a computer system and partially modelledafter the typewriter keyboard which uses an arrangement of buttons, or keys that act as electronic switches. Typically, keyboard has characters stamped on the keys and when a key is pressed, it corresponds to a single written symbol. Most of the keyboard keys produce letters, numbers or characters while real-time keys produce actions or computer commands.

There are many types of keyboards but users just need to find the keyboard that suits them. Figure 3.1 shows an example of new version keyboard.

Figure 3.1: Example of new version keyboard

(a) **QWERTY Keyboard**

QWERTY keyboard is the most common modern-day keyboard layout for English-language computer and also known as typewriter keyboard. It takes its name from the first six characters seen in the far left of the keyboard's top first row of letters. This type of keyboard was built in 1874 and the designing idea came from Christopher Scholes. The design was first implemented for mechanical typewriter.

Figure 3.2 shows the QWERTY keyboard designed by Christopher Scholes (1878) and Figure 3.3 shows the example of current QWERTY keyboard.

Figure 3.2: QWERTY keyboard layout by Christopher Scholes (1878)

Figure 3.3: An example of the current QWERTY keyboard

The design of the keyboard by Scholes is based on the problem faced by typists when typing English words. This design helps to reduce overlapping when typing, as alphabets such as 's', 't' and 'h' always appear continuously in most English words. Because of the problem, the arrangement of those alphabets must be separated.

From Figure 3.3, we can see that alphabet 't' is placed at a different row while alphabet 's' and 'h' at different columns. Until now, the design of QWERTY keyboard has been implemented in most computer keyboards.

SELF-CHECK

As we know, most keyboards that we use now are using QWERTY design because the design is based on English words pattern. The question is why we, in Asia, that use Malay language also use the same QWERTY designed keyboard?

(b) **Dvorak Keyboard**

The design of Dvorak keyboard (as shown in Figure 3.4) was patented in 1932 by Dr.August Dvorak, an educational psychologist and professor of education at the University of Washington in Seattle. Dvorak suggested this keyboard layout and believed that this keyboard is better than QWERTY keyboard. The reason is that typists can type faster using this keyboard layout compared to using QWERTY keyboard layout. That is based on the following principles:

- Letters should be typed by alternating between hands.
- For maximum speed and efficiency, the most common letters should be the easiest to type. This means that the vowel and consonant alphabets that are frequently used should be placed at the second middle row (see Figure 3.4); because 70% of these alphabets are used in English words.
- The least common letters should be on the bottom row, which is the hardest row to reach.
- The right hand should do more of the typing, because most people are right-handed.

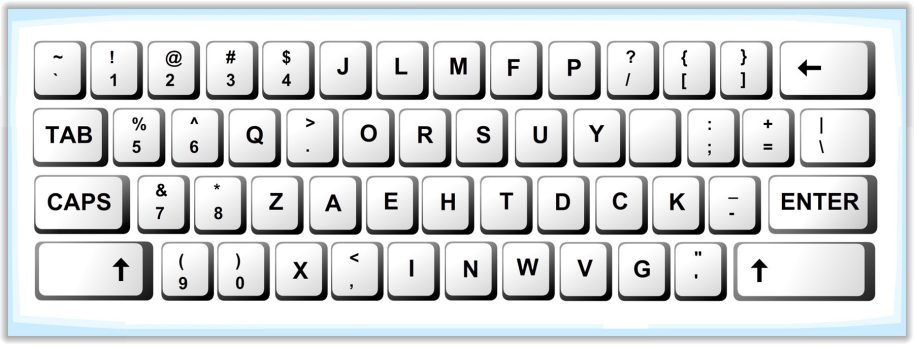
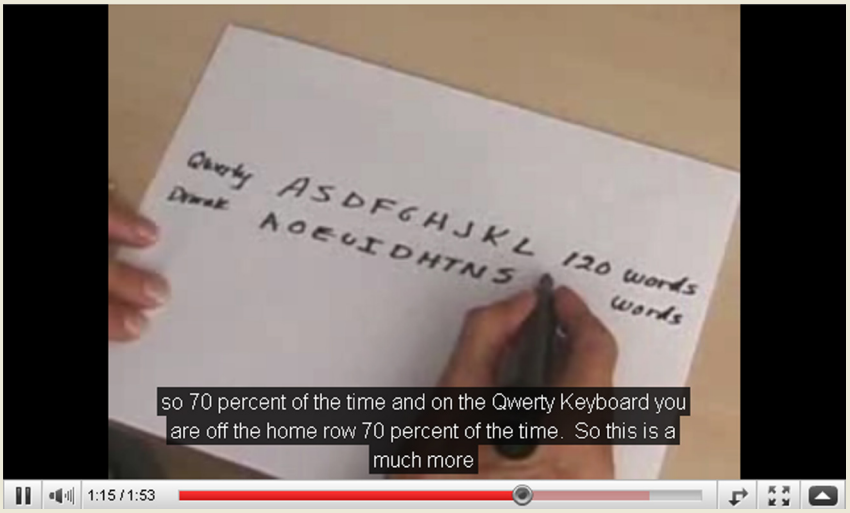


Figure 3.4: The Dvorak simplified keyboard layout
Source: (Microsoft.com, 2009)

Other than that, Dvorak keyboard layout also uses less finger movements. It has been estimated that a QWERTY typist's fingers travel 16-20 miles a day, while a Dvorak typist's fingers will only travel about 1 mile (Jared Diamond, 1997). This is a major benefit to the health of your fingers. Although it has many benefits, the use of Dvorak keyboard is not successfully commercialised. This is because the use of QWERTY keyboard layout is so widespread and it is hard to change technology. Most organisations do not want to train their staffs to use this keyboard because of high cost.

Now, let us watch a video clip below to know the differences between the QWERTY and Dvorak keyboard.

QWERTY and Dvorak Keyboards



Source: http://www.youtube.com/watch?v=l47HjQ3kCac&feature=fvsr

(c) Chord Keyboard

This is another type of keyboard and also a computer input device that allows user to enter characters or commands formed by pressing several keys simultaneously, like playing a "chord" on a piano. Using combination of keys allows text or commands to be entered with one hand. Figure 3.5 shows types of chord keyboards and Figure 3.6 shows us examples of Microwriter codes from combination of keys. These Microwriter codes have a few keys and the size is smaller than other keyboard.

Figure 3.5: Examples of chord keyboards

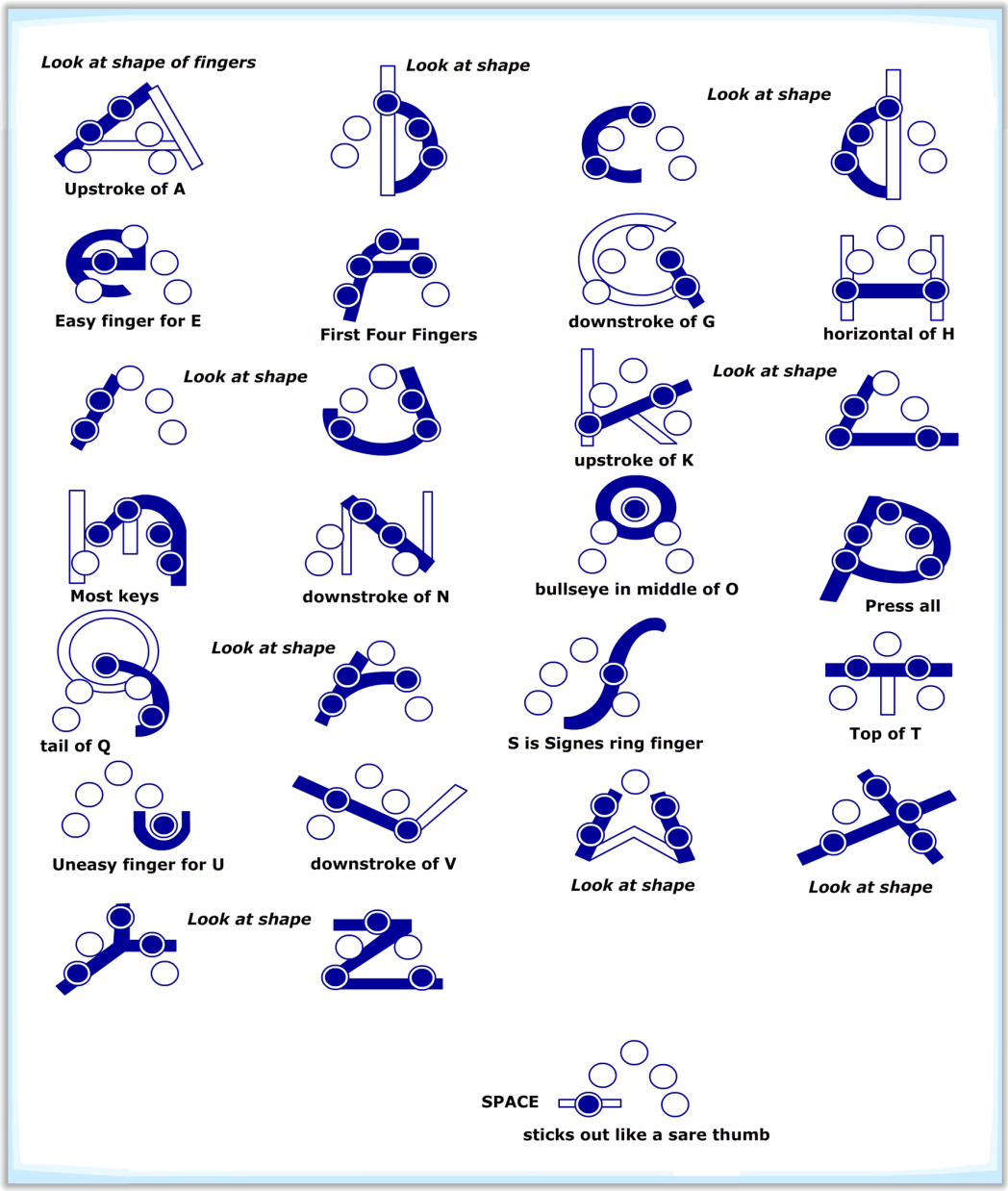


Figure 3.6: Microwriter codes
Source: (http://www.bellaire.demon.co.uk, 2009)

Table 3.2 shows the advantages and disadvantages of chord keyboard.

Table 3.2: Advantages and Disadvantages of Chord Keyboard

Advantages	Disadvantages
Small in size and easier to bring anywhere.	It makes user's hand tired faster than using other types of keyboard.
It can be operated using just one hand.	Need to learn and memorise the codes.

(d) **Other types of keyboard**

There are other types of keyboard design such as:

(i) **Alphabetic keyboard**

- The arrangement of the letter keys follows the alphabetical (A to Z) order. Figure 3.7 shows the design of the alphabetic keyboard layout.
- This keyboard helps new users without any experience and does not need any typing training to start using it.

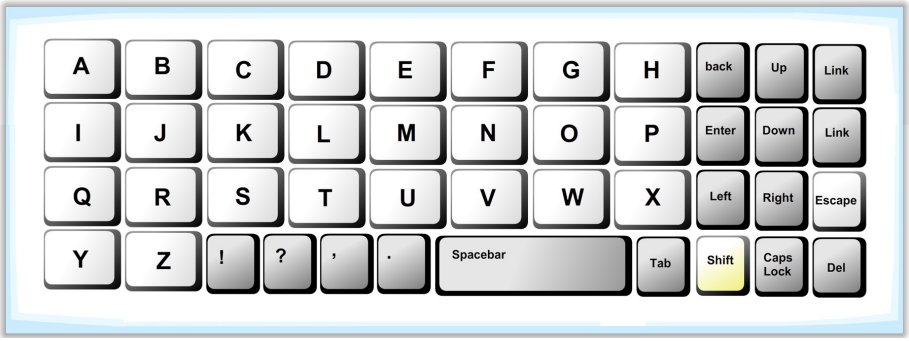


Figure 3.7: Design of alphabetic keyboard layout
Source: (http://www.ahf-net.com, 2009)

(ii) **Ergonomic Keyboard (Natural Keyboard)**

- The features of this keyboard follow guidelines from ergonomic expert.
- The design that has the curve shape is suitable with the position of user's fingers.
- It has a place for user to put their wrists to reduce the effect of repetitive-strain injuries. Figure 3.8 shows the design of the ergonomic keyboard from Microsoft.

Figure 3.8: Ergonomic keyboard
Source: (Microsoft.com, 2009)

(iii) **Special Keys**

Every computer keyboard has special keys for formatting purpose such as 'ENTER', 'CAPS LOCK', and 'NUM LOCK'. These special keys have been designed with different sizes or colors so that users can differentiate them from the other alphanumeric keys. Nowadays, these special keys on computer keyboard have lights to show their activation status.

There are two ways to arrange numeric keys on a keyboard. The first arrangement is in ascending order, as we can see at the first row on a keyboard layout.

Figure 3.9 shows the arrangement. The second arrangement is just like a calculator as shown in Figure 3.10.

Figure 3.9: The first arrangement of numeric keys on a keyboard

Figure 3.10: The second arrangement of numeric keys on a keyboard

Cursor movement keys or arrow keys are buttons on a computer keyboard that are either programmed or designated to move the cursor in a specified direction. The term "cursor movement key" is distinct from "arrow key" in that the former term may refer to any of the various keys on a computer keyboard designated for cursor movement, whereas the latter term generally refers to one of four specific keys, typically marked with arrows.

Figure 3.11 shows arrangement of cursor keys. This arrangement helps user to press the keys faster.

Figure 3.11: Cursor key

Modifier keys are special keys on a computer keyboard that modify the normal action of another key when the two are pressed in combination. For example, <Alt> + <F4> in Microsoft Windows closes programs in an active window. In contrast, pressing just <F4> will probably do nothing unless it is assigned a specific function in a particular program. By themselves, modifier keys usually do nothing. The most widely-used modifier keys include the Control, Shift, and Alt key. The Alt-Gr key is used to access additional symbols for keys that have three symbols printed on them.

On the Macintosh and Apple keyboards, the modifier keys are the Option and Command key, respectively. On MIT computer keyboards, the Meta key is used as a modifier, and for Windows keyboards, there is a Windows key. Compact keyboard layouts often use an Fn key. "Dead keys" allow placement of diacritic mark such as an accent on the following letter (e.g., the Compose key).

The Return key / Enter key (rarely "Execute") typically causes a command line, Window form or dialog box to operate its default function, which is typically to finish an "Entry" and begin the desired process. In word processing applications, pressing the Enter key ends a paragraph and starts a new one.

(iv) **Pointer Devices**

A pointer device is one of the input devices used to identify a point or path in one, two or three dimensional space. There are many types of pointer devices that can help user to easily navigate the computer system or playing games such as mouse, mini mouse (for laptop user), joystick, trackball and so on. The following subtopics explain more on these pointer devices.

3.1.2 Mouse

Mouse is one of the popular pointer devices, small in size, and functions by detecting two-dimensional movement relative to its supporting surface. Nowadays, other features have been added to the mouse, such as wheels that functions like a scroll bar but depending on certain operations, or extra buttons that can add more control or dimensional input. Every mouse motion is typically translated into the motion of a pointer on a display, which allows fine control of a Graphical User Interface. Figure 3.12 shows the examples of mouse.

Figure 3.12: Examples of mouse

There are two types of mouse:

(a) Mechanical Mouse

Usually this mouse has a ball in the center of the mouse housing. This ball can utilise two rollers rolling against two sides of the ball. One roller detects the horizontal motion of the mouse and the other detects the vertical motion. The movements of the mouse also make the ball rotate to generate electrical signals. Then, driver software in the computer system converts the signals into motions of the mouse pointer along X and Y axes on the screen. The movements of cursor in computer system can be monitored using this mouse.

Figure 3.13 shows the architecture of a mechanical mouse.

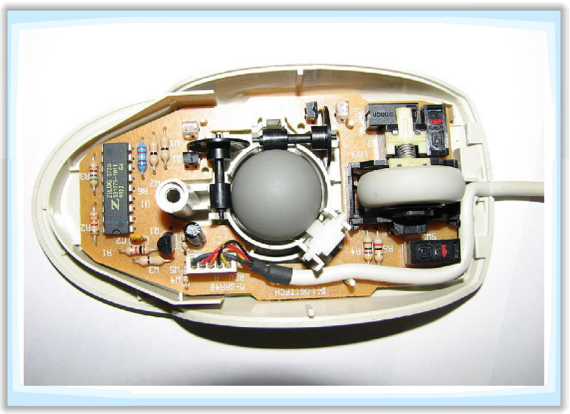


Figure 3.13: The architecture of mechanical mouse
Source: http://mousearena.com, 2009

(b) **Optical Mouse**

Optical mouse is a modern mouse. It has a modern surface-independent that works using an optoelectronic sensor. This sensor can take successive pictures of the surface on which the mouse operates. The embedded image-processing chip in the optical mouse has its special-purpose and makes the mouse more powerful. This advance feature allows optical mouse to detect relative motion on a wide variety of surfaces. The chip translates the movement of the mouse into the movement of the pointer and eliminates the need for a special mouse-pad. This feature also smoothes the way for widespread implementation of optical mouse. Using an LED or a laser diode, optical mouse clarifies the surface that they track over. Changes between one frame to the next are processed by the image processing part of the chip and translated into movements on the two axes using an optical flow estimation algorithm.

Figure 3.14 shows the optical mouse with red diode and Figure 3.15 shows optical sensor that is embedded in the optical mouse.

Figure 3.14: The optical mouse with red diode

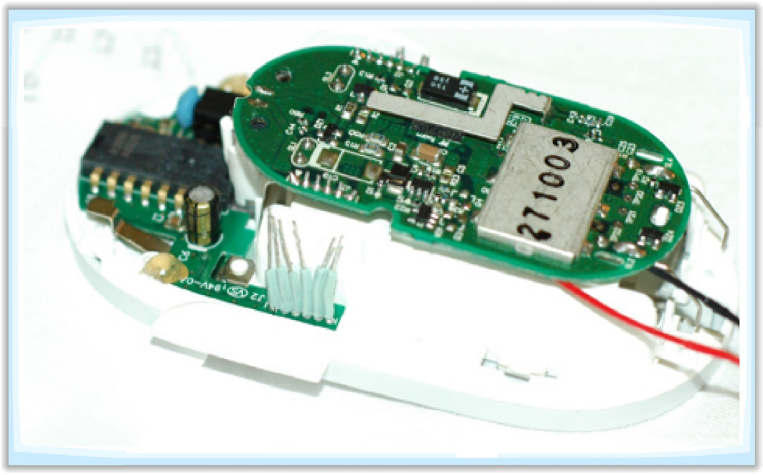


Figure 3.15: The optical sensor embedded in the mouse
Source: http://www.pctechguide.com, 2009

3.1.3 Trackball

A trackball is a pointing device consisting of a ball housed in a socket containing sensors to detect rotation of the ball about two axes. The concept of trackball is similar to mouse but the design is different. This trackball can be defined as an upside-down mouse with an exposed protruding ball.

In CAD workstations, the usage of large tracker balls is for easy precision. Before the beginning of touchpad, small trackballs were common on portable computers as there is no desk space to run a mouse. Some small thumb balls are clipped onto the side of the keyboard and have integral buttons with the same function as mouse buttons.

Figure 3.16 and 3.17 show some examples of hardware with the attached trackballs.

Figure 3.16: Mouse with trackball
Source: http://www.logitech.com, 2009

Figure 3.17: Keyboard with trackball
Source: http://www.made-in-china.com, 2009

(a) **Pointing Devices Based on Stick**

There are many types of pointing devices that are based on stick. Below are the categories of the pointing devices based on stick:

- **Joystick**
  A joystick is an input device that has a stick pinned on its base and reports its angle or direction to the device it is controlling. The shape of this stick is just like stick that can be grasped by hand. User can move the stick whether to the front, back, left or right. Because of the robustness and easy-to-use features, this joystick is very suitable to be used when playing computer games. Figure 3.18 shows a type of joystick for gaming applications.

Figure 3.18: Joystick

- **Analog Stick**
  An analog stick, thumbstick, control stick, or occasionally called as a c-stick is an input device for a controller that is used for two-dimensional input. An analog stick is a popular variation of a joystick and has been used together with game consoles such as Playstation 3, X-box 360, Ninetendo Gamecube etc.

Figure 3.19 shows the analog stick for Playstation 2.

Figure 3.19: An analog stick for Playstation 2

3.1.4 Touch Screen

Touch screen enables user to point and choose objects directly from the screen. All the inputs are received by detecting fingerprints or stylus pen pointing to the screen. The usage of touch screen makes interaction with the system easier and faster. It is very intuitive and makes the public very comfortable to use it. Because of the touch screen abilities, most of the systems for public such as LRT stations and ministry offices, as well as the Personal Digital Assistance (PDA) use touch screen.

Figure 3.20 shows the examples of touch screen applications.

Figure 3.20: Examples of touch screen applications

However, touch screen also has its weaknesses such as the use of user's finger as a pointer makes the screen dirty because of the oil marks left on the screen by user's finger and using touch screen for a long time makes users' hand tired as they have to lift their hand to touch the screen.

3.1.5 Touchpad

A touchpad, also named trackpad, is a pointing device consisting of a specialised surface that can transform the motion and position of user's finger to a relative position on screen. Nowadays, touchpad is the common feature of laptop computers and also used as an alternative to the computer mouse where desk space is limited. Touchpads vary in size but are rarely made larger than 40 square centimetres (about 6 square inches). They can also be found on personal digital assistants (PDAs) and some portable media players.

Figure 3.21 shows examples of the touchpad implemented on laptop and notebook.

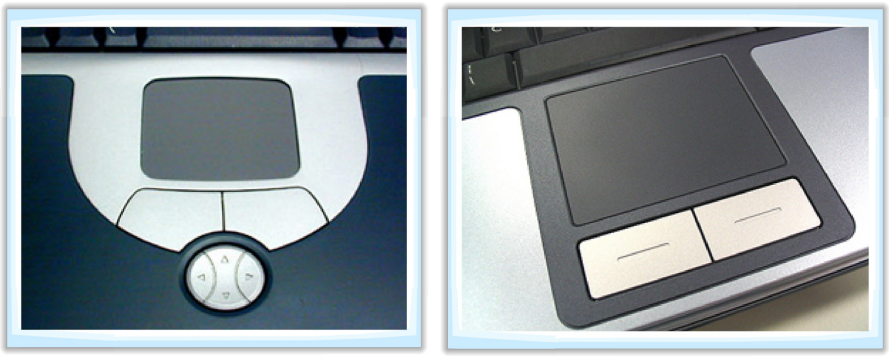


Figure 3.21: Types of touchpad for laptop and notebook

3.1.6 Graphics Tablet

A graphics tablet (also known as digitising tablet, graphics pad, or drawing tablet) is a computer input device that lets one to hand-draw images and graphics (Sue Chastain, 2009). It is very similar to the way one draws images with a pencil and paper. These tablets may also be used to capture data of handwritten signatures.

A graphics tablet consists of a flat surface upon which user can "draw" an image using an attached stylus, a pen-like drawing apparatus (Sue Chastain, 2009). The image generally does not appear on the tablet itself, but rather is displayed on the computer monitor. Some tablets however, come as a functioning secondary computer screen that you can interact with directly using the stylus. Figure 3.22 shows examples of the graphics tablet.

Figure 3.22: Examples of graphic tablet applications

3.1.7 Light Pen

A light pen is a computer input device in the form of a light-sensitive wand used in combination with the display screen (Webopedia, 2003). It allows user to point to the displayed objects, or draw on the screen, in a similar way to a touch screen but with better positional accuracy. A light pen can work with any CRT-based display, but not with LCD screens, projectors, and other display devices. A light pen is simple to use and implement. The light pen works by sensing the sudden small change of brightness of a point on the screen when the electron gun refreshes that spot. Figure 3.23 shows implementation of the light pen.

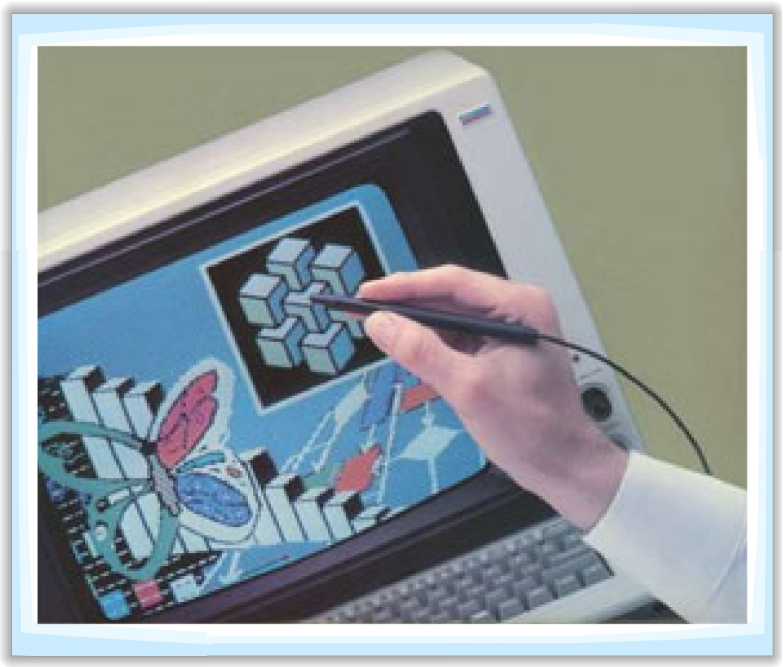


Figure 3.23: Light pen for office use

3.1.8 Wii Remote

The Wii Remote, sometimes nicknamed "Wiimote", is the primary controller for Nintendo's Wii console. The main feature of the Wii Remote is its motion sensing capability, which allows user to interact with and manipulate items on screen via movement and pointing through the use of accelerometer and optical sensor technology. Another feature is its expandability through the use of attachments. The unique features that Wii Remote provides are different than other typical gaming controllers.

Figure 3.24 shows the Wii Remote for Wii console.

Figure 3.24: Wii Remote

3.2.9 Dance Pad

A dance pad, also known as dance mat or dance platform, is a flat electronic game controller used for input in dance games. Most dance pads are divided into a 3×3 matrix of square panels for the player to stand on, with some or all of the panels corresponding to directions or actions within the game. Some dance pads also have extra buttons outside of the main stepping area, such as "Start" and "Select". Figure 3.25 shows the dance mat.

Figure 3.25: Dance mat for dance game

3.1.10 Microphone

A microphone is an acoustic-to-electric transducer or sensor that converts sound into an electrical signal (Lloyd Budhram, Mac 2009). Microphones are used in many applications such as telephones, tape recorders, hearing aids, motion picture production,live and recorded audio engineering, radio and television broadcasting, computers for recording voice, VoIP, and for non-acoustic purposes such as ultrasonic checking. Figure 3.26 shows an example of microphone.

Figure 3.26: Example of microphone

3.1.11 Webcam

Webcam is a device similar to video camera but is in fact a video capturing device connected to computers or computer networks via USB or connected directly to networks such as Ethernet or Wi-Fi. They are well-known for their low manufacturing costs and flexible applications. Figure 3.27 shows the webcam or web camera.

Figure 3.27: Example of webcam

3.1.12 Data Glove

Data Glove is one of the examples of 3 dimensional applications. It is made by lycra fabric that has fiber optic stripe in every glove finger. These fiber optic stripes can detect all angle of bent in every finger's joint. Fiber optic stripes also bent when fingers bent and all input from that movements are transferred to data. Then, the data is sent to two sensors at the end of the data glove. This glove can also detect the circle of hand rotation. All the movements made by hand are translated to three-dimensional position.

Figure 3.28: Data glove for Wii Console

Data glove is easy to use and very powerful because it can produce information for 3D space in a short time. This device has a very high potential in technology based on its gesture detection and sign language translation. Figure 3.28 shows data glove for Wii Console.

3.2 THE OUTPUT TECHNOLOGY

In the following sub chapters, we explain the examples of output technology. It is to introduce the technology and its devices that function for translating information in electronic form. These sub chapters also tell us the suitable way of using output devices for particular systems, situations, and users.

3.2.1 Visual Display Unit

Good output devices specification is needed to produce good quality visual output. For visual output, we need an output device named Visual Display Unit (VDU) or often known as monitor. There are many types of VDU that are:

(a) Cathode Radiation Tube (CRT)

VDU technology is very familiar with computer technology and also electrical appliances like television monitor. CRT consists of a vacuum tube containing electron gun and fluorescent screen. It can accelerate and deflect electron beam used to form images in the form of light produced from the fluorescent screen. The image can be waveform (oscilloscope), pictures (television, computer monitor), radar target and so on. Figure 3.29 shows the design of Cathode Radiation Tube (CRT).

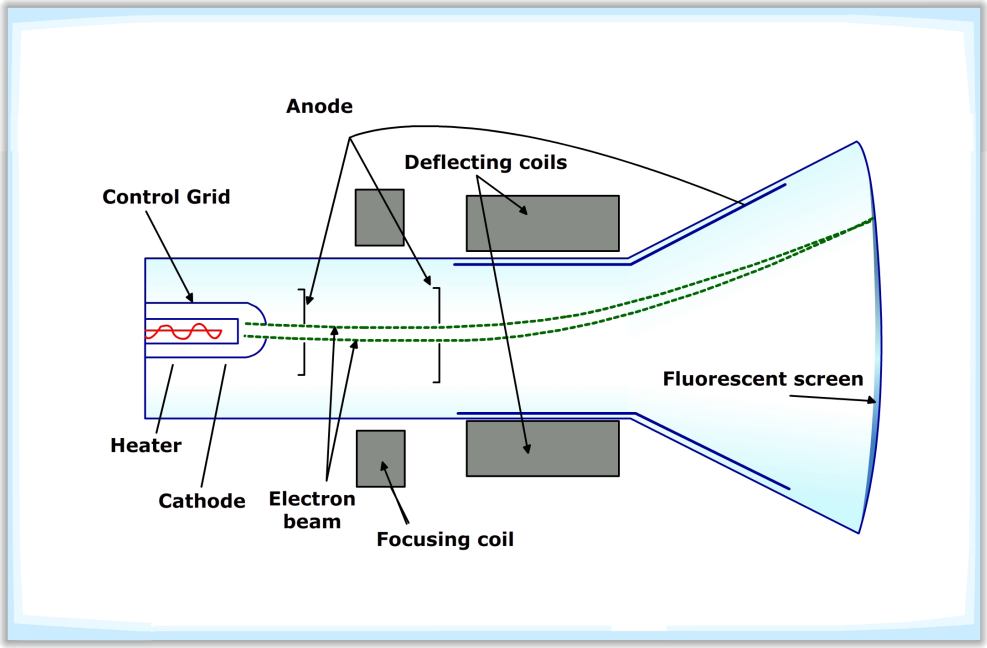


Figure 3.29: The design of Cathode Radiation Tube
Source: (Educypedia, 2009)

There are two techniques that have been used to deflect electron beam to fluorescent screen. Below are the two techniques:

(i) Raster Scan Technique

A technique used to detect and reconstruct pattern of image in television. It has been used in most computer bitmap image systems and is the storage and transmission for pattern of image. Process in raster scan technique can be described as follows:

- Electron beam scans from left to right, or from top to bottom and so on.
- The image on screen should be refreshed via the same re-iteration process so that stable image appears on the screen. This is because of the fluorescent light that dims after a certain time.
- The image then is refreshed with the same scanning as much as 30-70 times per second (3070 Hz).
- Increase the refresh rate;
- Do alternate scanning. For example, even rows should be scanned first and then scan the odd rows.
- Use fluorescent that can shine longer but this is not suitable for animation because it can make smear effect.

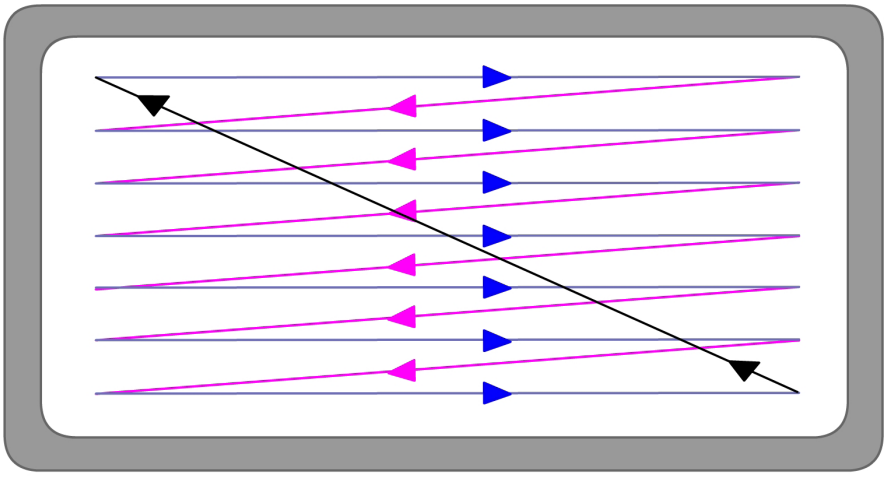


Figure 3.30: Path of electron beam when using raster scan technique

Figure 3.30 shows the path of the electron beam when using raster scan technique. Because of the refresh process, there is a twinkle-like effect appears on the screen. There are three ways to reduce this effect:

- Increase the refresh rate;
- Do alternate scanning. For example, even rows should be scanned first and then scan the odd rows.
- Use fluorescent that can shine longer but this is not suitable for animation because it can make smear effect.

(ii) **Random Scan Technique**

In random scan screen, electron beam is directly deflected to the screen for displaying the image. With this technique, electron beam is not deflected to other blank area, thus sharp image is displayed with medium refresh rate. However, this random scan technique is limited to image that is based on line only and not suitable for creating complex image like 3D object.

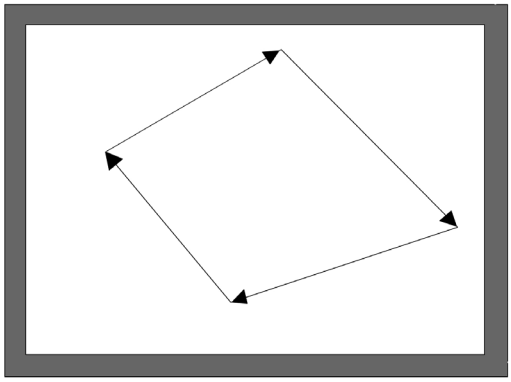


Figure 3.31: Path of electron beam when using random scan technique

Figure 3.31 shows the path of electron beam using random scan technique. This CRT display can give negative effects to user's eye after viewing the screen for a long time and in unsuitable place. For example, after several hours, user's eyes will become tired and dimmed. There are also tips for reducing these effects such as keeping eyes not too close to the screen, avoiding small size font, and placing computer far from window with bright light that can cause dazzling to eye.

(iii) **Flat Panel Display**

There are many types of flat panel display that we can see on the market right now. Nowadays, flat panel display is user's first choice when buying monitor for desktop computer. This is because flat panel display is smaller, thinner, and the design look more trendy and modern compared to the traditional CRTs. In many applications, the use of flat panel display is becoming popular for applications such as mobile phone, PDA, and laptop. Below, we present more types of flat panel display.

Want to know more about the manufacturing information of flat panel display?

You can visit this website, http://www.auo.com for more information.

- **Plasma Display**

  A plasma display panel (PDP) is a type of flat panel display that is frequently used now for large TV displays and its size is typically above 37-inch or 940mm. Most of the plasma display has features such as wide screen and only about 6 inches (15 cm) thick. The fundamental idea of a plasma display is to light up tiny, coloured fluorescent lights to structure an image. Each pixel is made up of three fluorescent lights that are red, green, and blue light. Figure 3.32 shows the picture of plasma TV.

Figure 3.32: An example of plasma TV
Source: (http://www.reviewzine.com, 2009)

- **Liquid Crystal Display (LCD)**

  A liquid crystal display (LCD) is a type of flat panel display, currently the great choice among notebook computer manufacturers, due to light weight, very good image quality, wide color scale, and fast response time. LCD is also suitable to run in high resolution like 2560 x 1600. In LCD, crystal molecules move like liquid that follows conductor ribbons direction in the LCD when electric current is connected. Light that is created from the movement of the crystal molecules is reflected to the screen. Figure 3.33 shows the picture of LCD.

Figure 3.33: An example of LCD

Can you give advantages and disadvantages of Plasma Display and LCD?

You can visit http://wwww.practical-home-theater-guide.com for the latest technology in flat panel display.

3.2.2 Sound Output

Sound has been used to give users alert and feedback from what they do or act against computer. There are different kinds of sound that can be either digitally recorded or replayed such as speech, musical sounds, and natural sounds.

The use of speech in computer system has been attracting system designers for a long time. However, the speech is not widely applied because of some constraints. There are two types of technique to create voice or speech.

- First, concatenation is a technique of combining sentences, words, or phrases in digital form.
- Second, synthesis by rule is a technique that uses fully synthesised words and sentences based on phonemic rules and rules based on the context of word and sentence.

For natural sound, there is no method or technique can be used to create this type of sound except by doing digital audio recording. Before the natural sound is used in computer system, it maybe need to go through several processes such as editing, cutting, and combining to make sure the natural sound is really suitable for the applications.

SUMMARY

1. Today, technology helps human to complete their jobs or tasks in easier way. Computer is one of the high technology machines that introduce more flexibility and power.
2. Since technology is a part of human life, every system developer or designer must have good understanding of human psychological process. This will ensure that all the designed systems suit users' capabilities and concern with their gender, age, culture, educational background, and physical abilities and disabilities.
3. There are four factors that influence suitability of devices:
   (a) Physiological character and user psychology.
   (b) Training and user skill.
   (c) Task to be completed.
   (d) Work and environment.
4. In this chapter, you have been exposed to the devices and the theory of output and input technology that have been used in computer system nowadays.
5. The input devices include the followings:
   (a) Keyboard
   (b) Mouse
   (c) Trackball
   (d) Touch Screen
   (e) Touchpad
   (f) Graphics Tablet
   (g) Light Pen
   (h) Wii Remote
   (i) Dance Pad
   (j) Microphone
   (k) Webcam
   (l) Data Glove

- The output devices include the followings:

  (i) Visual Display Unit.
  (a) Cathode Radiation Tube (CRT).
  (b) Flat Panel Display.

  (ii) Sound Output

- Every device and technique has its advantages and disadvantages. So, if we want to use a device by applying it to our system, we must make sure that it is really suitable and comfortable to use.

REFERENCES

Jenny Preece, *Human-Computer Interaction*, Addison Wesley.

Open University Malaysia, *Interaksi Manusia Komputer.*

Jared Diamond, *The Curse of QWERTY*, Discover Magazine, April 1997.

Steve Mann (2001), *Intelligent Image Processing* John Wiley.

Microsoft, http://www.microsoft.com, Mac 2009.

Sue Chastain, Before You Buy a Graphics Tablet Graphics Tablet Features and Advantages, About.com, Mac 2009.

http://www.bellaire.demon.co.uk/bellaire_cykey_codes.html, Mac 2009.

http://www.ahf-net.com, Mac 2009.

Sierra, http://www.mousearena.com/who-invented-the-computer-mouse/, Mac 2009.

http://www.made-in-china.com, Mac 2009.

Webopedia, http://www.webopedia.com, Mac 2009.

Wii at Nintendo, http://www.nintendo.com, Mac 2009.

Lloyd Budhram, http://lloydmicrophoneclassics.com/, Mac 2009.

Educypedia, http://www.educypedia.be/electronics/television.htm, Mac 2009.

CHAPTER 4

Technology In Interaction

LEARNING OUTCOMES

By the end of this chapter, you should be able to:

1. Explain 3D Virtual Reality, Model of Interaction, the windowing system and several interactive styles use HCI;
2. Identify some of the factors that need to be considered when selecting an interaction styles, and;
3. Identify which interactions styles to be used in different applications.

INTRODUCTION

In this chapter, the 3D Virtual Reality is explained.

3D computer graphics (in contrast to 2D computer graphics) are graphics that use a three-dimensional representation of geometric data that is stored in the computer for the purposes of performing calculations and rendering 2D images. Such images may be for later display or for real-time viewing. Despite these differences, 3D computer graphics rely on many of the same algorithms as 2D computer vector graphics in the wire-frame model and 2Dcomputer raster graphics in the final rendered display.

In computer graphics software, the distinction between 2D and 3D is occasionally blurred; 2D applications may use 3D techniques to achieve effects such as lighting, and primarily 3D may use 2D rendering techniques. 3D computer graphics are often referred to as 3D models. Apart from the rendered graphic, the model is contained within the graphical data file. However, there are differences. A 3D model is the mathematical representation of any three-dimensional object (either inanimate or living). A model is not technically a graphic until it is visually displayed. Due to 3D printing, 3D models are not confined to virtual space. A model can be displayed visually as a two-dimensional image through a process called "3D rendering", or used in non-graphical computer simulations and calculations.

3D Computer Graphics

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3D Applications

In computer graphics software, the distinction between 2D and 3D is occasionally blurred; 2D applications may use 3D techniques to achieve effects such as lighting, and primarily 3D may use 2D rendering techniques.

3D Models

3D computer graphics are often referred to as 3D models. Apart from the rendered graphic, the model is contained within the graphical data file. However, there are differences. A 3D model is the mathematical representation of any three-dimensional object (either inanimate or living). A model is not technically a graphic until it is visually displayed. Due to 3D printing, 3D models are not confined to virtual space. A model can be displayed visually as a two-dimensional image through a process called "3D rendering", or used in non-graphical computer simulations and calculations.

4.1 VIRTUAL REALITY

3D Virtual Reality is becoming widely used. 3D Virtual Reality is an artificial reality that projects the user into a 3D space generated by the computer. It creates an artificial reality and is used for entertainment and training. Let's have a look of some examples of 3D Virtual Reality that have been developed. Figures 4.1 and 4.2 show us two real examples of 3D Virtual Reality by Microsoft and Astronautic Technology (M) Sdn Bhd (ATSB®).

Example 1: Microsoft TouchLight

The Microsoft's TouchLight 3D technology lets you move and manipulate three-dimensional images with your hands.

Figure 4.1: Microsoft Touch Light

Example 2: **Virtual Reality Solar System**

Astronautic Technology (M) Sdn Bhd (ATSB®), the pioneer and leader in the design and manufacture of satellites in Malaysia has taken the bold step recently and embarked into new territories by developing a virtual reality solar system for Kompleks falak Al-Khawarizmi (Jabatan Mufti Melaka) as part of Al-Khawarizmi's Education Programme to promote Astronomy Science.

The Al-Falak VR Solar System is a 3D virtual reality application which enables the user to interact and explore our solar system. A Head Mounted Display and a pair of VR gloves allow the user to immerse oneself as the user navigates through the virtual world.

Figure 4.2: Al-Falak Virtual Reality Solar System

4.2 WINDOWING SYSTEMS

Windowing systems also known as WIMP from elements; WIMP.

These elements also are called widget. The main usage of the windowing system is to overcome the need for users to be able to refer to multiple sources in a short time.

Let say if the size of the display used is big, then a number of Windows can be opened and displayed simultaneously. However, the visibility and frequent movement of the eyes could pose as a serious problem. If the size of the display is small, then the size of the displayed Window would be too small to accommodate the correct context of the information.

So, it is very important to provide users with sufficient information and enhance the flexibility apart from reducing the management activities and compact displays due to too many Windows popping-up and the constant movement of the eyes and head. There are several elements of the Windows system such as Windows, icon, pointer cursors and other elements (e.g.; buttons, toolbar, dialogue box, and etc.).

4.2.1 Windows

Basically, Windows are use to split the display space into several number of virtual displays and enables a number of operations to be executed simultaneously. Each Windows can be moved and its size can be changed. The content within a Windows can also be manipulated and moved.

In addition, each Windows 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.

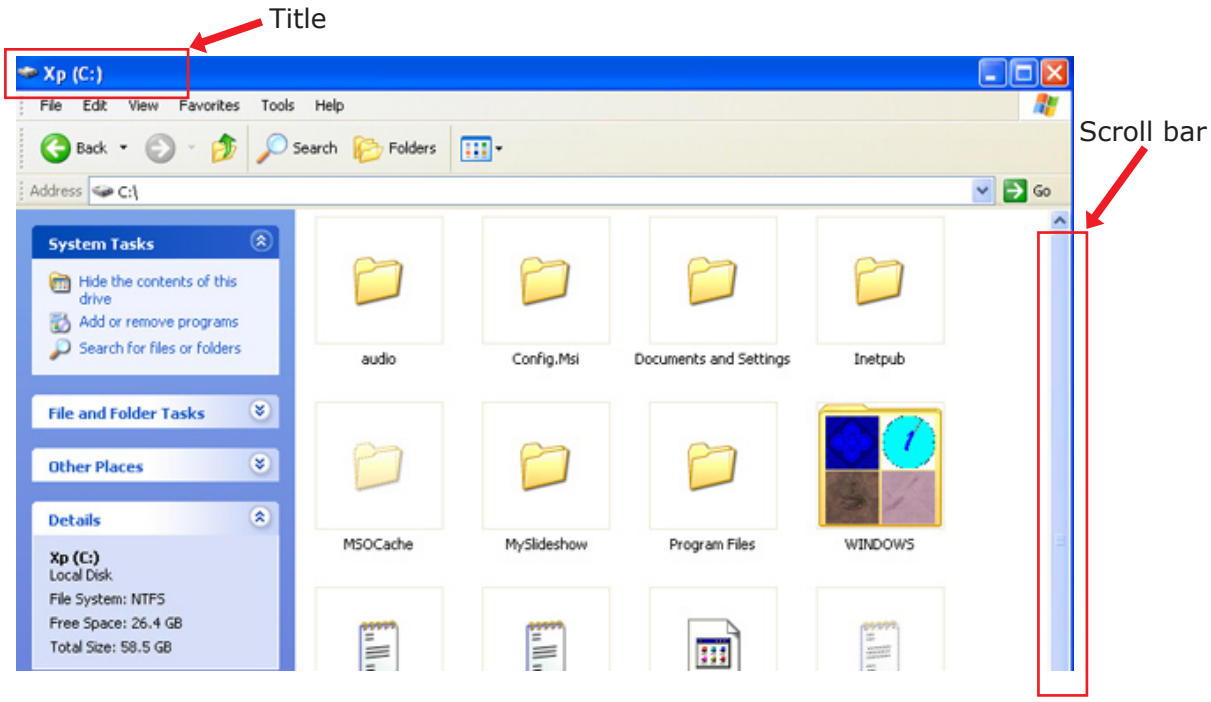


Figure 4.3: Example of a Window on the Windows XP Professional system

4.2.2 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 (OUM, 2008). For instance, a brush illustrates the concept of drawing or painting in a system and the magnifier represents a zooming tool in documents or files.

Figure 4.4: Various example of icons

The main reason of using icons is to save spaces and to enable more details of concept, operation or utilities to be presented in a simplified manner compared to words or sentences. The use of icons in system interface is not a new subject. In fact, it has been extensively used in printing media, notice boards in buildings, and maps. However, icons need to be accurately illustrated so that users can understand the message delivered by the system. Failure to illustrate icons that can be understood by the users may cause confusion and influencing the usability of the software.

4.2.3 Pointer Cursors

Pointer cursor is one of the active icons in the system. It is used as an indicator to a specific location and to indicate a mode. Pointer cursor is a very important element in WIMP since the interaction style in WIMP mostly depends on the process of pointing and selecting an item or element, such an icon.

Usually, users use the pointer cursor to point the items of an interface using the mouse or any other input devices such as joystick or track balls (see Chapter 3). The movement of these devices is illustrated on the screen using the pointer cursors.

There are many types of pointer cursors in the current computer systems. Each pointer represents the different modes of function. For instance:

Graphic cursor :	Arrows indicate a normal mode
Graphic crosshair :	Crosshair indicates a mode to draw lines
Graphic hourglass :	Hourglass indicates a system that is busy reading a file

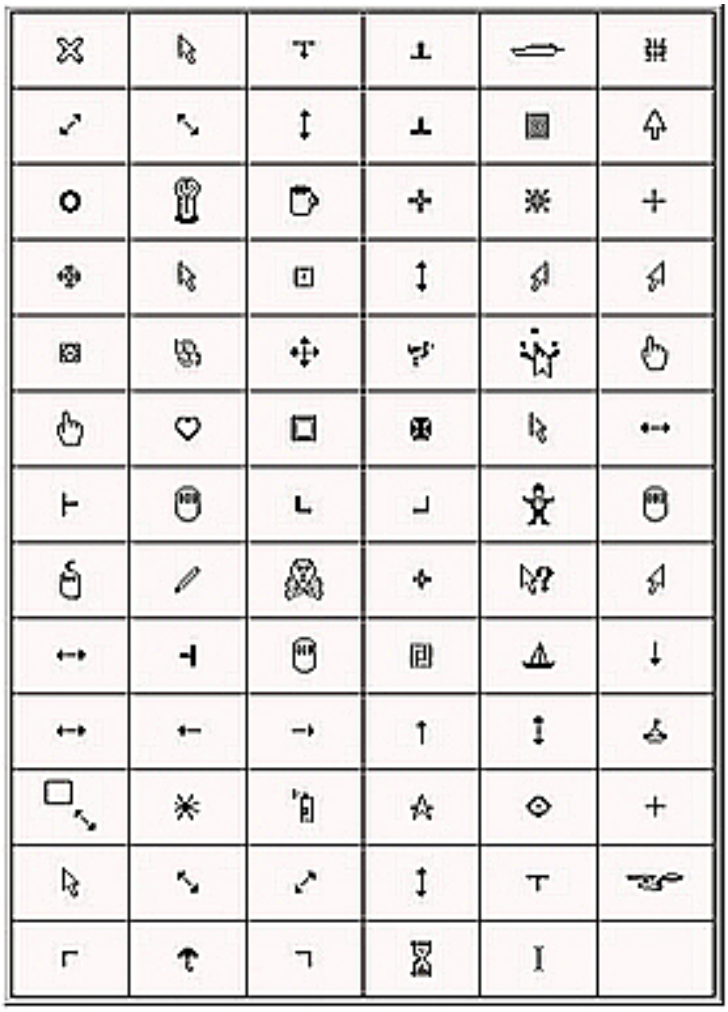


Figure 4.5: Different types of pointer cursors

4.3 INTERACTION STYLES

In order to have a better understanding of the computer system interface, developers have created a better and more attractive interface so that users can easily use the system. But how can the interface give better understanding to the human impression? Here, we explained about the interactive styles used in the system interface.

4.3.1 Command Prompt

Command prompt is one of the earliest command languages or interactive styles that users used. Conventionally, it is used by technical person who needs faster retrieval functional system. This style is used in UNIX and DOS operation systems. By using this interaction style, users need to enter certain instructions to run the system.

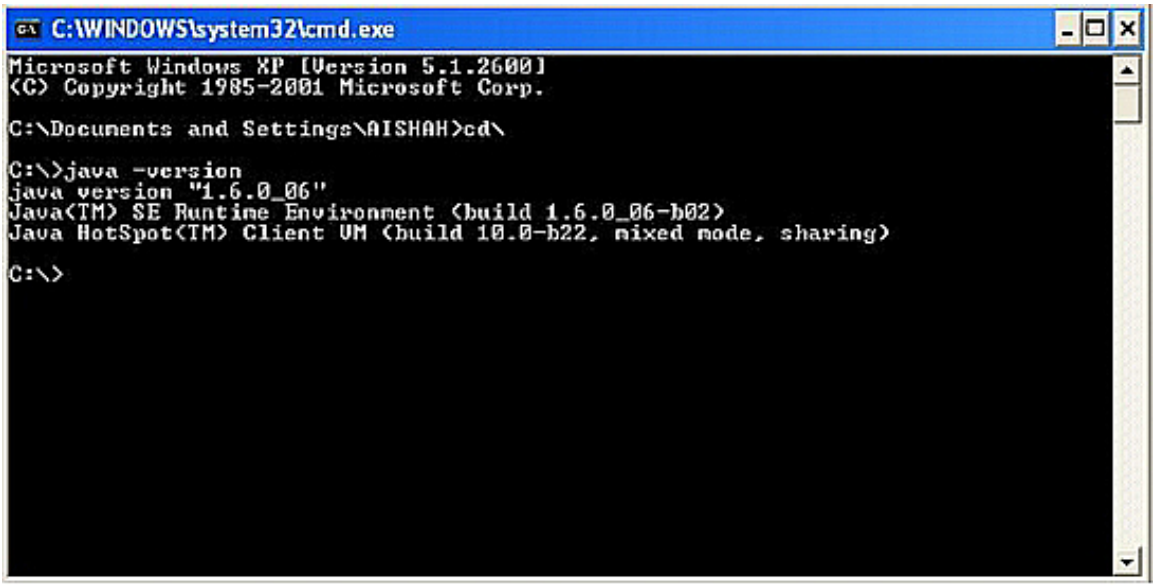


Figure 4.6: MS-DOS system interface

4.3.2 Menu

Interface with menus is a set of choices that has been provided to users. Users just need to select an iten from the menu, using the 'mouse' or hit the keyboard. This menu can be easily used by users without the need to enter any instruction or remember the command.

Basically, the items in the menu list are arranged hierarchical. Sometimes, the item that the users search for will not be in the first list in the menu. Thus, the user will depend on the clue that can be found in the menu.

There are several types of menus and most of the previous menus are based on text. Commonly, the menu that based on text will be merging with numbers. So, users can make a choice either wants to move the cursor to the menu or just entering the number that pointing to the menu.

With User Graphical Interface (GUI), various menus can be used, such as:

- Pull-down/Drop-down menu.
- Pop-up menu.
- Tear-off menu.
- Walking or cascading menu.

(a) Pull-down menu

This menu is the most commonly used. Items that included in this menu represent the tasks or utilities that users used. Figure 2 shows the example of the pull-down menu. These items are categorized into several groups of tasks. To select these items, user need to choose the menu based on category. Only after the user has made the selection, then the items will be displayed.

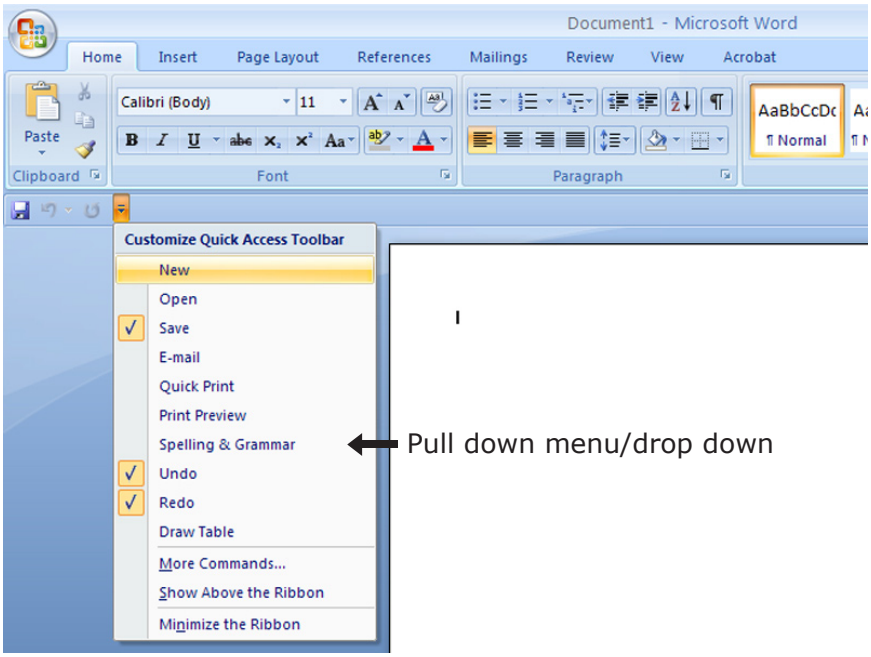


Figure 4.7: Pull down menus in Microsoft Word 2003 ©

(b) Pop-up menu

Commonly, this menu is used to select the tasks that are seldom used by users. This menu will only be displayed when requested by the users. For instance, when users right-click the 'mouse', the pop-up menu is displayed. Figure 4.8 shows the example of the pop-up menu.

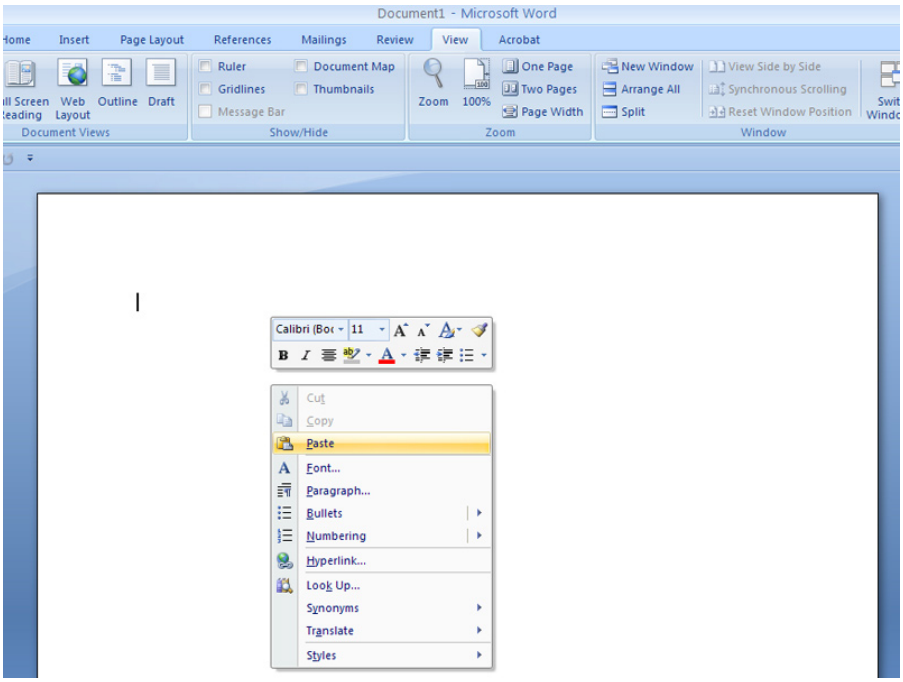


Figure 4.8: Pop-up menus in Microsoft Word 2003 ©

(c) Tear-off menu

Tear-off menu is used to select the colors and patterns that includes in the drawing applications. Compared to other menus, this menu can be moved to any location in the screen. This is to prevent any space in the screen hidden by the tear-off menu. This menu is suitable for drawing application such as Adobe Photoshop and Illustrator because users can use the whole space on the screen. Moreover, users can select the menu easily without the need to open the menu continuously. See Figure 4.9.

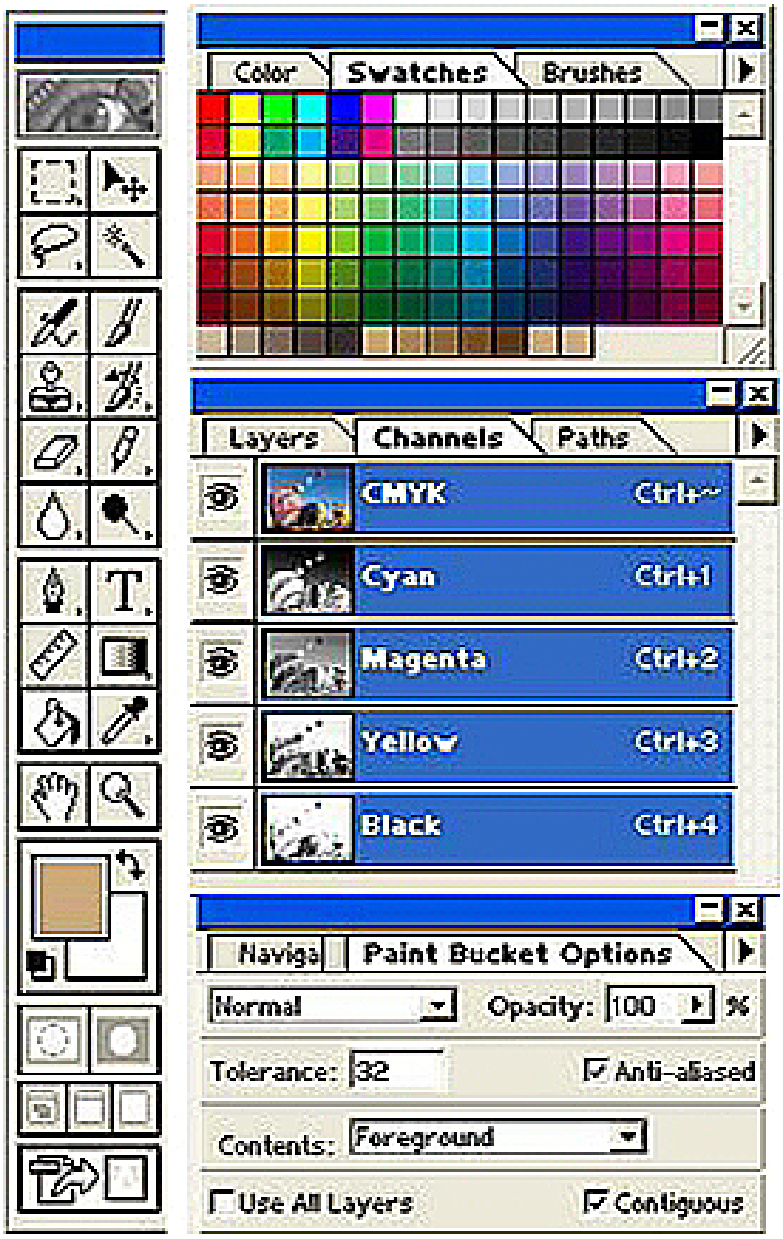


Figure 4.9: Tear-off menu

(d) Walking or cascading menu

Walking or cascading menu is menu with submenus inside. These submenus can be seen when users select the category that consists these submenus as in Figures 4.10 and 4.11.

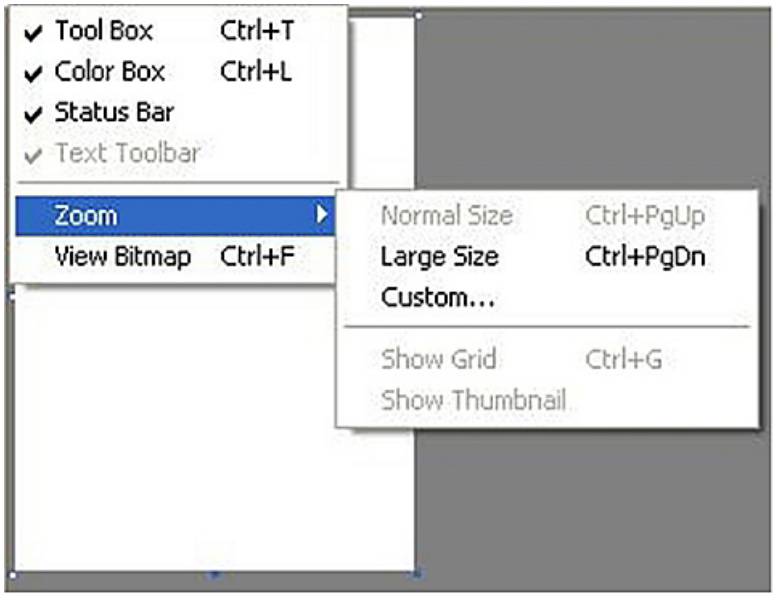


Figure 4.10: Walking or cascading menu

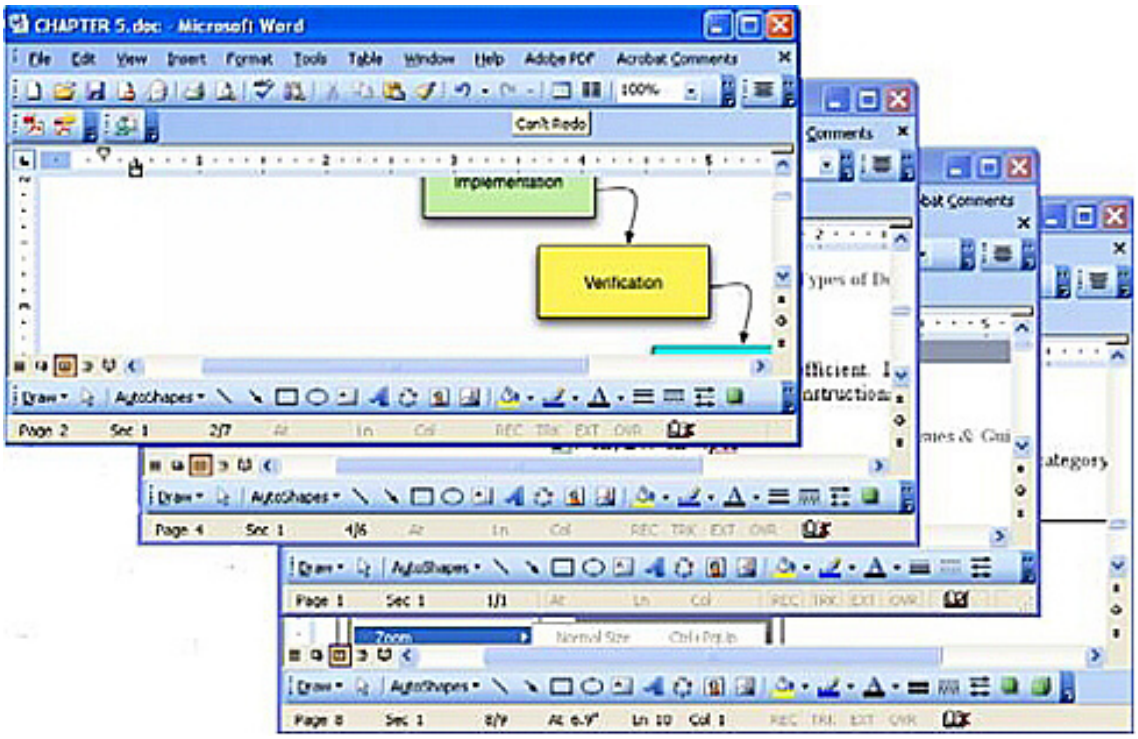


Figure 4.11: Walking or cascading menu

4.3.3 Forms

Basically, forms were used to help the data entry clerks. They did not need a long time to learn the system since the interaction style was similar to the physical design as they used previously.

Currently, this interaction style (forms) is broadly used in information retrieval applications. In the forms, users are provided with an interface that looks like a paper form, with blank spaces that need to be filled with text typed by users. By using this form, users can input all categories of data simultaneously where the sequence of input is disregarded. In Figure 4.8, the example of the forms in interaction style is shown.

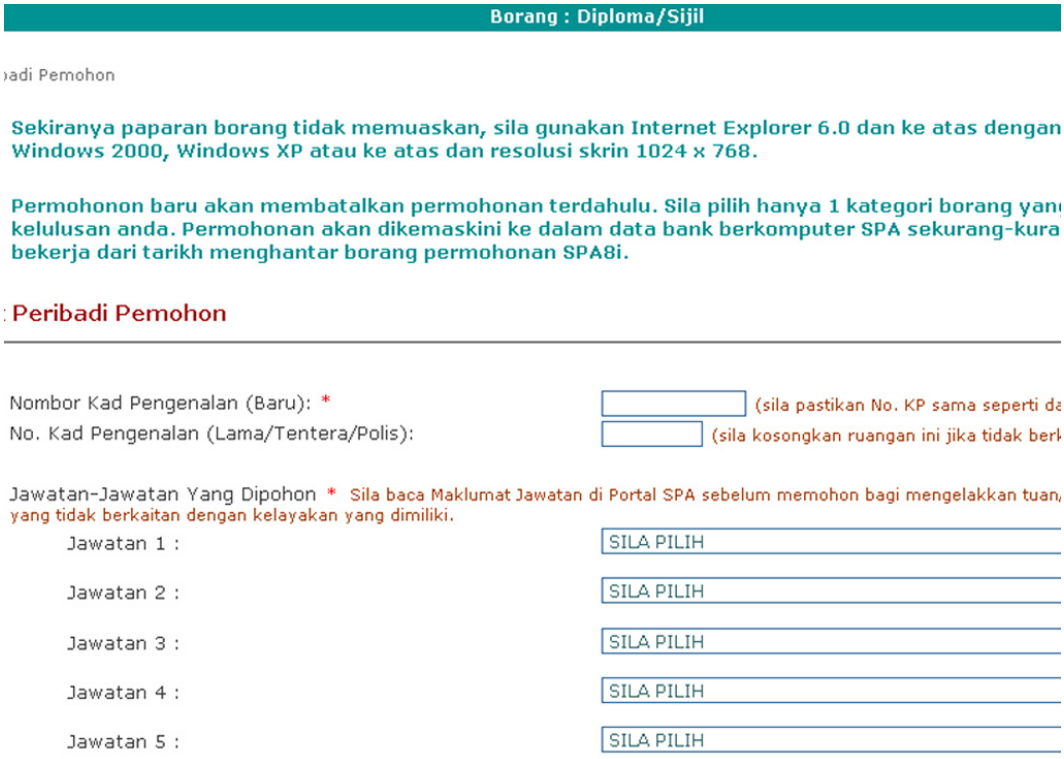


Figure 4.12: An example of form

Nevertheless, the forms in interaction style should have a default input to help the beginners and to quicken the process for expert users. A 'default' is data that have been preset and proposed by the system. It is determined based on the answers or choices the system developers feel are the most commonly provided by users.

To make sure that the correct data is entered by users, input examination needs to be conducted for each step of entry. In case there is an error, a system will prompted a notification message to ensure immediate correction.

4.3.4 Question and Answer Dialogue

The question and answer dialogue is an easy mechanism for the input receiving process. Usually, users are given a series of questions with Yes/No answers options or a set of choice of answers. By using this, the interaction between users and system can be implemented step by step.

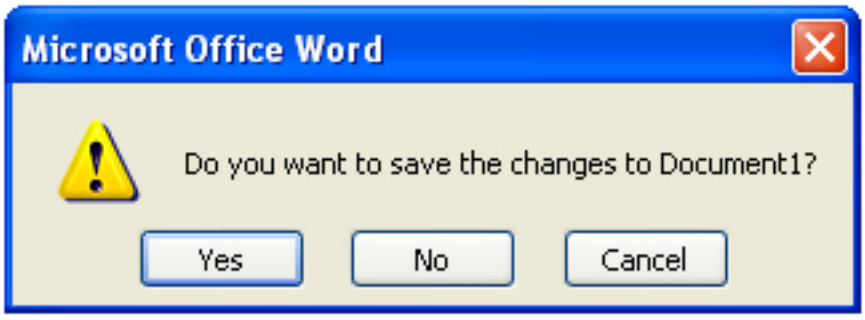


Figure 4.13: Question-answer dialogue

Question and answer dialogue interface are easy to learn and use, but they have limitations in their power and capabilities so they are much more suitable for smaller domain and for the beginners and casual users.

Basically, the question and answer session is used in the situations where users are not allowed to make many choices or in the critical conditions. Figure 4.9 illustrated the example of the question and answer dialogue interface during the occurrence of an error.

Similar with the forms (4.4.3), question and answer dialogue also needs a default to help the beginners in making selection. By using the default, users merely follow the selection suggested by the system.

Do we need the default in the forms-filling interaction style and question-answer dialogue? Explain.

SUMMARY

1. 3D Virtual Reality is artificial reality, developed using 3D computer graphic software to create 3D effect images.
2. Windowing system have four main elements, that is windows, icon, menu and pointer, also known as widget. The main usage of the windowing system is to overcome the need for users to be able to refer to multiple sources in a short time.
3. Besides the four elements, there are other elements, for examples, buttons, toolbar and dialogue box.
   - There are several interaction styles for users to easily use the system, such as pull-down and pop-up menu.
   - There are a number of factors that need to be considered when selecting an interaction styles.
   - Different interactions styles are to be used in different applications.

REFERENCES

Jenny, P., Yvonne, R., Helen, S., David, B. & Simon, H. (1994). Human-Computer Interaction. University of Michigan, Addison Wesley

Centre for Learning & Performance Technologies. (2007). 3D/Virtual World/ Avatar Tools. http://www.c4lpt.co.uk/Directory/Tools/vworld.html

Agentland.com. (2005). Intelligent Agents and Bots. http://www.agentland.com/

Google Maps. (2009). Google Maps. http://maps.google.com/

Cybertown. (2003). Welcome to Cybertown. http://www.cybertown.com

ATSB. (2009).Al-Falak Virtual Reality Solar System. http://www.atsb.my/index.php?option=com_content&view=article&id=94:al-falak-virtual-reality-solar-system-&catid=43:advanced-technology&Itemid=102

CHAPTER 5

Design Evaluations and Technology

LEARNING OUTCOMES

By the end of this chapter, you should be able to:

1. Describe the fundamentals of design;
2. Identify the stages involved in software and development; and
3. Explain why the principles of user-centred design are important.

INTRODUCTION

As we know, mostly, every system or product needs to go through a process called evaluation before it goes for commercialisation. Why evaluation is important? The answer is that every designer that develops new products or systems does not know and is not sure about what users really wants and how to make the products or systems useful for them. However, evaluation has always been the eliminated phase by designer to reduce cost and time. As a result, sometimes, the developed products irritate users and are not sensitive to their needs. For example, a system that provides a function that is confusing with its messy and not user friendly interfaces.

There are many definitions and evaluation techniques that have been created to collect data from user in order to know how to improve the design to meet user criteria. In this evaluation, there are some techniques that involve user directly, while others indirectly for understanding user needs. In other words, the designer uses psychological discipline to understand user needs.

Watch a video clip below online to see the technique of Competitive Evaluation that is part of a User-Centered Design approach to product development.

Source: http://www.youtube.com/watch?v=eV4At9_Kr2w

For developing good products or systems, we need to apply a concept called 'User centred design' (UCD) that considers user needs throughout the products design and development process. This can be done by evaluating every stage of design and development process to suit user needs (Gould and Lewis, 1985). The UCD is a concept to describe design processes in order to allow end-users to influence the shape of the design. This concept has a broad philosophy and variety of methods.

The UCD concept has been created in 1980s by Donald Norman from the University of California, San Diego and has been widely used in Human Computer Interaction field. Basically, UCD has a spectrum of ways in which users can be involved in one way or another. For example, UCD allows users to discuss their requirements and engages them at specific moments during the design process. Commonly, users take part during the requirements gathering and usability testing. At the end of the spectrum, the UCD methods that give users the opportunity to contribute ideas have a deep impact on the design because the users are being involved as partners with the designers throughout the design process.

5.1 PRINCIPLES OF APPLICABILITY OF HCI

As mentioned before, designer needs to understand product requirements before developing any product. In human computer interaction, this is the basic principle that needs to be followed before moving on to the next process. The process of understanding, analysing, and gathering requirements about the product should continue until the results are satisfactory. When the systems become more complex, simple approach such as trial-and-error becomes less viable and waste of effort. For this stage, we need to change our approach to be more detail by checking every design before it is being used by another stage. In each stage, we need to simplify the representations so that it can be evaluated before being included in more detailed work.

In the representation stage, we need to develop suitable representations of an artefact to show the fundamental of our design. These representations can be in any forms such as formal, informal, precise, or vague but this form must be based on the purposes of the overall design activity. The representations that also can be called models are used during the design process and it is something that is constructed for a particular purpose. If the model is good, then it must be accurate enough to represent the features of the system being modelled to avoid confusion.

Example:

A motorbike designer wants to produce a motorbike, then he sketches a few designs on paper and shows it to other designers. From the discussions with other designers, they give a lot of comments and criticisms that give the motorbike designer new ideas on how to change the old design. Lastly, the result of the new design satisfies the designer and he draws up detailed blueprints before giving it to the firm's model maker. The firm's model maker then produces the design of scale models and sends it to the marketing and sales department to gather customer reaction.

The scale model is also sent to the laboratory to be used in experiments to examine the design. The results from computer program show the calculation of the speed and fuel efficiency. In this case study, motorbike designer has four different models:

- The designer uses the original model which is the sketches of the motorbike design to generate new ideas, examine possibilities, and get quick feedback.
- Next, designer gives the blueprints to the model maker and creates scale model for marketing purposes that helps in explaining the ideas to others.
- The experiments need to be done on the models to test the ideas.
- This model is designed using computer software to help in making predictions.

From the example above, which model do you think is suitable for exploring the problem space?

From the example above, it shows that choosing and constructing appropriate models are difficult but the most critical part of a designer's job. As a designer, you must remember how the model is to be used by the users and who the users are. You also need to pick an appropriate modelling technique to require the level of abstraction and intended recipient. So, in human computer interaction design we should:

- Be user-centred and engage users as much as possible for influencing the design;
- Integrate knowledge and expertise from various disciplines that can contribute to HCI design; and
- Be highly iterative in doing test to check whether the design meets users' requirements.

5.1.1 The Design of Software Systems

From the traditional view of software engineering, the growth of software can be characterised by considering the number of processes and representations. This characterisation is also produced in an essentially linear fashion. In this part, we show you several software production models. First, the waterfall model shown in Figure 5.1 is one of the good models for software production.

Figure 5.1 shows the waterfall model of system development.

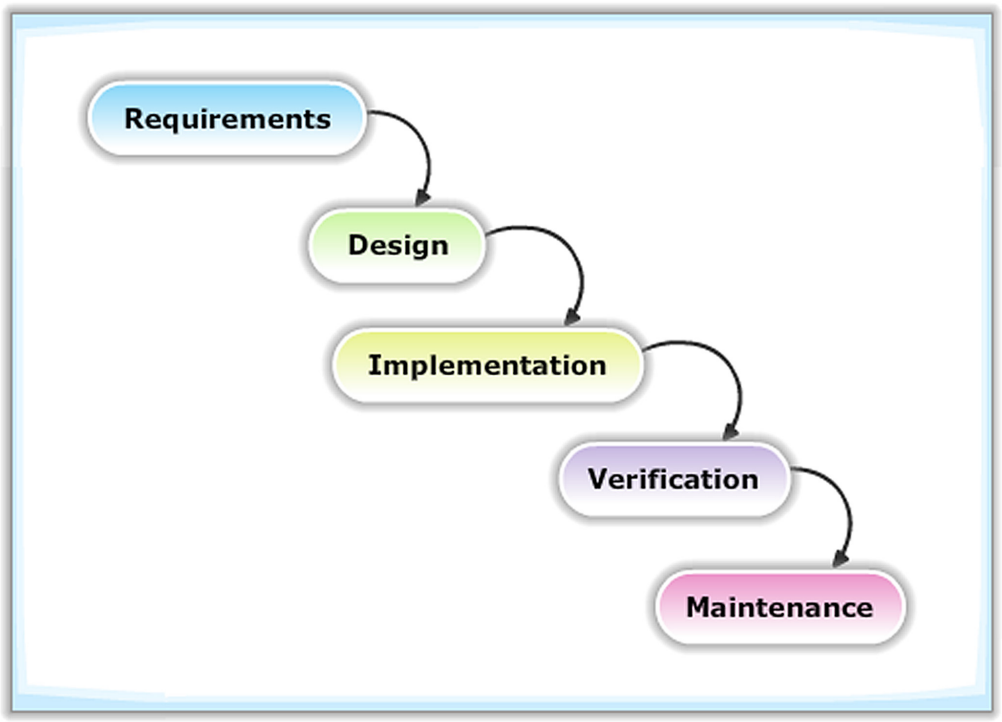


Figure 5.1: Waterfall Model of System Development (Preece, 1994)

The reason why this model is called the waterfall model is that the output of each process in this model falls down neatly to the next process. But, there are several problems with the waterfall model.

- Unrealistic: requirements are often incomplete and ambiguous.
- In practice, the stages overlap and there is feedback from a stage to the previous stage(s).
- The process of this model is not a simple linear model but it also involves a sequence of iterations of the development activities.
- Maintenance is an important stage, up to 60% of the total effort.
- Main problem: not user-centred. It is impossible to completely understand and express user requirements until a large amount of design has already been done.

Figure 5.2 shows spiral model of software process.

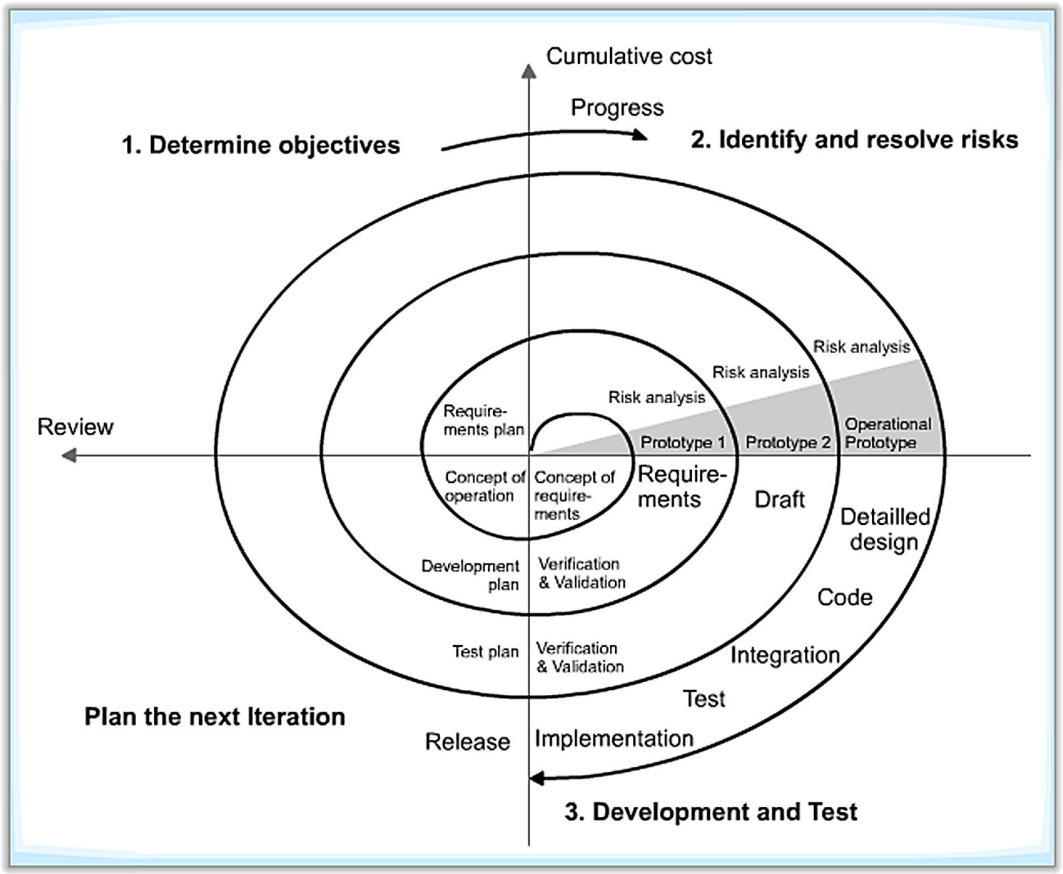


Figure 5.2: Spiral Model of Software Process (Pressman, 2005)

The waterfall model has several issues concerning users. In the mid 1970s, the development of software engineering has emerged and has given system designer more power to create systems quickly and effectively. Then, a new model called spiral model came out in which it uses prototyping approach for system development and involves users' requirements at different stages. Figure 5.2 shows the spiral model of software process.

This model provides a platform for user to comment the design of the system before the work is completed. In other words, this model helps to deal with the problem of understanding requirements although it is still lack of management control. This model has applied the HCI design concept because it is primarily oriented towards the development of large systems by focusing on system functionality. Indirectly, the field of HCI has established user centred design because it can recognises the importance of repeated user testing using informal representations as well as computer based prototyping.

5.2 USER-CENTRED DESIGN

As explained before, user-centred design is important as it is based on the involvement of users during the system design process. In designing system process,users should be intimately involved in all aspects of the development and implementation.Figure 5.3 shows method for user-centred design which has various techniques and activities.

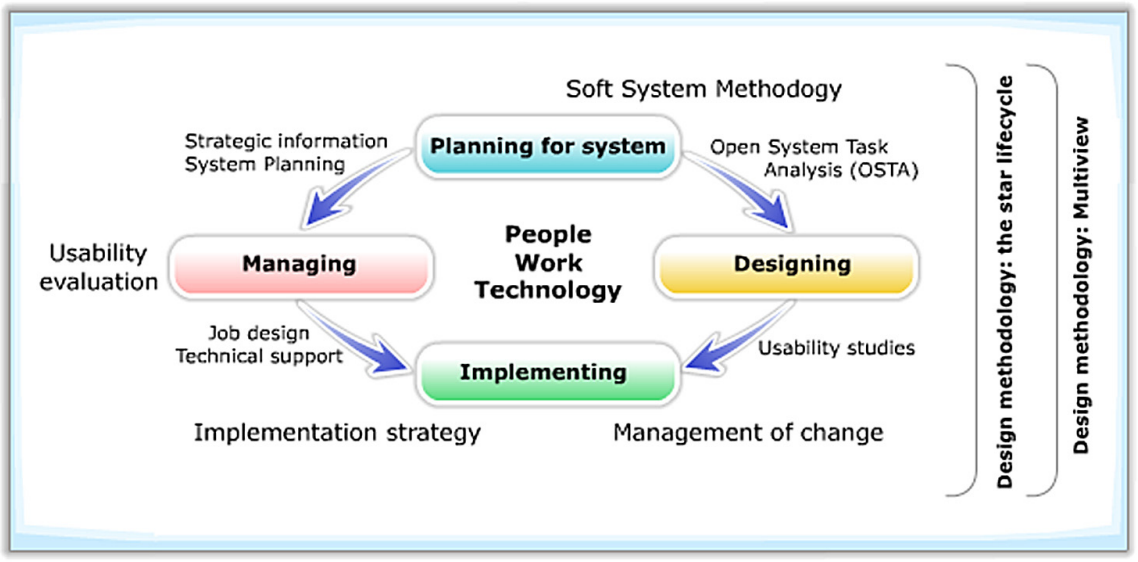


Figure 5.3: Method for user-centred design (Eason, 1992)

About this topic, Eason (1992) has views regarding the design and development of user centred design methods. In this method, it shows four key stages in the development that are planning, designing, implementing, and managing. As we can see in Figure 5.3, Eason has listed various techniques and activities around the circle with a number of keywords as follows:

- Planning for systems: When developing the systems, he stressed that human, computers, and human-computer systems must be ordered in a more appropriate manner than the adhoc way. This means that the important things in planning are to consider the reason the system is being developed and to find the way on how the systems can fit other human or technical systems that already exist. Finally, the main aim is how planning can make a system contributes to the success of overall goals of the organisation.
- Designing: The process of transforming design to implementation involves guaranteeing that the system meets its usability targets.
- Implementing: Implementing the system in real environment effectively and gaining acceptance from user population.
- Managing: Managing the changes that occur and helping to introduce a new system depending on the situations.

Table 5.1: Advantages and disadvantages of user-centred design

Advantages	Disadvantages
Create a good system that is more efficient, effective, and safe.	The process is costly and takes more time to involve the users.
Help in managing user expectations and levels of satisfaction towards the system.	Cannot be applied if the organisational and political climates are not stable.
Developing a sense of ownership of the system among users.	The system is unidirectional if there is an involvement of design team members such as ethnographers, usability experts and other stakeholders.
Because the systems have less requirements to be redesigned, it makes the system integrates quickly into the environment.	Sometimes, it is difficult to interpret some types of data into designs.
The collaborative process produces more creative designs that can solve problems.	The system is too specific for general use. Thus, it is not suitable to be transferred to other clients as it can be costly.

5.2.1 Soft systems methodology

It is important for us to understand the whole concept of human-computer system because human actions happen within wider contexts or situations (Suchman, 1989). For better understanding, we need to observe the situation from the perspective of a system by considering the overall system. In this chapter, we briefly explain the most popular description of a system known as Soft Systems Methodology (SSM). This SSM stresses on understanding the situation based on a pre-judgement that the problem may not be a clear problem to be solved. Figure 5.4 shows the illustration of SSM.

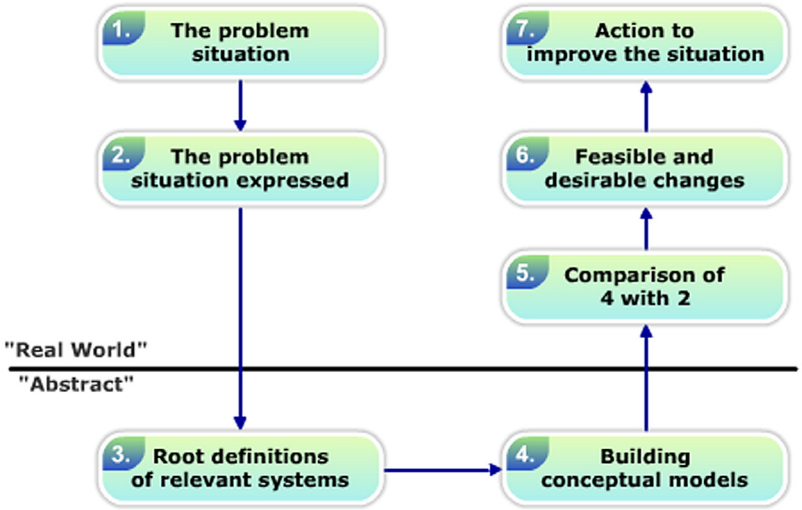


Figure 5.4: Stages of soft systems methodology (Preece et al., 1994)

From that figure, we can see that there are 7 stages of SSM. Stage 1 and stage 2 focus on getting rich expressions regarding the problem situation. While completing these stages, all interested parties such as the stakeholders involve with the situation by holding a meeting. This meeting provides a platform for stakeholders to voice out their own views about the systems. All these views are not essentially conflicting as they may highlight the different aspects of the whole situation and help the system during reconciliation.

5.2.2 Cooperative design

For this cooperative design, there are many approaches that involve users with the design. There are two designs that are commonly used:

(a) **Participative design**

This approach, also known as Scandinavian approach, recognises the significance of involving users during the design process. The users can argue for their right to be involved in designing the systems that they will consequently use. For this design, the participation from users is used to analyse the organisational requirements and to plan for the appropriate social and technical structures. Indirectly, these activities can support both individual and organisational requirements.

(b) **Sociotechnical design**

A form of cooperative design that focuses more on developing complete and rational human-machine systems. The stress of this approach is on allowing social and technical alternatives to problems.

(c) **Open Systems Task Analysis (OSTA)**

This method has been created by Eason and Hacker (1989) in which it follows a sociotechnical system analysis model. This model requires technical aspects such as system's structure and functionality to realize the usability and acceptability of the system. The fundamental of this model is to offer a methodology for understanding the transformation issue that arises during the implementation of computer system into real environment. Figure 5.5 shows the process in OSTA methodology.

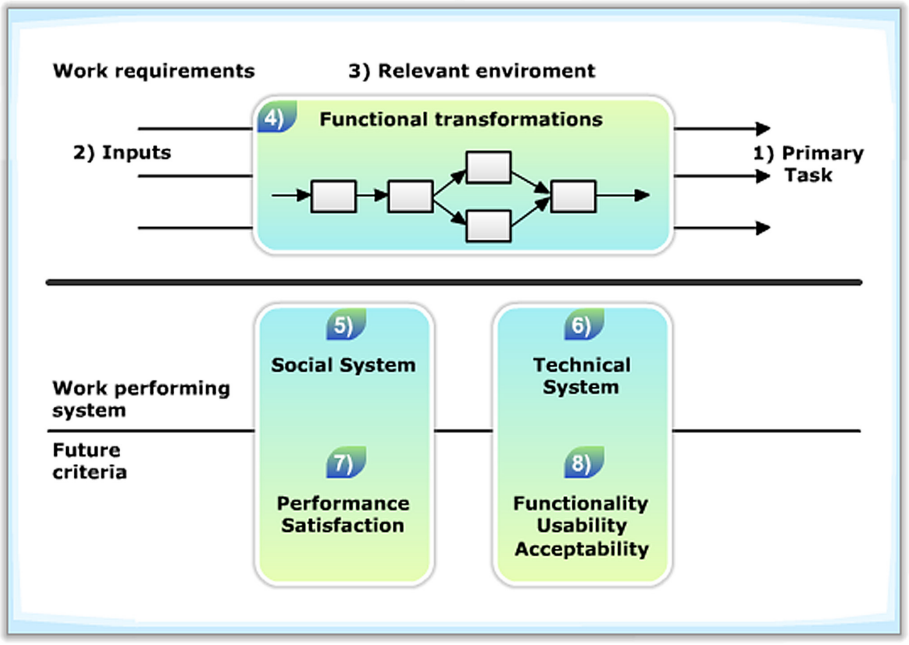


Figure 5.5: OSTA methodology (Eason, 1988)

From the figure, we can see that system analysis should be done to explore organisational issues such as goals, values, and sources of job satisfaction. After the analysis, sociotechnical solutions concerning the identification of technical and social limitations are recognised. The collected information will be explained to the design team using flow chart and written text description. Below are the detail steps of OSTA.

1. **Primary task:** State work group and work system goals.
2. **Task input:** Identify the taskiputs of the system such as customers, orders, telephone, sentences, words, etc. These inputs can affect how the system will perform.
3. **External environment:** Relate other external environment such as economic, political, and the demand of task output. This is because sometimes the process of the system can interact with the outside world.
4. **Transformation processes:** Describe every transformation process like transforming in put to output for achieving goals. This can be done using flowchart as the tool for describing process.

5. **Social system:** Analyse every role of the people in the organisation who are connected to the system because a new people can ultimately become the new user for thesystem.
6. **Technical system:** Analyse on how to integrate the system with other actual and new systems. Analyse also the effect of the new systems towards the nature of the work.
7. **Performance satisfaction:** Refer back to the requirements listed for a new social system during the introduction of the new system.
8. **New technical system:** For new technical system, the requirements are derived from task analysis. In this last step, you should define the functionality of the new system from the usability and acceptability aspects, the role of technology, and the people involved. Create a detail report about the system in terms of interface and the changes of the overall system as well as provide training for the staffs.

5.2.3 Multiview: A user-centred methodology

Figure 5.6 shows the picture of Multiview methodology.

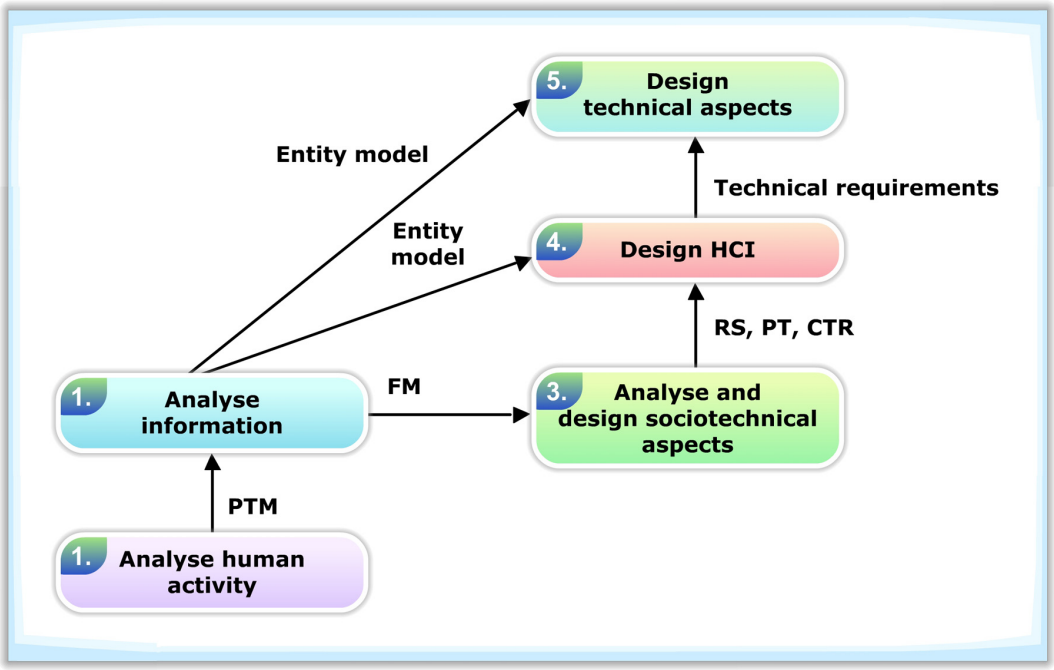


Figure 5.6: Multiview methodology (Avison & Wood-Harper, 1988)

Multiview approach is a combination of sociotechincal and soft systems that use an information system design methodology to join different approaches into a staged and controlled methodology. Figure 5.6 above shows the picture of Multiview methodology and below is the description of this methodology.

Stage 1: The main task is to describe the purpose of the system, the stakeholders who take parts, and the standpoint of the system owner.

Stage 2: In this stage, information analysis is done concerning conceptual modelling information flows and information structure.

Stage 3: The functional model (FM) is used for task allocation such as designing people tasks (PT), role sets (RS), and computer task requirements (CTR).

Stage 4: The result from stage 3 and the entity model of information structure are used to steer the design of HCI.

Stage 5: Determine the design of computer system after user has defined the technical aspects of computer system.

In this Multiview methodology, the most important is it begins with the analysis of human activities that influence the results in the production of primary tasks model (system purposes). It also utilises entity relationship modelling and dataflow modelling for developing a conceptual model before doing physical design. Multiview also gives more directions to system designer and stresses the order on which activities should be done. This sometimes helps designer by ensuring the development of a careful and logical system, but it can also be difficult to the designer to choose specific design for an inflexible framework.

5.2.4 The star model

Figure 5.7 shows the star model created by Hartson & Hix.

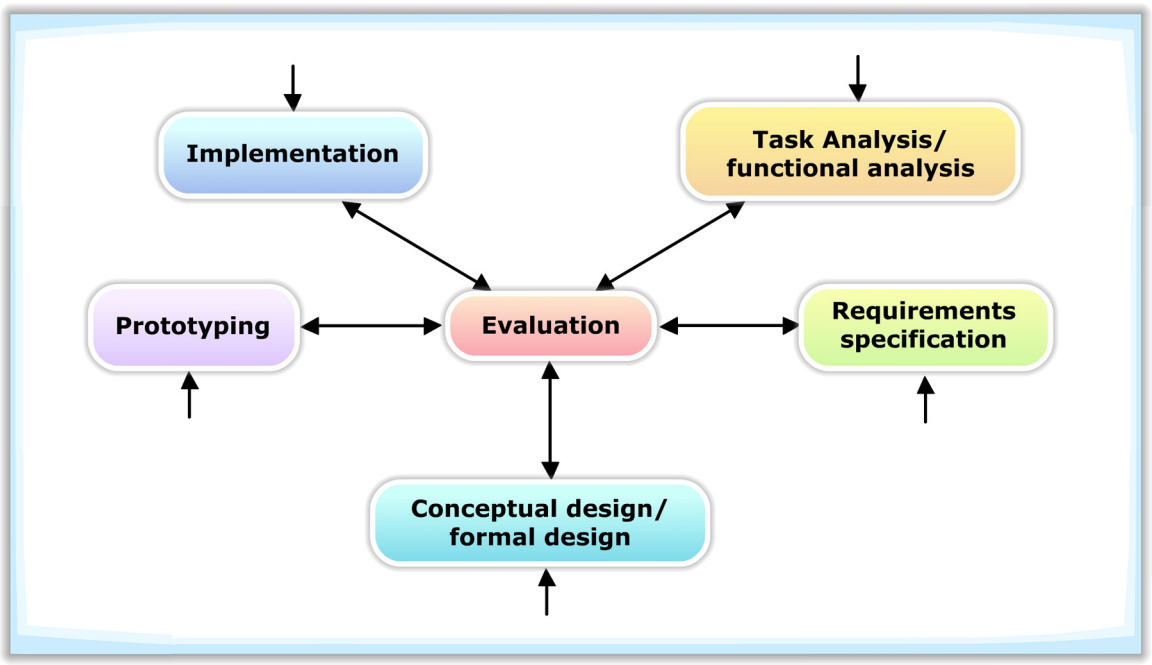


Figure 5.7: The star model (Hartson & Hix, 1989, 1993)

In 1989, Hartson and Hix created the star model as shown in Figure 5.7. This model is obtained from an extensive analysis of actual design practice between HCI designers. This model also allows more prototyping and evaluation compared to other approaches. As we can see in Figure 5.7, evaluation is the central stage of this method because each aspect of system development has issues that need regular evaluation by users and experts. This star model also provides an 'alternative waves' approach for system development. It also stresses on rapid prototyping and the growing number of final products development.

The unique feature of this model is it can start at any stage and can also be followed at any other stages. With this style, the requirements, designs, and the products are steadily evolved and increasingly well developed. The life cycle of this model emphasises on the distinction between conceptual design and physical design (formal design).

1. **Conceptual design:** Concerns about requirement questions in terms of data, capabilities, and usability for the user, etc.
2. **Physical design:** Concerns about questions in the process of achieving the goals, objectives, etc.

These two designs are the fundamentals to make the provision of good systems because it can put back decision for who or what will finally perform which functions or supply which data until late in the design process.

5.3 USER-REQUIREMENT

User requirement is a technique for gathering the requirements or also known as analysis. This technique is a process of clarifying user requirements (customer) in the system and to recognize infeasible requirements, omissions, ambiguities, and vagueness. In this technique, document from client is important where it describes statement requirements to develop the system. Below are the details that need to be included in the document:

1. Requirements necessitate detailed user studies.
2. Different types of requirements have been identified.
3. Application description or statement of requirements from clients is usually too vague.
4. Identify constraints of context and technology.
5. Identify subtleties of the context and activities that are not readily visible.

Figure 5.8 shows the general process of user requirements.

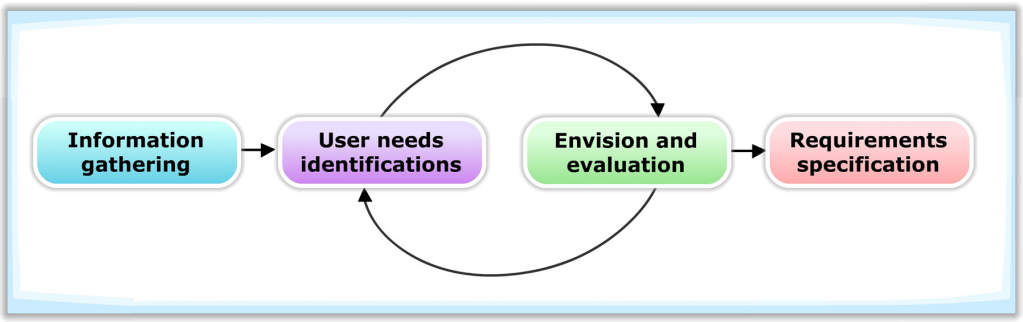


Figure 5.8: General process for user requirements analysis (Preece et al., 1992)

In this process, the responsible person is a system analyst that will decide the techniques such as interviewing, observation, and document gathering in order to elicit the requirements. This process helps the system analyst to understand the whole organisational and social characteristics. Tools like prototyping also can help to facilitate requirements gathering and animation can be used for demonstrating possibilities. The result of requirement gathering is the representation of the problem with the current system and the requirements of the new system.

There are three types of requirements in this requirements gathering:

1. **Functional requirements:** specify the capabilities of the new system.
2. **Data requirements:** specify the structure of the system and the data that are available for doing the next step.
3. **Usability requirements:** Specify the acceptance level of user in terms of performance and satisfaction with the system.

(a) Functional Requirements

The outcome of analysing and collecting functional requirements from user is a representation of a system called functional specification. This is a formal document or other requirements that are generally partitioned in separate modules and organized in a hierarchical manner. The important part of gathering functional requirements is that the gathering and specifying process cannot all be executed in one go. In functional requirements, it is usually specified using charting technique like dataflow diagrams which give a description about natural or structured details of the functional components. A dataflow diagram can describe a system from each point of data that is passed between processes. Dataflow diagram uses circle to show the process in the system and uses line arrow for data flowing in and out. Figure 5.9 shows an example of dataflow diagram.

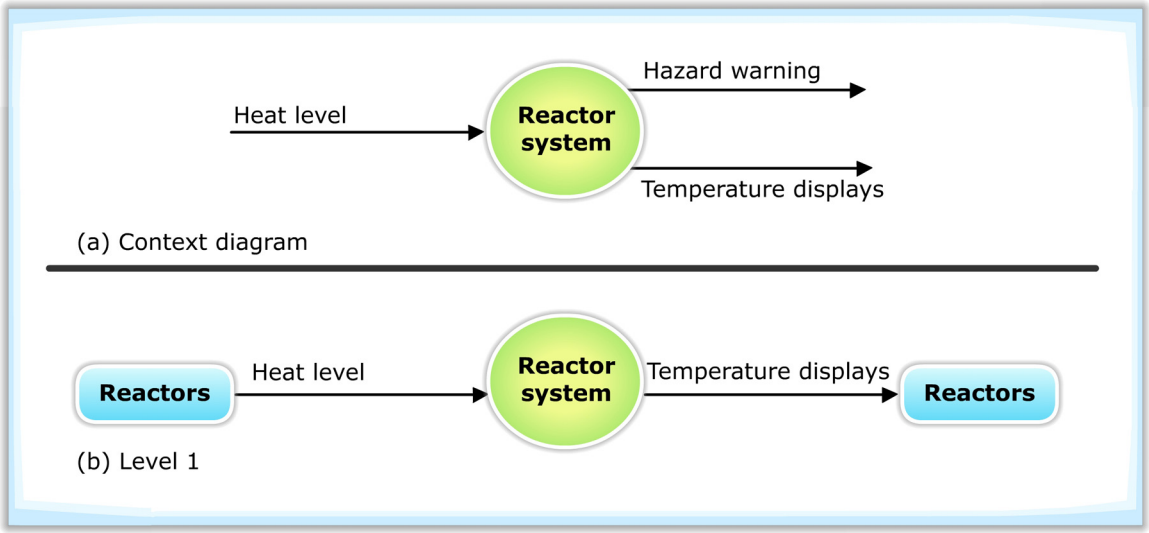


Figure 5.9: Dataflow diagram

(b) Data requirements

For data requirements, it focuses more on structure as opposed to processing and specifies the whole system but not minimally the part that may be computerised. These data requirements can be obtained by using techniques such as observation, document analysis, interviewing, etc. In this part of analysis, we can use data dictionary as a tool to help the analyst by defining the meaning of data, mostly data elements. Data analysis from this activity will give a description of data required

for the process in the system. The result from functional requirements and data requirements can help to build the Entity Relationship Diagram (ERD) which is the formal descriptions of the data elements, entities, and relationships in a data dictionary. ERD can describe the structure and content of the data in a system.

(c) **Usability requirements**

Usability requirements is a technique for making the designed system easy to learn and remember, useful, containing functions people really need in their work, and is pleasant to use. Bennett (1984) and Shackel (1990) found that there are four terms in usability requirements such as:

1. **Learnability**: The time and effort that help to reach a particular level of user performance.
2. **Throughput**: The tasks finished by experienced users, the speed of task execution and the small percentage of errors made.
3. **Flexibility**: The extent to which the system can put up changes to the tasks and environments those to specify first.
4. **Attitude**: The positive attitude produced in users by the system.

Usability requirements is also known as usability study and gathered along with functional and data requirements when doing gathering activity such as interviewing and observation. In usability requirements, user modelling techniques have been used to instantiate these models as parts of computer systems. Most of user modelling depends on checklists of user characteristics. Measuring the performance of usability study can help make the system easy to use and usability metrics are used to measure the performance that needs the involvement from users.

SUMMARY

1. HCI design methods need involvement from users in each stage of system development. Design is a creative process in which it employs engineering principles and it needs user-centred approach which can help on developing good system for user.
2. The design of human-computer systems can help to recognise the organisational, local, and users needs and focus on each part of work situation. It will make us change our mentality as designer to be concern about everything in the project and not just recognising the problems.
3. Requirements gathering can be used to get the requirements and specification from users in order to help the system achieves the objectives and goals of the organisation.

REFERENCES

Preece, J., Roger, Y., Sharp, H., Benyon, D., Holland, S., Carey, T (1994). Human-Computer Interaction. University of Michigan, Addison Wesley.

Gould, J. D., & Lewis, C. (1985). Designing for usability: Key principles and what designers think. Communications of the ACM, 28, 3, 300-311.

Norman, D. A., & Draper, S. W. (Eds.) (1986). User centered system design: New perspectives on human-computer interaction. Hillsdale, NJ: Lawrence Erlbaum Associates.

Eason, K.D. (1988). Information Technology and Organisational Change. Taylor & Francis, London.

Shackel, B. (1990). Human factors and usability. Hemel Hempstead: Prentice Hall.

Pressman, R., Software Engineering: A Practitioner's Approach, 6th. Edition, ISBN0072853182, 2005, McGraw-Hill, USA.

CHAPTER 6 Types of Design

LEARNING OUTCOMES

By the end of this chapter, you should be able to:

1. Give an understanding about the fundamental of design;
2. Explain three types of design; conceptual design, dialogue design and functional design;
3. Describe conceptual design and explain why it is an important step in design process, and;
4. Create a content diagram to outline the organisation of an interface.

INTRODUCTION

In Chapter 5, we have given the description of how researchers doing the evaluation on the systems or products based on some methodologies. In this chapter, we explain to you the concept and types of design to be applied in our system to make sure that it is easy to use, user friendly, etc. This chapter also describes the fundamental of design, the types of design, and the importance of design in developing new system. We also explain the factors that will affect the design and how to solve it. The design process tends to remain implicit as researchers are embarrassed by not being able to show evidence of the same kind of control, structure, predictability, and rigorousness in doing design as they are able to show in other parts of their research. Thus, this chapter will discuss briefly the types of design whereby they will be the conductor that will make sure the success of the prototype.

6.1 FUNDAMENTAL OF DESIGN

The term design is very important in the engineering and computer science field, especially for designing a computer system. According to the review of general design philosophy by Jones (1981), there are several definitions of design, including:

- finding the exact physical components of a physical structure,
- a goal-directed problem solving activity,
- simulating what we want to make or do before we make it, repeatedly until it become necessary to feel confident in the final result,
- the imaginative jump from present facts to future possibilities and
- a creative activity - it involves creating something new and useful.

> "Engineering design is the use of scientific principles, technical information and imagination in definition of a mechanical structure, machine or system to perform pre-specified functions with the maximum economy and efficiency."
> – Jones (1981)

The design also refers to both the process to develop a product, artefact or system and the variety of representations of product produced during the design process. As discussed in Chapter 5, requirements from user help designer to create better and reliable products or systems. These requirements can be the factors that influence the design. So, designers need to be able to understand these requirements and represent this understanding in each design process. We want to clarify that design is very important to the product to be developed; it helps designers to make sure

that they choose suitable representations. The reasons for choosing the suitable representations are to help user to explore, test, record, and communicate design ideas and decisions with design team and other users.

Now, we explain further the main things that have been discussed before; requirements for design and representations for design. These two things are very important because they help in understanding requirements, discussing the requirements, and analysing existing systems to discover the problems with the actual design. Besides, the development of a product also includes producing a selection of representations until an appropriate artefact is produced. Below are the descriptions of these two important things in design as shown in Table 6.1.

Table 6.1: Descriptions of requirements and representation for design

Requirements for Design	Representations for Design
To create a new system, designer must first determine the requirements by examining other similar systems and analysing the requirements from user about the features that need to be implemented in the system. Designer should sketch several different designs of the system; this will clarify how the real system will look like. Of course, the first design is usually not very successful and it will make us search for other requirements and designs. After we got the suitable idea for the design, the designer can proceed to the next process for analysing the requirements and gathering information about the new system until it is satisfactory.	Representation is very important in system design and developing suitable representations of an artefact is the basic of the system design. As described in Chapter 5, the representations can be in variety of forms such as informal, formal, precise, or vague. Each representation can be used for different purposes in each design process activity. Choosing the best representations and making the good use of representations in each stage of design are the skills that a designer should have. The detail about representations for design can be reviewed in Chapter 5.

6.2 CONCEPTUAL DESIGN

Now we move forward to another concept in HCI design called conceptual design and this design is concerned about transforming the requirements from user to another model known as conceptual model (Please refer Chapter 2). In this sub chapter, we explain in more detail the development of the conceptual model. Conceptual model can be defined as an explanation of the proposed system based on a set of integrated ideas and concepts about what it should do, behave, and look like. So, it can be understandable by the users in the manner anticipated. The foundation for designing this model is this model needs the set of user tasks that the system can offer. There is no easy way of doing this transformation as we need to apply a set of requirements data to produce a good conceptual model.

In developing this model, the best way to proceed is you as a designer need to involve in the data and try to understand it with the users when the issues are raised. From the user requirements and your experience as the designer, you can get an image of what you want the users to experience when using the new product. Below are the principles of the conceptual design to guide user or designer:

- Be an open minded designer but remember the users and their context.
- Always discuss ideas with other stakeholders.
- To get more rapid feedback, use low-fidelity prototyping.
- Iterate (to get good ideas, get lots of ideas).

Conceptual model is important to drive the designing activities in conceptual design. There are two kinds of designs; product oriented system and process oriented application. For product oriented system, it needs the main products and the tools to produce the main structure of the application. For a process oriented application, it lists out the process and steps that form the fundamental of system. For applying conceptual design into the products that are primarily product oriented or process oriented, below are the issues that need to be concerned by designer.

1. Designer needs to clarify products or processes such as what documents need to be produced and what processes can be supported into system.
2. Designer also needs to design a set of presentation rules. For example, designing GUI for a system must follow the rules and choose the right platform.
3. You need a set of rules for the functions and the usage of windows.
4. Designer needs to recognise the major information and functionalities of the system.
5. You also need to define and design the major navigational pathways for better analysis and structure of the system. You as a designer also need to ensure easier navigation, do not over constrain users, and provide facilities to make sure users know where they are.
6. Try to document the system design using conceptual model and explanatory notes.

Designer must consider all the issues that have been discussed before in the previous paragraph to help you envision a product. All the ideas must be thought more deeply to get more detail design before being prototyped or tested with users. Designer also needs to decide what technologies to use, e.g., multimedia, virtual reality, or web-based materials as well as to choose the best devices to be suited with the best situation for input and output, e.g., pen-based, touch screen, speech, keyboard, etc. When making the decisions, you need to think about the constraints on the system because they arise from the requirements you have established. For example, the influence of input and output devices is based on the user and environmental requirements. You as the designer also have to come to a decision on what concepts need to be communicated between the user and the product and how they are to be structured, related, and presented. All these decisions are required to support the system. Although these decisions must be made, a designer should remember that decisions are made only tentatively to begin with and it can be changed after prototyping and evaluation.

6.3 FUNCTIONAL DESIGN

Now we proceed to functional design that can be performed after we have completed the requirements analysis and conceptual design. The functional design focuses more on the commands and what the commands can do. For functional design, we must give concentration to the information that is needed for each command, to effects of each command to the new or modified information presented to the user when the command is changed, and to error possibilities. This design must first select a suitable set of dialog style and apply this style to the particular functionality. Functional design and dialog style for the system can be developed concurrently. If the functional design prototype could be completed earlier before the deployment to the end users, then it can be evaluated by the potential user for further improvement of the system.

Instructions or commands are the way user can communicate with the systems directly. MS-DOS in Windows and in UNIX operating systems are the examples of functional design in which they need user to key in all the commands in order to communicate with the system. Figure 6.1 shows the example of MS-DOS interface.

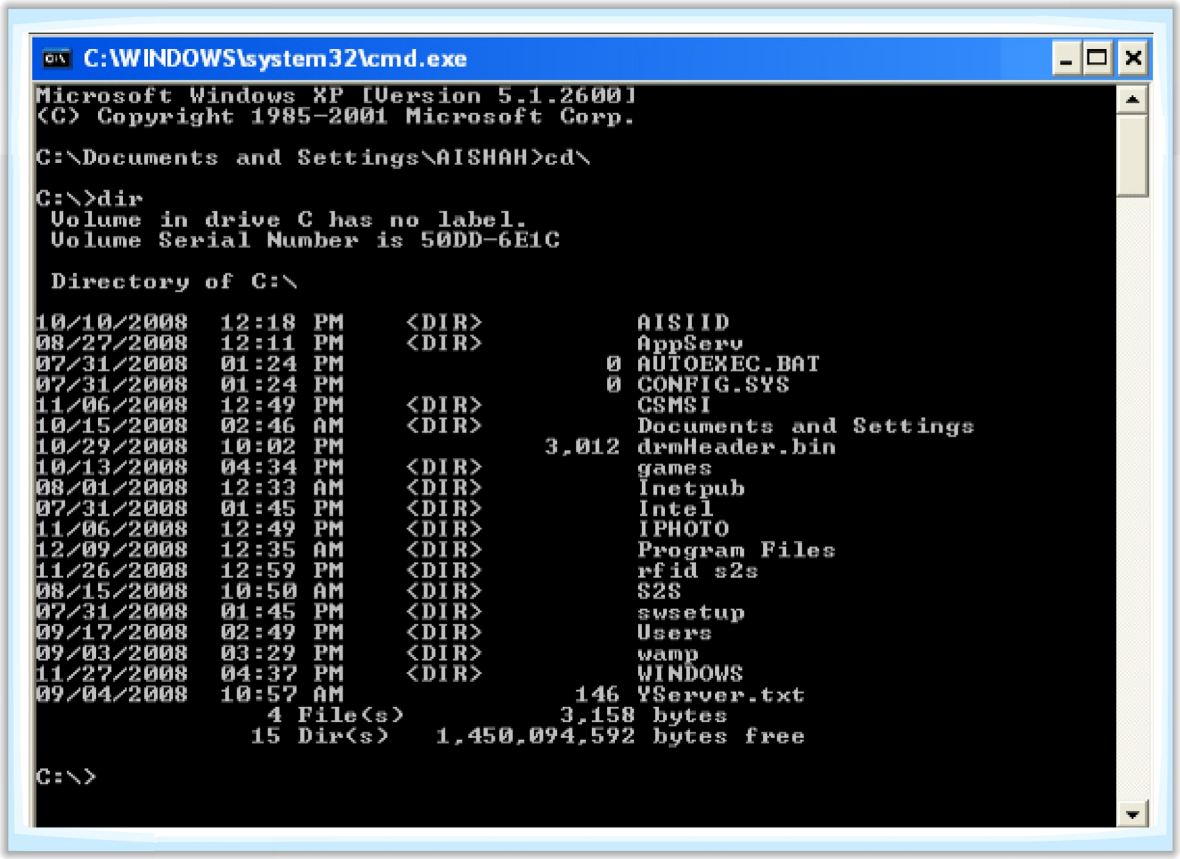


Figure 6.1: MSDOS Interface

From this figure, you can see that in the interface of MS-DOS window, the users need to type the instructions or set of instructions to run some processes. The command 'C:\>dir' is used for listing all the files and folders in directory C. As we can see, most software applications based on Windows platform has menu selection at the top of the interface. In Figure 6.2, it shows the example of Windows software application called Microsoft Word 2003. If the user clicks on the 'File' menu, the user can see there are several choices such as New, Open, Close, etc. The "words" or "labels" from each menu can be considered as instructions to the system. For example, if the user wants to save their new file, they can select the instruction 'Save' in which it will save the current .doc file into user's selected directory. User needs to choose the suitable instructions in order to ensure that the system can perform well.

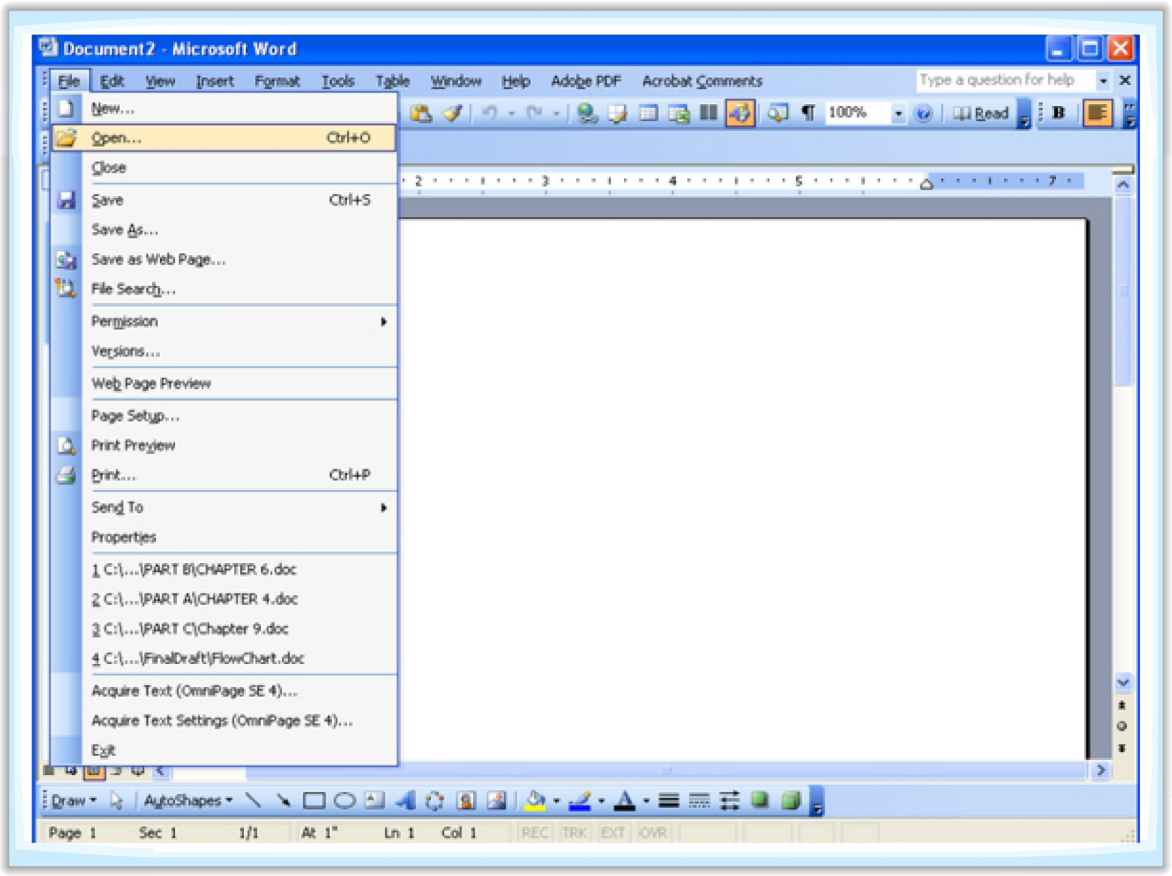


Figure 6.2: Microsoft Word 2003 Interface

Conversation also is categorised in this functional design in which it is useful for applications that are related to search information or applications that can support discussions or forums. For example, search engines, advisory systems, help facilities etc. In Figure 6.3 below, user has a typing error when using the Google search engine. For example, he/she wants to search for 'java source code'. However, the typed keyword, 'java sourc code' is incomplete. Even though the search engine has displayed the results, it still asks the user, 'Did you mean: java source code' in order to make sure the query from the user is correct.

There are several types of conversation that are supported by the system. Speech recognition is one of these types of conversation. For instance, it can be used in automatic telephone operator, tickets booking, bank system, search engine, and so on. Systems that use this conceptual model are designed to react as how human would normally interact with otherhumans. The systems will act as a communication partner for the users and will be able to answer questions, give instructions, etc.

Figure 6.3: Google Search Engines Interface

Give the advantages and disadvantages of using the conceptual model based on conversation.

6.4 DIALOGUE DESIGN

Before we discuss dialogue design, we first need to know what is the meaning of dialogue. Dialogue is a communication process between two agents and during this process, the agents will exchange information upon the meanings that are attached to the words involved.

> "The structure of dialogue can be referring to the formal description of dialogue elements in terms of their component structure together with the ordering within and between the dialogues exchanges" - (Barnard & Hammond, 1983).

Dialogue design is an easy mechanism in the process to receive input. When user wants to do some process, the system will ask some questions as a confirmation or permissions to do the process. In this process, the interaction between human and computer is done in step by step. This dialogue design is easy to learn and use. However, it has limited functions and power. Because of this limitation, it is only suitable to be used in a small domain. According to McMillan and Moran (1985), there are general dialogue design guidelines that have emerged as follows:

- A system should identify any rational approximation of a command.
- After user entered the command, the system should provide an acknowledgement or some reference on how the system interpreted the command.
- Every syntax and commands should be kept simple and natural.
- There must be limitation of the number and format of the commands in a system.
- The amount of information passed using the command must be limited.
- The designer must choose easy command names to make it easier for the user.
- Provide the effects for user to undo the last command.

Shneiderman (1987) also has suggested eight rules to be applied in human computer dialogue design as shown in Table 6.2.

Table 6.2: Suggested rules to be applied in human computer dialogue design

Rules 1	Dialogues used in the system should be consistent.
Rules 2	The system must allow users to use shortcuts for familiar dialogue.
Rules 3	Every dialogue must provide informative feedback.
Rules 4	Dialogues must be arranged in sequence and organised in logical groups.
Rules 5	The developed systems must offer simple error handling.
Rules 6	The developed systems must allow undo action.
Rules 7	The developed systems must give authority for experienced user to control the system rather than let the system to control by itself.
Rules 8	The developed systems must aim to reduce short term memory load; do not expect user can remember many things.

Basically, the question-answer dialogue is used when user is not allowed to make many choices or in critical conditions. For example, when user wants to do some changes in the current document, the user can just click the 'Save' menu and Windows system will alert the user by showing the dialogue box. Figure 6.4 shows the dialogue box that needs confirmation from user to complete the next process which is to save the changes in the document. In this case, the dialogue box that appears need an answer, either Yes, No, or Cancel from user.

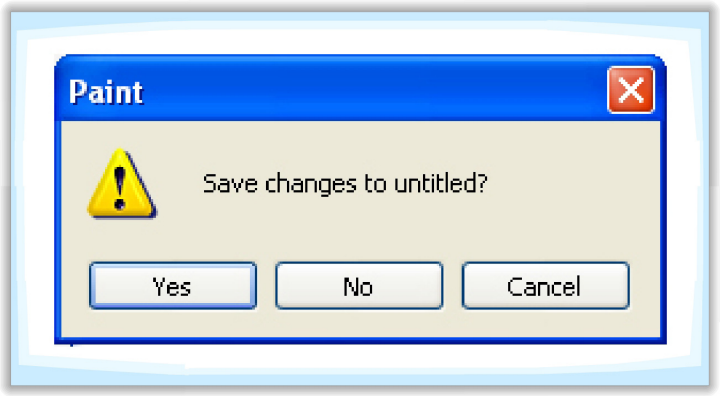


Figure 6.4: Example of dialogue design

All those guidelines are very important and must be followed when a designer wants to develop a system. It will help in designing better interface and guiding the designer towards considering the relevant human computer dialogue issues and interpretation.

ACTIVITY

1. Give two reasons why you should include a conceptual design phase in your design process.
2. What is the relationship between mental model and conceptual model?

SUMMARY

1. In this chapter, we have discussed the fundamental of design in terms of human-computer interaction.
2. Then, we relate it with three types of design; conceptual design, functional design, and dialogue design that can influence the design of process and interface of the system.
3. All these types of design give designer the ideas on how to develop good system and make it easier for user to use the system.
4. We also provide guidelines for the designer to design the system based on these three types of design.

REFERENCES

Jenny, P., Yvonne, R., Helen, S., David, B. & Simon, H. (1994). *Human-Computer Interaction*. University of Michigan, Addison Wesley.

Jenny, P., Yvonne, R. & Helen, S. (2002). Interaction design: beyond *human-computer interaction*. United States of America, John Wiley & Sons, Inc.

Jones, P. (1981). A practical guide to federal special education law. New York: Holt, Rinehart and Winston.

Norman, D. A., & Draper, S. W. (Eds.) (1986). User centered system design: New perspectives on *human-computer interaction*. Hillsdale, NJ: Lawrence Erlbaum Associates.

Olphert CW & Damodaran L, (2002). *Getting What You Want or Wanting What You Get*? Beyond User Centred Design. Proc. Design and Emotion Conference, Loughborough.

Rajendra, R. K. (2005). *Human Computer Interaction*, Firewall Media.

McMillan, T. C. & Moran, B. P. (1985). *Command line structure and dynamic processing of abbreviations in dialogue management*. Interfaces in Computing, 3, 249-257.

Barnard, P. J. & Hammond, N. V. (1983). *Cognitive contexts and interactive communication*. IBM Hursley Human Factors Laboratory Report.

Shneiderman, B. (1987). *Designing the user interface: Strategies for effective human-computer interaction*. Reading, Massachusetts: Addison-Wesley.

Booth, P. (1989). *An Introduction To Human-Computer Interaction*. Psychology Press.

CHAPTER 7 Prototypes

LEARNING OUTCOMES

By the end of this chapter, you should be able to:

1. Identify a variety of different prototyping techniques; and
2. Explain how and when you should use different techniques of prototyping.

INTRODUCTION

Prototype development is a main principle in developing hardware and software, this principle is based on users. Before we look at the different techniques of prototyping, let us see what a prototype is.

What is a Prototype?

We can say that **prototype** is an integral part of iterative user-centered design. This is because it allows designers to try out their ideas with user's requirements and feedback.

A **prototype** is frequently used as part of the product design process to let engineers and designers the ability to discover design alternatives, test theories and prove performance prior to starting production of a new product.

Users are part of the system development. Therefore, their involvement in decision making in the final design is important. However, most users seem to have difficulties in explaining and visualizing the design concept, unable to give their comments on the technical design documents and virtually impossible for them to provide a complete representation of the design. In many product development organisations, prototyping specialists are often employed to help bridge between the theoretical designs and the fabrication of prototypes.

In this chapter, you will learn a variety of prototyping techniques and when you should use different techniques of prototyping.

Before you learn about the techniques of prototyping, you should first understand the goals and importance of prototyping

7.1 GOALS AND IMPORTANCE

Prototyping shows us how well a design work when doing evaluation. It usually helps designers to make decisions by collecting information from users on the following matters;

- Required functionality of the system.
- Operation sequences
- User support needs.
- Required representations and interfaces.

7.1.1 The Goals of Prototype in HCI

What are the goals of having a prototype in HCI. Following are the goals of prototype in HCI:

- To differentiate between interaction design, interface design, and interface element design.
- To conduct a participatory design session.
- To create both horizontal and vertical designs.
- To create low-fidelity, interactive prototypes using techniques such as Wizard -of-Oz, storyboarding, or role-playing.
- To hold and participate in design critiques.

7.1.2 The Importance of Having a Prototype

Now let's look at the importance of having a prototype. Why is having prototype important. A prototype is indeed important because of the following reasons:

The Importance of Having a Prototype

- Prototype is a very useful tool when designers are to present their design ideas to users. It can be a communication tool between the users and system designers.
- Prototype is suitable and effective for testing the ideas. Sometimes a prototype can give answers to all the questions that exist; indirectly it helps designers make choices of other alternatives.
- Prototype is a production of an intermediary product, to be used as a basis to be tested to users.
- Prototyping can save time and money to some organisations when building a system or product that causes billion of dollars.
- Prototype can be tested to real users to ensure that the final product has the necessary functions that satisfied users and avoid bottlenecks.

7.1.3 Computer-based Prototyping

Computer-based prototyping offers an edition of the system with limited functionalities. By having prototype, users can easily interact with it and have some basic ideas and broad understanding of how it works. In the area of engineering, the philosophy of prototype is that, it is quick and inexpensive to produce and can be discarded, terminated or improvised if things are not working out as required and expected after tested. As a result, prototypes can be different from the final systems in size, reliability, robustness, and completeness and construction materials.

7.1.4 Software Prototyping

For software prototyping, it can be defined as dynamic simulation. Users can test the operations by interacting with the system in real time. Usually a prototype is only partially simulated. Characteristics of software prototypes by Jenny Preece are:

a). Actually works.

b). Will not have generalized lifetime. For example, sometimes after the prototype has been presented, it may not be used (throw it away) or it may be evolved for the development of a final product.

c). Can serve different purpose.

d). Quickly and cheaply built.

e). An integral part of iterative user centered design in which evolution and subsequent.

f). Modification of the design are fundamental concepts.

Table 1 shows us advantages and disadvantages of prototypes:

Table 7.1: Advantages and disadvantages of prototypes

ADVANTAGES	DISADVANTAGES
May provide the proof of concept necessary to attract funding.	Producer might produce a system inadequate for overall organisation needs.
Early visibility of the prototype gives users an idea of what the final system looks like.	Users can get too involved whereas the program cannot be to a high standard.
Encourages active participation among users and producer.	Structure of system can be damaged since many changes are made.
Enables a higher output for users.	Not suitable for large applications.
Cost effective (development costs reduced).	
Increases system development speed.	

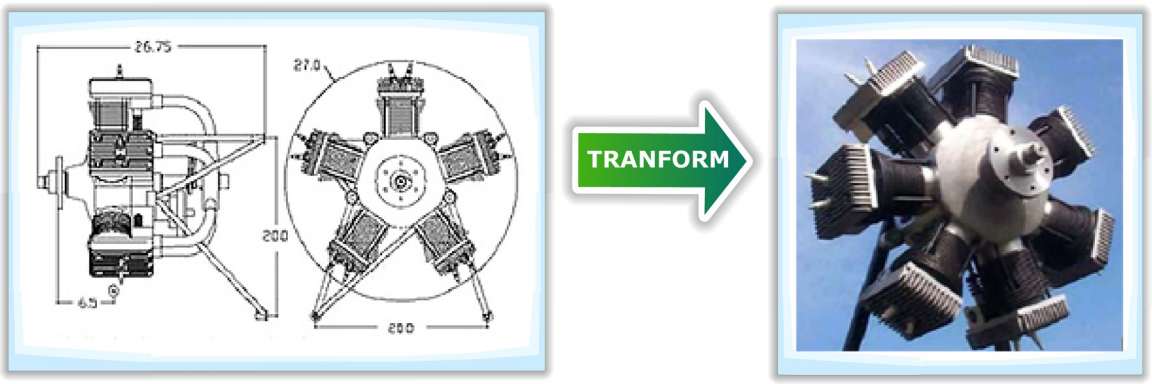


Figure 7.1: Sketches of prototype R-220 engine and the real engine of R-220

Figure 7.1 shows us how prototype plays an important role in designing the R-220 engine. From the sketches it will help the designer gather information from users and conduct task analysis. Detailed explanation on the next stage of prototyping will be explained in the next subchapter.

7.2 THE TECHNIQUES OF PROTOTYPES

Prototyping helps designers to ensure that the final design caters to all the users' needs. There are several aspects from the users that should be taken into consideration by the designers in the design decision making. Some of the aspects required from the users are:

- The required functionality of the system.
- Operation sequences.
- User supports needs.
- Required representations.
- Look and feel of the interfaces.

In all these factors, designers should gather requirements and conduct task analysis in order to obtain the required functionality of the system from users. Information on operation sequences gives designers ideas on how users shall interact with the system. In some ways, prototypes can reveal how operating systems can create tasks for users that are unsuitable and provide information for designers to create more appropriate operation sequences. Prototype also plays an important role in obtaining suitable help and other kinds of user supports. Information on representation is a part where symbols and displays are presented in such a way that is easy to recognize and not confusing to the users. Suitable representations are needed for icon design, display layout, message content and command or menu item. There are various types of prototype to extract different kinds of information. Table 7.2 below shows various types of prototype that commonly are used by designer to build the products.

Table 7.2: Prototyping methods and tools (Jenny Preece, 1994)

PROTOTYPE METHOD	DESCRIPTION	USEFUL TOOLS
Requirements Animation	Allows possible requirements to be demonstrated in a software prototype which can then be assessed by users.	Purpose built animation packages and screen painters are suitable for animating the representational aspects. Data manipulation languages are suitable for animating the functional aspects.Authoring languages, menu builders and active images tools prototype operational aspects.
Rapid (throw it away) Prototyping	Aims to collect information on requirements and the adequacy of possible design. Recognises that requirements are likely to be inaccurate when first specified.The emphasis is on evaluating the prototype before discarding it in favor of some other implementation.	Representational requirements and design can be created quickly using animators, screen painters, forms systems,report generators and menu systems.Hypermedia and high level language systems are also particularly suitable.
Evolutionary Prototyping	Compromise between production and prototyping. The system can cope with changes during and after development. Helps overcome the traditional gap between specification and implementation.	It is important to prototype using the facilities that will eventually be used to implement the final system. Additions and amendments are made to the model following evaluation and the system is regenerated.
Incremental Prototyping	The system is built incrementally, one section at a time. Incremental prototyping is based on one overall design.	Reusable software and highly modular language can be useful as more pieces are 'bolted on' to produce the final system gradually.

How to develop a prototype? Figures 7.2 and 7.3 show the flowchart for development of rapid and evolutionary prototype.

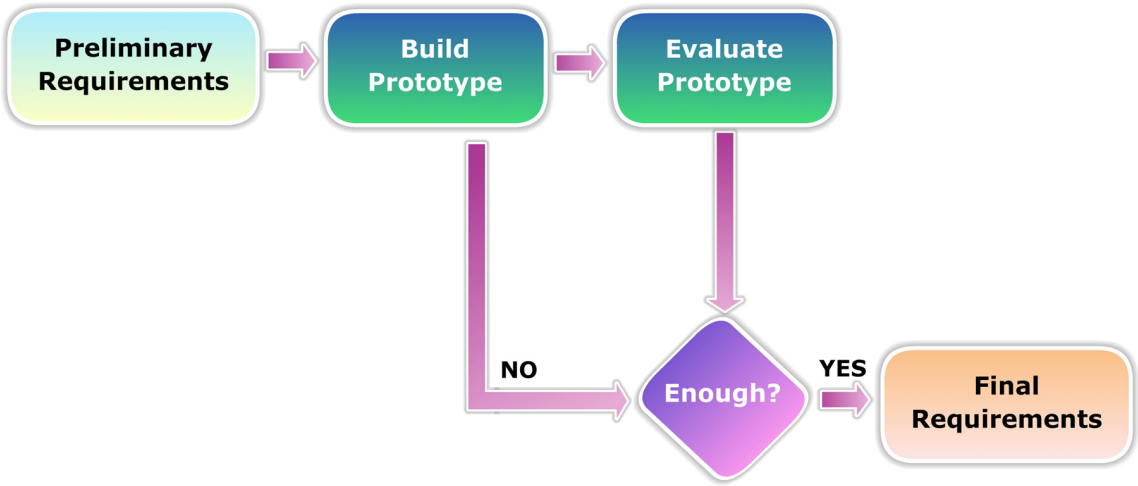


Figure 7.2: Development of Rapid Prototype (Dix 1998)

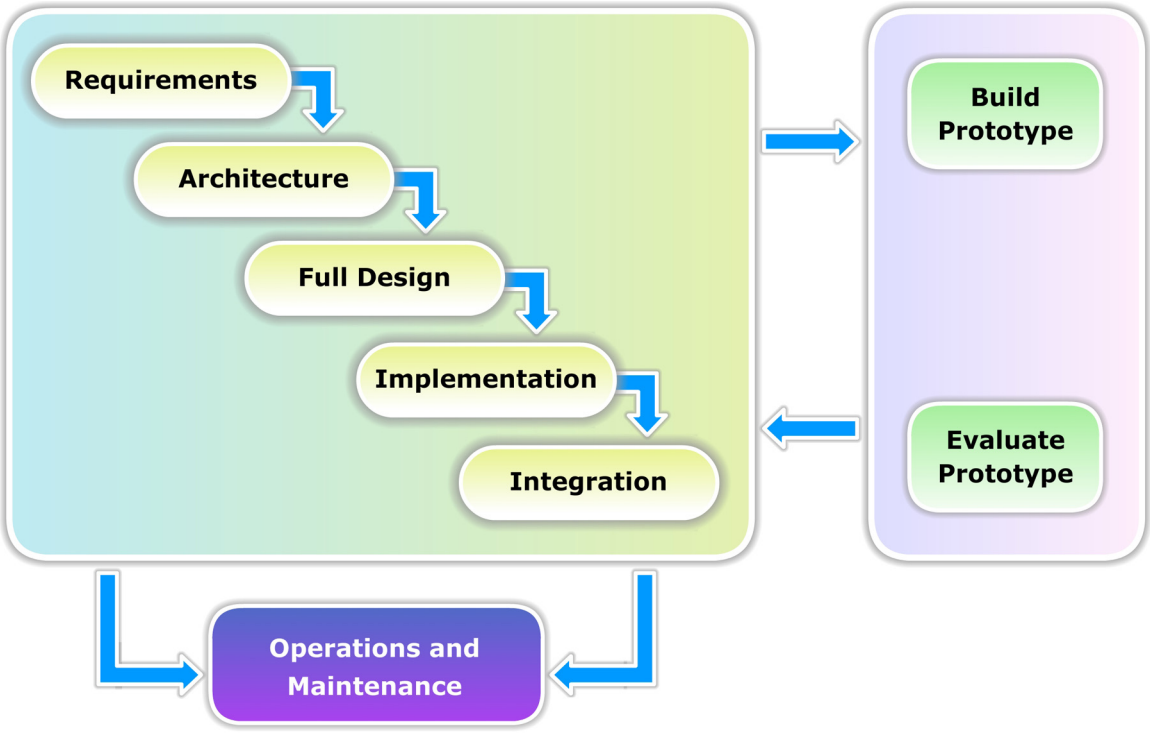


Figure 7.3: Development of Evolutionary Prototype (Dix 1998)

There are other terms in HCI literature for prototyping:

TERMS	DESCRIPTION
a. Full prototype	Contains complete functionality even though with low performance.
b. Horizontal prototype	Shows the user interface but has no functionality behind the buttons.
c. Vertical prototype	Contains all of the high and low level functionality for restricted part of a system.
d. High fidelity prototyping	Prototyping through a medium, such as video, which resembles the final interface as closely as possible.
e. Low fidelity prototyping	Involves the use of materials that are further away from the final version and tend to be cheaper and faster to develop.
f. Chauffeured prototyping	Involves the user watching while another person, usually a member of the development team, 'drives' the system.
g. Wizard of Oz	Involves a third party but the user is unaware of it. For example,the user interacts with a screen, but instead of a piece of software responding to the user's requests, a developer is sitting at another screen answering the queries and responding to the real users.

With all these terms in prototyping, Chauffeured and Wizard of Oz prototyping have added advantages for the development of the system because the development team can have extra understanding and work closely with the users. Figure 7.4, shows us the characteristics of full, vertical and horizontal prototypes.

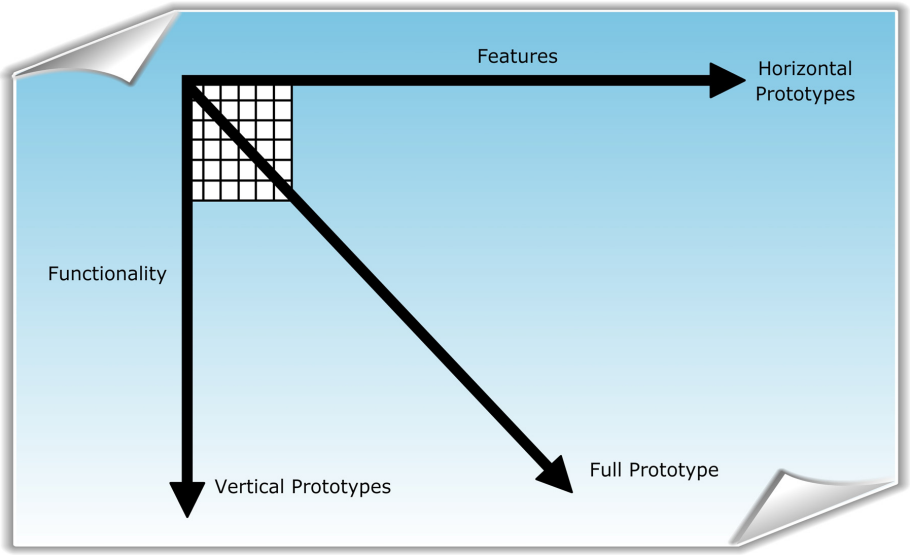


Figure 7.4: Vertical and Horizontal Prototypes

Using different types of prototype in different stages of a design results in a two-phase view of iterative design. In the first phase, the prototypes are developed to get different types of information, and completely different alternatives may be tested in parallel. Sometimes, this prototyping phase ends with a proposal for a single full initial design. The solution of prototype is iterated through design, code and test cycles.

7.3 PROTOTYPE EQUIPMENTS

There are different stages of design in prototyping. They are product conceptualization, task level prototyping and screen design determination.

a). Product conceptualisation

In the early stages of system development, prototyping is used to better understand the product requirements. There are several sketch designs (like in Figure 7.6) can be shown to users and other project members to get their comments and feedback for enhancement. Using this sketch, helps architects or designers explore other design alternatives and HCI designs.

Exercise 7.1

What are the advantages and disadvantages of prototype design if members of the project and user can seed design of prototype?

Storyboarding and sketching are the best method of prototyping because both use papers for prototyping. Indirectly, it avoids prematurely closing the design space, as a result in suboptimal system being produced, although prototype is a good technique that gives a picture of what the final product or system should be. In this new era the paper-based prototyping has been used for preliminary prototyping. But now most of designers and architects use a software named Autocad. This software lets the designers to design, visualize and documents ideas clearly and effectively. Figures 7.5 and figure 7.6 show you the interface of Autocad and prototype design that has been produced using Autocad software.

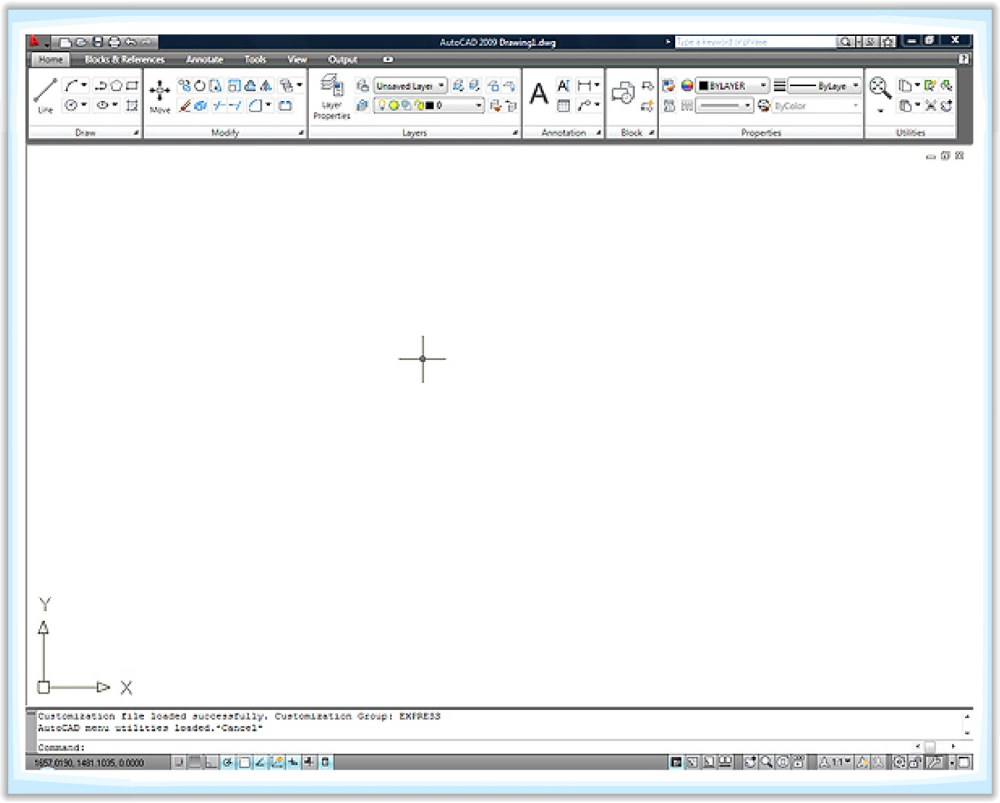


Figure 7.5: The interface of Autocad

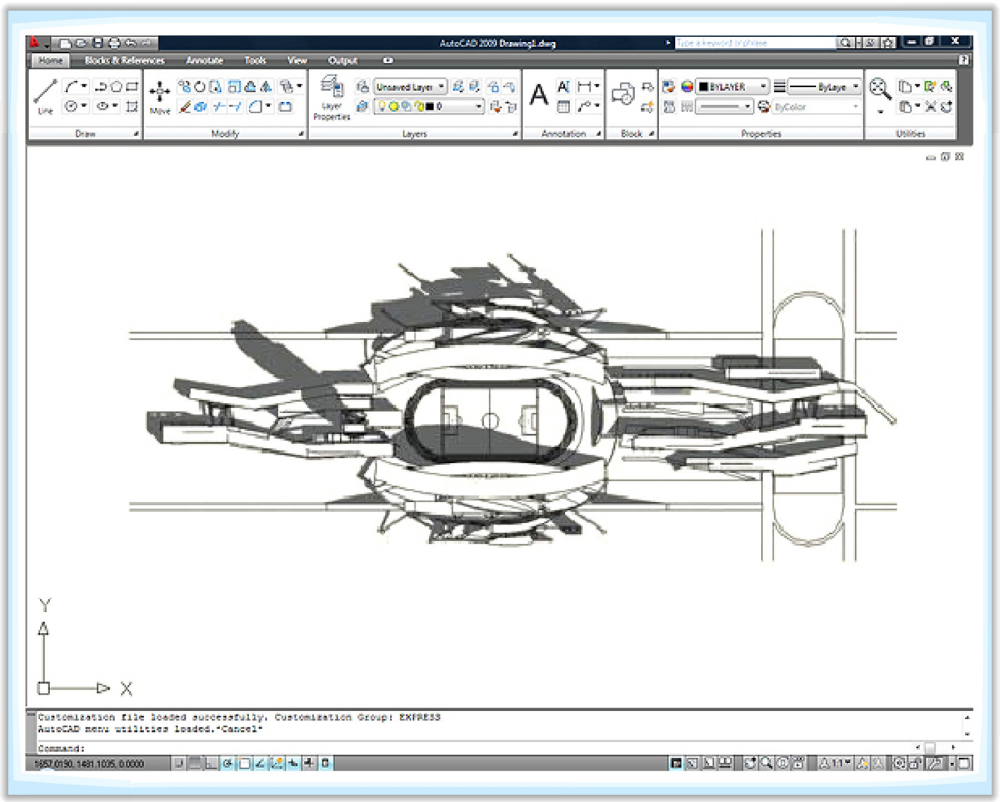


Figure 7.6: The sketch of football stadium using Autocad

In this software, it redesigns the user interface to accelerate tasks, let commands to be easily found, and helps rapidly train new users. Autocad also provides new features such as solid and surface modeling and visualization, good user interface for navigation, action recorder and many more. Using this software, designers can show their sketching on the prototype just by using tools that are embedded in the AutoCAD called Autodesk ViewCube and SteeringWheels. This tool can rotate and orient any solid or surface model in AutoCAD. In addition to allowing quick access to the orbit command, the new SteeringWheels™ tool allows quick access to the pan, center, and zoom commands. It is highly customisable so you can add walk through commands to help create and record a walk-through of your model.

If you want to know more about Autocad software, you can surf the URLs addresses below and download the free version of Autocad 2009.

- http://usa.autodesk.com/
- http://download.autodesk.com/us/autocad/screencasts/ConvertLT-toACADFinal.wmv

b). Task Level Prototyping

After showing the prototype design to the project team members and users, the requirements and functionality are determined. Prototype can now be developed and help establish the appropriateness of the interface at the task level. The purpose is to ensure that users can perform the tasks necessary for the job and can complete them in an easy and effective way.

For all forms of prototyping, the realistic situation is very important so that the features in the system can be chosen for future use. Designers should conduct system and user acceptance tests which shall standardise the system through standard software engineering practices.

c). Screen Design Prototyping

Screen design prototyping focuses on icons, menus and screen layout for the final product. Suitability of the icon and screen layouts in terms of colors, visuals and audio effects and the grouping commands within menus are always being the issues that need to be resolved. Preliminary ideas can be prototyped using paper-based sketches and drawings. The issue on the perception of the effects of screen design requires high fidelity prototyping, which should be in the form of a software prototype.

The suitability of interface elements and layouts depend on the context and theme in which the system will be used. For example, if the system that you develop is for kids, the icon and menu should be interactive and colorful. The features in the system shoulds be easy for kids to use. Figure 7.7 shows two examples of interface design.

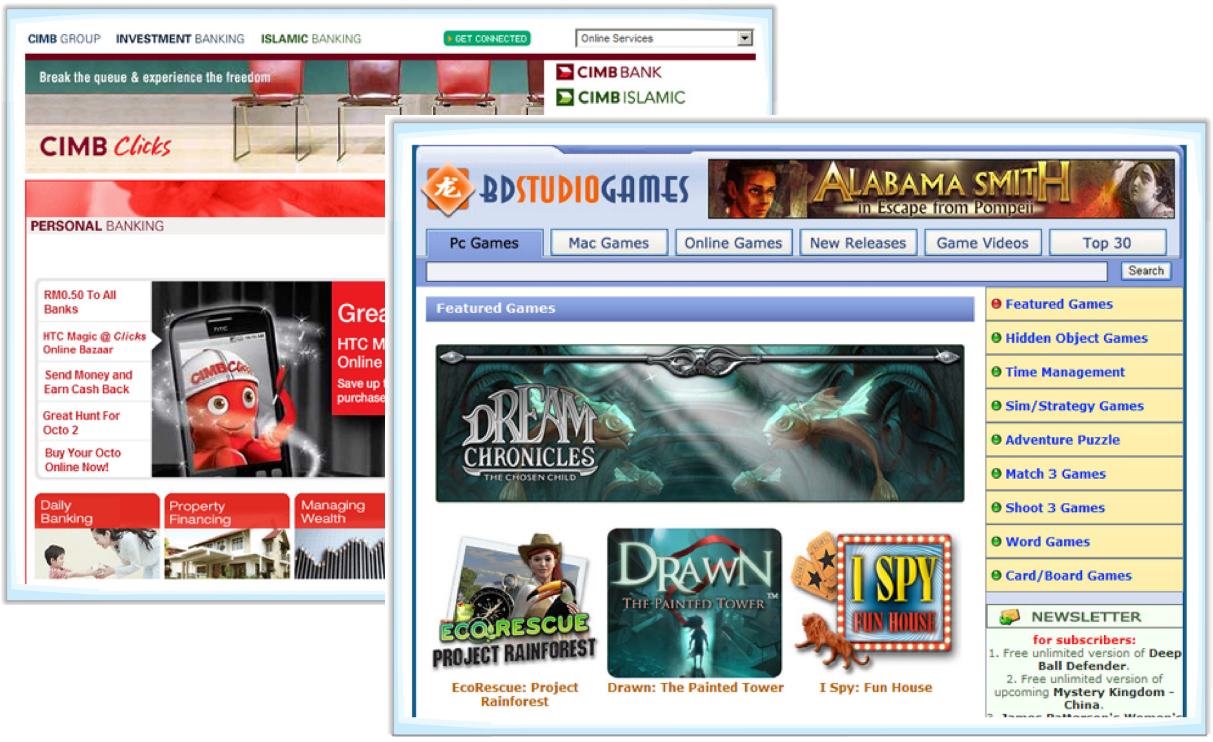


Figure 7.7: Two examples of interfaces design

ACTIVITY

Exercise 7.2

Can you find the differences of interface design between cimbclicks.com and BDStudio Games?

SUMMARY

1. In this chapter you have been exposed how prototype has been used to help designer to gather the requirements from user and do task analysis.

2. This chapter also tells you about different prototyping techniques and description on how and when you would apply the different techniques.

3. There are main components in prototyping such as conceptualization, task level and screen design that should be aware by designers so that the final product is suitable to user use.

GLOSARY

Terms	Definition
Prototype	
Requirements animation	
Rapid prototyping	
Evolutionary prototyping	
Incremental prototyping	
Full prototype	
Horizontal prototype	
Vertical prototype	
High fidelity prototyping	
Low fidelity prototyping	
Chauffeured prototyping	
Wizard of Oz	

REFERENCES

Jenny, P., Yvonne, R., Helen, S., David, B. & Simon, H. (1994). Human-Computer Interaction. University of Michigan, Addison Wesley.

Dix, A. J., Abowd, G., & Beale, R. (1998). Human Computer Interaction (2nd). Pearson Education.

War Aircraft Replicas. (2002). Warbuddies. http://warbuddies.homestead.com/HCI.html

Autodesk. (2009). Autodesk - 2D and 3D Design and Engineering Software for Architecture, Manufacturing, and Digital Entertainment. http://usa.autodesk.com.

CHAPTER 8 Evaluation

LEARNING OUTCOMES

By the end of this chapter, you should be able to:

1. Identify how design and evaluation are intermeshed;
2. Classify the evaluation methods;
3. Describe the effective and efficient evaluations;
4. Discuss the benefits of different types of collecting and analysing data;
5. Identify why interpretive evaluation is important and how it can be different from forms of evaluation; and
6. Describe what predictive evaluation is as well as positive and negatives aspects of expert reviews as an evaluation technique.

INTRODUCTION

Do you know what is meant by evaluation in HCI?

Evaluation in HCI is said to be the most critical component throughout the systems development process. Evaluation enables the designers to see what their users really want and whether their system meets up to the requirements.

This is what we are going to learn in this chapter. We will look into the evaluation methods and see how we can make and do our own evaluation studies. This chapter also discusses on the evaluation within framework of people, their work, the environment at their workplace and the technology used.

As additional information, you may want to watch the video clip below to give you more insights on evaluation in HCI:

What history can teach us about evaluation in HCI

Source: http://www.youtube.com/watch?v=pgoPtM5xELY

8.1 EVALUATION AND ITS FUNCTIONS

Let us begin by looking at Figure 8.1 below, which shows how evaluation supports the whole design process:

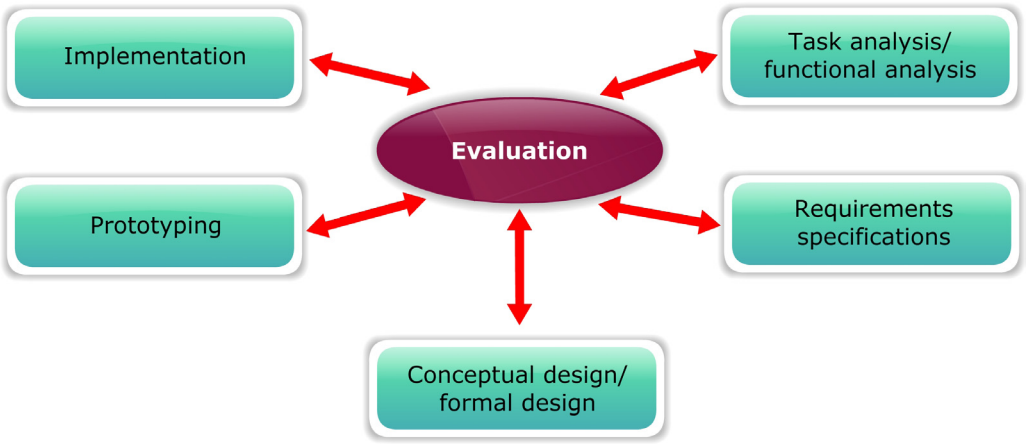


Figure 8.1: The star life cycle (adapted from Hix and Hartson, 1993)

Evaluation will help the proposed design fits the needs of user in terms of features by informing the design team. The evaluation also tells design team about activities for which the system, environment and technology that will be used. Evaluation is also concerned about gathering data for the usability of a design or product by a specified group of users for a particular activity within a specified environment or context of work. For types of evaluation being done, there are aspects that are important to be considered, as shown in Figure 8.2 below:

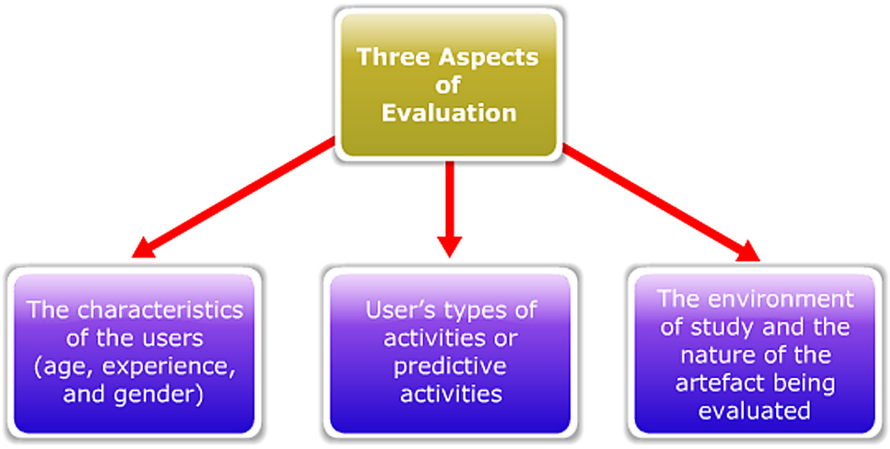


Figure 8.2: The three aspects of evaluation

Experts try to predict the usability of a system without directly involving users. Evaluators take all of these evaluation aspects to make sure the product fits to user's needs.

8.1.1 Functions of Evaluation

For this subchapter, there are many questions for us to understand the function of evaluation for the final product. One of the questions is why do the evaluation? The answer is find out what users want and what problems they experience, because the more understanding designers have about users' needs, then the better designed their product will be (J. Preece, 1994).

In marketing, most of company wants to know comparison between their products and other products. For example, if the proposed product from the designer should be better than other products at the market.

Evaluation can be divided into **formative** and **summative**. **Formative** evaluation helps to form a useful product and **summative** is concern about making judgments for the finished item such as confirming the design of a final product of notebook.

Could you list some of questions that designer should ask when design the products.

Table 8.1 shows the reasons for doing evaluation:

Table 8.1: The Reasons for Doing Evaluation

Reasons for evaluation	Description
(a) Understanding the real world.	• This activity is important during requirements gathering and then later for checking whether the prototype of the system fulfils the user needs.
(b) Comparing designs.	• Sometimes there are situations where designers want to compare their ideas and design to differentiate with other products. For example, in the early development of a product, there will be a debate on the design of the product, functions as well as the difference of the product as compared to other products.
(c) Engineering towards a target.	• Design process can be viewed as a form of engineering. Designers should have target and goals in order to ensure that the design will produce a product that fulfil all the user requirements and its features are as good as the competitor's product.
(d) Checking conformance to a standard.	• All products design should conform to a particular standard. For example, all Malaysian products that have been produced need to be verified by SIRIM before it enters the market.

8.2 EVALUATION TECHNIQUES

In this chapter, you have been told about task analysis. This part will explain to you about how to do task analysis and to get collection of data about the design product. There are several methods that we can do to collect and analyse data. To do this task analysis, there are a lot of questions that need to be answered before we can choose the methods. The question is more to the suitability of methods to collect data and it is more on logistics factors such as time to do evaluation, availability of suitable expertise and equipment, access to users and so on. Below are the methods on how to collect and analyse data:

(a) **Observing and monitoring usage**

This method helps users interact with a product or prototype. Observing and monitoring can be as part of formal usability testing and can be done from a participative or ethnographic perspective. The aim of this method is trying to understand how users interact with technology in natural settings. In this method, there are number of techniques that can be used to collect and analyse data. With direct observation, data can be collected by observer using some techniques such as making notes or recording video (as shown in Figure 8.3). To analyse data is depend on the question that evaluators want to answer.

Figure 8.3: Observing and monitoring usage

(b) **Collecting users' opinions**

We need to examine user's performance to find out what user think about the using technology. To make sure the technology have good scores of users' performance, the technology must be used by user. So we need way like surveys by doing some questionnaires and interviews to collect data about users' attitudes to the system (as shown in Figure 8.4).

Figure 8.4: Collecting users' opinions through survey and interview

(c) **Experiments and benchmarking**

It is not easy to do well design laboratory experiments; the designers need a stated testable hypothesis, controlled variable of interest and knowledge statistics to validate results. It is very difficult to involve humans when controlling all of the variables in complex interactions and it always is debatable. Engineering approach in HCI is to testing in which benchmark tests are given to users in semi scientific conditions. Experiment need to be setup and procedure roughly follows the scientific paradigm in the experimenter efforts to control certain variables while examining others. Often the user works in a usability laboratory to examine product and do benchmarking.

(d) **Interpretive evaluation**

This kind of evaluation give designer more understands how users use the product in their natural environments and how to integrate the product with user's activities. Data for interpretive evaluation is collected in informal and naturalistic ways, with the goal of causing as little trouble to users as possible. Participative and contextual evaluation is types of methods to collect data. Researchers must attempt to absorb themselves in the environment of study and sometimes, they can use video and audio recordings for collecting data. With these types of methods, data collected is much

less formal than usage or benchmark data. The way o to analyse and interpret data is quite different.

(e) **Predictive evaluation**

This evaluation is to predict problems that users will face when using the product without involving users to test the product. To do this evaluation, we need a psychological modelling technique such as keystroke analysis or experts to review the design and predict the problems for typical users of the system would be likely to experience. This technique needs specification, mock up or low level prototype.

Table 8.2 below shows the relationship between types of evaluations and reason for doing evaluation:

Table 8.2: The relationship between types of evaluations and reason for doing evaluation (ü= very like choice, ü = less likely)

	Observing and monitoring	Users' opinion	Experiments and benchmarks	Interpretive	Predictive
Engineering towards a target	●	✔	✔		●
Understanding the real world	✔	✔		✔	
Comparing designs	✔	✔	●		✔
Standards conformance			✔		

(f) **Pilot Studies**

Before doing an evaluation to your product, you need a very clear question to answer or hypothesis to test. You also need to plan your study carefully before draw up plans so that no unexpected things happen. To avoid all this things you need to plan well to ensure success. You need conduct small study before doing something, which is also known as pilot study. Pilot study is a study that gives an opportunity to designer to learn from your previous mistake without ruining your main study. The benefits are:

- you can plan better main study because it will help you see what kinds of problems arise in the pilot and you can fix them;
- to make data collection is consistent pilot studies gives an opportunity to practice a technique; and
- you will be more confident to design the product.

There are many methods to do pilot studies; one of the examples is print out about 300 set of questionnaires to public. From this pilot study, you can see which questions were unclear; it can help you to change the questionnaires before doing the main case study. Figure 8.5 below shows example of online questionnaires that can be used to conduct pilot study.

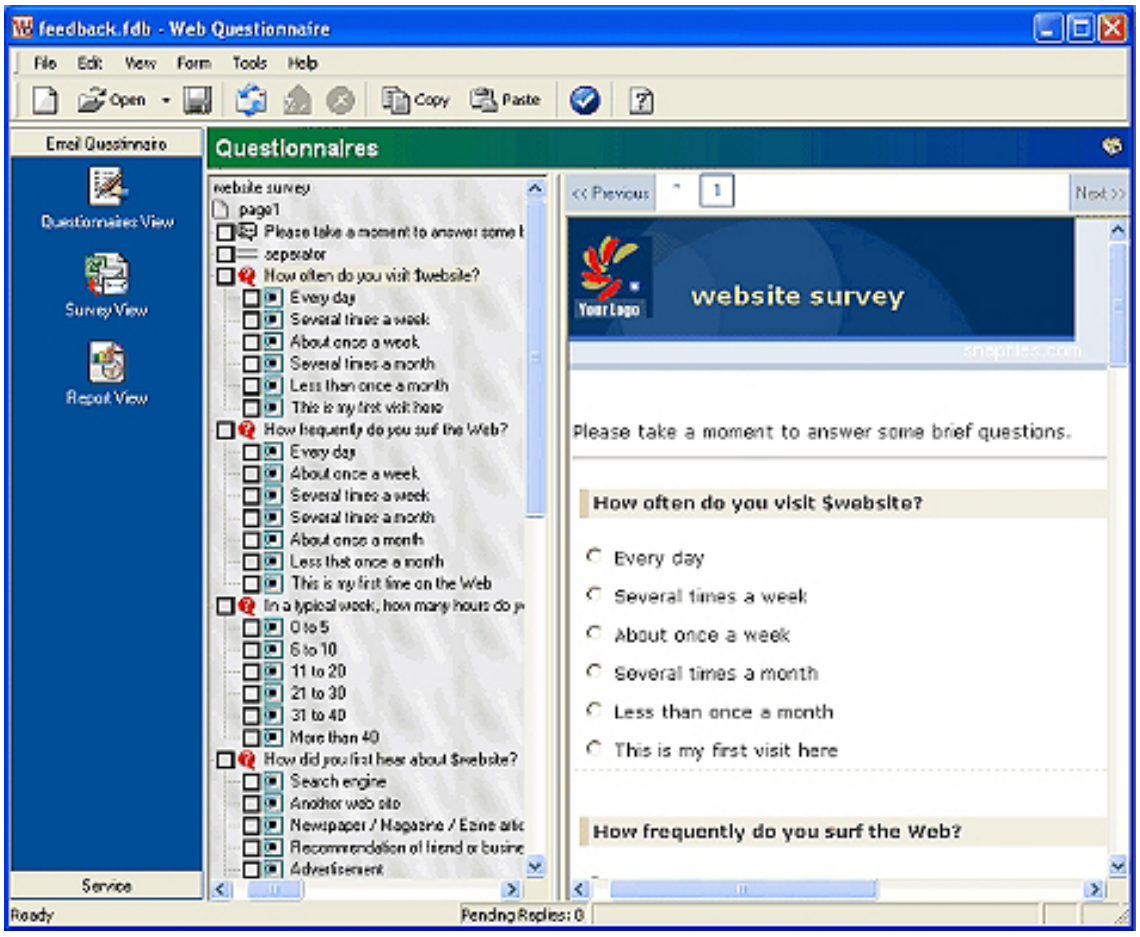


Figure 8.5: Examples of questionnaires for pilot study

(g) **Users' rights**

In evaluation, users also have rights to give opinions and express their feelings about the product. Generally in this method, users do not help designer but this method will make users aware of their own rights and make them know that designer are sensitive to user's rights. With this evaluation, designer need to guarantee them privacy and assure data that have been given by user should be secret (as shown in Figure 8.6). Then, designer needs to label transcripts of interviews, questionnaires and others data.

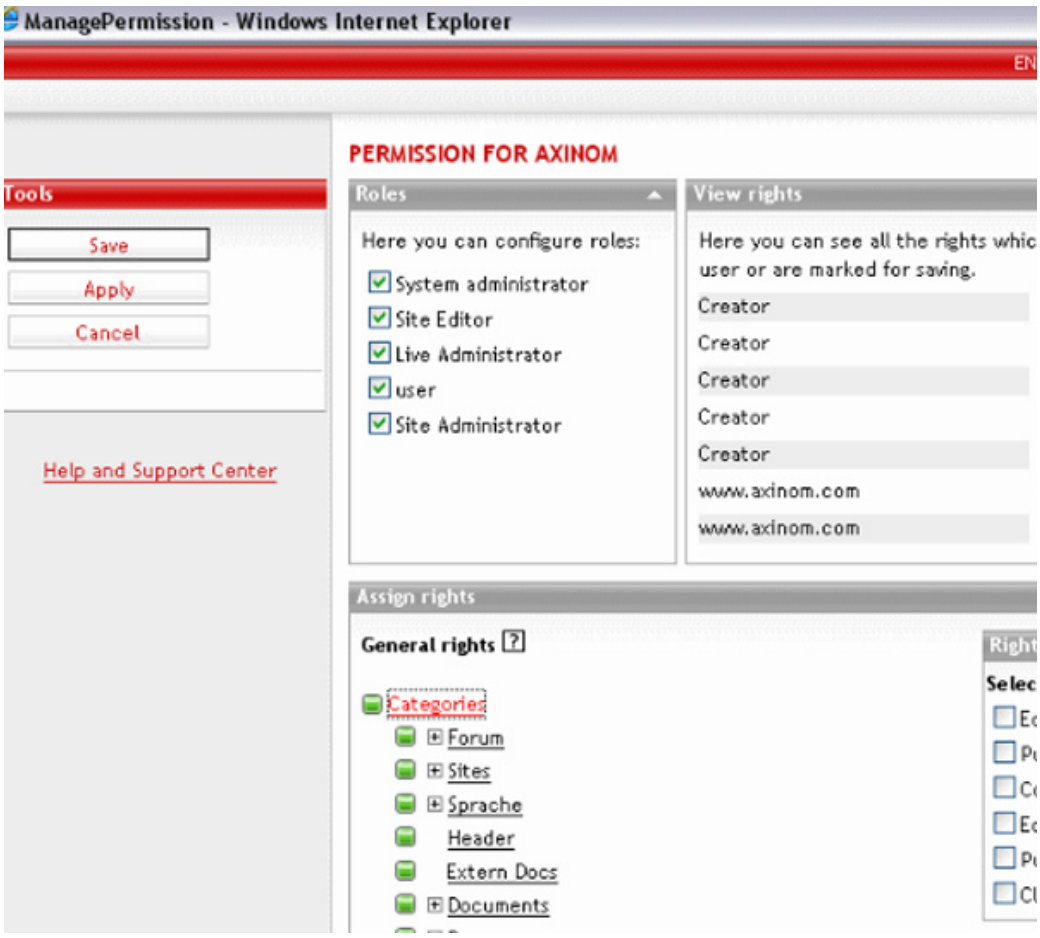


Figure 8.6: System designers must be sensitive to user's rights

8.3 USAGE DATA: OBSERVATIONS, MONITORING, USERS' OPINIONS

After introduce several techniques of evaluation used for evaluate the product. Then this chapter introduces number types of collecting and analysing usage data from users and to find out the aspects of the product from user's feel.

8.3.1 Observing users

For observing users, designer needs to use various psychological and physiological. For example eye produces visual image and brain has to interpret (Gregory, 1966). During the process of design and development, designer will start to observe users for using and reacting to designer's ideas. In the observation process, designer will ask users what to do and how it will depend on the reasons for observing them. For example, designer wants to see how user do specific task or how user use the technology in

their own work environment that uninfluenced by designer. The reason for doing observations is to access the resources such as equipment, how designer determine to record the observation.

(a) **Direct observation**

Individual users can be directly observed doing their normal works, the observer will making notes about interesting behavior or performance in some way. For example by timing sequences of actions. Direct observation also can be an obtrusive method because of users continually aware of their performance being monitored that can alter their behaviour and performance levels. This phenomenon called Hawthorne effect, after a 1939 study of workers in the Hawthorne, Illinois, plant of the Western Electric Company. Although the observer may take notes, the record of the observation will be usually incomplete. Direct observation also have problem because it only allows a 'single pass' at the data collection, and the evaluator seldom gets a full record of user activity for several passes at the detailed analyses.

(b) **Indirect observation: Video recording**

There are several aspects of user activity can be monitored by different video cameras. For example, there a situation where one camera focused on the keyboard and screen and the other camera focused directed to the user. From this activity, we can record how the user uses the computer and record their body languages that picture user's feelings about using the computer. All the records are very useful, especially if the data support data analysis too.

However, there are some important issues that need to be considered. The issues are we need to plan the observation (thinking about what you want to find out and what types of data needed). For example, in a study of user's behaviour when using a system in the context of workplace, it may be useful if we can collect daily record samples over a certain days or weeks and then analyse all the activities by classify them.

There are also practical problems that need to be considered when associate with setting up video equipment. However unobtrusive you try to be, users will be aware that they are being filmed. So you need to have a strategy on how to solve this problem before start recording so user will get used to try out the system. With this technique, it will help to reduce the Hawthorne effect. You also need to decide the period of recording, label of recording to catalogue, changing the cassette, where the equipments will be located and so on.

(c) Analysing video data

There are many types of study that can be done using video; most of researchers agree that analysing video data can be very time consuming if the studies have be

planned early. In this part, there are two types of analysis can be undertaken: task based analysis and performance based analysis. Task based analysis can be defined as determine how the users tackled the tasks given, where the major difficulties lie and what can be done. For performance based analysis is to obtain clearly defined performance measures from the data collected (J. Preece, 1994). There are common measures in these two types of analysis such as frequency of correct task completion, task timing, use of commands, frequency of user errors and time taken up by various cognitive activities. Measuring the frequency of errors requires an error classification scheme. Reliability issues raised with performance based analysis, the measure have to be obtained in a uniform fashion that can be repetitive by different evaluators across different groups of users.

The key factor in the use of video is the trade off between time spent and depth of analysis. An informal evaluation can be undertaken in a few days, perhaps consisting of direct observation, system logging or video recording typical users undertaking selected tasks. If evaluators want to understand more detailed about user action, the evaluators either have to collect and analyse user protocols or select relevant performance measures and play through any videotape or system log several times to extract all the measures.

8.3.2 Verbal Protocols

As we know, everything that has been related to video recording usually coupled with some form of audio record, which known as a verbal protocol (Ericsson and Simon, 1985). Verbal protocol sometimes contains users' spoken observations and adding with extra dimension to the information gathered by addressing the cognitive activity underlying the user's physical behaviour. From such a protocol it is possible to obtain a wide range of information, for example, when user planned to do a particular task; his identification of menu names or icons for controlling the system; his reactions when things go wrong and whether or not he understands the error messages provided by the system and so on. Evaluator can get a hint about his subjective feelings about the activity from comments and the tone of her voice. Verbal protocols sometimes can be collected on their own without video, either because the video added little extra information for some logistical reason use of video was not feasible.

A think aloud protocol is a the term for special types of verbal protocol in which the user says out loud what the individual is thinking while doing some task or solve problem. Verbal protocol can leave some effects on users, who required doing two things at once – the task itself and talk about their actions or what they are thinking about.

Before we go to other chapters, let try this exercise. Imagine that you are driving from Johor Bahru to Kuala Lumpur. On the way to Kuala Lumpur, when you arrived at Seremban suddenly you stuck because of traffic jam. What do you think we would notice about your verbal protocol?

A post event protocol is a technique that enables users view videos of their actions and provide a commentary on what they are trying to do. This technique always been used in situation where task require careful concentration and for critical time such as air traffic control rooms, where it is a feasible way to collect data for verbal protocols.

8.4 SOFTWARE LOGGING

Software logging is automated data analysis process that not requires the researcher to be present and always has been popular among researchers. There are number of software logging tools but separated into two categories:

(a) **Time-stamped key presses**

Provide a record of each key that the user presses and also record the exact time of event.

(b) **Interaction logging**

This technique is similar to time-stamped key presses but the recording is made in real time and can be replayed in real time. This can make observer see the interaction between the user and the machine exactly as it happened.

Most of researchers like to combine video, audio and key presses or interaction logging. Now researcher use playback system to watch a video screen set up in another room to observe user input at a terminal. The screen will shows a log of the user input and system responses. The researcher also can add own input to the time-stamped log in the form of a code and short comments about each user operation. The feature that has been provided by playback system is the researcher can replay the log of user actions in different speeds and perform further detailed analyses during this run through. The advantages of combining data capture techniques is that evaluator can relate revealing data about body language such as posture, smile, angry and so on and comments or detailed audio protocols with records of the actual human computer interaction. The disadvantages of software logging are it can be expensive because we need to buy equipments and the data can be quite daunting.

8.5 SOFTWARE LOGGING

After we review several techniques of evaluation, we should know that user's attitude can give a strong influence to the design and development of products. Checking user's opinion at various stages can save a lot of time by ensuring that unusable, unnecessary or unattractive features are avoided. So, we need techniques to gather user's opinion. The techniques are interviews and a questionnaire, these two techniques helps to gather data from user's preferences, but users differ in the amount of preparation, style of presentation and the flexibility of question asking. The data from interview is more qualitative than surveys that are qualitative. Surveys also have benefit that large numbers of people can be reached, there also a possibility of obtaining statistically important if required.

(a) **Interviews**

To do interviews, you need to plan interviews carefully so that your interview session is relevant to the issues being asked. There are two type of interviews; structured and unstructured. Figure 8.7 shows the picture of situation interview.

Figure 8.7: Situation during interview

Structured interview usually have predetermined questions that are asked in a set way and there is no exploration of individual attitudes. For fixed structured always can be found in public opinion surveys and it is important if you collect and compare the responses by different subjects or statements supported by statistics. Unstructured interview is an interview that has some set topics but do not have set sequence. Interviewer can freely to communicate with the interviewees' replies and to find out about personal attitudes. This kind of interview is less formal and can be used in the early development for gathering data. In HCI research, unstructured interview have been used mostly to determine user understands of interfaces.

There are two types of style when doing interview, first is semi-structured interviews where interviewer regularly has a set of questions that interviewer can direct draw the interview if the interviewee either digresses or does not say very much. But for prompted interviewing is a style that can be used to draw out more information from the interviewee. Most of the interviewer use tactics such as saying 'can you tell me a bit more about that', 'and what do you mean' and etc. As interviewer we should know that the structured the interview the easier it is for the interviewer.

There are also other variations of interviews such as card sorting and twenty questions. Card sorting in which users are presented with a numbers of cards and give a space to classify them to form answers to certain questions. Usually this kind of technique will be used by professional market researchers and it is very popular technique. For twenty questions, the expert or users ask the questions to which only give answer 'yes' or 'no' and in this way information is elicited.

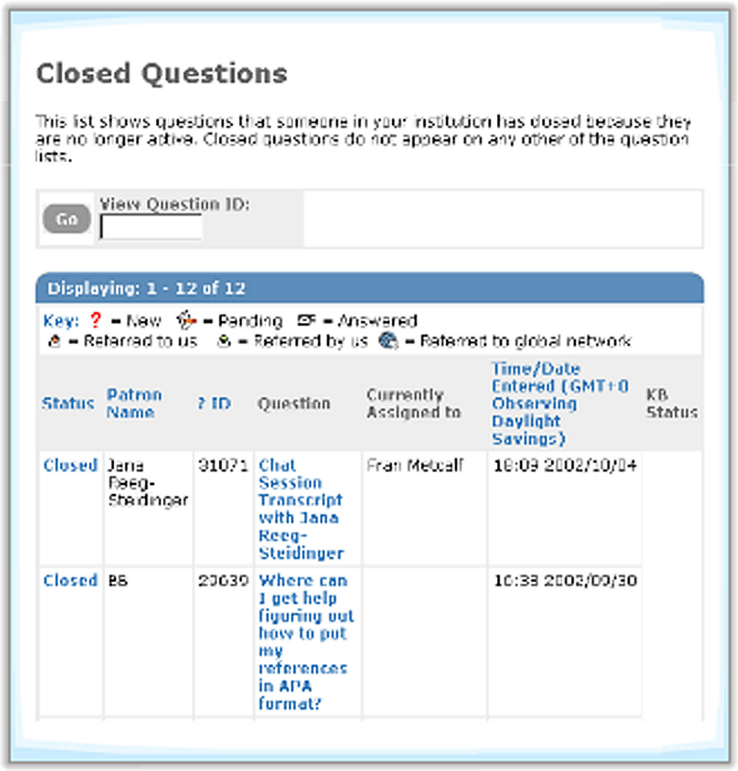
Data analysis can become difficult with flexible or poorly structured interviews but user can provide much richer information when interview. In this case, verbal protocols should be used to get the interview transcribed so that it will make easy the interviewer to examine it in detail because sometimes it is easy to miss subtle comments.

(b) **Questionnaires and surveys**

Questionnaires and surveys take a different method than interviews. These kinds of method have another style of presentation and the consideration of the flexibility of the data gathering to the preparation of unambiguous questions. A questionnaire is a technique that can reach a very large number of people and it is important to make sure that questionnaires are well design by doing pilot study.

There are two types of question structure for questionnaires; closed questions and open questions. Closed question is when the respondent is asked to select an answer from a choice of alternative replies and for open questions; the respondent is free to give answer. Closed questions usually have some form of rating scale associated with them. The usage of rating scale make user just check the list based on the basic alternatives and responses to a very specific question.

The process of gathering data from questionnaire is you need to give numbers of questionnaires to selected population or group target. After collecting back your questionnaires, you can see responses of question based on the different rating scales are converted into numerical values and statistical performed. Usually for analysis of most survey data, means and standard deviations are the main statistics used to get the numerical values and statistical. There are many statistical packages are available to support data analysis. Figure 8.8 shows example set of questionnaires.



Closed Questions

This list shows questions that someone in your institution has closed because they are no longer active. Closed questions do not appear on any other of the question lists.

Go View Question ID:

Displaying: 1 - 12 of 12

Key: ? = New = Pending = Answered
= Referred to us = Referred by us = Referred to global network

Status	Patron Name	? ID	Question	Currently Assigned to	Time/Date Entered (GMT+0 Observing Daylight Savings)	KB Status
Closed	Jana Reeg-Steidinger	31071	Chat Session Transcript with Jana Reeg-Steidinger	Fran Metcalf	10:09 2002/10/04	
Closed	BS	20030	Where can I get help figuring out how to put my references in APA format?		10:38 2003/09/30	

Figure 8.8: Example of close questions

To make good questionnaires, you need to consider any measure that will increase the chance of respondents completing and returning the questionnaires. You must make sure that the set of questionnaire is short and easy to be answered.

You can surf http://www.surveysystem.com for get information about statistical tools for analysis data from questionnaires.

8.6 INTERPRETIVE EVALUATION

This section shows you some ways of collecting and analysing data and how people use the provided technology in natural conditions like at home, at school and at workplace. From previous section, we have discussed that all methods rely on the researcher controlling subjects in some way or another. The data collection techniques are quite formal and there has been a strong dissimilarity between evaluators and users.

> *Interpretive methods of research start from the position that our knowledge of reality, including the domain of human action, is a social construction by human actors and that this applies equally to researchers. Thus, there is no objective reality which can be discovered by researchers and replicated by others, in contrast to the assumptions of positivist science.'*
>
> (Walsham, 1993)

This section shows you some ways of collecting and analysing data and how people use the provided technology in natural conditions like at home, at school and at workplace. From previous section, we have discussed that all methods rely on the researcher controlling subjects in some way or another. The data collection techniques are quite formal and there has been a strong dissimilarity between evaluators and users.

The techniques discussed in this section vary in the degree to which they can be described as interpretive but illustrate a distance from objective evaluation on the way to more subjective interpretation of the findings in the relation to the context of study. Interpretive evaluation is suitable for understanding the complex interactions that arise in natural environments. The interpretive evaluation can be helpful at various stages in the development life cycle especially for a feasibility study, design feedback or post-implementation review. It also makes much better understanding and engenders shared commitment.

8.6.1 Contextual Inquiry

Contextual inquiry is a form of elicitation which can be used in evaluation; usually this approach user and researchers take part to identify and understand usability problems within the normal working environments of the user. Contextual inquiry has a connection in the ethnographic paradigm, so usability issues of concern are identified by users or by users and evaluators collaboratively while users are working in their natural work environments on their own work. The term 'contextual interview' has been used to describe the discussions that drive contextual inquiry. These discussions are an interview between users and evaluators together in which any aspect of concern is discussed and recorded on video for re-examination. There are works from Holtzblatt and Beyer (1993) that give type of things that are of particular interest to the evaluator, as shown in Figure 8.9:

Type of things that are particular interest to the evaluator

(a) structure and language used in the work;
(b) individual and group actions and intentions;
(c) the culture affecting the work; and
(d) explicit and implicit aspects of the work.

Figure 8.9: Four types of things that are particular interest to the evaluator

With other protocol data, this analysis can be time-consuming but Holtzblatt and Rayer recommended steps for the evaluators to try, as shown in Figure 8.10 below:

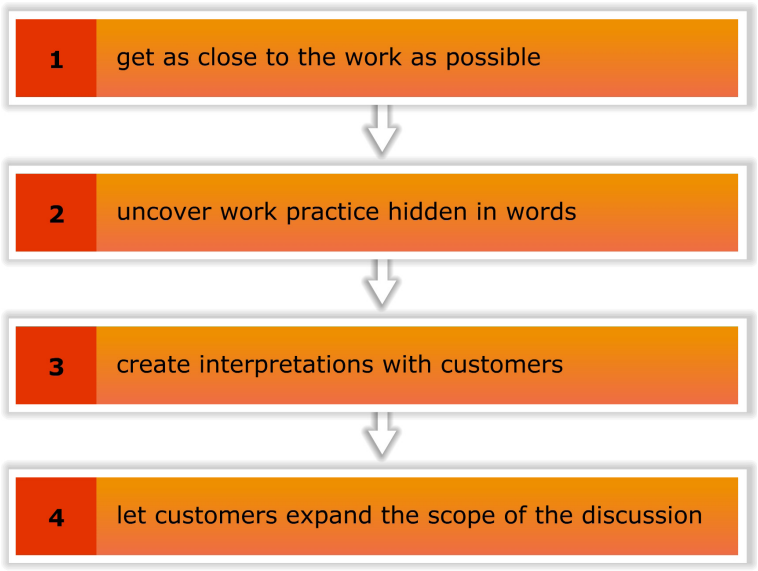


Figure 8.10: Four steps for evaluators

The interpretation of the data can be done with the reference to the wider work context and users' general aims.

8.6.2 Cooperative and participative evaluation

(a) Cooperative evaluation

From Monk et al., (1993), co-operative evaluation is a technique to improve a user interface specification by detecting the possible usability problems in an early prototype or partial simulation. It also sets down procedures by which a designer can work with

the sort of people who will ultimately use the software in their daily work, so together they can identify potential problems and their solutions.

This evaluation designed to be a low cost technique that can be used by designers and users without specialist HCI knowledge but need a little training to do cooperative evaluation. The aim of cooperative evaluation is to give natural interaction where designers identify the evaluation tasks but users are encouraged to comment and to suggest good alternatives and to ask questions.

(b) Participative evaluation

This type of evaluation is different than cooperative evaluation, but participative and cooperative evaluations are in the same philosophy, techniques and in practice they are closely interwoven. Participative evaluation also make user feel not threaten and accessible but encourages them to participate evaluation. It also makes users and designer to trace breakdowns in the interaction by recreating them, trying solutions and discussing issues in users' own language.

8.6.3 Ethnography

There are many researchers about ethnography in HCI as a method of collecting data about the real work situation and acknowledge the importance of learning more about the way technology is used. Ethnography can provide an alternative view which is deeply contextual in contrast. Most of the ethnographic researchers strive to immerse themselves in the situation to learn about. For example, anthropologists willing to go into the community so that they can learn the language to build the technology for the community. According to Monk et al. (1993), the role of the ethnographer as an uninformed outsider such as:

(a) the ethnographers can use the range of methods including intensive observation, in-depth interviewing, participation in cultural activities and simply hanging about, watching and learning as events unfold;
(b) the ethnographers also should go into the holistic perspective such as belief systems, rituals, institutions, artefacts, texts etc.

All types of data sources can be collected by using video, annotations in notebooks, snapshots and artefacts from the activity being observed. In HCI, video can be primary recording mechanism and a major problem is created by the time-consuming nature of analysis. In ethnographic researchers, this problem can be occur when the same video rewatched several times in order to identify previously missed subtle insights into the behaviour recorded but the video can be watched repeatedly for further analysis. In the new era of technology, all the analysis can be used by using automated tools to support the process.

8.7 PREDICTIVE EVALUATION

Predictive evaluation is an evaluation for attempt to lower the cost of evaluation by predicting aspects of usage rather than observing it directly. Most of the methods in this evaluation do not involve users but involve some form of inspection such as case of reviews and heuristics evaluation or modelling. Furthermore, there is no more specialist equipment required. Because of these characteristics it makes attraction for software developer to evaluate the product.

8.7.1 Inspection Methods

This method involves the inspection of aspects of technology by specialists who have knowledge of both technology and the intended users (which they can bring to bear in the evaluation).Typically, the emphasis is on the interaction between a single user and a system. Nielsen (1993) said that, the usability of inspection methods as 'a set of highly cost-effective methods for finding usability problems and improving the usability of user interface design by inspection'. The aim of all inspection methods is to generate list of usability problems. All of these problems can be fixed early in the design or to go forward an alternative parallel design.

(a) Usage Simulations

Usage simulations involve reviewing the system to find out usability problems. The evaluation in this method can be done by experts, who simulate of less experienced users and try to predict the usability problems that they will encounter. Because of arises subject, this method also can be named as expert reviews or expert evaluation. The experts usually expert in HCI fields and have a broad experience of different kinds of systems. With this knowledge they be able to spot usability problems that need to be taken care with inconsistency, poor task structure, confusing screen design and so on.

The main reason to use experts in this method is to do with efficiency and prescriptive feedback. With this kind of method, it will make experts identify a potential problems for users during a single session than a real user that take longer time and need more facilities. Experts are often forthcoming with prescriptive feedback about improvement of the system and how usability problems can be put right. Sometimes, a little prompting to get reviewers alert and suggest solutions for the problems arises because generally theyhave experienced in many systems and for the design team it will make an additionalinput for them. After that, they will provide detailed reports based on their use of the prototype or working system.

You go to http://aimsweb.utm.my and try to role-play typical users and make a note of the kinds of usability problems that you think they might encounter.

It is necessary to considering some problems while reviews are relatively straight forward:

- Make sure opinion from reviewers not involved with previous version of the system or prototype.
- The reviewers should have suitable experience in HCI and the applications. Media and creative design expertise can be additional to the system but finding small panels of reviewers can be difficult.
- The role of reviewers needs to be clearly defined to ensure that they adopt the required perspective when using the system. This method relatively easy to assess both the very limited understanding of novice users and the very experienced user's with the extensive knowledge.
- The task undertaken, the product or prototype used and any accessory materials.

When collecting and analysing data, we aim to obtain a ordinary set of factors from the individual reports that address the most important problems. This aim is to achieve in three ways:

- Structured reporting The reviewers have to report observations in a set way.
- Unstructured reporting The reviewers report their observations and a categorisation of common problem areas is determined.
- Predefined categorisation The reviewers are given a list of problem categories and they report the occurrence of problems in these categories.

Table 8.3: Advantages and disadvantages each types of reporting styles

Reporting style	Advantages	Disadvantages
Structured	Easy to analyse	Requires time to categorise problems. Inhibits spontaneous suggestions.
Unstructured	Invites spontaneous comments and suggestions	More difficult to analyse than structured reporting. More difficult to categorise common problems.
Predefined categories	Categories of problems already agreed. Very easy to analyse	Completely inhibits spontaneous comment and advice. May miss problems not already categorised.

Table 8.3 show advantages and disadvantages each types of reporting styles. In this method, there are many problems that need to be noted. These problems are bias, locating suitable reviewers, role playing and the behaviour of real users:

- Experts may concentrate on certain features and virtually ignore others because they are often renowned for their strong views and preferences;
- Finding reviewers with the right experience and expertise can be difficult, particularly for small companies;
- Good role playing needs an extraordinary amount of information about the level of user's knowledge, types of things to use for the system and their response to problems.
- Reviews cannot capture the variety of real users' behaviour.

(b) Structured Expert Reviewing

- Heuristic evaluation.

This method response to the need for cheap, cost effective methods that can be used by small companies who could not afford or did not have the facilities, time or expertise necessary to do usability engineering.

From Nielsen (1992), in heuristic evaluation reviewers examine the system or prototype as in a common review or usage simulation, but their assessment is guided by a set of high level heuristics. It will guide the reviewers to focus on key usability issues of concern. It obviously makes good sense to evaluate the system directly against the principles used in its design, as shown in Figure 8.11 below:

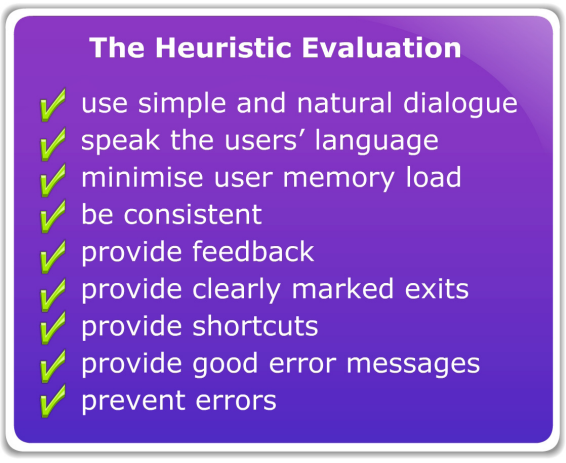


Figure 8.11: The heuristic evaluation based on principles used in design

- Discount usability evaluation.

This technique enable developers with few resources such as time, money or expertise that can we get the benefits usability testing during product design and development.

> *'The discount usability engineering consists of scenarios, simplified thinking aloud and heuristic evaluation and is intended to alleviate the current problem where usability work is seen as too expensive and difficult by many developers'*
>
> Nielsen (1989)

Discount usability engineering is a hybrid of empirical usability testing and heuristics evaluation. The features that have been provided by discount usability evaluation are:

1. The small scenarios that can be easily change;
2. The think aloud method is done formally that not require psychologists;
3. Just a few key guidelines are used rather than the large number available;
4. The whole cycle need only involve testers since the number of additional usability problems found by more testers was not worth the extra effort.

- Walkthroughs.

The aim of walkthrough in HCI is to detect problems very early on so that the problems can be removed. This technique involves constructing carefully defined tasks from a system specification or screen mock-ups.

In walkthrough, before doing this technique experts must determine the exact task that will be done. Then they can walk through the task, reviewing the actions that necessary to achieve the task and also attempt to predict how the user population would most likely behave and the problems that will be encountered.

(c) Modelling

Modelling techniques provide a form of evaluation that has more remote from methods that involve users. The list below is required in this kind of evaluation:

- A specification of the system's functionality or at least that part of it which is to be examined;
- A task analysis, which is basically a list of all the proposed user tasks with a breakdown of each task into its components.

There are several analytic evaluation methods have been developed and the differences between these methods revolve around task structure, user operations and the combination of user and system operations. For example:

- The task structure can vary from a simple task consisting of a single user commands to more complex tasks;
- User operations can be evaluated with analytic methods using either extremely simple memory operations closely linked to physical actions at an interface or more complex cognitive operations.

These two types of models exists; single layer models that can be thought of as having a flat representation and for multi layer models, the models are more complex and which will not be considered further in this book. One of most analytical methods widely known is keystroke level model by Card et al. (1980). The purpose of keystroke level model is to enable designers to calculate task performance times that can be achieved by experienced users and also give designer ideas of the minimum performance time for specified commands.

SUMMARY

1. The chapter discussed on some well known evaluation methods that the designers can plan and carry out to make their own own evaluation studies and critically appraise documented studies.

2. Evaluation can be divided into formative and summative. Formative evaluation helps to form a useful product and summative is concern about making judgments for the finished item such as confirming the design of a final product of notebook.

3. As designers, we must know why the evaluation is needed when developing the products, the reasons are engineering towards a target, comparing alternative designs, understanding the real world and checking conformance to a standard.

REFERENCES

Jenny Preece, Y. Rogers, H. Sharp, D. Benyon, S. Holland, T. Carey, (1994), Humana Computer Interaction. University of Michigan, Addison Wesley.

Nielsen J. (1989). Usability engineering at a discount. In Designing and Using Human-Computer Interfaces and Knowledge Based Systems (Salvendy G. And Smith M.J.,eds), pp. 394-401. Amsterdam: Elsevier

http://www.glasbergen.com

http://www.surveysystem.com

CHAPTER 9

User Requirement Analysis

LEARNING OUTCOMES

By the end of this chapter, you should be able to:

1. To describe the user requirement analysis that involved documentation.

INTRODUCTION

User requirements are the starting point for any project development. Users may see things from different angles and have various ideas and different expectation of a new system development. Therefore, they shall come out with some vague requirements to cater their various needs and ideas. Due to this situation, user requirements are important to be thoroughly studied and understood before starting a project development.

Understanding user requirement is an integral part of information systems design and is critical to the success of interactive systems. However, specifying these requirements is not a simple task and not so simple to achieve. It sometimes can be a long process as a lot of clarifications need to be done for the requirements to be clearly specified and conveyed to those who are involved in the project development. Otherwise, there shall be a lot of confusions going on during the development process.

Can you imagine what will happen if everyone involved in the project development has different interpretation of the user requirements? Observe figure 1.1 below.

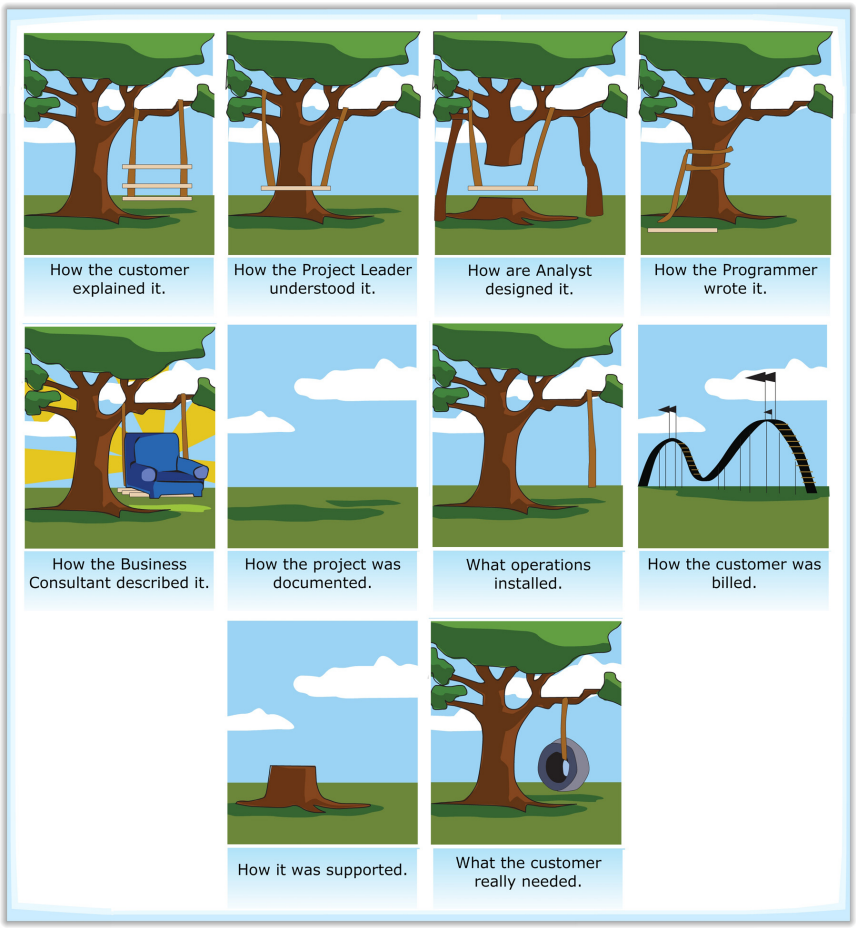


Figure 1.1: Thinking exercise

Can you imagine what will happen if everyone involved in the project development has different interpretation of the user requirements?

What do you see from your observation of Figure 1.1? What can you say about requirement analysis? Do you see that different interpretation of requirements can affect the end product that may not meet the user requirements at all? To avoid this situation from happening, requirements analysis is to be conducted.

Requirements analysis is indeed critical to the success of a development project. Requirements must be:

Actionable
Measureable
Testable
Related to identified business needs or opportunities.
Defined to a level of detail, sufficient for system design.

Systematic requirement analysis is also known as requirement engineering. It is sometimes referred as requirements gathering, requirements capture, or requirements specification. The term requirements analysis can also be applied to the analysis proper (as opposed to elicitation or documentation of the requirements, for instance) (Preece, 1994).

9.1 REQUIREMENT

What do you need in order to specify requirements for information systems design? Do you need any technical skills or knowledge?

The truth is that you do not need a great deal of technical knowledge to specify requirements; in fact it can be a big disadvantage. A requirement for a computer system specifies what you want or desire from a system. For a business in particular this is, "What you want or desire from a system, which you believe will deliver you a business advantage".

This benefit need not just be a reduction in costs, in fact many systems justified on a reduction in operating costs, fail to deliver as low skilled but relatively cheap staff,

have to be replaced by high skilled, and more expensive staff. The advantage can be a reduction in time to process something, which will lead to a reduction in costs, or being able to better use the unique knowledge base belonging to a business.

As you begin to specify what you want or wish, you must hit up against technical language of requirements. Fear not, this is quite straightforward:

Requirements	Description
Functional requirements.	What you want a system to do.
Non-functional requirements.	Limitations on the types of solutions that will meet the functional requirements.
Design objectives.	The guides to use in choosing a solution.

The requirement process involves requirement feasibility, requirements analysis, requirements definition, and requirements specifications. Figure 1.2 shows the requirement process.

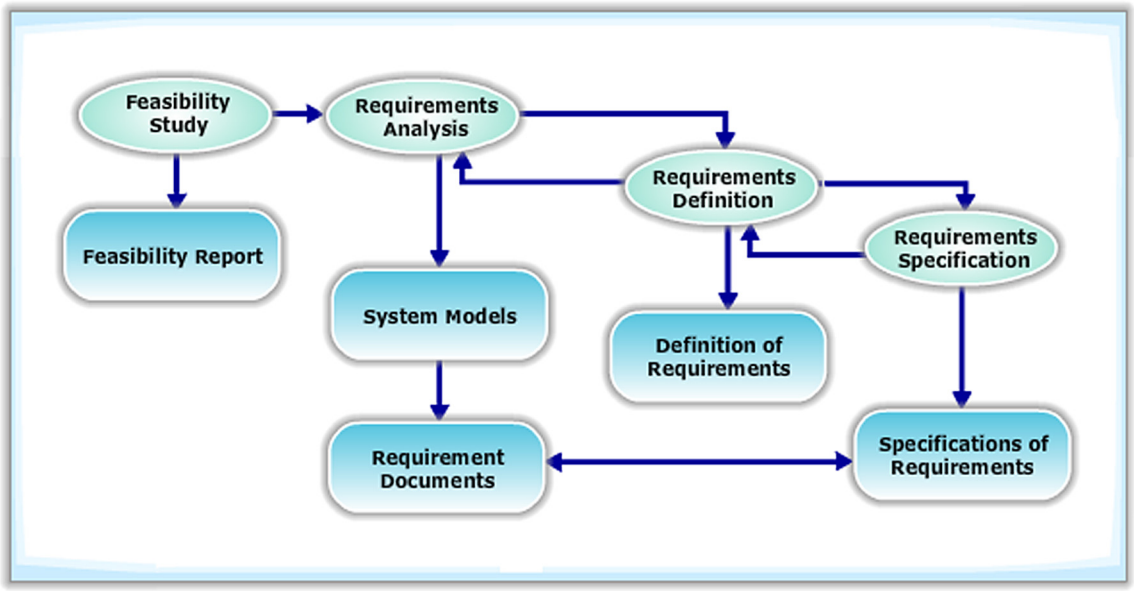


Figure 1.2: Requirements process

9.2 USER REQUIREMENT

When we mention 'user' we means those people who are going to use the system or products. However, there are several meanings of 'user'. User can be a user that has a direct interaction with the system (programmer, system analyst, etc.) and the end-user. Figure 1.3 shows the general process for user requirements analysis.

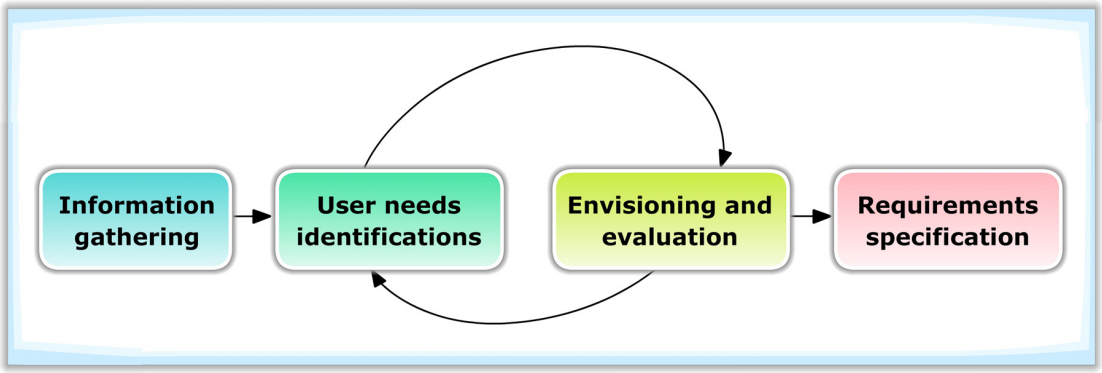


Figure 1.3: General process for user requirements analysis

9.3 DOCUMENTATION REQUIREMENTS

When we mention 'user' we means those people who are going to use the system or products. However, there are several meanings of 'user'. User can be a user that has a direct interaction with the system (programmer, system analyst, etc.) and the end-user. Figure 1.3 shows the general process for user requirements analysis.

Requirements should be written in precise and accurate language.

The uses of words such as "must," "shall," "will" and others have particular importance in this area.

There is a capability maturity model called Requirement Maturity Model (RMM).

Requirements Maturity Model which describes five levels of maturity when dealing with requirements. The lowest is no formal management or documentation, the highest provides for a highly capable and reusable set of requirements documentation and management systems.

Requirements should be written without inappropriate constraints, or with the imposition of a particular solution approach.

By defining solution approaches (eg using a particular development approach, a particular computer system and so on) mean that a solution designer is constrained unnecessarily. This has been identified as a common cause of delivery problems for projects by reports such as the infamous Standish Groups CHAOS report.

Requirements managed and documented by a Business Analyst (BA) should add value to the project.

Requirement should not simply be a report of what project stakeholders have asked for. A key reason for the business analysts' participation in the project is to ensure requirements are valuable and contribute to the project's success as defined in the business case.

SUMMARY

1. In this chapter, we have discovered that:

   Specifying requirements does not require a user to have technical background. A good set of requirements consists of prioritized sets of:
   - Functional requirements
   - Non-functional requirements
   - Design objectives

2. The requirement process involves requirement feasibility, requirements analysis, requirements definition, and requirements specifications.

3. A general user requirement process analysis involved information gathering, user needs identification, envisioning and evaluation as well as requirement specification.

4. There are several techniques of writing requirement documents.

REFERENCES

Wiegers, Karl E. (2003). Software Requirements 2: Practical techniques for gathering and managing requirements throughout the product development cycle (2nd ed.).

Redmond: Microsoft Press. ISBN 0-7356-1879-8. http://www.processimpact.com.

Alain, A., James W. M., Pierre, B., Robert, D. (March 2005). Guide to the software Press. engineering body of knowledge (2004 ed.). Los Alamitos, CA: IEEE Computer Society ISBN 0-7695-2330-7. http://www.swebok.org/ch2.html.

Wikia. (2006). Knowledge Area: Requirements analysis and documentation. http://businessanalyst.wikia.com/wiki/Knowledge_Area:_Requirements_analysis_and_documentation

Nigel, B. (2006). Professional Usability services. http://www.nigelbevan.com/papers/WCC_UserRequirements.pdf

Coley Consulting. (2001). What is a user requirement or specification? http://www.coleyconsulting.co.uk/require.htm

CHAPTER 10

Rules and Regulations

LEARNING OUTCOMES

By the end of this chapter, you should be able to:

1. Identify what are the rules and regulations;
2. State some of the major HCI guiding rules;
3. Identify the various forms of guidance available for HCI designers; and
4. Evaluate rules in response to a specific design.

INTRODUCTION

In every development of interface design, there should be a guideline that guides the designers to develop the product effectively and efficiently. However, the designers sometimes misinterpret or misapply the types of design to be adopted in the applications.

Source: http://www.unt.edu/benchmarks/archives/2000/october00/brainupgrade.gif

This chapter will explain in depth about rules and regulations as well as some of the major HCI guiding rules. The chapter also discusses on various forms of guidance available for HCI designers and how to evaluate the rules in response to a specific design.

10.1 RULES AND REGULATION IN HCI

According to Shneiderman (1998), there are two general guidelines that can be used to improve the user interface look and feel, which are high level guiding principles and low detailed rules.

Let us watch short video clip, showing Shneiderman himself talking about the key thing in designing user interface, which is providing comprehensible, predictable and controllable user interfaces:

Source: http://www.youtube.com/watch?v=FfmwFsBIyb0&feature=related

10.2 SOME TIPS TO CONSIDER BEFORE ENFORCING RULES FOR THE SYSTEM

In order to use the rules and regulations in practice, we need to interpret these rules and regulations in relation to the context of use. In rules and regulations, there are several factors that we should understand clearly such as know the user population, reduce cognitive load, engineer for errors, and maintain consistency and clarity.

In HCI development, applying all these factors in rules and regulations sometimes do not lead to good design. For example, the 'reduce cognitive load' factor can be interpreted as 'minimise learning by being consistent'. So we need to change all the rules and regulations in practice as follows:

- Always position the trash can at the bottom right-hand corner of the screen,
- Always use 'quit' to mean the abort command for the system and 'exit' to mean 'execute the command and continue',
- Always require an 'end of input' signal, such as pressing 'enter'.

So, a design rule is an instruction that can be obeyed with minimal filling out and interpretation by the designer. For example, data filled in the form such as date field must follow the format that is understandable like DD-MM-YY.

In order to identify varieties, the designer must take into account the type of user that frequently uses the product ranging from novice user, intermittent user, and expert user. As we know, each type of user looks forward for the product to accommodate their desires. Novice users need extensive help while expert users

want the fast and reliable product. You can address the differences in users by including both menu or icon choices as well as commands or providing an option for both full descriptive menus and single letter commands.

Table 10.1 below shows some of the tips that need to be considered before we can enforce the rules for the system.

Table 1.1: Eight Tips to Consider Before Enforcing Rules for the System

Tips	Description
1. Strive for consistency	As a designer, consistent sequences of actions are required in similar situations and identical terminology should be used in prompts, menus, and help screens.
2. Enable frequent users to use shortcuts	Designer also needs to increase the pace of interaction using abbreviations, special keys, hidden commands, and macros.
3. Offer informative feedback	For every user action, the system should respond in some way. For example, a button will make a clicking sound or changing colour when clicked to alert the user that something has happened.
4. Design dialogs to yield closure	The sequences of actions should be organised into groups with a beginning, middle, and end. The informative feedback at the completion of a group of actions illustrates that the user activities have finished successfully.
5. Offer error prevention and simple error handling	The designers should design the form so that users cannot make a serious error and if users make an error, instructions should be written to detect the error and offer simple, constructive, and specific instructions for recovery.
6. Permit easy reversal of actions	This feature relieves anxiety, since the user knows that errors can be undone; it thus encourages exploration of unfamiliar options. The units of reversibility may be a single action, a data entry, or a complete group of actions.
7. Support internal locus of control	For experienced users who want to be in charge, surprising system actions, tedious sequences of data entries, inability or difficulty in obtaining necessary information, and inability to produce the action desired, all build anxiety and dissatisfaction.
8. Reduce short-term memory load	You can reduce short term memory load by designing screens where options are clearly visible, or using pull-down menus and icons.

All the above aspects can be the useful guidelines to help designers to focus on what are needed when developing a product. So as a designer, you need to choose and apply the right guidelines as good or bad design decision is reflected on the way you design your product. In this process, attitude, experience, insight, and common sense can help you to choose the appropriate guidelines.

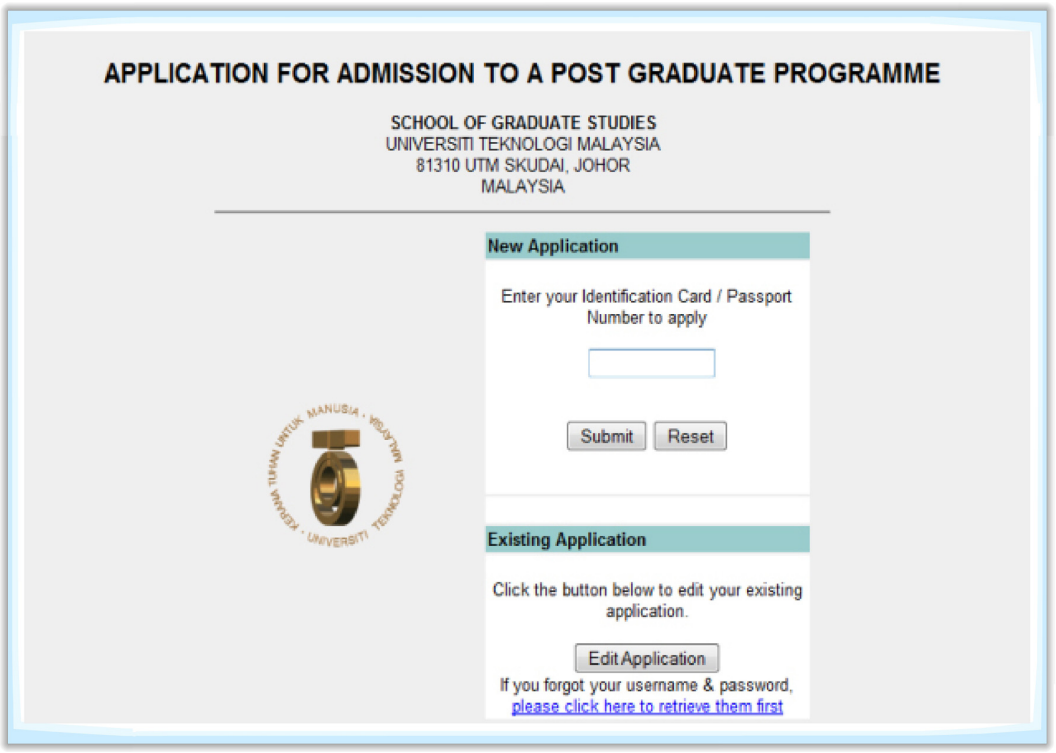


Figure 10.1: Main Interface of UTM Graduate School Application Forms
Source: http://www.sps.utm.my

Figure 10.1 shows the application system for admission to the post graduate programme in Universiti Teknologi Malaysia (UTM). These are good examples of user interfaces that follow the rules and regulations to make the system easier to use. It assists the users from all over the world such as Nigeria, Sudan, Afghanistan, Thailand, Indonesia, etc. to enter the website and enrol the post graduate programmes offered by UTM. To make the system standardised for every user who comes from different countries, the system uses a global language like English so that the instructions are easy to understand. We can also see that all of the interfaces do not use many colours and graphics, but only use four types of colour for the font, background, and form to create simple interfaces.

Apart from that, before filling in the form, the applicant who is applying the programme and entering the system for the first time needs to enter the main interface of this system. The main interface will require number of identification card or passport

to create a new account for this applicant to use this system. For those who already have their account, they can directly click the "Edit Application" button to edit their accounts and application form. There is also a function to help applicants who forget or misplace their username and password. This function will help applicants to get back their username and password to enter the system. All these features have fulfilled some of the aspects to follow the rules of the system design that we have discussed before.

Now, let us move on to the next interfaces shown in Figure 10.2 and Figure 10.3. These interfaces show us the application form that should be filled in by the applicant when applying the postgraduate courses in UTM. There are also many aspects that need to be followed for creating the application form. From these two figures, we can see that the administrator of this system has given simple instructions on how to fill in the application forms. The system administrator should provide sentences and examples of data that are easier to understand by the applicants. This is to make sure that the data that has been entered is correct. A good system must give an alert message to the applicants if they have entered incorrect or did not enter information into the system. For example, applicants always confuse to put how many number in the telephone's text field. Thus, the system must give an example of the data to be entered or an alert message to correct the wrong information.

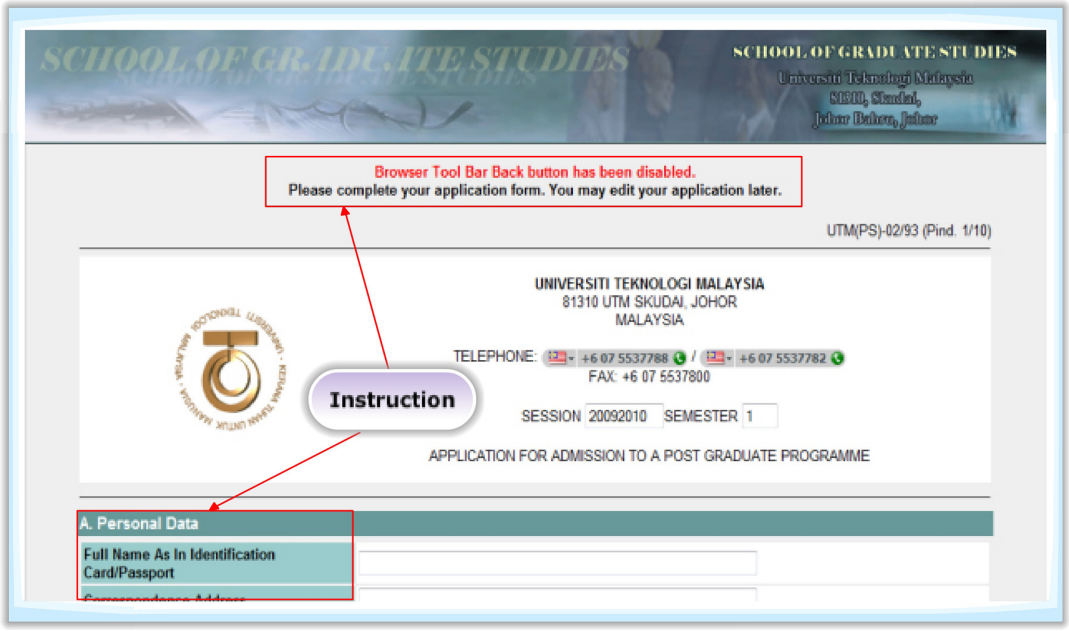


Figure 10.2: Entering personal particulars for registration
Source: http://www.sps.utm.my

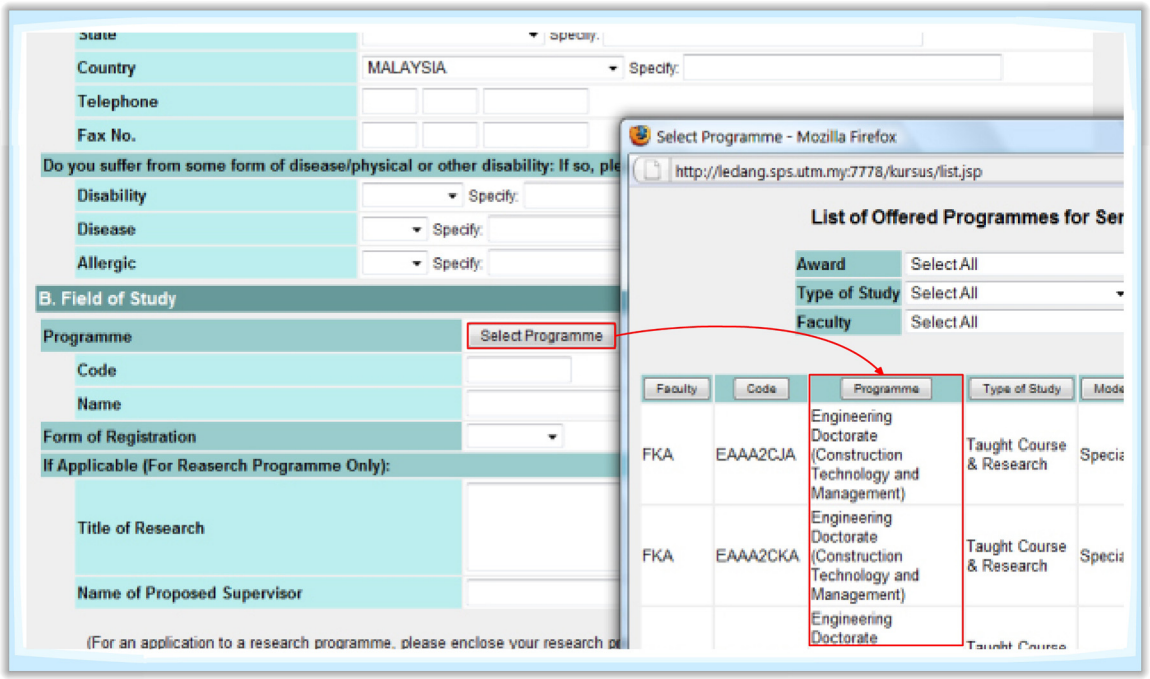


Figure 10.3: The pop-up for showing information to applicants
Source: http://www.sps.utm.my

If we look at Figure 10.3, we can see that this system has provided a pop-up window to give a list of information to be chosen by the applicants. It happens when applicants click the button "Select Programme", then the pop-up window will appear and show the list of programmes offered by UTM. This is the easier way to display theinformation to be selected by the applicants rather than direct them to another web page because it can interfere the application process.

From this example, you have learned a good way of creating a good interface for the users that use the system. As have been mentioned before, you as a designer must understand who the target users and how to educate them to use the system appropriately. Make sure that you have followed all the rules and regulations to achieve all the aspects for better understanding the user.

10.3 CASE STUDY 1: TRIS DESIGN AND EVALUATION IN THE REAL WORLD: COMMUNICATORS AND ADVISORY SYSTEMS (YVONNE, R., HELEN, S. & JENNIFER, J. P., 2007)

In this case study, we focused on the redesigning of a large system that provides information and advice about filling out tax for general public. This was developed as an advisory system to be communicated with public via phone. This work was carried out bya usability consultant, Bill Killam and his colleagues, who worked with the US Internal Revenue Services (IRS) to evaluate and redesign the telephone response information system (TRIS) (Killam & Autry, 2000).

This case study was done in the United State of America. TRIS provided information via such a numerous number of menus, so it was not surprising that users reported many problems. To solve these problems, the TRIS system then was planned to be redesigned and improved. To perform the changes, it needs specialists for applying as many techniques as possible to get different perspectives of the problems and to find the possible solutions. The techniques chosen to be applied must consider a combination of constraints: schedules, budgets, their level of expertise, and possibility of redesigning part of the already existing system. To improve an existing product, the design space needed by the designers for making decisions was limited by existing design decisions and the expectations of a large existing user population.

In the US, everyone over age 18 pays tax each year either individually or included in a household. There are over 100 million tax returns each year and it is very difficult to complete the actual tax return. This is the reason why IRS must provide tax information in a variety of forms to help people. The most used information service for completing tax return is TRIS, which provides voice-recorded information through an automated system and also allows simple automated transactions. There were over 50 million calls made to the IRS each year, but only 14% of the calls were handled by the TRIS. This phenomenon made designers believe that something was wrong.

Many of TRIS users are the public, who get information by calling a toll-free telephone number. When a user calls TRIS, he or she will be directly taken to the main IRS help desk. The interface of TRIS is the recorded voice information for auditory output. To navigate through this system, the user will select choices from the auditory menu by typing on the telephone keypad. Firstly, the users must interact with the Auto Attendant portion of the system. Auto Attendant is a sort of simulated operator that figure out what the call is about and connect it to the proper part of the system. This looks simple but there is a problem with the process because there are some paths that have too many sub paths and the classification of information under the four main paths is often not receptive to users.

In addition, some of the functionalities offered through TRIS are provided by two other independent systems. Thus, users become confused about which system they are dealing with. When using the system, users get very few clues about the existence of these systems and how they relate to each other. Yet, unexpectedly things may be quite different and even the voice they are listening to may change. The navigation through this system is very difficult because of its lack of visual feedback and few auditory clues. Can you imagine being in confusion with your eyes blindfolded and your hands tied so you can't feel anything and the only given information is auditory?

1. What techniques can be used by the usability experts to identify the problems with the current version of TRIS?
2. After the evaluation, what did they do with the findings?

10.4 CASE STUDY 2: MULTIMODAL SOFTWARE AGENT IN ASSISTING VISUALLY IMPAIRED INDIVIDUALS FOR ACCESSING TOURISM WEB PAGES (SELAMAT, ET. AL., 2009)

The advancement of technology in Malaysia and the continuing convergence of computing and telecommunications produce a wealth amount of information available to the public. However, it is very difficult for people with disabilities to earn the knowledge from this information and the accessibility issues limit the impact of such widespread availability. There are many types of disabilities such as mobility, hearing, and learning impairments. However, vision impairments are the most pervasive in the general population, especially among seniors. The world's rapidly aging population is redefining visually impaired, which refers to individuals with low vision (people for whom ordinary eyeglasses, contact lenses, or intraocular lens implants don't provide clear vision), colour blindness, and blindness.

This system was developed to assist the visually impaired users to get the tourism information using spoken dialogue system. It has become a central of importance in order to provide a solution in the field of universal accessibility. We developed these systems that are particularly looking at the method of fulfilling the requirements of those visually impaired individuals when they browse the Web to search for tourism information.

In this system, after the page has successfully loaded, the Genie as an agent appears at the screen (as shown in Figure 10.4). The reason we create this Genie

agent is that it can be assigned as a middleman that is able to communicate with the user. This Genie has the ability to listen to user command and speak to user. The Genie Agent can be dragged by using mouse to relocate it to any other location on the monitor screen. It also can be hidden or shown by using the appropriate command. With the help from this Genie agent, the visually impaired users can easily navigate the web site by using proper speech command from the agent. The Genie agent recognises the spoken command from the user by using speech recognition concept and then provides the navigation service to the user. Figure 10.4 shows the result of State/Hotspot Navigation View by using speech command.

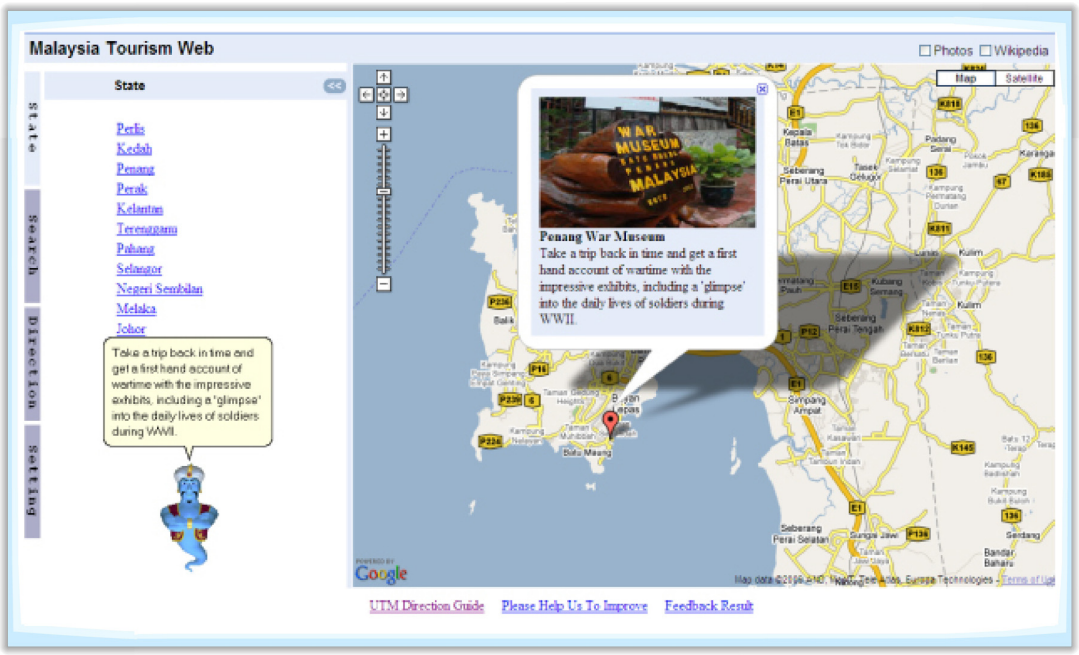


Figure 10.4: The Genie agent and the result of State/Hotspot Navigation View

After a command is given to Genie, the system directly finds the place that user wants to find by zooming in and out for giving clear information about the map such as route, street, name of place, etc. Figure 10.5 shows the Search Navigation View.

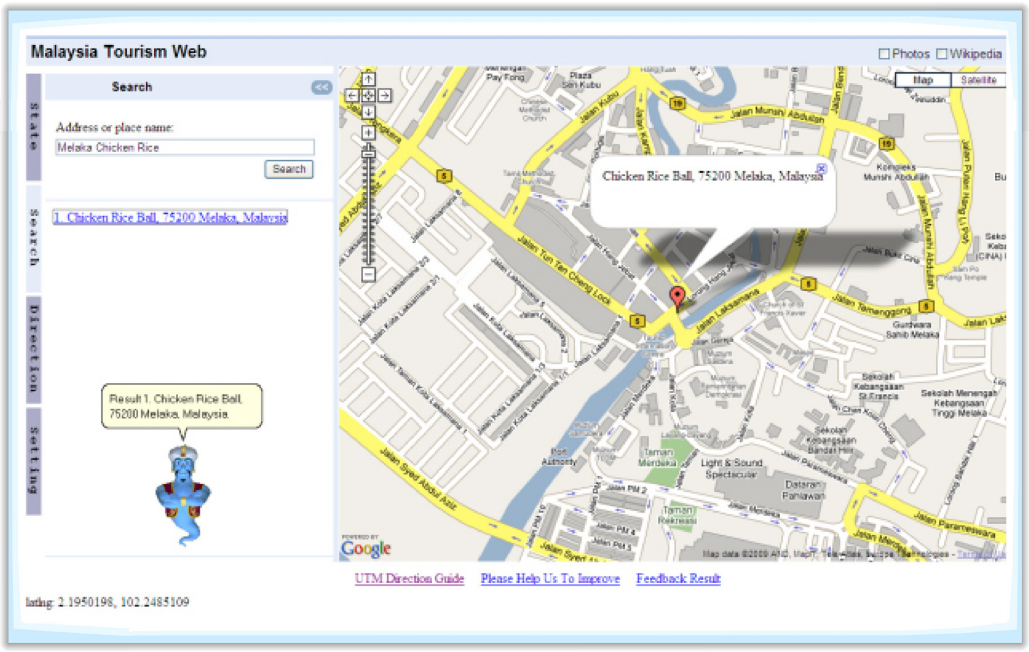


Figure 10.5: Search Navigation View

The user can also enter the keyword in the provided search textbox for searching the places that they want to go. This system can also give user detailed information by showing the direction from where user wants to start and end the destination.

Figure 10.6 shows the Direction Navigation View. The application of the Google Map engine completes this system. This is because Google Map engine already has the pictures and can easily search the information about the pictures from the Google search engine. To help the visually impaired users to get the information about the places, the Genie will read the information to the user.

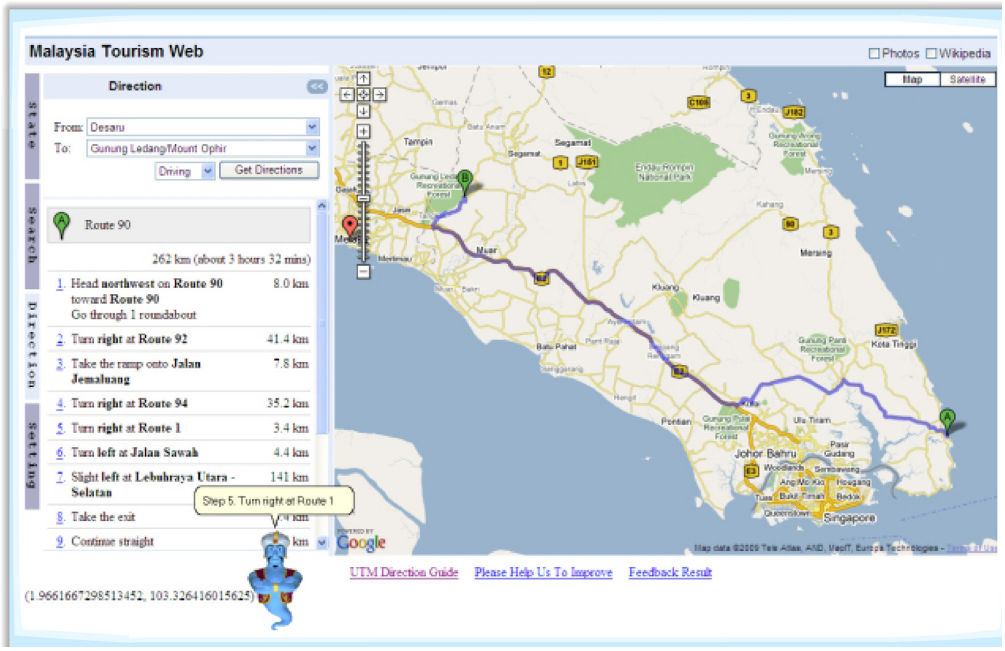


Figure 10.6: Direction Navigation View

Figure 10.7 shows the Photo View, when the user ticks the photos checkbox on the right-upper side of the page. This system also uses information from the Wikipedia to support the information given to the user.

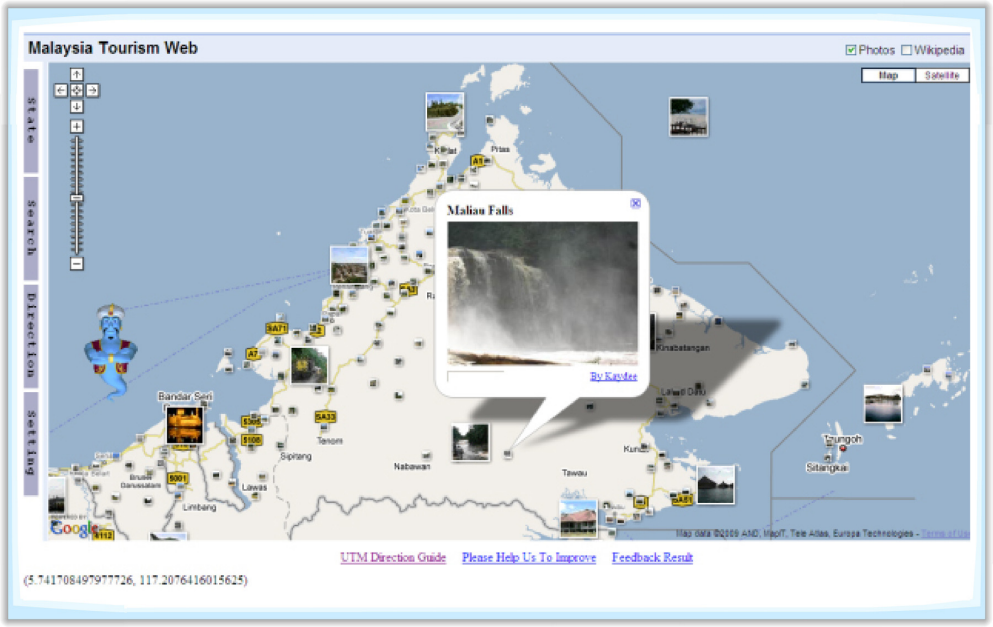


Figure 10.7: Photo View

Figure 10.8 shows the Wikipedia Info View when the user ticks the Wikipedia checkbox on the right-upper side of the page.

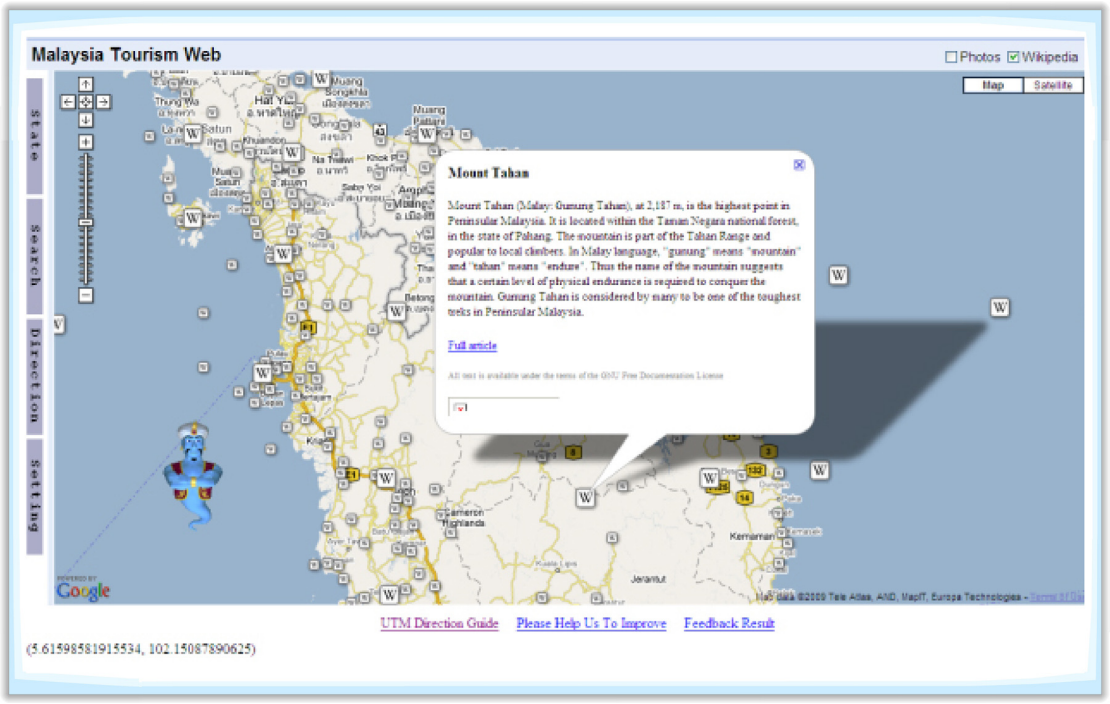


Figure 10.8: Wikipedia Info View

SELF-CHECK

1. What are other suitable devices that can be used to help the visually impaired users to use this system effectively?
2. Do you think that the concept of prototype is very suitable to get the feedbacks and requirements from the user to improve the system? If yes, what types of prototype techniques can be used to get those feedbacks and requirements? If no, what is your suggestion to improve the system function and interface?

10.5 CASE STUDY 3: UTM ROOM RESERVATION (SELAMAT, ET. AL., 2009)

As soon as you start your education in a new university, you are probably worried about subjects, classes, and time arrangement. This is because you do not know where and when the classes will be held. Consequently, students would waste their time to find their classes. It is also a problem when the lecturers do not know the effective ways to announce their absent to the class.

After we have reviewed all these problems, we come out with a solution and idea to develop a system called "UTM Room Reservation". The main objective of this system is to solve all the problems above by informing the students and lecturers about their classes through this system. For a big university like UTM, the usage of thissystem can really help the students and lecturers to find the exact class by using the web technology. The function that we have developed in this system can make it easier for users to search for their classes in two different ways. First, after the user registers in this system, the system will automatically create user account and from that account they can view the information about the user's classes. The information about the classes such as schedule and place are automatically arranged by the system.Figure 10.9 shows the interface of the class information arranged by the system. The second way to find the information about classes is by using a general function that can easily search for the whole information about classes in the UTM. This function can search based on user criteria such as lecturer name, specific date, subject, and type of room.

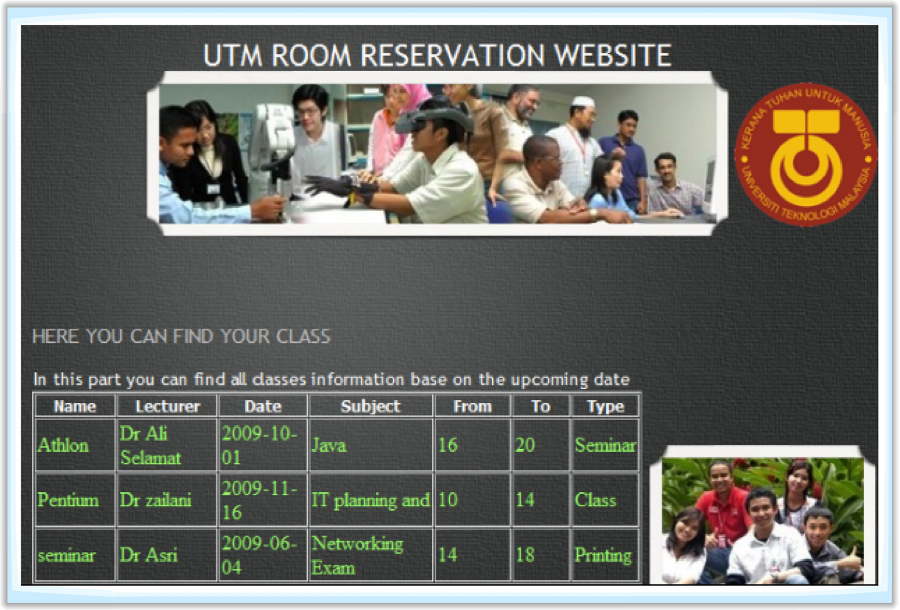


Figure 10.9: The interface that shows all classes that have been scheduled

Figure 10.10 shows the interface to search classes based on the criteria.

Figure 10.10: Search function to find classes based on the criteria

SELF-CHECK

1. What are the benefits that users of UTM Room Reservation systhem get when they use the system?
2. Give 3 examples of rules and regulations that have been fulfilled in this system.
3. What is the best technique of evaluation that can be done to improve the functions in the system?

10.6 CASE STUDY 4: ONLINE UTM ALUMNI HOUSE ROOM RESERVATION SYSTEM (AHRRS) (SELAMAT, 2009)

Nowadays, IT becomes very important in our life. You can see PC or laptop in every house, and sometimes more than one. People computerize all processes. Via the Internet, we can do everything that we want such as sending mail, shopping, watching TV, or listening to radio. Reservation process is not an exception.

Online Reservation system is a web–based system that provides a service for customer to do room reservation for UTM Alumni house. The advantage of this system is it allows customer to do reservation by accessing this system whenever and wherever they want. This online reservation system can be used anywhere to simplify room reservation in hotel, ticket booking process for airlines, appointment booking process in hospital, and so on.

Figure 10.11 shows the main interface of the UTM Alumni House Room Reservation System (AHRRS). UTM Alumni house offers rental facilities for UTM staffs and students, government and private sectors as well as the general public. These facilities can be used for various functions such as seminars, courses, conferences, wedding ceremonies, training programs, corporate meetings, exhibitions, and other events.

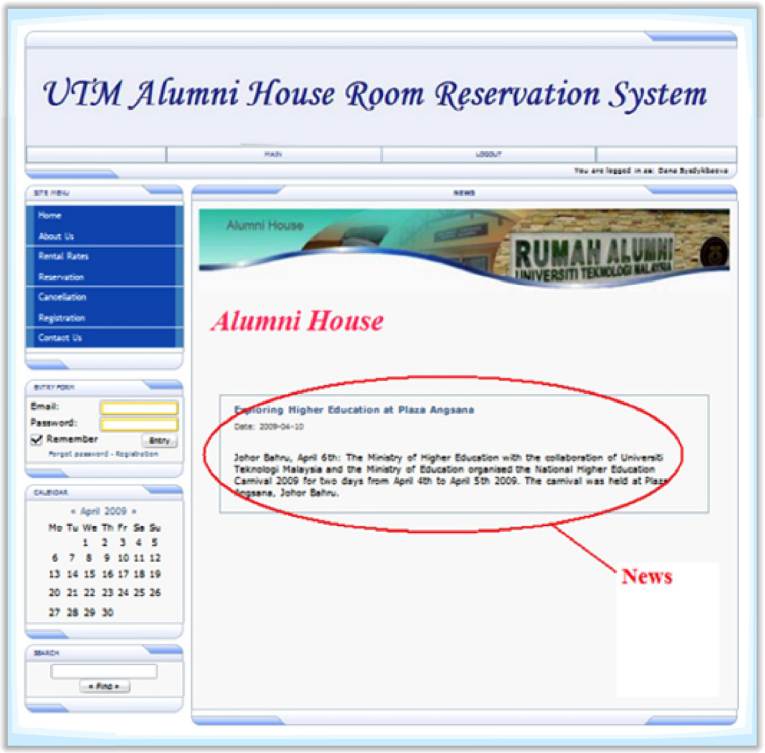
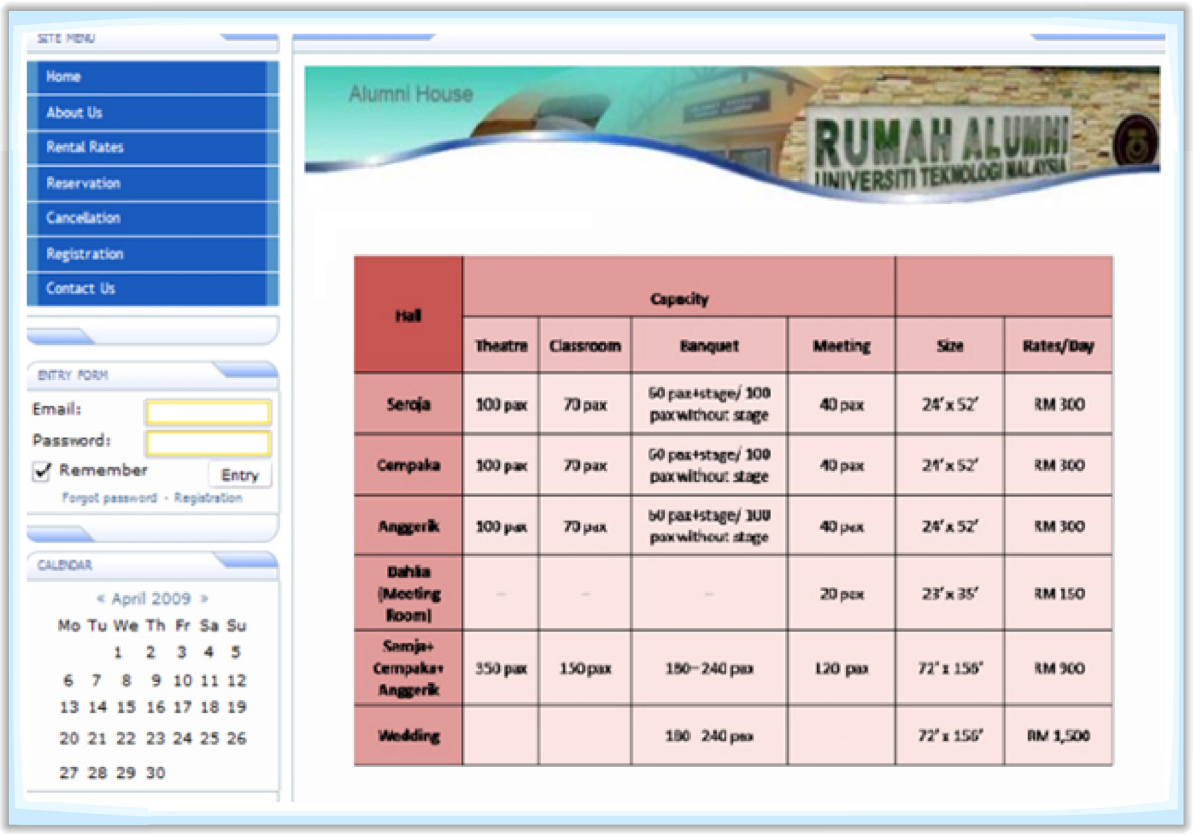


Figure 10.11: The main interface of the Online UTM Alumni House Room Reservation System

By using the AHRRS, the renter can easily complete the room reservation process as it is now very convenient to do. Before the development of this system, the renter should call the staff or come to the office of Alumni house. For paying the rent, the renter needs to pay it at another department in the Treasurer Office. After the implementation of this system, the renter only needs to fill in the registration form to make the room reservation. Figure 10.12 shows the list of rental rates at the Alumni house.



Hall	Capacity				Size	Rates/Day
	Theatre	Classroom	Banquet	Meeting		
Seroja	100 pax	70 pax	60 pax+stage/ 100 pax without stage	40 pax	24' x 52'	RM 300
Cempaka	100 pax	70 pax	60 pax+stage/ 100 pax without stage	40 pax	24' x 52'	RM 300
Anggerik	100 pax	70 pax	60 pax+stage/ 100 pax without stage	40 pax	24' x 52'	RM 300
Dahlia (Meeting Room)	-	-	-	20 pax	23' x 35'	RM 150
Seroja+ Cempaka+ Anggerik	350 pax	150 pax	180~240 pax	120 pax	72' x 156'	RM 900
Wedding			180 240 pax		72' x 156'	RM 1,500

Figure 10.12: The list of rental rates

Figure 10.13 shows the interface of the registration form for room reservation. After the renter submits the application form, the system will show a confirmation message to the renter for confirming the reservation.

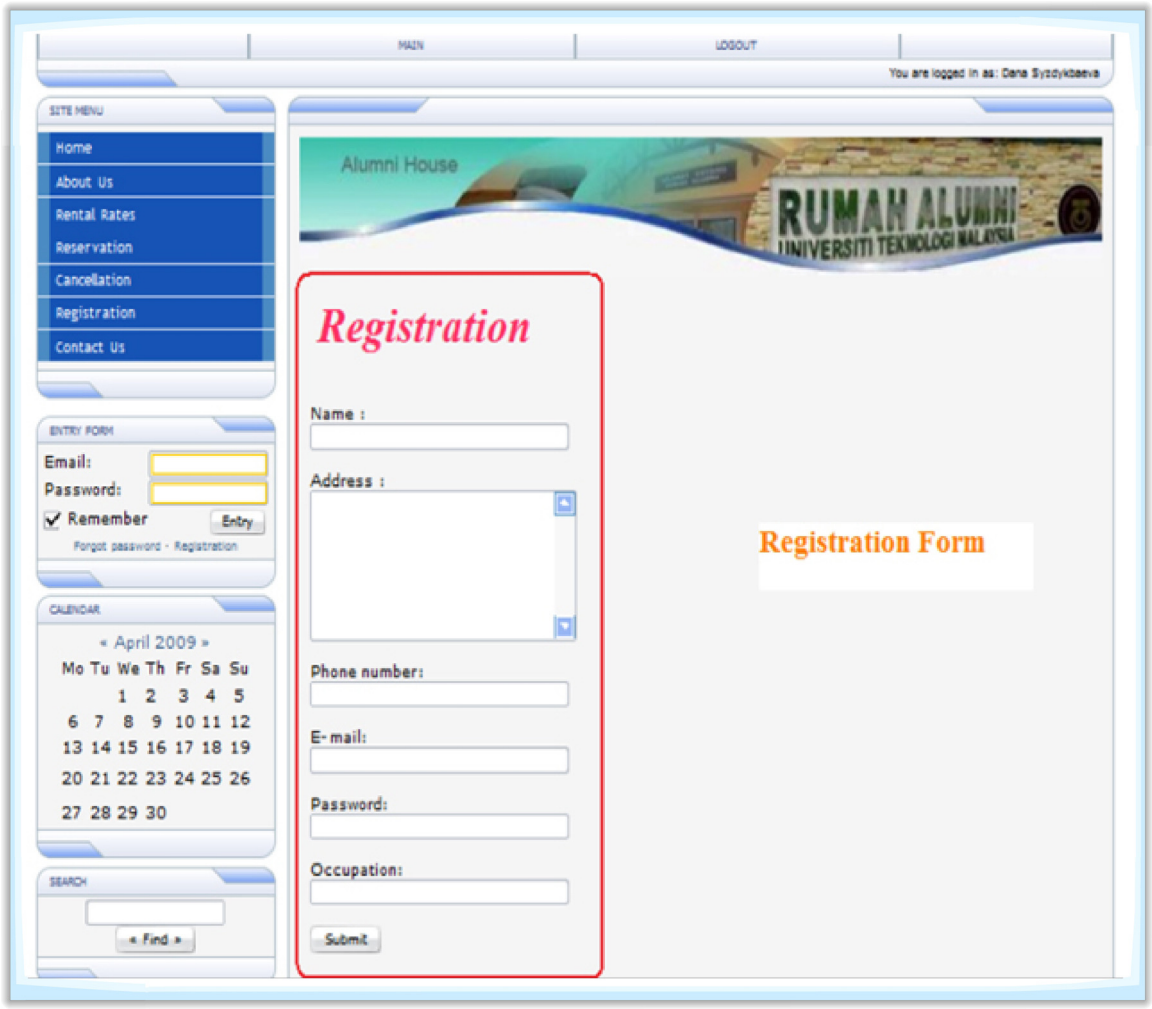


Figure 10.13: Registeration form for room reservation

Figure 10.14 shows the interface for confirming the room reservation. Once the renter confirms the reservation, the system will automatically send an email (as shown in Figure 10.15) to the renter to give detailed information about the room reservation. The email then can be used for paying the bill of the reservation at the Treasurer office.

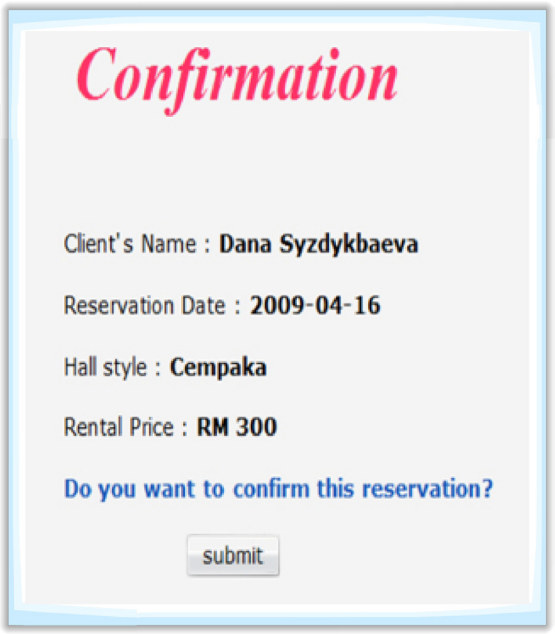


Figure 10.14: Confirmation for room reservation

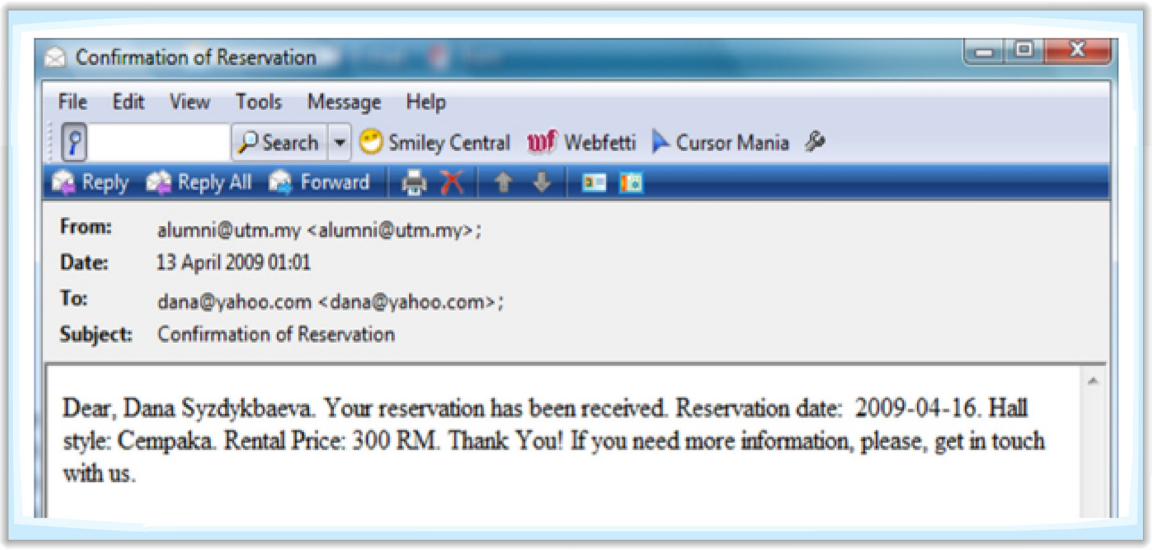


Figure 10.15: Email to confirm the reservation

SELF-CHECK

1. From this case study, what are the problems faced by the renter when they use the old system?
2. From your opinion, what are the benefits that renter can get when they use this AHRRS?
3. What is your idea to improve the AHRRS system in order to have safe and secure transactions?

SUMMARY

1. In this chapter, we have provided knowledge on how rules and regulations help to make a good design for your product and how your product gives benefits to the user. The best way to make sure that a guideline is appropriate is to implement it and observe the result, paying exacting attention to the context in which it is used.

2. There are two general guidelines that can be used to improve the user interface look and feel, which are high level guiding principles and low detailed rules.

3. Rules and regulations to be used in developing the application products can provide a framework that can guide designers in making decisions. The rules and regulations can also be the guidelines that can be obtained from several sources, for examples, journal, general books, and company house style guides.

4. There are eight tips that need to be considered before we can enforce the rules for the system:
   (a) Strive for consistency.
   (b) Enable frequent users to use shortcuts.
   (c) Offer informative feedback.
   (d) Design dialogs to yield closure.
   (e) Offer error prevention and simple error handling.
   (f) Permit easy reversal of actions.
   (g) Support internal locus of control.
   (h) Reduce short-term memory load.

GLOSARY

Terms	Definition
Bureaucracy	An organisational structure with well defined functions, rules and tasks that require certain methods, criteria and assigned roles to carry out the defined functions. With bureaucracy, there are standardised procedures of conducting daily functions and official tasks.
Conflict perspective	Theory that is concerned with the relationship between education and inequality.
Functionalist perspective	Theory that is concerned with the functions of education.
Labelling	An act where an individual is referred to by others as having a specific characteristic or certain pattern of behaviour, example lazy.
Moral values	Virtues such as honesty, hard work, diligence and discipline.
School culture	The values, norms, attitudes, beliefs, customs and procedures that make up the system of doing things in school.
Schooling	The more organised form of formal education. It takes place in schools and is concerned with how the educational process influences individuals and societies.
Sociology of education	A study of what happens with members of society within the context of education.
Symbolic interactionist perspective	Theory that is concerned with how classroom communication patterns and educational practices affect students' self-concept and aspirations.

REFERENCES

Books:

Jenny, P., Yvonne, R., Helen, S., David, B. & Simon, H. (1994). Human-Computer Interaction. University of Michigan, Addison Wesley.

Shneiderman, B. (1998). Designing the user interface: Strategies for effective human-computer interaction (3rd). Reading, MA: Addison-Wesley Publishing.

Yvonne, R., Helen, S. & Jennifer, J. P. (2007). Interaction Design: Beyond Human-Computer Interaction (2nd). Wiley

Alan, D., Janet, F., Gregory, A. & Russell, B. (2004). Human Computer Interaction (3rd). Prentice Hall

Selamat, A. & Yep, M. C. (2009). Multimodal software agent in assisting visually impaired individuals for accessing tourism web pages. Universiti Teknologi Malaysia.

Selamat, A. (2009). MCP1203 – Software Technology Coursework, Technical Report. Universiti Teknologi Malaysia.

Websites:

Bonnie, S., (1999). Human-Computer Interface Design. http://www.usask.ca/education/coursework/skaalid/theory/interface.htm

UTM's School of Graduate Studies. (2009). Welcome to UTM's School of Graduate Studies. http://sps.utm.my/sps

Yvonne, R., Helen, S. & Jennifer, J. P., (2007). Interaction Design Second Edition. http://www.id-book.com