AN EMPIRICAL STUDY:
THE CRITICAL ISSUES OF HUMAN COMPUTER INTERFACE DESIGN AS WEB-BASED APPLICATIONS GROW IN PROMINENCE

by

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This thesis is dedicated to the memory of my Father

Jimmy O Connor

Who always was and will be my inspiration

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ABSTRACT

The purpose of the research was to examine human computer interface design within an Irish context. The primary objective was to identify and examine the critical issues of human computer interface design, and their application in an Irish context, as focus is shifting from stand-alone alone applications towards web-based applications.

For the purpose of the study it was decided to e-mail a questionnaire to a random sample of five hundred organisations in order to obtain the information required. In total, sixty completed and valid questionnaires were returned. The overall response rate was 12%, 4.5% directly and 7.5% after follow up.

The results suggest that Irish software companies are knowledgeable of the critical issues of Human Computer Interface Design but do not differentiate between the design of stand-alone applications and web-based applications/static websites. Irish software companies also realise and utilise the importance of user centred design with the majority of companies involving the user during design and development.

Chapter One
Introduction

1.1 Objective of the Study

This study is generally concerned with human computer interface design within an Irish context. It is specifically concerned with identifying and examining the critical issues and principles of human computer interface design, and their application by Irish software developers. The Internet is a relatively new technology, and one of its most useful tools, the World Wide Web poses new challenges to software developers. This is particularly true of human computer interface designers as the challenge is to present the end user with a consistent usable model as they browse from site to site.

The study looks at the evolution of human computer interface design and examines how the introduction of the Internet and the World Wide Web has affected it. The study aims to identify and qualify the expanding set of human computer interface design issues as web-based applications grow in prominence. It also aims to identify sets of metrics currently available for the evaluation of human computer interface design in a web-based context.

For the purpose of this research it was decided to categorise systems into three groups – websites, web-based applications and stand-alone applications. These are defined as follows:

Stand-alone Applications: applications that are based on an internal server in a company. They can be viewed on many computers but cannot be viewed over the web.

Web-based Applications: applications that are based on a server that is connected to the web and can be viewed and downloaded by anyone attached to the web. Web-based applications can also be applications that may be held on an internal server but can only be viewed using a web browser.

Websites: These are mostly static in nature and make up the majority of sites on the web. Any website that has an application running behind it will be classed as a web-based application.

1.2 Introduction to the Literature Review

The purpose of the literature review is to establish the background to the study which is bounded within the context of information systems, incorporating web-based, stand-alone alone, and website development. The main principles of interface design are identified and examined. Web specific principles for interface design are also identified and evaluated.

The remainder of this chapter presents the research plan by outlining the objectives of subsequent chapters and the strategy employed for achieving those objectives.

1.3 The Research Plan

The layout of the thesis is as follow. Chapter two introduces Human Computer Interface (HCI) Design. The technological development of computers is examined from first generation computers up to the fourth generation computers of today. The emergence of HCI due to the continuous evolution of computer technology is examined. This chapter also outlines the evolution of the user interface from a text-based model of interaction between human and machine, towards a multimedia-based interface.

Chapter three presents an overview of the Internet and reviews its evolution. It examines the emergence of the World Wide Web (WWW) and describes the WWW as a major Internet tool. The principles of web design are introduced and its evolution is traced from first generation web design to fourth generation web design. The chapter examines the Internet in an Irish context. The concept of multimedia and its impact on the Internet is examined. The chapter introduces hypermedia applications, which are based on multimedia systems and extend their media-oriented features.

Chapter four examines the critical issues of human interface design. It looks at the design principles for both stand-alone applications and web-based applications. It is important to remember that the fundamental principles of design relate to any kind of communication between user and computer. Most apply to both traditional graphical user interface (GUI) environments and web design while others are relevant only to web design. Many applications designed for the web reflect a lack of understanding of the basic principles of design (Nielsen et al., 1998). Applying good design

principles can be even more important when designing for the web. The concept of usability is introduced. According to Murray and Costanzo (1999) incorporating usability for the web will have more difficulties that incorporating usability for stand-alone applications. The key principles to designing sites that are easy to use are outlined. The chapter also looks at usability testing and evaluation and the number of users needed to get proper results.

Developing a website application or an Intranet site is similar to developing other information systems in that a formal life-cycle approach should be followed. The life cycle will be slightly different from the traditional systems life cycle as web applications have many differences to traditional information systems (Bidgoli, 1999). The possible lifecycle of web design is examined. The main differences between graphic user interface (GUI) design and web design is examined. The chapter examines the problems users have with poorly designed websites. Eighty percent of Internet home pages reviewed by 'Human Factors International' revealed 15 to 20 problems for users (Schaffer, 2000). Finally the chapter explores the future of human computer interfaces.

Chapter five outlines the research methodology used in the course of the survey. The latter constitutes an empirical study of the critical issues of HCI design in Irish industry. The research methodology was planned with due consideration of cost and time constraints. The e-mail questionnaire was chosen as the research instrument because of its suitability for obtaining the type of data required. It was envisaged that most of the data, both of qualitative and quantitative nature could be categorised and thus be amenable to statistical analysis.

The research findings based on analysis of the received questionnaires are presented in chapter six.

1.4 Summary of Findings and Conclusions

This section provides a summary of the results and the main conclusions drawn from the research.

1.4.1 Summary of Findings

The majority of respondents employed an average of fewer than 50 personnel. No respondents had more than 100 employees. The majority of respondents developed more than one type of system. A large proportion of respondents developed stand-alone applications mainly. Web-based applications were the least designed by respondents but a general trend of movement toward web-based applications and websites was apparent.

Respondents felt that the use of 'user interface prototyping' was very important. The vast majority of respondents used some type of prototyping when developing systems. Most of the respondents used user interface prototyping during the design phase but also in the analysis and design preparation and also, but to a lesser extent during project planning.

Multimedia and hypermedia is seen as extremely important to the development of websites. They are both considered important for web-based systems with ratings of just above three for each respectively. They are considered of average importance for stand-alone applications with an average rating of three respectively. Overall the

use of multimedia is considered more important when designing systems than hypermedia.

Respondents are very aware of the importance of design principles. The principle 'understanding the users needs' is seen as extremely important for all systems types. The results received correspond to the results received to the question about the involvement of users in the design process with a majority of 74% of respondents involving users. The majority of respondents feel that users should have a vital input into the finished product with 44% giving it a rating of four out of five and 17% giving it a rating of five. Designers spend considerable time with users and seem to be aware of the main problems users have with systems. Designers identified slow download and lack of support as the two greatest problems facing users. The research findings suggest that while most respondents are carrying out research into new technologies, many have not yet incorporated them into the design of their systems.

1.4.2 Conclusions

The research identified that designers are aware of the importance of HCI design. Respondents rate the practice of applying design principles to HCI's as very important. The majority of respondents employed most staff in, and put the majority of their effort into HCI design, followed by HCI analysis and HCI testing. User centred design was rated as very important by the majority of respondents.

Only an average of three employees per organisation have received training in the area of HCI design. In addition, 20% of companies are not employing any

professional HCI Designers. This may indicate that designers do not realise that the same principles that are applied to traditional graphic user interfaces cannot be applied to web-based applications and websites.

A large proportion (36%) of companies consider user centred design to be very important awarding it an average rating of four out of five. Seventy four percent of companies involve users in the design process and estimate that the average input of users into the design of the product is 38% for stand-alone applications, 32% for web-based applications and 30% for websites. Users also have a substantial effect on the overall finished product with a large number of respondents rating their effect as being very strong (44%).

The majority of companies (77%) carry out usability evaluations and 88% carry out usability testing. Only 52% of respondents have a set of predefined quantifiable usability criteria, which are essential for measuring the success of the implemented system. There is a large variance in the results concerning the number of testers needed to obtain a proper result when carrying out usability testing. Designers rate 'understanding users needs' as one of the most important design principles for all system types. They also see 'speed', 'responsiveness' and 'clarity of content' as very important design principles.

The results suggest that designers are aware of the importance of user interface prototyping with over 70% of companies using some type of prototyping. The majority of companies use prototyping predominately throughout the design process and to a lesser extent in analysis and design preparation and finally project planning.

Formal methodologies are used mainly for stand-alone applications. No methodology stands out as predominant but respondents indicated that 'user centred design' and 'rapid application development' (RAD) are the most used.

All designers are aware of the importance of Multimedia. This is especially true for the design of effective websites. Hypermedia is seen as very important for websites. Overall multimedia was seen as more important than hypermedia.

Most designers see the lack of system support as the greatest problem experienced by users of stand-alone applications and web-based systems. Lack of navigational support is a major problem for stand-alone systems. Respondents list slow-download times as a problem for both web-based applications and websites. The need for users to download new technologies and the occurrence of broken links are also considered as major problems for websites.

The research indicates that designers have a good awareness of the importance of effective HCI design and the involvement of the users throughout the design process.

Chapter 2

Evolution of Human Computer Interface Design

Without the development of computers we would not have the field called Human Computer Interface (HCI). To understand the development of HCI, the technological developments of computers will firstly be outlined.

2.1 History of Computers

The evolution of computers is normally categorised by generation. Computers are placed into the different generations based on technical performance. Along with the development of technology there is also an obvious pattern of how the use of computers has changed. The introduction of new technology has changed the way computers could be used. The following table 2-1 outlines how the use of computers has changed in line with the changes in technology.

Table 2-1 Technology Development and the Change of Computer Use.

Period	Computer Technology	User Contexts	User
40s -	1st generation; ENIAC, UNIVAC	The Computer as a specific scientific instrument	(Military) Computer scientists
50s -	2nd generation; Mainframes	Computing as a "remote" service.	Scientists/computer specialists
60s -	3rd generation; Minicomputers	Used in special departments of a company	Specialists/Non-specialists
70s -	4th generation; Microcomputers, Pc's, Apple Macintosh	As a general office tool or just for fun.	Specialists/Non-specialists, Non-professionals, (i.e. anybody)

Source: Long and Long (1990)

As computers developed they became less expensive and easier to use which made them much more accessible to the ordinary person. As newer generations of programming languages were introduced e.g. 3rd Generation BASIC, non-specialists could start to make their own programs and thus "stimulated interest in the human factors problems of non-specialists users" (Gaines, 1985). The number of personal computers in use more than doubled from 2 million in 1981 to 5.5 million in 1982. Ten years later, 65 million PCs were being used (IBM, Sept 2000b). The computer revolution has been the fastest growing technology in man's history.

2.2 Emergence of Human Computer Interface Design

During the 60's, as computer use became more widespread, the design of the user interface and human factors started to gain attention. The field did not yet exist as a scientific discipline. According to Gaines (1985) "It took a long time for our scientific knowledge and professional skills as psychologists to begin to catch up with our creative imaginations as computers users". Ideas and thoughts about HCI design have existed since the first computer. HCI can be described as follows:

> *"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."*
>
> (Hewitt et al., 1996)

HCI design is the study, planning and design of the interaction between a computer and user. HCI is a combination of three elements, the user, the computer, and the ways they work together. HCI design is usually regarded as having emerged during the 1970's. As personal computers with graphical displays became available there

was a great increase of literature discussing the subject in academia and elsewhere (Gaines, 1985). Research focused on the relationship between man and technology and organisation and technology.

HCI designers must look at what the users expect and need, their physical abilities, and what they like and find enjoyable to use. Designers must also take into account the fact that users have various preferences, therefore, alternative ways must be provided for the user to communicate with the computer such as voice, keyboard mouse etc. (Whitten et al., 2001). These are called translation aids and consist of input devices, output devices and controls. Input devices are the hardware components the user needs to "talk" to the computer such as keyboards, mouse, pen, and touch-sensitive screen. Output devices are the various hardware elements that a computer uses to communicate with the user such as printer, speaker, and monitor. Controls are software elements that allow the user to make choices e.g. menus, radio buttons. An interface is also needed that is easy to understand and use. It is important that designers understand how peoples sensory system relay information e.g. care must be taken not to distract users with flashing fields or movement in the outer part of their visual fields (IBM, Sept 2000 b). Software designers need to consult with users as well as applying design principles when designing a user interface.

The user interface can be defined as:

> "*the parts of a computer and its software that you (the computer user) see, hear, touch, or talk to. It is the set of all the things that allow you and your computer to communicate with each other*".
>
> (IBM, Sept 2000b)

A well-designed interface is one that allows the user not to pay much attention to. The interface should always do what the user would expect them to do (Norman, 1988). It is important that the user does not waste time looking for a button or key to press. A well-designed interface should speed up the user rather than inhibit them.

2.2.1 Evolution of the User Interface

Human computer interfaces have evolved greatly since the earliest computer. When computers first emerged computer experts designed them. These experts were usually the end users of the computer also. Computers were very complex and not very user friendly and one had to be a computer specialist to use them (Gaines, 1985). It was in the early 1970's before non-specialists started to use computers. At this time the user interface was still being designed by computer specialists and was difficult to learn and use. As computers became more widespread among non-specialist users, the computer industry began to realise the growing problems in HCI design (see table 2-2). Computer companies realised that if they could improve the user interface, they would stand a better chance of being widely accepted and successful (Preece et al., 1990). They attempted to make their systems more user friendly, less intimidating and simpler.

Table 2-2 Growth of digital computer and user issues

Computer type	Approx. growth era	Main users	Issues
Research	1950's	Mathematicians Scientists	Size, reliability, users must learn to do every bit of programming.
Mainframes	1960's and 1970's	Data processing professionals supplying a service	Users of the output (business managers) grow disenchanted with delays, costs, lack of flexibility
Minicomputers	1970's	Engineering and other non-computer professionals	Users must still do much programming; usability becomes a problem
Minicomputers (plus applications packages)	1980's	Almost anyone	Usability is the major problem

Source: Adapted from Human-Computer Interaction, Jenny Preece and Laurie Keller (1990)

The computer interface has evolved significantly moving from command line interfaces to point and click programs to the introduction of graphics and object-oriented interfaces. The growth of the World Wide Web (WWW) is a direct result of Human Computer Interface research (Nielsen 1995 c). The idea of hypertext technology and interface improvements has caused it to grow and spread rapidly. The user interface is continuing to evolve and merge with other environments such as the World Wide Web. Soon the user will not be aware of differences in location of contents (Leiner et al., 2000). Applications will use a mixture of desktop, www,

relational database etc. The user will interact with content in the same manner, regardless of origin.

2.2.1.1 Early Computers

The earliest computers had no user interfaces at all. They communicated using flashing lights. The user had only mechanical means to interact with the system. The computer could only be operated by moving mechanical switches (Zetie, 1995). The user had to be highly trained to be able to operate the computer.

The next step in the evolution of computers allowed users to communicate with computers using punch cards. The users received information from the computer through printing devices. Users had to be trained specialists and although it was an improvement over earlier computers it still had a long way to go (IBM, 2000).

The introduction of video screens greatly changed the use of computers. These screens allowed the computer to easily communicate information to the user. Around this time new input devices, such as keyboards, were also developed which allowed the user to communicate with the computer. Although screens were a major step forward, they still were limited as they only displayed characters that were found on the keyboard. This innovation allowed the ordinary user to be able to communicate with the computer more easily. As users still had to memorise commands that were difficult, a lot of training was still required (IBM, 2000).

With the first computer screens, users had to type lines of computer jargon on black screens. Significant improvements were needed to improve and increase productivity and to achieve the real benefits of computers. The next advance was the addition of techniques such as menus that meant that users did not have to remember as many commands. Every application still had its own unique interface and there was little similarity across applications (Anderson, 1988). The use of computers was still limited to highly skilled specialists who had to invest a significant amount of time learning computers. The following table 2-3 shows the significant developments in the evolution of the user interface.

Table 2-3: User Interface - Time Line

1955 Light guns - SAGE air defence system and its predecessor, the Cape Cod System at MIT

1960 Light pen as screen pointer

1962 Joysticks - Analog air traffic control displays in the late 50s, e.g., the rbde-5(Radar Bright Display Equipment) made by Raytheon.

1963 Douglas Engelbart receives a patent on the mouse-pointing device for computers.

1968 Douglas Engelbart, of the Stanford Research Institute, demonstrates his system of keyboard, keypad, mouse, and windows.

1975 Pointing device with on-screen pointer Doug Englebart@SRI(mid 70s). Cursor changes to show context David Tilbrook(Newswhole). Menus - LRG@Xeros PARC (approx). dimming of inactive buttons David Tilbrook(Newswhole).

1976 Popup Menus - Ingalls(LRG)@Xerox PARC

1978 (approx) Keyboard-based hierarchical menus UCSD's Pascal system. Bitmapped displays CSL@Xerox PARC, for the Alto. PERQ was first commercial product Dialog Boxes Xerox PARC(property sheets). Multiple fonts & styles in text Xerox PARC.

1979 Hierarchical menus – Xerox PARC (Smalltalk)

1980 (approx) Pull down menus, menu bar, disabling of menu items, command keys for menu items, check marks on menu items - Apple. Move/Copy.Delete - Xerox PARC.

1982 Mouse Systems introduces the first commercial mouse for the IBM PC. VisiCorp announces the VisiOn graphical user interface. Overlapped windows Xerox PARC(approx). Tiled windows Xerox PARC.(approx) Icons David Smith(SDD)@Xerox(approx) Scroll bars, push buttons, radio buttons, check boxes, cut/copy/paste with a mouse – Xerox PARC(approx).

1983 Microsoft formally announces Microsoft Windows. Apple unveils the new Macintosh to the press.

1984 Silicon Graphics begins shipping its first 3-D graphics workstations. MIT begins developing the X-Window system.

1986 The Small Computer System Interface standard is finalized as ANSI.

1989 Creative Labs introduces the Sound Blaster.

1991 Microsoft and others announce the Multimedia PC (MPC) standard.

1994 Mosaic Communications releases Netscape Navigator 1.0, a worldwide web browser.

Source: ***The Core of Information Technology: User Interface, (Fischer, Lee, Sept 2000 e)***

2.2.1.2 Graphical User Interfaces

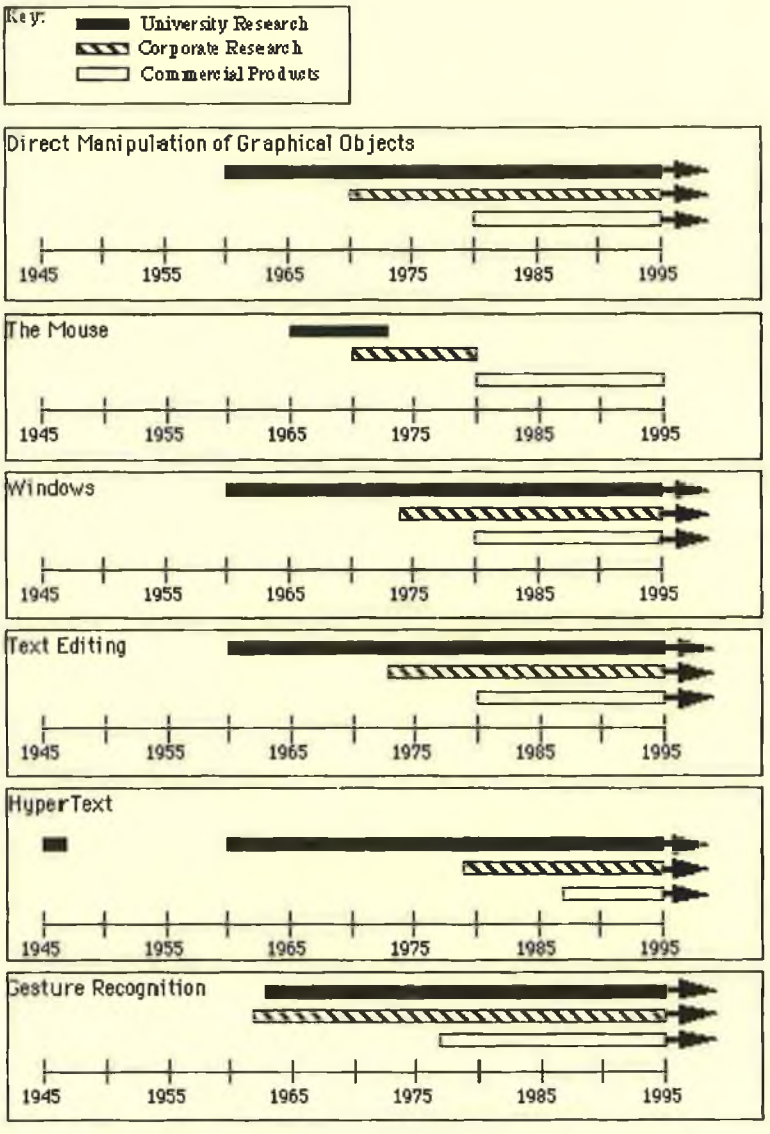
The next major step in the evolution of the HCI's was the introduction of the Graphical User Interface (GUI). This was first designed and tested for the 8010 Star by Xerox Palo Alto Research Centre (PARC). This interface used graphics and icons (little pictures) and the mouse to make using computers easier for the non-specialist (Anderson, 1988). It was the most significant advance in user interface design for twenty years. People were able to learn how to use applications much easier. Also, graphic interfaces were much easier to remember and allowed users to get more work done. Applications changed greatly in appearance and a similar look began to appear across applications. Designers began using standard controls such as menus, buttons and checkboxes (IBM, 2000 b). Applications also featured drag and drop manipulation of objects and formatted text. This made the development and the use of user interfaces much easier.

GUI's allowed users to directly manipulate graphical objects on the screen. This was done using a pointing device such as a mouse or a light pen Ivan Sutherland in Sketchpad first introduced this in his 1963 MIT Ph.D. thesis (IBM, 2000 b). The area or GUI's was greatly researched by Xerox PARC in the 1970's. The research lead to many of the interaction techniques that are used today such as the way objects and text are selected and manipulated. The idea of "WYSIWYG" (What You See Is What you get) systems originated here (Naughton, 2000). 'WYSIWYG' enabled users for the first time to be able to view and edit their work.

Although highly skilled specialists still argued that a command line structure was faster, GUI's became popular as it gave users multiple ways to perform tasks. Users no longer had to remember long lines of code and commands. Functions were contained in menus and toolbars and were much more easily accessible. Systems were also easier to learn and did not involve a great deal of specialist knowledge. Often first time users could use most of a systems' functionality with little or no training (Fisher et al., 2000 d). The use of icons and graphics made system functions easily recognisable. Real-world objects or metaphors were used, such as a disk to save or a printer icon to represent the print function. GUI's gave the user much greater feedback, which in turn gave them greater confidence when using and experimenting with the system. With the older DOS/UNIX systems the user has little feedback e.g. if the user types in the delete command there is no status confirmation from the computer. There is no indication of how many files have been deleted. This scares all but the most highly trained specialists. GUI's provided visual and tactile feedback mechanisms that let the user know the status of the system at all times. Most users rather using GUI's due to the use of colour/graphics etc as they are more inviting and less boring.

As interfaces were becoming more consistent and easier to use, applications became larger and much more complex (Baron, 1986). Word processors now included spreadsheets, drawing applications, etc as well as just document writing applications. Also, as computers became more powerful, users could run many applications, all opened in separate overlapping windows, at once. Figure 2.1 shows the timelines for some of the major technologies.

Figure 2.1: Timelines for major technologies



Source: ***The Core of Information Technology: Graphical User Interface (Fisher, Lee, Sept 2000d)***

2.2.1.3 Multi-sensory and Multimedia Systems

As computer systems are becoming more complicated, new solutions are emerging to help users operate and understand them. The majority of systems in the past were almost completely visual by nature. They usually used only the most simple and basic sounds such as a single beep to help users. As the systems evolved they became more complex with more and more information

being added to the screen. This lead to an increasing difficulty for users as their visual channel was overloaded, leading to an increase in errors (Dix et al., 1993). This increase in errors left the user feeling frustrated. By utilising the other sensory channels, such as sound, the visual channel can be relieved of some pressure, thus allowing the user to more easily interact with the system (Shneiderman, 1992). The use of multiple sensory channels increases the bandwidth of the interaction between the human and the computer. The use of sound was investigated and integrated into more and more systems. Sound had been previously used in a limited manner such as a beep used to warn users. Systems that utilise more than one sense are described as multi-sensory systems (Dix et al., 1993). These systems make use of the auditory channel, the visual channel and also to a lesser extent, the tactile channel to improve the interaction between the user and the computer.

Multimedia systems combine a number of different media to communicate with the user. Often this is in the form of using multiple sensory channels, such as visual and auditory, but it can also take the form of different types of visual input such as text, graphs, icons, animation, video and CDROM (Dix et al., 1993). As computers are becoming more powerful they have the capabilities to handle the above without slowing down the system. Multimedia has been slow to reach the web due to bandwidth limitation. However, new solutions are being found daily.

The use of speech in providing a method of communication between computers and users is being investigated. This form of communication

offers a very natural and fast mode of interaction. Speech recognition and synthesis is a very complex and difficult area in computers as languages are very complex in nature. There have been numerous attempts at developing speech recognition systems but so far they have only had a limited success (Lewis, 1994). There is a vast difference in the way people speak. Speakers use different inflection and also have different accents. Often systems are successful if they are designed around and used by one particular speaker. However, when others use the system the performance diminishes greatly.

There are many other factors that effect speech recognition such as background noise. The computer cannot differentiate between speech and background noises. There have been many problems with speech synthesis also. The main problem is that users are so used to natural speech with variations and intonations that they find it extremely difficult to listen and follow the monotonic tones of synthesisers (Nielson, 2000 c). Use is generally limited to warning signals.

The role of sound in interface design is very important. Humans can differentiate a wide range of sounds and can react faster to auditory stimuli than to visual. Non-speech sounds have many advantages. When sounds are associated with a particular action they can be understood and reacted too much quicker. Non-speech sounds are also universal. Sound can successfully be used to indicate network or system changes or errors. It is also very helpful in providing status information on background processes, for example, informing the user when a process is completed. Sound is

usually used to support visual modes and provide confirmation (Whitten et al., 2001). Users find it easy to learn sounds and associate them with particular actions. Newer systems are introducing auditory icons, which are icons that use natural sounds to represent different types of objects and actions in the interface.

2.2.1.4 Web and Hypermedia

The development of the World Wide Web (WWW) has had one of the greatest impacts in the history of computers. It has changed the way users access information. The Web browser is probably the most popular form of electronic information retrieval interface in use today by all users (Weibel, 1995). Many of today's applications are being designed to run on the Internet or be interfaced via a web browser. The browser interface is very popular due to its simplicity. The screen is not cluttered and it is easy to use and navigate due to the use of a few simple buttons such as back, forward, stop and print. The user of hyperlinks also makes it easy to navigate from page to page. Vannear Bush invented the idea of hypertext/hyperlinks in 1945 (Raggett, 1998). This allowed documents to be linked to related documents. Ben Shneidermans, 'Hyperties' was the first system where highlighted items in text could be clicked on to navigate users to another document (Leiner et al., 2000). Tim Berners-Lee used the hypertext idea to create the WWW in 1990. Mosaic, developed by Unix, was the first hypertext browser for the WWW.

HTML (Hypertext Mark-up Language) is the scripting language that is the backbone of most web pages on the Internet. HTML is comprised of a set of

tags used to describe, format and relate information in a variety of different ways that can then be viewed/interpreted using a web browser.

Web browser technology does present problems. Users often follow hyperlinks and are unable to navigate back to where they have visited as their paths are usually non linear (Nielsen 1996). Users also find exploring each link tedious and find that the information they want may be buried deep in the site. Poor design also causes problems such as too many links, incorrect/broken links and this can leave the user frustrated. Work is being carried out to overcome these problems. This will be discussed in greater detail in chapter 4.

2.2.1.5 Object Oriented User Interface

As the capabilities of computers became more advanced they became increasingly difficult to use. In the late 1980's the HCI group at IBM developed the object-oriented user interface or OOUI. This is the type of interface used today in systems such as Microsoft's Windows 95/98 and IBM's OS/2 Warp. Three out of the four major user interface styles are object-oriented (IBM, March 2002). An OOUI hides many of the traditional aspects of using a computer that users don't need or want to worry about, thus allowing the user to focus their attention on vital tasks. The approach of using object modelling during systems design is called object-oriented analysis. This technique is used to study existing objects to see if they can be re-used or adapted for new users and also to define new or modified objects that will be combined with existing objects into useful business computing

applications (Whitten et al., 2001). Object-oriented user interfaces help users to form stronger user models and also allows designers to develop a more explicit mapping between the designer's model and the system (IBM, March 2002).

2.2.1.6 Natural Language, Speech and Voice Recognition

For years designers have been experimenting in artificial intelligence and natural language processing. It has long been a goal of researchers to develop a computer with which humans can interact with simply by talking. As far back as 1965, the System Development Corporation (SDC) in Santa Monica, California, conducted a series of experiments with a system called Protosynthex. This system was designed to answer a series of questions based on a child's encyclopaedia (Hahn, 1998). Natural Language process is not a new concept but is an important area of new research in user interface design.

Early retrieval systems required specialised training and had a very structured command language. This limited the use of the system. The user had to know the exact sequence and syntax of the commands. The goal of modern interfaces is to make them easier to use and to require less training. This is where natural language processing plays a large role. The more the user can input commands and request information in plain English the less time they will need to learn the system. It will also make it easier for users with no training to use the system for the first time. Microsoft Word designers try to

do this with their help system, which asks you to input a question and then looks at words in that sentence and tries to match help topics to them.

Natural Language systems are advancing slowly. Advances made include automatic truncation. This is where the system can recognise with greater reliability the plural and singular forms of a noun. Some systems are able to add or subtract portions of a word e.g. suffixes.

With the advances in search engines, some can recognise phrases or word variations. This is called "fuzzy matching" and involves the computer looking for similar words or phrases in close proximity to others. The use of 'fuzzy matching' helps compensate for errors in data entry or misspelling and makes systems easier to use.

There are questions regarding whether or not natural language systems are an improvement over past systems. Some studies have shown that often there is little difference in performance between artificial and natural language systems (Ogden & Bernick, 1997), but users tend to be happier and more confident using them. Computers can be programmed to recognise speech or typed text that adheres to a particular pattern. Currently, voice recognition can interpret, process and carry out some well-defined tasks such as opening or closing a document. Further advances are needed before they can handle more complex procedures.

2.2.1.7 Future of User Interfaces

The design of computer interfaces is still evolving. There is a major shift from engineering towards more psychologically and artistically designed screens. The computer interface is continually moving to an interface that is more simple and easier to use. Interfaces are beginning to resemble what users see and experience in the real world. As computers get more powerful and have more memory, users will be able to see objects, such as telephones and faxes, on their screens. These objects will look and behave like the real object therefore the users will instinctively know what to do with little training. In the future users will be able to 'visit' places using 3D graphics and virtual reality. Companies like Microsoft are already advertising this with their famous line "where do you want to go today?" They advertise the concept that the user can "go" anywhere by just sitting at their computer. The user will then be able to interact with computers using natural human-oriented techniques, such as writing and speaking.

The advent of so many new design elements brings with it many new problems. Just because the user interface has incorporated design principles does not mean that the system will be easy to use. Donald Norman (1988,1992) identifies two key principles that help to ensure good HCI: visibility and affordance. Controls need to be visible, with good mapping with their effects and their design should also imply their functionality (Preece et al., 1994).

2.3 Summary and Conclusions

Users are increasingly demanding more from their computers. Historically designers had little time for HCI design. It is vitally important for designer and computer manufacturers to spend time researching human computer interfaces' as it is one of the most critical elements of consumer acceptance. The early improvement in computer interfaces was little more than making the screen more aesthetically pleasing and did not match users needs.

As the field of Human-Computer interaction began to grow in the 1980's the focus was on the broadening and encompassing of not only the design of the interface but of all aspects that relate to the interaction between users and computers. The general trend in computer interface design is moving from the mechanical working of the inside of the computer and towards the surface with graphically designed user interfaces. With the older DOS programs users were required to rely heavily on a remembered or learned sense of history. Windows and Mac interfaces try to totally eliminate this by making all options within reach of the user.

With the advances in User Interfaces, designing of the interface has become much more complex. It is much more difficult to incorporate the characteristics of a well-designed interface. There are a lot more considerations when designing a GUI. Poorly designed systems often leave the user frustrated and inhibit their work. There are many principles and design issues to be considered when designing GUI's. These will be discussed in more detail in chapter 4. HCI design is still evolving and will be around as long as computer technology is used.

Chapter 3

Internet and Multimedia

3.1 The Internet: An Overview

The official definition of the Internet is as follows:

> *"The Internet: A loosely organized international collaboration of autonomous, interconnected networks, supporting host-to-host communication through voluntary adherence to open protocols and procedures defined by Internet Standards."*

(Internet Standards, RFC 2026, formerly RFC 1602, S. Bradner, Harvard 1996)

Source: The Web is not the Internet, Kephart (2001)

According to PCWebopedia (Jan 2002) the Internet can be described as follows:

> *"A global network connecting millions of computers. More than 100 countries are linked into exchanges of data, news and opinions. Unlike online services, which are centrally controlled, the Internet is decentralized by design. Each Internet computer, called a host, is independent. Its operators can choose which Internet services to use and which local services to make available to the global Internet community. Remarkably, this anarchy by design works exceedingly well".*

The Internet is often described as a "network of networks" (Wiggins, 1994). It has revolutionised the computer and communications world like nothing before (Leiner et al., 2000). The Internet is said to represent one of the most successful examples of the benefits of sustained investment and commitment to research and development of information infrastructure (Leiner et al., 2000). As of February 2002 there are

approximately 544.2 million people online worldwide (Nua, March 2002). This can be broken down as follows:

Africa	4.15 million
Asia/Pacific	157.49 million
Europe	171.35 million
Middle East	4.65million
Canada & USA	181.23 million
Latin America	25.33 million

3.2 History and Evolution of the Internet

The history of the Internet dates back to the early 1960's. The Internet started as a project of the United States government's Department of Defence to create a non-centralised network designed to survive partial outages and still function when parts of the network were down or destroyed. This was called ARPANET (Advanced Research Projects Agency Network) and was created by the Pentagon's Advanced Research Projects Agency established in 1969 to provide secure and survivable communications network for organisations engaged in defence-related research (Web Developers Virtual Library, 2002). The concept behind the Internet was that there would be multiple independent networks beginning with the ARPANET as the initial packet switching network, but then encompassing packet satellite networks, ground-based packet radio networks and other networks (Leiner et al., 2000).

The Internet works on the principle that all nodes are equal in status and that each can send and receive messages. These messages are sent in packets, and each has its own address (Mayr, Aug 2002). In 1969, the first node was installed. At the end of 1969

there were only four host computers connected to the ARPANET and by 1971 this had increased to 23 nodes (Leiner et al., 2000). During the following years the number of computers quickly increased. By the end of 1970 the Network Working Group (NWG) under S. Crocker finished the initial ARPANET Host to Host protocol, called the Network Control Protocol (NCP). This meant that network users could begin to develop applications (Leiner et al., 2000). By 1972 the first e-mail program was invented by Ray Tomlinson of BBN (Mayr, Aug 2002). The Internet went international in 1973 with the nodes located in England and Norway. One year later Vint Cerf and Bob Kahn published "A protocol for Packet Network Internetworking" which specified the design of a TCP. This standard IP (Internet Protocol) technology was developed to set out a standard for the way electronic messages were packaged, addressed, and sent over the network. TCP/IP (Transmission Control Protocol/Internet Protocol) allowed users to link various branches of other complex networks directly to the ARPANet, which soon grew into the Internet (Web Developers Virtual Library, 2002).

The TCP/IP became standard on 1st January 1983, replacing NCP and the name "Internet" was first used. By 1983 the US military separated from ARPANET and was called MILNET. In 1984 the number of hosts reached over 1,000 and Paul Mockapetris of USC/ISI introduced the Domain Name System (DNS) (Leiner et al., 2000). This allows packets to be directed to a domain name, which is then translated by the server database into the corresponding IP number.

In 1986, the US National Science Foundation (NNF) initiated the development of the NSFNET. It had the capacity to carry 45 megabits per second. Similar operations

took place internationally allowing thousands of computers to join the network (Internet Society, 2001). By 1990 the ARPANET ceased to exist. The Internet experienced explosive growth and by mid 1990 the Internet connected an estimated two million computers in more than 100 countries, serving some 23 million users (Web Developers Virtual Library, 2002). In 1993 the first browser called Mosaic was released. By this time the growth rate of the Internet was 341% (Mayr, Aug 2002).

3.3 The World Wide Web (WWW)

The technical definition of the WWW is:

> *"the global network of hypertext (HTTP) servers that allow text, graphics, audio and video files to be mixed together."*

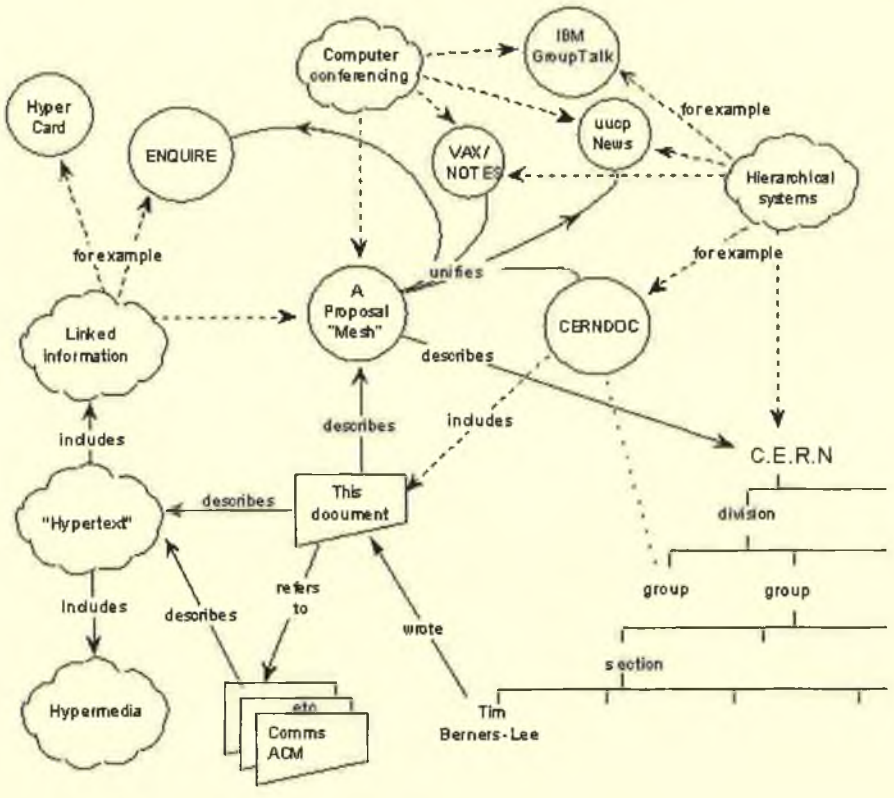
According to the PCWebomedia (Jan, 2002) the WWW can be described as:

> *"A system of Internet servers that support specially formatted documents. The documents are formatted in a language called HTML (Hypertext Mark-up Language) that supports links to other documents, as well as graphics, audio, and video files This means you can jump from one document to another simply by clicking on hot spots. Not all Internet servers are part of the World Wide Web."*

Tim Berners-Lee designed the WWW in 1989 in conjunction with scientists at CERN (Geneva). CERN, the European centre for High Energy Physics, were interested in making it easier to retrieve research documentation. The World Wide

Web (WWW) is a network of sites that can be searched and retrieved by a special protocol know as a Hypertext Transfer protocol (HTTP) (Griffiths, 2001). The original proposal for an Internet-based hypertext system called 'Information Management: A Proposal' by Tim Berners-Lee, was written in March 1989 to persuade CERN management that a global hypertext system was in their interest (see Appendix C). Tim Berners-Lees idea was to enable researchers from remote sites in the world to organise and pool information together and make this information downloadable to individual computers while also linking the text in the files themselves (Addison et al., 1998). This meant that while reading one research paper, it would be possible to display a part of another paper that had directly relevant text. He planned to do this by using a form of hypertext. Tim Berners-Lee went on to develop the hypertext mark-up language (HTML) to display hypertext. The concept behind HTML is to describe the structure of a document and make it independent of the formatter that actually displayed the text on screen (Addison et al., 1998). A proposal for the original WWW is schematised in figure 3.1 overleaf.

Figure 3.1 The WWW Proposal (schematised) (1989)



Source: From ARPANET to World Wide Web, Griffiths, 2001

In April 1993, the first version of the Mosaic browser was released by Sun Microsystems Inc.'s workstation. By 1994, Mosaic was used by tens of thousands of users throughout the world. By late 1994 the World Wide Web Consortium (W3C) was set up by Tim Berners-Lee to fulfil the potential of the web and to develop open standards (Raggett, 1998). According to the W3C, its mission was to lead the World Wide Web to its full potential by developing common protocols that promote its evolution and ensure its interoperability (W3C, Jan 2002). From this time on, the web went from strength to strength. By 1997 the number of host computers integrated into the Web had reached 19.5 million hosts and the number of websites was 1.2 million. By January 2001, the number of hosts stood at 110 million, and the

number of websites had reached 30 million (Griffiths, 2001). Instone (1996) identified the major reasons for the success of the web as follows:

- The URL provides geographic universality and a single conceptual space.
- The web is simple to use.
- It leverages existing documents on the Internet.
- The protocol is easy to implement.
- The standards make it fairly interoperable and compatible with multiple platforms.
- It is built upon free software.
- It provides immediate access and retraction.
- It is easy to become an author.
- There is a very large content.

3.4 Difference between the Internet and WWW

Many people still get confused between the Internet and the World Wide Web. The Internet can be described as a network of networks consisting of computers and cables. The Internet passes around small packets of information that have addresses on them. There are many different programs that use the Internet such as electronic mail and hypertext. The web is an abstract space of information. The web consists of programs and documents, which communicate between computers on the Internet. A serious of hypertext links is used to connect documents on the web (Griffiths, 2001).

3.5 Web Design History

Siegel (1997) in his book entitled "Creating Killer Websites" classifies websites into four types:

- First Generation Websites
- Second Generation Websites
- Third Generation Websites
- Fourth Generation Websites

These are described and expanded upon in the following sections, which draws heavily on Siegel (1997).

3.5.1 First Generation Website Design

Siegel (1997) described first generation websites as linear yet functional for scientists around the world to share information. The browsers of this era usually had little or no capacity to display graphics and provide for visual design. The first successful available browser, Mosaic, was launched in 1993. Mosaic was capable of viewing text and graphics but it had limited layout capabilities (Gilmore, 2002). According to Gilmore (2002) there were also technological restrictions that influenced the design of websites during this period such as (Gilmore, 2002):

- Slow modem connections
- Monochrome monitors
- Service providers (the computer where the web page actually hosted on) inability to transfer the data quickly.

First generation websites usually had little formatting. The layout was generally top to bottom, left to right with black lines segmenting the different sections. When the W3C was established the levels of HTML code progressed. W3C worked with Microsoft and Netscape to provide more dynamic content over the web (Gilmore, 2002). Microsoft and Netscape began to compete to become the market leader in browser products and web technologies. This competition greatly fuelled the rate of progression.

3.5.2 Second Generation Website Design

According to David Siegel second generation websites had the following changes to first generation sites:

- Icons replaced words
- Tiled images were used for backgrounds
- Buttons had bevelled edges
- Banners replaced headlines.
- A top to bottom bullet-list menu driven system was used to present a hierarchy of information.

Websites created during this period tended to have little consideration for good HCI characteristics, with overuse of new technology and clutter. Pages were often overcrowded and had flashing icons and multicoloured backgrounds. As HTML became more powerful, designers started to use features for the sake of using new technologies.

3.5.3 Third Generation Website Design

Many sites presently on the web can be described as third generation websites. Web browsers have become increasingly technology based in order to deliver multimedia content. Designers can now deliver dynamic content. Third generation sites are much more concerned with attracting and communicating with viewers. There is much more emphasis put on project design and management, which attracts more users to sites. More importance is put into site structure and making the site easier to navigate. Web design has greatly evolved with third generation websites. Marketing has become a big part of web design.

3.5.4 Fourth Generation Website Design

Fourth generation websites are multimedia rich sites. There is an abundance of sound, animation, video and 3D. Fourth generation websites are often used for delivering remote education over the web and for on-line training. These types of sites will be discussed in more detail in the next chapter.

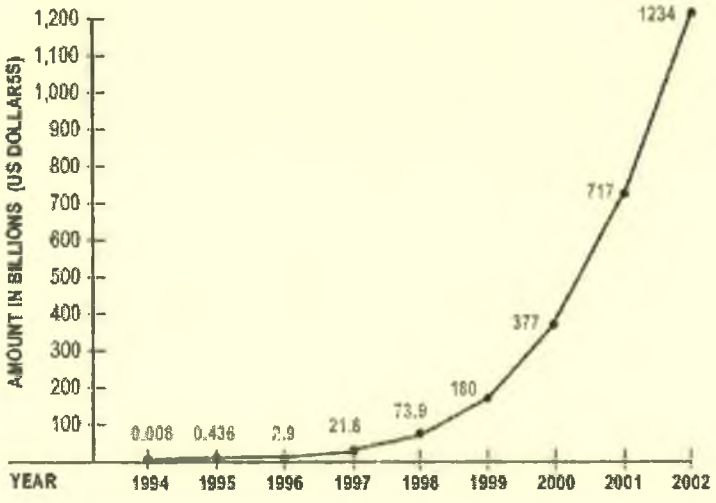
3.6 The Internet Today.

Today more and more companies have a presence on the Internet as they realise the Internet is an important business tool in an expanding global marketplace (Eaton, 1998). The Internet allows small and medium sized businesses to compete with larger corporations. According to Mulquin (1997) the following benefits can be obtained from getting online:

- Messages can be sent to many people at once very cheaply - useful for building campaigns and alerting users or potential users and partner organisations to new initiatives etc. It costs the same to send a message to one person as to 100 or more people.
- Research indicates that there is only a 20% chance of reaching someone by phone during the business day. Using e-mail eliminates this problem as both parties can read/write at their convenience.
- Questions can be asked of a lot of people at once to find if anyone knows the answer or has relevant experience. Using electronic mailing lists and newsgroups give access to a theoretically unlimited pool of international expertise.
- Documents can be sent almost instantly. This includes spreadsheets, databases, graphics and even sound as well as text and also, using a scanner, you can copy documents to send.
- Bulletin Boards can facilitate the discussion of issues. You can post your ideas publicly and other people can publicly or privately comment on them.
- Other users and other local, national and international groups with similar interests, whether they are voluntary, statutory or private can be communicated with.
- The ethnic background, gender, age or physical ability of people online is much less obvious and so people's contributions are valued much more on their own merit.
- Skills can be acquired that are becoming increasingly important.
- Research can be carried out by using 'search engines' to hunt through billions of words on the World Wide Web and in discussions groups.

A website is one of the best advertising means of reaching people around the world (Eaton, 1998). In the United States 53% of people claim to have used websites as part of a buying decision (Eaton, 1998). Companies are starting to realise the potential of Internet selling and it is rapidly becoming common practice. Websites are becoming more customer friendly every day and companies are getting more knowledgeable about how to deal with customers. It is predicted that e-commerce will account for 8.6 percent of worldwide sales of goods and services by 2004, according to new findings by Forrester Research (Nua Internet Surveys, Feb 2002). The following graph shows the worth of Internet Sales worldwide for the years 1996 – 2002.

Figure 3.2 Internet Generated Revenue 1996



Source: ActivMedia (Nua Internet Surveys, Jan 2002)

3.7 The Internet In Ireland

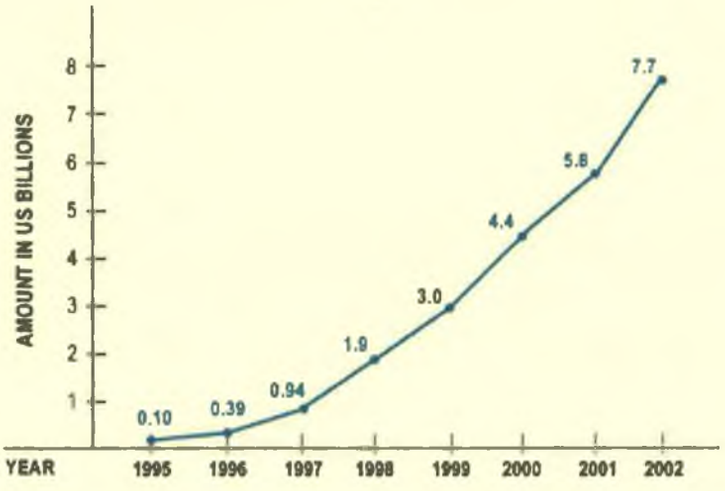
Irish users are beginning to access the Internet in large numbers. According to a survey carried out in February 2002 by Nielsen NetRatings, approximately 33% of the population or 1.27 million people are connected to the Internet in Ireland (Nua, March 2002). This represents large marketing opportunities for companies. A survey carried out by the Irish Internet Society (IIA) (1997) of both business people and members of the public showed that the vast majority of Irish users are male, urban-based, professional and well educated. According to the survey, one of the most significant findings for companies considering using the Internet to sell products is that almost 40% of users have already used it for shopping. The level of female usage was 25% lower than most other countries. 47% of respondents had been using the Internet for between one and three years, with 42% online for less than a year. Sixty per cent of respondents accessed the Internet from home and 35% accessed it from the office. Access from rural areas was only 15%.

The IIA conducted their fifth Survey in 2000 (IIA, 2000). The results showed a significant rise in E-commerce activity. Sixty two per cent of participants had made a purchase online in the last year. The amount spent by consumers online had grown also in the last year with 40% of respondents spending between £100 (€127) and £500 (€635) in the previous 12 months. Consumers were also much happier with their purchases on the Internet with 88% saying that they would be happy to repeat the experience. Of those who had not yet purchased online 47% intended to do so in the next six months.

The survey revealed interesting trends towards online/permission marketing with 61% of participants subscribing to e-mail magazines or updates. This shows a huge opportunity for Irish companies to target consumers through e-mail. The results showed that Irish Internet Users have mixed attitudes towards banner advertising. Seventy per cent of Internet users notice banner advertising at least occasionally yet only 16% finds them useful. Forty two per cent of Irish users actually find banner advertising to be very annoying. The survey showed that there is a continuation of the trend towards an improving balance between male and female users, rural and urban users and the increase in home Internet usage.

Overall the results of the surveys show that the profile of the Irish Internet user is changing rapidly. According to Frances Buggy, chairman of the IIA "there is still a worrying lack of affordable access to Internet usage in Ireland among those who have not had third level education and are outside of the higher earning occupations" (IIA, 2000). Figure 3.3 shows the total online advertising revenue for the years 1995 – 2002. It shows the revenue has greatly increased during these years.

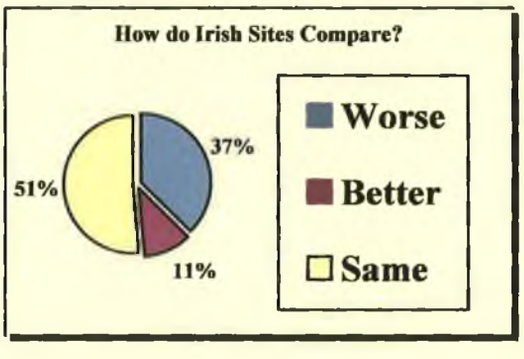
Figure 3.3 Total Online Advertising Revenue 1995 – 2002.



Source: Jupiter Communications – (Nua Internet Surveys, Feb 2002)

A study carried out by Amárach (Feb 2002) asked respondents how well Irish company websites compared to those in countries such as the US or the UK. The results can be seen in Figure 3.4.

Figure 3.4 Comparison of Irish Websites versus their overseas counterparts.



Source Online Pole of Internet Users, Amárach (Feb 2002)

Only about one in ten Irish Internet users consider Irish websites to be better than their overseas counterparts, about half believe the standard to be comparable and

37% say they are worse. According to Amárach those who believe Irish sites to be worse than overseas sites are more likely to be using the Internet for longer than the Internet population in general, suggesting that they have had more time to compare sites and are not impressed. They are also more likely to have made an online purchase.

3.8 Multimedia and the Internet

Multimedia is the use of computers to present text, graphics, video, animation, and sound in an integrated way. It can be further described as follows:

> '*Any computer-delivered electronic system that allows the user to control, combine, and manipulate different types of media, such as text, sound, video, computer graphics, and animation. Interactive multimedia integrates computer, memory storage, digital (binary) data, telephone, television, and other information technologies. Their most common applications include training programs, video games, electronic encyclopaedias, and travel guides. Interactive multimedia shifts the user's role from observer to participant and are considered the next generation of electronic information systems.*'
>
> **Encyclopaedia Britannica (2002)**

Multimedia is the largest area of growth in the computer industry at present. The advantages of Multimedia can be described as the following: (Anderson, Feb 2002)

1. *Enhancement of Text Only Messages*: Multimedia adds greatly to text only presentations by adding interesting sounds, graphics video and animation.

2. *Improves over Traditional Audio-Video Presentations*: Audiences are more attentive to multimedia messages than traditional presentations and will remember the information presented to them.
3. *Gains and Holds Attention:* Research has shown that the combination of communication modes (aural and visual) gives the user a greater understanding and retention of information.
4. *Good for "computer-phobics":* People who are not experienced on computers find it more comfortable clicking buttons with a mouse or on a screen.
5. *Multimedia is Entertaining as Well as Educational.*

Multimedia applications were not used until the mid 90s, as the hardware required was expensive. Multimedia is now fast finding its way into the mainstream with its increases in performance and the decreasing costs of hardware. Up to this point multimedia titles were mainly used for games or reference material but it is now being used in a wide number of areas, particularly in training, website development and education (Eaton, 1998).

Multimedia has been slow to reach the web due to the limitation of bandwidth. Multimedia is now gaining popularity on the Web due to several new technologies that support the use of animation, video, and audio to supplement the traditional media of text and images and the increasing bandwidth speeds (Nielsen, 1995). Extreme care must be taken when integrating multimedia elements into user interfaces as it can confuse users and make it more difficult for them to understand the information (Nielsen, 1995). Research carried out in this area has identified that

there are no widely accepted conventions for developing multimedia and hypermedia artefacts (Lynch and Jaffe, 1990). This can cause problems for the end user. According to McKerlie and Preece (1993) poorly designed multimedia elements are dangerously easy to make and they often result in uncoordinated media, which can lead to divided attention and memory overload for the users.

Irish businesses have begun to realise the possibilities of using multimedia. Multimedia is attractive to an Irish audience as it allows its audience to interact with the message, rather than passively receiving it in a linear narrative form (Eaton, 1998). The Internet has effectively changed the way the world communicates and has become a very important business tool. The Internet enables companies of all sizes to be viewed by the world through a desktop computer (Eaton, 1998). According to Stuki (2002) multimedia systems and hypermedia still need much research before they can become common tools for industry and society.

3.9 Hypertext and Hypermedia

According to Webopedia (March 2002) Hypertext can be defined as follows:

> *"A special type of database system, invented by Ted Nelson in the 1960s, in which objects (text, pictures, music, programs, and so on) can be creatively linked to each other. When you select an object, you can see all the other objects that are linked to it. You can move from one object to another even though they might have very different forms. For example, while reading a document about Mozart, you might click on the phrase Violin Concerto in A Major, which could display the written score or perhaps even invoke a recording of the concerto. Clicking on the name Mozart might cause various*

illustrations of Mozart to appear on the screen. The icons that you select to view associated objects are called Hypertext links or buttons".

Hypertext is further defined in the Computer Science Encyclopaedia as follows:

"Hypertext is the concept of interrelating information elements and using these links to access related pieces of information. A hypertext is a collection or web of interrelated or linked nodes. Typically hypertext systems mark link access points or link anchors in some manner with a node when displaying it on a computer screen. When the user selects the link marketer by clicking on it with a mouse cursor, the hypertext system traverses to and displays the node at the other end of the link."

(Bieber, Jan 2002)

Hypertext is the concept of linking pieces of information and using these links to access related pieces of information. The document is structured in such a way that references exist between parts so that, at certain well-defined points in the document, the reader has the option to continue or to go to another part. If the reader chooses to go to another part of the document they then have the option of returning to the original section or to go to further sections. When the user selects a link marker by clicking on it, the hypertext system will display the information at the other end of the link (Bieber, Jan 2002).

Hypermedia can be defined as follows:

"A communications medium created by the convergence of computer and video technologies. The term was originally coined by Ted Nelson to describe hypertext systems that include multiple media – text, image, sound, animation and video, extended by the authors to cover a variety of other computer-based applications, such as interactive multimedia,

> *videogames and virtual reality systems that have some, but not all, of the elements of "pure" hypermedia."*
>
> *(Cotton, 2001)*

Hypermedia can also be further defined as follows:

> *"An extension to hypertext that supports linking graphics, sound, and video elements in addition to text elements. The World Wide Web is a partial hypermedia system since it supports graphical hyperlinks and links to sound and video files. New hypermedia system under development will allow objects in computer videos to be hyper linked."*
>
> *(Webopedia, Mar 2002)*

Hypermedia and virtual reality applications are based on multimedia systems. Hypermedia extends the media-oriented features of multimedia systems by the addition of hyperlinks (Stucki, 2002). The word Hypermedia is an acronym, which combines the words hypertext and multimedia (De Bra, Mar 2002). Often people regard the terms hypertext and hypermedia the same. Technically, hypertext refers to linking textual elements, while hypermedia refers to the relationships among elements of any media type. The concepts behind both are the same, though it is more difficult to implement hypertext in non-textual media. (Bieber, Jan 2002). The term Hypermedia was originated by Ted Nelson to describe hypertext systems that include multiple media (Cotton, 2001).

Hypermedia permits the user to customise the presentation of the information in some way. This may simply be the order of traversal or may be more complex with the user adding to the hypermedia link structures (Ashman, 1993). Pure hypermedia can be characterised as having three major features: (Cotton, 2002)

- It is interactive.
- It involves a variety of combinations of multiple media with the control of the particular combination selected with the user.
- It is non-linear, with no beginning, middle or end.

Hypertext and hypermedia allows the user to read in a non-linear format. Also, the user can choose to click only on the areas of interest to them thus saving time. Hypertext components include nodes, links, link anchors, link markers and composites. In hypermedia, information is encoded in small units called nodes. The nodes contain the content and attributes of information elements (Bieber, Jan 2002). The connections or cross-references between nodes are known as links. These combined are called a hyper document.

3.9.1 Benefits of Hyper Document

There are many benefits for the use of hyper documents. The follow are advantages hyper documents have over traditional paper documents: (De Bra, Mar 2002)

1. Use of hypermedia systems lets the user interact and gives hands on experience.
2. A hypermedia system is easier to explore than a traditional paper documents. There is no predefined order in which to read the sections.
3. You can easily add bookmarks and annotations. The use of history lets the user return to a place previously visited.
4. Using tools provided by Hypermedia software, various searches and query operations can be performed, which cannot be performed on books.

5. Hyper documents may contain audio, video and animation elements whereas a paper document can only contain text and still pictures.
6. Hyper documents can be open-ended i.e. can contain links that give the opportunity to explore additional information not contained in the hyper document.

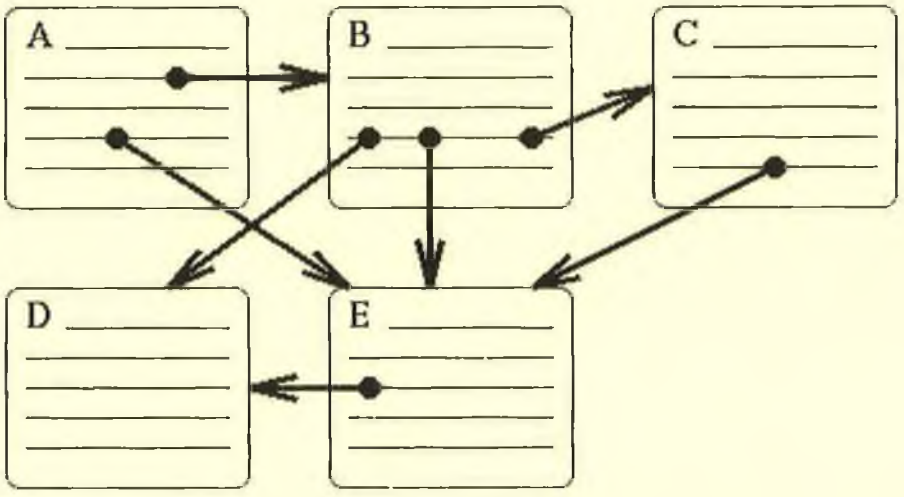
3.9.2 Disadvantages of Hyper Documents

Although hyper documents have a lot of benefit over more traditional forms, they still have many disadvantages of their own: (De Bra, Mar 2002)

1. The user has to be at a computer to read the document. If a hyper document is printed its benefits and flexibility is lost.
2. Software has to be installed to read a hyper document. Depending on which software is used, the document may appear very differently to what the author intended.
3. It is more difficult and slower to read text on a computer screen.
4. There is a risk that users of a hyper document may become disoriented.

The following shows a simple view of a small hyper document containing five nodes and seven links. The figure shows that links are tied to a specific point within a node known as an anchor.

Figure 3.5 – Small Hyper Document.



Source: Hypermedia structures and systems, Prof. De Bra, (March 2002).

Hypertext will enable the user to read and comprehend information more effectively than traditional documents if it is well designed. (Bieber, Jan 2002).

3.10 Summary and Conclusion

The onset of the Internet revolutionised the computer and communications world like nothing before. The history of the Internet dates back to the early 1960's. The Internet started out as a project of the US Government Defence Department and was called ARPANET. The Internet first went international in 1997 but it was not until the mid 90's that it experienced an explosion in growth. In 1993 the first browser called Mosaic was released. The WWW was designed in 1989 by Tim Berners-Lee. The WWW is a network of sites that can be searched and retrieved by a special protocol knows as a hypertext transfer protocol (HTTP).

Website design has changed greatly since its inception. Early websites were linear and functional and were mainly used by scientists for the sharing of information. There was little or no capacity to display text and had very little formatting. The next generation of websites contained more graphics and icons. Designers were not yet aware of the principles of good HCI design and often overused graphics and colours. The third generation of websites had much more emphasis on design of the site and on attracting users. The site structures were improved and as a result users found them easier to navigate. The newest generation of websites are multimedia rich sites. These include use of sound, animation, video and 3D. They are often used for on-line training etc.

The number of companies that have a presence on the Internet is continually increasing. The Internet allows small and medium sized business to compete with larger corporations. Companies are realising the potential of Internet selling. Fifty three percent of people in the US claim to have used websites as part of a buying decision (Eaton, 1998). It is predicted that e-commerce will account for 8.6% of world sales of goods and services by 2004.

The use of multimedia on the Web is increasing partially due to increasing bandwidth speeds. Care must be taken when integrating multimedia elements into the user interface as it may actually hinder the user if used incorrectly. Hypermedia and virtual reality applications are based on multimedia systems. Hypermedia extends the media-oriented features of multimedia system by the addition of hyperlinks (Stucki, 2002). Hypermedia gives the user the ability to interact with a site. Hyper systems are easier to explore and tend to lead to better user satisfaction.

The websites we see today have changed dramatically from those that first appeared on the web. The improvement in design methods and web browsers have brought along a new set of problems. Designers often over utilise graphics and new technologies, such as scrolling banners and flashing text. Designers need to be aware of the importance of good design principles if they are going to design a successful site. Design principles are discussed further in the next chapter.

Chapter 4

Critical Issues of Human Interface Design

The most important aspect of Human Interface Design is the understanding of users' tasks and requirements. Traditionally the designers of software were also the users. They were usually highly skilled and developed complicated systems. Users had to remember long strings of commands in order to do the simplest of things. There is now a major shift in customer base as computers can be used by non experts, and this shift must be reflected in the way that interfaces are designed (IBM, April 2001). Users must be satisfied and find the final product easy to use. The interface should support the users objectives and match the needs and capabilities of the user. The user should not have to think about how the computer works. The format of input and feedback will affect the success with which the computer is used. Controls, commands and links should be highly visible and design should suggest their functionality. The way in which computer screens can be used to communicate information to the user is changing continually and will continue to evolve.

There is an increase in the use of 3-D and real-world representations. This, along with the growth of the Internet has strongly influenced the progression of the user interface (Orubeondo, 2000). According to Orubeondo, it is surprising, that with the growth of graphical user interfaces, very few screens exhibit good interface design. Effective interfaces should be visually apparent and should give users a sense of control. The ultimate goal is to produce a design that is comprehensible, predictable, and controllable (Shneiderman, 1998). Successful GUI's usually share many

common characteristics and display a number of the following principles, which are described in the following section:

An article by Newsbytes (Nua Internet Surveys, May 2002) states that many businesses are losing customers because of inadequate websites. They state that 66% of respondents never return to a website where they have a negative experience. Factors found to influence a negative experience include ease-of-use, not being up-to-date and simple navigation.

4.1 Design Principles

There are a number of design principles that should be noted by designers when designing any user interface. They can be classified under the following headings.

- Clear and simple to use
- Understand users
- Efficiency
- Consistency
- Speed and responsiveness
- Anticipation and support
- Error detection and prevention
- Help and documentation
- System status
- Control design
- Icons and metaphors
- Messages
- Display attributes
- Language
- Text
- Colour
- Navigation
- Customisation
- Model versus modeless
- Position and alignment

The following sections explain how these principles should be used and incorporated into the design of user interfaces.

4.1.1 Clear and Simple to Use

A good interface design will allow the user to quickly see their options and do their work. It should speed up the time it takes for the user to reach their goal. The screen should only contain objects the user will need to use frequently. The user should be able to see basic functions immediately. Less important information or objects should be hidden, but obtainable, so as not to distract the user (IBM, March 2001). The objective for the designer is to keep the number of objects and actions to a minimum while still allowing users to accomplish their tasks.

The system should be as easy to use, for a new beginner, as possible. The number of windows that the user must display and the number of mouse clicks or keystrokes they have to use to complete a particular task is often used to measure the simplicity of a system (IBM, March 2001). No matter how simple a system is, help information should be provided. The help system should be simple to use and not too detailed. It should have clear simple steps and offer the user solutions to problems.

The goal of the interface should be foremost in the design process. Designers should be careful not to provide too many features that do not add to the user interface (Skaalid, 1999b). An interface cluttered with many functions will only serve to distract the user from accomplishing their everyday tasks. The overuse of features leaves the user feeling confused and makes it harder to navigate around the screen.

Features should only be added if they add significant value to the application. A well-organised interface will support the user's tasks and allow them to work efficiently (Skaalid, 1999b).

It is also important that a system is aesthetically pleasing. Aesthetics will not have an impact on the effectiveness of the user interface, but they will leave the user feeling happier and the system will have a higher acceptance rate (Nielsen, 1997e).

4.1.2 Understand Users

It is vital for a good designer to get to know their users and to understand and be familiar with their characteristics, behaviours, and how they will be using the system. When designing a system it is important to take into account the type of user (Shneiderman, 1998). Users can range from totally novice users, users who have some knowledge but only use the system intermittently, and expert users who use the system frequently. The system must accommodate the users wants and needs. Novice and infrequent users will need extensive help. Experts and frequent users will want a system that they can customise and use shortcuts (Orubeonda, 1999). They will expect more from the system in terms of speed and performance. It can sometimes be difficult to accommodate a range of users on one system. One method is to allow an experienced user to customise the system to their requirements. Another option is to include both menu or icon choices as well as commands such as CTRL+P for the print command. Frequent users should be allowed to use abbreviations, special shortcut keys and macros to speed their interaction with the application.

It is important that developers also learn about people in general e.g. they should be aware that people can learn more easily by recognition than by recall. It has been shown in studies that humans can only store five (plus or minus two) pieces of information in their short-term memory (Nielsen, 2001). This should be taken into account when designing screen. The amount of information needed to be stored in the users short-term memory can be reduced by providing clearly visible options or by using pull-down menus and icons.

4.1.3 Efficiency

Designers should concentrate on the user's productivity and not the computer's. People cost more than machines so it is important to increase the human's productivity rather than the machines (Nielsen et al., 1998). The amount of keystrokes or mouse clicks needed by the user to complete a particular task should be kept to a minimum. Close co-operation between the system designers and the system engineers is needed if this is to be achieved. Menus and button labels should have the keywords first. Also, messages should be kept as short and concise as possible.

4.1.4 Consistency

It is essential that all the interfaces of an application are consistent, and that they have the same look and feel. It is important that colour, layout fonts etc. be consistent throughout the application (Hobbart, 2000). When users have used one screen or experienced one or more message boxes they should then have some sense of how to interact with the next screen or message box (Skaalid, 1999b). The user should be able to immediately recognise familiar features as they move from one dialog box to

the next. Labels and icons should always be consistent. It is important that objects be placed in a consistent manner throughout the application and that they are always consistent in their behaviour. A consistent sequence of actions should all occur to similar situations. It is good practice for designers to provide permanent objects as reference points throughout the system (Skaalid, 1999b). This will help prevent the user from getting lost or disoriented. It is important that an application be consistent with user expectations (Nielsen et al., 1998). This can only be ascertained by doing user testing. The terminology used in the prompts and menus should be the same throughout the application.

4.1.5 Speed and Responsiveness

Speed and responsiveness is a vital part of a good GUI. The speed of an application is affected by the design of the GUI as well as the hardware. Speed can be a major factor affecting the acceptability of an application by the user (Shneiderman, 1998). GUI's can be given the appearance of speed in many ways. It is recommended that applications have basic background elements, which are not constantly changing (Nielsen et al., 1998). Design screens so that the user is given the option to enter fields or perform functions rapidly. Features such as accelerator keys, toolbar buttons and easily understandable buttons will speed up the user and give them more control.

With the introduction of many GUI applications the focus has been on the mouse as the main interactive device. This is helpful for the less experienced and infrequent users, but will slow down and frustrate more frequent users of the application.

Providing keyboard accelerators will increase efficiency of the user and allow a faster method of access to specific menu items or controls within a window. A successful application should be able to accommodate both frequent and infrequent users. It is preferable to have equal keyboard and mouse support for all menu and windows operations

4.1.6 Anticipation and Support

A well designed system will try to anticipate the users wants and offer assistance to make the task easier (Nielsen et al., 1998). As users become familiar with the system they can be given the option to turn off this support if desired. All the information that the user needs to perform a specific action should be at their fingertips. It is important to ensure the following points: (Nielsen et al., 1998).

- Users do not have to search for a particular function.
- Users are not required to remember information from one part of the system to the next.
- Instructions are clearly visible or easily obtainable.
- The user options are always visible.
- Numerous paths are provided to complete any one task to accommodate different user preferences.
- Shortcuts are provided for most actions to speed up the more experienced user.
- Users are provided with a method to customise frequently used actions.
- All the information and tools that are needed for a particular step are grouped together.

According to Nielsen, the incorporation of these points can help create a successful interface.

4.1.7 Error Detection and Prevention

It is important that the system is able to anticipate errors the user may make. The user must be protected from making errors and also from the consequences of these errors. The screen or forms can be designed so that it will help prevent users making mistakes as they make them (Whitten et al., 1998). This can be achieved by not allowing users to proceed through the application without correcting any error they have made first and by giving the user clear instructions on how to correct errors. Drop down boxes or checkboxes should be used wherever possible to avoid the user having to type in directly.

Checks can be included to make sure data is valid, e.g. completeness checks which make sure all required fields are entered, data type checks ensures that the correct type of data is inputted i.e. text or numeric (Whitten et al., 1998). Users often choose system functions by mistake. If users execute risky actions, such as delete, they should be given a warning box and an opportunity not to complete this action (Whitten et al., 2001). It is preferable to prevent the user from performing tasks wrongly at all. Systems should be designed so that users cannot access dangerous functions in the first place. This can be done by disabling and greying elements under certain conditions e.g. with the average save dialog box, such as those used by Microsoft, the save button will be grey and disabled until a name has been entered into the name field (Whitten et al., 2001).

All systems should support redo and undo to several layers (Nielsen et al., 1998). Users will have much more confidence using the system if they know that they can try out functions/buttons and undo their action in one simple step. Users will learn a system much quicker by trial and error. It is preferable for a system to allow the user a way out or an exit. The user should never feel trapped when using the system.

When users do make errors, the error message should be written in easy to understand language and be accompanied by instruction on how to correct the error or contain a link to further help. A well-designed system will allow for errors but at the same time provide an easy path back to recovery (Shneiderman, 1998).

Actions should not be bundled together. If actions are bundled together the user may not know or be able to anticipate the side effects. If a user chooses to cancel something e.g. sending an e-mail, only the 'send' should be cancelled. The e-mail should not be automatically deleted. Actions should be inherently independent with options to combine them if wished.

4.1.8 Help and Documentation

Designers must aim for a system where the user can use it instinctively without the need for supporting documentation, however, even if this can be achieved, help and documentation should be available if required by the user. This information should be easily retrievable and should be clear and easy to understand. A search option will allow users to obtain their required topic with ease. It is preferable to provide a list of easy to follow steps. The language used must be simple to understand and not

too long or complicated with links to related subjects. If possible make sure that users can get to useful information in four clicks or less (Shneiderman, 1997a).

4.1.9 System Status

A user must always be aware of what is happening with the computer system and know what needs to be done next. Message boxes can be used to tell the user what the system expects. Users can be made aware that what they have done is correct by providing simple messages such as 'Input Ok'. All button clicks should be acknowledged by visual or aural feedback immediately. Status mechanisms are vital so that users can respond to any situation (Nielsen et al., 1998). If a system has poor visual feedback then the user will be left feeling frustrated.

The user should be informed of any delays. A signal, such as an hourglass, should be displayed for any action that will take much more than a second. It is better to have the hourglass or object animated so that the user will know the system is still working. For any delay that is longer than two seconds the system should display a message indicating the potential length of the wait (Nielsen et al., 1998). Most users like to have a message box with a progress indicator displayed when the operation they are carrying out is going to take longer than seven seconds. This delay can vary depending on the types of user and the characteristics of the application. The users should always be given a reason, e.g. 'printing – please wait", for the delay. If there has been a long delay in a system, a large aural and visual clue can be given to let the user know that they can continue. Messages can be given to the user to tell them, whether or not tasks were successfully completed, thus saving them valuable time

seeking out status information (Nielsen et al., 1998). At a glance, the user should be able to get an approximation of the current state and workload.

Audible feedback can also be used. Designers must be careful when using sound that it does not become annoying to frequent users of the system. Audible feedback should be used sparingly and carefully (Shneiderman, 2000). It can be useful in cases to warn the user of impending serious problems. Audible signals are also useful to let the users know that background actions have been completed. The user of the system should be able to disable the audio feature if desired, except in cases when an error must be addressed.

4.1.10 Control Design

When designing the User Interface there are a wide range of user interface styles and controls to choose from. Traditionally these styles and controls were viewed as alternatives but in more recent times designers have moved more towards an interface that is a combination of different styles and controls (Hobbart, 2000)

It is vital that the designer chooses the appropriate control for each user task, as it will result in higher productivity, lower error rates, and higher overall user satisfaction (Skaalid, 1999b). As with messages the behaviour and placement of controls are important. Designers should make sure that controls are consistent throughout the application. A table containing common controls and guidelines for using them can be seen overleaf in table 4-1.

Table 4-1 Guidelines For Using Controls

Control	Number Of Choices In Domain Shown	Type Of Controls
Menu Bar	Maximum 10 items	Static action
Pull-Down Menu	Maximum 12 items	Static action
Cascading Menu	Maximum 5 items, 1 cascade deep	Static action
Pop-up Menu	Maximum 10 items	Static action
Push-button	1 for each button, maximum of 6 per dialog box	Static action
Check Box	1 for each box, maximum of 10 to 12 per group	Static set/select value
Radio Button	1 for each button, maximum of 6 per group box	Static set/select value
List Box	50 in list, display 8 to 10 rows	Dynamic set/select value
Drop-down List Box	Display 1 selection in control at a time, up to 20 in a drop-down box	Dynamic set/select single value
Combination List Box	Display 1 selection in control at a time in standard format up to 20 in a drop-down box	Dynamic set/select single value; add value to list
Spin Button	Maximum 10 values	Static set/select value
Slider	Dependent on data displayed	Static set/select value in range

Source: ***Principles of good GUI Design, James Hobart, Sept 2000***

4.1.11 Icons and Metaphors

Icons must be clear and easily understood. Designers must take into account the users perspective as well as their own. Just because an icon is self-explanatory to them, does not mean that the user will be able to understand it or know its function.

Care must be exercised when choosing metaphors. Wherever possible real-world representations should be used when designing icons. Make sure that the users will instantly be able to understand them. If the metaphor used is not easily understood it will act as a hindrance rather than making the system easier and will leave the user feeling confused and frustrated. Where possible text should be attached to icons or else a prompt should be provided that appears when the mouse rolls over the icon (Nielsen et al., 1998). Size icons so that they can be seen clearly. Shortcuts and keystrokes can be provided for every button so that when users have mastered them they can hide icons from view. Metaphors can facilitate learning by allowing the user to draw upon the knowledge they already have about the reference system e.g. a 'shopping cart' metaphor for e-commerce immediately helps the user to understand the basic functionality. Shopping carts are now so common on e-commerce sites that they have morphed from metaphor to interface standard. (Nielsen, 2000)

4.1.12 Messages

All messages and instructions etc. should be displayed in the same area of the screen so that the user will know where to look for specific information (McGovern et al., 2001). Consistency makes it easier for the user to move from one application to the next and to learn new packages e.g. Microsoft use similar styled and placed message boxes in all their applications.

It is important that all messages or instructions are displayed long enough for the user to be able to read them. An OK button that the user can click on when finished reading the message or instruction should accompany each message or instruction

and all messages should be kept as short and simple as possible (Whitten et al., 2001).

4.1.13 Display attributes

Display attributes such as blinking and video must be used sparingly as they can be very distracting to the user. According to IBM (2001) these attributes should only be used to highlight very important information.

4.1.14 Language

A user-friendly system will use easy to understand language. When designing the systems language, designers should try to adhere to the following points (Whitten et al., 2001):

- Keep messages as simple and to the point as possible.
- The overall tone should be user friendly.
- Sentences should be kept as simple as possible and should be grammatically correct.
- Always use the users' language rather than system-oriented terms.
- Avoid using computer jargon and abbreviations except in systems that are in operation in specialised areas.
- Keep terms simple. Use terms like 'Not Correct' rather than 'Incorrect' as there is less chance of misreading it.
- Always be clear and consistent in the use of terminology and do not use similar words with the same meaning e.g. Edit and Modify.

- Phrase instructions carefully and use only appropriate action verbs. Use terms such as Select rather than Pick.
- Always let the user know if more than one option can be selected.
- Ensure objects are always consistent in their behaviour.
- The appearance of information should follow a natural and logical sequence.

A table containing a sample list of reserved words along with their mnemonic keystrokes and shortcut keystrokes can be seen in table 4.2.

Table 4-2 Example of a list of reserved words.

Text	Meaning And Behaviour	Appears On Button	Appears On Menu	Mnemonic Keystrokes	Shortcut Keystrokes
OK	Accept data entered or acknowledge information presented and remove the window	Yes	No	None	<Return> or <Enter>
Cancel	Do not accept data entered and remove the window	Yes	No	None	Esc
Close	Close the current task and continue working with the application; close view of data	Yes	Yes	Alt+C	None
Exit	Quit the application	No	Yes	Alt+X	Alt+F4
Help	Invoke the application's Help facility	Yes	Yes	Alt+H	Fl
Save	Save data entered and stay in current window	Yes	Yes	Alt+S	Shift+Fl2
Save As	Save the data with a new name	No	Yes	Alt+A	F12
Undo	Undo the latest action	No	Yes	Alt+U	Ctrl+Z
Cut	Cut the highlighted characters	No	Yes	Alt+T	Ctrl+X
Copy	Copy highlighted text	No	Yes	Alt+C	Ctrl+C
Paste	Paste the copied or cut text at the insertion point	No	Yes	Alt+P	Ctrl+V

Source: ***Principles of good GUI Design, James Hobart Sept 2000***

The table above contains common reserved words for menus and buttons. These should always be used in interfaces as the user will almost certainly have experienced them before and will know their exact meaning. Experienced users will also be aware of the mnemonic keystrokes and shortcut keystrokes.

4.1.15 Text

Text must be readable and easy on the eye. Dark text on white or pale yellow background is the easiest for users (Zetie, 1995). The use of grey backgrounds should be avoided. It is important to ensure that fonts used are large enough to be readable on a standard monitor. Small amounts of text can be displayed anywhere on the screen and are often accompanied by an icon to associate the text with a function or object. If the amount of text to be displayed exceeds the amount of space available, a scrolling text field can be used. Large amounts of text should be broken down by topic or category.

4.1.16 Colour

When designing the user interface the designer must take into account disabilities such as colour blindness. Ten percent of males show some indication of colour blindness. The most common form of colour blindness is red/green blindness, with blue/yellow blindness being less common (Nielsen et al., 1998). When using colour to convey information, a secondary visual aid should also be used such as the display of different graphics or having an additional text label or even something as subtle as different grey scale with each colour.

Excessive or inappropriate use of colour can confuse users and take away from the information. Colour should be used to attract attention and to bring the display to life. It is important to be consistent in the use of colour. Colours can also be used to link materials. When choosing colours, try to stay with four colours or less (Nielsen et al., 1998). Text should be readable against the background colour. Harsh busy backgrounds should be avoided, as they will cause eye fatigue.

4.1.17 Navigation

Users must always be made aware of where they are in a system and how they got there. Users should never be in a situation where they are in a window and they do not know how they got there or how to get out. Systems must have a well thought out menu structure from which to launch specific features. A search feature should be provided on larger sites (Spool et al., 1997). When designing dialog boxes a descriptive title bar should be included to let the user know exactly what part of the system they are in.

The user should not be forced to follow a single path through an application (Shneiderman, 1998). Objects or cues that enable the user to get "home" in a single click home should be provided. This will give the user more confidence to explore a system and also help them to navigate faster. Users must be able to identify the relationship between actions and effects. When the user pushes a button or uses a control they should have confidence in the outcome. Norman (1998) describes this as mapping. Natural mapping is what is known as "response compatibility" in the fields of ergonomics.

4.1.18 Customisation

When designing the system interface features should be incorporated that can be tailored by the user to reflect their individual needs and preferences. Users with different levels of experience and ability must be able to change the appearance of the application to suit them. Customisation of the interface will give the users a sense of control and also improve the acceptance of the application. Customising an interface can also lead to higher productivity and user satisfaction (IBM, 2001).

If there are multiple users sharing an application on a particular computer, then users should be able to customise the system. This can be accomplished by giving each user their own profile, which will contain their preferences and customisations e.g. as used by Microsoft in Windows 95 onwards. When the user logs onto the system their particular profile and preferences will be loaded. This will also allow users who may be using many computers to carry their preferences and customisations from one system to another.

4.1.19 Modal versus Modeless Dialogs

Allow users the option of using all objects at any time. Where possible the use of modes, in which normally available actions are no longer available or where an action causes a different result than normal, should be avoided (Hobart, Sept 2000). Modal-dialog boxes are often used when input is needed from the user. This type of dialog is extremely constraining on the user. It restricts the users ability to interact with the system. Modal dialogs lock users out of the system. If users needs to check something in an underlying window while competing a dialog box they are forced to

complete or cancel the dialog box, check the information they need and then re-access the dialog box.

Modal dialogs can have uses in complex applications (Hobart, Sept 2000). According to Hobart, modal dialogs are used when a measurable task exists. For tasks with no fixed duration, modeless dialogs will normally be used. Users should be restricted to no more than three modeless windows at any one time. Anything beyond this will cause problems for the user, increasing time spent on managing the open windows rather than concentrating on their tasks. A list of different types of dialog boxes and windows, along with recommendations of when to use them, is show in table 4-3 overleaf.

Table 4-3 When to Use Dialog Boxes Or Windows

Type	Description	Use	Example
Modal	Dialog box	Presentation of a finite task	File Open dialog box Save As dialog box
Modeless	Dialog box	Presentation of an ongoing task	Search dialog box History List dialog box Task List dialog box
Application Window	Window frame with document (child) windows contained within	Presentation of multiple instances of an object Comparison of data within two or more windows	Word Processor Spreadsheet
Document Window	Modeless dialog box or document window contained within and managed by Application window	Presentation of multiple parts of an application	Multiple views of data (sheets)
Secondary Window	Primary window of a secondary application	Presentation of another application called from parent	Invoke Help within an application

Source: ***Principles of good GUI Design, James Hobart, Sept 2000.***

When designing the user interface, it is important that designers take into consideration that people tend to view the screen from left to right and top to bottom. Information that is most important should be placed in the top left corner of the screen. Common objects should be placed together with white areas separating the different groups of objects.

It is important that columns and pictures etc. are aligned properly. Items that are not well aligned are less pleasing symmetrically and will give the appearance of clutter and make a screen more difficult to read (IBM Sept 2000 a).

4.2 Designing for Web

The development of the World Wide Web (WWW) has greatly changed the way people access information. The web browser is fast becoming one of the most popular forms of electronic interfaces being used today (Weibel, 1995). The popularity of the web browser is largely due to its simple layout, with easy accessible buttons such as forward, back, stop and print. This makes it easy to use even for first time users. The use of hypertext also provides links to more information so the original screen does not have to be as cluttered. Also, the Internet is built on free software so it is obtainable to most users.

The web browser has also made the life of the developer easier. With the convergence of the Internet and many programming languages such as Java, developers are now able to write software that can be used across a variety of platforms (Shneiderman, 1998). Users are no longer forced to buy particular hardware and software systems. Also, the basic development tools needed to

develop sites on the Internet have become simpler and cheaper so now even those with little technical expertise can become developers.

There are also many difficulties in relation to applications running on web browsers. Users can easily become disoriented and lose their way. Users also find it hard to know where they have been and to know if they have explored a site completely. Poor page and site design are other major problems; pages contain too many links or there is inconsistent organisation of material (Shneiderman, 1997a).

The web is fast evolving and more and more applications that run on web browsers are being designed. It is important for designers to keep users of all levels in mind when designing web-based applications. The Internet is moving from the early phase, which primarily provided people with information from Internet sites, to the second generation Internet, where applications are being designed for the web and intranets and extranets are becoming important commodities (Dreyfus, 1998). The second phase of the Internet is also getting much more complex and a lot more issues such as usability are arising. The slowness of the web was tolerated previously as it was new, but now companies are concerned over the cost-effectiveness of systems. Nowadays, users are expecting web systems to perform as fast as any network or computer system. Lynch said of the website design:

> *"Proper World Wide Website design is largely a matter of balancing the structure and relationship of menu or "home" pages and individual content pages or other linked graphics and documents. The goal is to build a hierarchy of menus and pages that feels natural and well-structured to the user, and doesn't interfere with their use of the Website or mislead them"*
>
> ***(Lynch et al., 1995)***

4.2.1. Web Design Principles

It is important to remember that the fundamental principles of design relate to any kind of communication between user and computer. Most apply to both traditional GUI environments and web design while others are relevant only to web design (Shneiderman, 1997a). Many applications designed for the web reflect a lack of understanding of the basic principles of design (Nielsen et al., 1998). Applying good design principles can be even more important when designing for the web. Web design principles can be classified under the following headings:

- Clear and Simple
- Understand Users
- Consistency
- Speed and Responsiveness
- Error Detection and Prevention
- Online Help System
- System Status
- Control Design
- Display Attributes
- Page Design
- Text
- Colour
- Navigation
- Orientation
- Position and Alignment
- Platforms
- Security

The principles are explained in more detail in the following sections.

4.2.2 Clear and Simple

One of the problems with web-based applications is that they can contain too much information and too many links to other pages/sites. The user can easily get lost and

confused. It is important that the site or application is kept simple and that users can always get back to where they were (Hobart, 2000).

Designers should not get heavily involved in using the latest web technologies. They may look good initially but most users care more about the content and speed of a site. Content should account for at least half of a page's design, and preferably closer to 80% (Nielsen, 2001). Care should be taken when using technologies that have not been properly tested as if the system crashes, the user will be left with a feeling of frustration and will not come back to the site/application. The use of too many technologies and gimmicks will distract from the content of the site. It will also slow down the time it takes for a site to download or an application to respond (Shneiderman, 1998). Often the users do not have the ability to view the new technologies and have to download new components. This can lead to users leaving the site immediately and not returning.

It is important that the pages/application are readable in all formats and common web browsers. Often users have very old versions of browsers or if they have old computers/modems they turn off the graphics. Use as little text and graphics possible to get your message across (Nielsen, 1997). Keep the look of the site simple as too many graphics can obstruct the users understanding and also the use of too many colours and fonts will be distracting to the user.

Clarity is also vital on the web. Designers should try to avoid using technical terminology (unless the site is geared at a particular audience). Informal language should be used with simple examples given whenever possible (Whitten et al., 1998).

Sentences and paragraphs should be kept as short as possible and information should be presented in bulleted form where possible. Studies carried out by Nielsen (1997) found that simple and informal writing is preferred.

4.2.3 Understand Users

It is important that designers know exactly who will be accessing their site/application (Murray et al., 1999). It is impossible to design correctly for unknown users. Creating a site for a specific audience gives designers increased flexibility. This can be especially important when considering the use of multimedia in a site or application. If an audience is clearly defined then they can be required to use specific browser software and plug-ins.

If the user is not a casual visitor, and they are viewing a site specifically to view something of interest to them, lengthy download times and more demanding site interaction will be tolerated (Shneiderman, 1997a). Also, if a site or web-based application is designed for use in a university or a large organisation, it is likely that the user will be accessing the web server at much higher Ethernet speeds therefore designers can be more ambitious with the use of graphics and multimedia. It is very important that designers know if any potential users have physical disabilities such as poor vision, colour blindness as this would require special design considerations. Design should always include feedback obtained from users to see if they are satisfied.

A well-designed site gives users a sense of freedom and control. Users will not want to use an application or visit a site if they feel they have little freedom or control. The use of a wizard for complicated tasks is considered an exception to this rule. Most users like to have the option of being able to use an automated wizard to automatically complete a number of complex or tedious steps for them. Well-designed sites should be able to accommodate a range of user skills and interests. The more novice the user, the clearer the site will have to be. If users do not find the homepage attractive they will not go further into the site. A "frequently asked questions" page and a glossary of any technical terms used is often helpful for novice users. More experienced and frequent users will be less patient. They will expect to find the information they are looking for fast. They can handle more complex and faster menu systems.

4.2.4 Consistency

Consistency is especially vital on a web-based application. The design of screens and colours used must be consistent if the user is going to be able to successfully navigate the site. The standard links used by most web browsers are blue and the links that have been visited are purple. Links should always be underlined. Users automatically know from past experience that clicking on an underlined phase will take them somewhere else (Nielsen, 2000c). Using standard links lets occasional and new users immediately know which pieces of text are hyperlinks and which are just plain text. It also makes it easier to see which links have been visited. If the standard link colours are deviated from, care should be taken to ensure that the user knows what the new colours stand for and that the links stand out clearly. It is

important to be consistent throughout the application, as this will allow users to learn what link colours represent.

A proper layout should be established at the very beginning. Designers should try and establish a grid system with a specific area for text and graphics. This should then be continued right through the site/application (Nielsen, 1997). This will help make a site more memorable and will allow readers to gain confidence and adapt to the site/application much faster. Consistency and predictability are essential to the success of a site/application. All controls, inputs, feedback etc should always be consistently placed on the screen. Other items that should be consistent include headings, fonts, colours, terminology, controls and functions. A consistently designed site speeds up navigation, minimises the users frustration, and builds up their confidence in using the site.

4.2.5 Speed and Responsiveness

Speed and responsiveness are probably the most vital issues concerning the web. The performance of applications can be limited by bandwidth problems. Generally the Internet does not deliver the response times to which one is accustomed to when using standalone applications. This can be a cause of user frustration. It is important therefore for web designers to prioritise different criteria than they would if designing for a standalone application. Users have little tolerance. If a page is taking too long to download they will not wait.

It is important not to overload pages with graphics and large tables that take a long time to download. If a page is too long the user will not scroll down to see it (Nielsen, 1997). Animation will also slow down users both in the download speeds and also it will distract them when they are working. Multimedia and animation should be used sparingly. Often designers limit their use of multimedia and animation to the opening page. This opening page, like a cover of a book, is intended to entice users into the site. If the site or application is to be accessed by users using modems then large objects such as digital video should never be used. The use of digital video should be confined to use on an intranet when the browser and system specification used is known and can be controlled.

According to Nielsen (2001), the limit of the users ability to keep their attention focused while waiting is 10 seconds, therefore, this should be the minimum goal for response times. It has been found that on the web users have come to expect delays and slow downloads and are more tolerant of them. It is thought that the response time can be increased to 15 seconds (Nielsen, 1996). The main navigation area should download fast so that users who have been to the site or used the application previously do not have to wait for the whole main page to download. Also a text index should be available for quick access to all pages of the site.

It is important to always inform users when entering a high-bandwidth area. The users should always be given the option before they enter. It is good design to offer an alternative, such as a text based, or low-bandwidth version, for users who do not have fast modem speeds (IBM, Sept 2001). The users should also be informed of any browser software and plug-ins that are required before they enter.

4.2.6 Error Detection and Prevention

The same error detection and prevention principles used for traditional interfaces should be used with web-based pages/applications with a few extra considerations. All documents should be run through a HTML validator, as often pages look fine when checked on some browsers, but will crash on other browsers. Using a HTML validator will help to identify and eliminate embedded HTML errors which cause pages to crash.

Pages should be checked on a number of different browsers and also on a number of different versions to check compatibility. The designers should also look at the site in a text only view. This will demonstrate what the sites looks like on systems where the graphics have been turned off, and whether the site is still readable and navigational.

When using forms on the web, they should be broken up so if an error occurs on sending the form, the user will not have to fill the whole form in again. The user should be informed at the start that there are multiple sections coming up (Skaalid, 1999).

Due to the dynamic nature of the Web, documents are constantly being moved, deleted or changed. Broken links will cause users frustration. Regular checks should be carried out to make sure that all links are up to date and are consistent. This is especially important for hyperlinks that connect to external sites. A site that has very few errors and broken links, gives the user the feeling that it is well maintained, up to

date and will give them more confidence in the content. Automated link checkers can be obtained that will check and remove broken links on a variety of platforms.

4.2.7 Online Help System

Online systems should always provide help systems. It is important that the help system is in an online form. Nielsen (2001) states the following basis rules for online documentation:

- Users only turn to documentation when they have a specific problem, therefore it is essential to make the documentation pages searchable.
- Online documentation should include numerous examples. Users find it easier to follow examples and then modify them to their own circumstance.
- Instructions should be task-oriented and emphasise how to do things step-by step.
- It is a good idea to provide a short conceptual model of the system, often including a diagram that explains how the different parts work together.
- Hypertext links should be used to link any difficult concepts or system-oriented terms to a glossary.
- Be as brief a possible.

A good online help system will make systems easier to learn and will lead to less mistakes being made. It can also contribute to users satisfaction for the system.

4.2.8 System Status

It is even more important than with a traditional stand-alone application that a web-based application or site gives the user proper feedback to their actions. This is

easily done on the web using DHTML and JavaScript (Skaalid, 1999). Objects should always respond in some way, e.g. a button could make a sound when clicked to let the user know that something has happened or the image might change periodically when clicked. Another way of providing feedback on web browsers would be to use rollover buttons, which cause the image to change when the mouse is held over the button.

Designers should make sure that the user has constant confirmation of their status and the options available to them. This can be achieved by using graphics, navigation buttons or hypertext links. It is important when designing for the web that you allow for multiple clicks of the same button or object, as the Internet is slower than normal applications and users often tend to press the same button repeatedly (Nielsen et al., 1998).

When designing feedback mechanisms designers should always incorporate a facility to respond to users inquiries and comments. Users should have a direct link with the site's Webmaster or whoever is responsible for the upkeep and maintenance of the site. Providing this kind of feedback will help keep the information relevant to the users and will contribute towards making the site a long-term success.

4.2.9 Control Design

When designing the controls and navigation through a site, research suggests that several large menus work better than a large number of menus with smaller amounts of links (Shneiderman, 1998). Research, which studies breadth versus depth in

menus, suggests that "breadth should be preferred over depth...when the depth goes to four or five [levels], there is a good chance of users becoming lost or disoriented" (Chisholm et al., 1999). For straightforward searching, hierarchical menus work best. Embedded contextual menus however will aid more complex searches.

4.2.10 Display Attributes

Page elements that are constantly moving should not be included in a web page or application. Moving images distracts the user (IBM, 2001). It is also difficult to predict how fast or slow the animation will appear on the users screen, depending on their browsers and connection speed. If possible the need to have plug-ins to view objects such as audio, animation and video should be avoided. A large number of users may not have the plug-ins required and will receive a dialog box informing them that they do not have the necessary plug-in and asking them if they wish to download it. A large proportion of users will be lost at this stage (Nielsen, 1998a). Another disadvantage of plug-ins is that they can quickly become obsolete.

Care should be taken that any animation used is meaningful and adds to the site rather than distract from it. Attention should be paid to the file size and the benefits should then be weighed against the disadvantages (Nielsen, 1995a). It is important that any graphics/multimedia elements used are of excellent quality. When audio or visual elements are viewed on web resolution, any flaws in the original will be emphasised and exaggerated. The ALT tag should always be used to properly describe graphics, as many users do not wait for all graphics to be downloaded.

4.2.11 Page Layout

4.2.11.1 Layout

When designing a page for a website/application, care must be taken in the layout. Elements such as frames should be avoided. These usually cause trouble for users (Nielsen 1996). The page displayed often cannot be book marked as when you return to it the bookmark will point to another version of the frameset. It is more difficult to print from a frames page and this makes the predictability of users actions more difficult.

It is important to plan before starting. Designers should determine the main purpose of the site, the target audience, how to reach the target audience, what type of browser/modem/computer screen they have and what is the budget available. It may be difficult to get all this information, however, certain assumptions can be made (Shneiderman, 1998).

Attention should be given to the limitation of the target audience. According to cognitive psychologists most people can only hold about four to seven discrete chunks of information in short-term memory (Skaalid, 1999a). The designer must therefore aim to keep the number of items the users must keep in short-term memory as low as possible. This can be achieved with the use of graphics and good layout and the use of on-screen prompts.

4.2.11.2 Title

The title of a page is important, as it is often the first thing the user sees and the main reference to a page. It will be what the browser uses if you decide to bookmark the page (Nielsen, 2001). Different pages should be given different titles as otherwise it would be difficult to find a specific page in the history and also there will be problems with book marking pages (Nielsen, 2001). Pages should be dated and should also contain revision dates.

4.2.11.3 Hypertext

It is important to remember that web pages are different to other screens in that they contain hypertext links that allow the user to access directly any particular single web page and browser in no particular order. It is vital that web pages are reasonably independent. Elements such as headers and footers should be more informative than with a normal application, as a single particular page may be the only part of the site/system the users ever looks at. Every page in a site/application should be kept as freestanding as possible and should contain items such as the title, author, date, links to home page etc (Skaalid, 1999a).

4.2.11.4 Content

The amount of information that is put on a single page should be kept to a minimum. All the critical content and navigation options should be near the top of your page. According to Nielsen (1997a), studies have shown that only 10% of users scroll beyond the information that is visible on the screen. Even

though this figure has increased in more recent studies (Nielsen, 1996), it is still better where possible to keep scrolling to a minimum.

The division of information into easily obtainable units can lessen the burden on the users short-term memory. Information should be organised into chunks that deal with one particular topic or idea. This will make a site more functional and easier for the user to navigate. Users do not like having to scan through long chunks of text to find the information they require (Nielsen, 1997a). Good layout should be easier to achieve using browser technology as the information can easily be organised and referred or linked to with the use of hyperlinks. The only problem with this type of segmentation is that it is difficult for the users to print, therefore designers should also include a link to a printable version (Skaalid, 1999b).

Information should be organised sequentially if possible. This can be chronologically, by topic, alphabetically or by other methods. As websites become larger this becomes more difficult. The best way to organise larger and more complex system/sites is to use an information hierarchy. This is particularly suited to web browsers and users can easily grasp the layout. When designing for the web care must be taken not to limit the user to too strict a hierarchy. Links should be provided directly back to the main topics and also directly back to the home page.

4.2.11.5 Graphics

The amount of graphics on a web page should be minimised, as they cause long download times. Opening pages should not contain many illustrations, as the user has not yet indicated a concrete interest. As the user moves further into the site to more specific pages, more images can be added (Nielsen, 2000).

4.2.11.6 Author

When putting a web page on the Internet it is vital that the user is informed who the author is. There is an increasing amount of information on the Internet with no governing controls, so the users need to be able to authenticate the information they are viewing. The website will have to be carefully designed to convince users that the information contained in it is accurate and reliable (Nielsen, 2000c). Web applications/sites must display high editorial and design standards. Information and links etc. should be regularly checked and updated.

4.2.11.7 Balance

Often designers forget about the importance of correct balance when designing screens (Skaalid, 1999b). If a screen is not properly balanced it creates a feeling of tension and also draws the users attention to one particular part of the screen. Screen balance can be affected by the size of objects and also by aspects such as colour and lightness/darkness. There are two ways of achieving balance across the screen (Skaalid, 1999b). The first is by achieving symmetry. This is where all items on one side of the screen are

corresponding with the items on the other side of the screen in shape, size and colour. The second type of balance is asymmetrical. This is where a large item is balanced on the other side by a number of smaller items. Often when several small items are used on one side of the screen it can be balanced by using a darker item on the other side. Asymmetrical balance is much more informal than symmetrical but is also much more difficult to design.

4.2.11.8 Quality Process

A vital step in designing web pages is to have an established quality process for all Web documents. This will help prevent errors and losses. A measurable set of standards should be set out. These standards can evolve over time but care must be taken in making any changes to quality standards. It is important to stick rigidly to these standards throughout your web pages. Standards should be quantitative wherever possible as quantitative criteria will be much more reliable and stable and are less subject to interpretation (Sullivan, 1997b).

4.2.12 Text

Users generally scan blocks of text and pages to find the particular information they require (Nielsen, 1997a). The use of bulleted lists, headings and highlighting of key words will aid this (Nielsen, 1997d). Paragraphs should be kept short. Nielsen (1997a) advocates avoiding the excessive use of white space, as it can hinder scanning. If you have large amounts of text, the user should not be expected to read it online. Research shows that reading from a computer screen is about 25% slower than

reading from paper (Nielsen, 1997a). A printable or downloadable version should be provided. All text should be left justified. Having a set starting point for the eye to start scanning increases the speed at which a user can read. Text that is centred or right justified will slow down the user (Nielsen, 2000).

When designing on the web major HTML headings should be used sparingly. The HTML heading tags H1, H2 etc. (which make text larger and darker) give the designers little freedom and they tend to be overly bold. An alternative to this is to use physical style controls of HTML. With this method you can make text bold, underlined or italic without increasing the text or alternatively increase the text without making it bolder. This method is becoming more popular but does have one disadvantage. The HTML heading tags are designed to break up text into major titles and subtitles. Automatic indexing and text analysis programs will usually not recognise heading unless these attributes are used (Neilsen, 2000).

When choosing a font face, only the most commonly used typefaces for both Macintosh and Windows should be used (IBM, March 2000). If the browser is unable to display a particular typeface it will switch to the default font with is usually Times or Times New Roman. To increases the chances of browsers being able to read the font chosen, multiple fonts can be listed in the FACE attribute. The browser then checks for the presence of each font before it will default to the standard. Any non-standard fonts used should be made into a graphic in order to be viewed on all browsers. The use of all caps for text should be avoided. Users read all caps about 10% slower than they read text in mixed cases, as it is harder for the eye to recognise the shape of words and characters in uppercase (Nielsen, 2000).

Avoid the use of flashing or blinking text. This is distracting to the user. Plain backgrounds make text more legible than patterned backgrounds. Text should be kept to a minimum of 12 – 14 points, depending on the character size (IBM, March 2001).

4.2.13 Colour

When choosing colour for the web, designers should limit the colours they use to a 216-colour palette as this is considered a web safe colour palette and will give more consistent results on most browsers. It is important to test how a page prints. Dark fonts on a light background will print out best. It is important to remember that different screens will have different resolutions so blue on the designers screen could appear green on the users screen.

Care should be taken not to rely on colour alone to convey information, as this will hinder people who cannot differentiate between colours (Chisholm et al., 1999). Use colours with high contrast between the test and the background. If foreground and background colours are too close to the same hue it may not be possible to differentiate between them when viewed on lower colour capacity monitors (Chisholm et al., 1999). Optimal legibility requires black text on a white background (Nielsen 2000). The use of colour should only be used to provide clarity and functionality (Skaalid, 1999 b).

4.2.14 Navigation

This principle is even more important for web design than for traditional graphic interfaces. On the Web, people are moving through a very big information space. The requirements for clear navigation are much more severe than in PC- style applications. (Nielsen, 1995b). There is so much information on the web that it can be difficult for the user to find what they are looking for. Designers should try to ensure that travelling through the site is as simple as possible.

4.2.14.1 Clear and simple navigation

The link structure should be consistent and simple throughout the system. Links should not contain more than two to four words. Nielsen (2000) strongly recommends including additional (non-anchor) verbiage that explains the link. The number of steps needed to locate an item should be kept to a minimum (Trump, 2001). It is important to remember that users will not be able to build elaborate mental maps and can easily become tired and frustrated. Nielsen (2000) states that navigation should be kept below 20% of the space for destination pages, although navigation options may account for much higher proportions of home pages and intermediate navigation pages. Nielsen also states that it is vital for the user to know at all times "Where am I?". The user's current location needs to be shown at two different levels: (Nielsen, 2000)

- Relative to the Web as a whole
- Relative to the site's structure.

Nielsen also states that the number one rule in navigation is to include your logo or other site identifier on every page. This logo should have consistent placement in the page. Listing parts of the site structure and highlighting the area where the current page is located can show the location relative to the site's structure.

4.2.14.2 Invisible navigation

The WWW tends to have an invisible navigation. It is difficult to ascertain how many pages are on a single site/application when one first enters. It is important to reduce navigation to a minimum and make navigation as simple and natural as possible (Orubeondo, 2000). This will help reduce the need for navigational maps and give the users a greater sense of control. In a complicated system a map or navigational aid should always be given. Users need a strong sense of structure and place. It is important to make things visible. The alternative actions and results of actions should be clearly visible. An overview map of the site will help users form their own mental map of how the site works. A search feature can be a useful addition to a site map for larger sites/applications (Spool et al., 1997).

4.2.14.3 Label pages and buttons

Pages should be clearly labelled so that users know exactly where they are. All pages should include a clear indication of what website/application they belong to (IBM, March 2001). With web browsers many users will not be accessing a particular page through the main page but will be coming directly into the page. Every page should contain a link to the home page and to other

pages and also to the site map (IBM, March 2001). These links off every page will give the user more confidence in using your site. Every single page should contain at least one link. Dead end pages frustrate users and also are a missed opportunity to encourage the users to visit other parts of the site (Bevan, 1997). You are essentially locking the user out of the rest of your site. The users should always know immediately where they are and what their options are. Navigation buttons on the top and bottom of a page minimises the need for the users to keep scrolling (IBM, March 2001).

It is important that the user knows exactly what the function of a button or menu is. Designers should stick to conventions that are already established for the web and that users are already familiar with e.g. an underlined phrase on a web page is known to the majority of users as a link to somewhere else (Skaalid, 1999a). Designers must take care to use the same URL to refer to a given page. If one link uses one URL and another link uses a different URL the browser will not know that both links lead to the same page (Nielsen, 2000).

4.2.14.4 User controlled navigation

Web designers need to accommodate and support user-controlled navigation (Nielsen, 2000). On the web, users will choose which path to take through the website. They can also go into the site without ever going through the site's home page. It may be possible to force users through a certain path but this often discourages users.

4.2.14.5 Structures

The following sections draws heavily from Nielsen 2000. Web browsers need to have better support for structural navigation. They need to incorporate features for visualising the relationships among the pages visited by the user. Going through an application on the web provides the users with more options and usually more hyperlinks to other pages. Meaningful structures must be provided. It is important that the user is able to get back to where they were at all times. This can be accomplished by having objects or cues that let them go back or home in a single click (IBM, March 2001). Problems sometimes arise where the designer and the browsers use different models. A web designer may create a linear structure using Next and Previous links to take the user through a number of pages. Netscape however says that any user-initiated link is a step forward, regardless of where it is and the back button retraces the link the user followed (User Interface Engineering, 2001). So if the user clicks previous they might be brought back to the same page there were on in another site rather than the page previous to the one they are on now. This leaves the user confused as to what back might mean - the page they were last on or the page that comes previously in the linear structure.

Poor site structure will always lead to poor usability. Most sites have a hierarchical structure with increasingly detailed levels of information. Other sites have a tabular structure with pages arranged relative to a number of attributes or parameters. Linear structures are the best for Web-enabled applications that are a progression of steps but not for websites as the web is

inherently non-linear in nature (Nielsen, 2000). The site structure should be determined by the tasks users want to perform on your site, even if that means having a single page for information from different departments.

4.2.15 Orientation

Orientation is crucial to web pages since users may enter your site at any level or page. Orientation lets the users know when they are in a site, similar to page numbers or chapter headings in a book. A well-designed site will have orientation information positioned in the same place on every screen. There are many ways to ensure that the users does not become lost or disorientated, such as overview diagram, guided tours, history list, bookmarks, embedded menus etc. According to Lynch and Horton (1997b) the following items should be present on every page of a site to aid in orientation:

- The title
- The author
- The author's institutional affiliations
- The revision date
- Links on each page which will move the user to the next or previous page in sequence
- A link to the local home page.

Nielsen (1997e) identifies the following items as important in aiding users with navigation:

- Include a site identifier on every page

- Make it easy to go to landmark pages such as the homepage or the search page
- Do not change the default colours for links and visited links
- Keep underlines intact for monochrome viewers
- Draw a sitemap or use some other orienting devices to illustrate the relationship between main areas of your site.

4.2.16 Position and Alignment

Page layout and position and alignment are especially important for web-based applications as usually only about the top four inches of the page is visible on a typical 14 to 16 inch monitor. Designers should take into account that some users will not bother to scroll down to see the rest of the page, therefore the most important information should always be situated on the top of the page (Skaalid, 1999a).

4.2.17 Cross-Platforms

With traditional GUI design, every pixel on the screen is controlled. This does not happen on the web (Nielsen, 2000). The end user of a web-based application has the freedom to choose the technologies with which they wish to use the Internet. It is important that the application is designed to run on cross-platforms.

Increasingly the operating system is not the key technology factor in user interface design. Most browsers run in many operating systems making it possible to design a user interface that is less dependent on the computer. This is sometimes referred to as platform independence (Whitten et al., 2001). It is not good design to try and limit

the users to use a particular browser and a particular version (IBM, March 2001). Designers must accommodate users with older versions of browsers, slow modems or users who have turned graphics off.

Designers need to take into account different screen sizes and different colour displays and graphic cards. It is better to create page layouts that will work across a range of window sizes as even users with bigger screen sizes may not have their windows maximised. If you choose to design for a specific size try to stay under 600 pixels in width. The use of 600 pixels instead of 640 is important as several pixels are used up by the browser's window borders (Nielsen, 2000). The following table shows the distribution of screen sizes used to access the Internet in 1997 and 1999. The figures show that in the two-year period there was little growth in users with large screen (Nielsen, 2000).

Table 4-4 **Distribution of Monitor Size in 1997 and 1999**

Screen Size	1997	1999
Very Small (640 x 480 or less)	22%	13%
Small (800 x 600)	47%	55%
Medium (1024 x 768)	25%	25%
Large (1280 x 1024 or larger)	6%	2%

Source: ***Designing Web Usability, Nielsen, Jakob (2000)***

Every Web browser interprets HTML tags a little differently therefore pages should be thoroughly tested on different browser types and versions.

4.2.18 Security

Security is a much more important issue with web-based applications. Businesses require a high-level of security for Intranets and Extranets. They need to be assured that browser software does not leave the users system security breached and that unauthorised people cannot gain access to private data.

Designers must have a good knowledge of the above design principles and of how to incorporate them into the user interface. Applying good design principles is very important when designing for the web as users will easily become frustrated and leave a site. A well-designed site is one that is easy to use and supports the users objectives.

4.3 Usability

Web users have an overwhelming choice. In January 2000 there was about 10 million sites on the web and this was expected to increase to 25 million by the end of the year and a hundred million by 2002 (Nielsen, 2000). As of August 2001 the number of people online is 513.41 million (Nua, March 2002). Users have so much choice that they tend to be impatient and insist on instant gratification. If they can't figure out how to use a website in a minute or so, they will leave (Nielsen, 2000). Good usability helps keep users on a website. Generally a web interface that is considered usable is one that is accessible, appealing, consistent, clear, simple, navigable and forgiving of blunders (Murray et al., 1999). Up to recently website design and development has been mainly driven by technology and by organisational objectives rather than by the needs of the user (IBM, March 2001). Today usability

is assuming a much greater importance in the Internet economy (Nielsen, 2000). Incorporating usability for the web will have more difficulties than incorporating usability for software for stand-alone applications due to the following: (Murray et al., 1999).

- The web audience spans across a wide range of demographics and is of a global nature. This makes it difficult to define who the target audience will be.
- The same site can look very different for different users due to end user configurations (hardware, software, browsers, connectivity and bandwidth).
- Users have extremely high expectations of user technology and this can be difficult to achieve.
- The development lifecycle for the web is much shorter than traditional stand-alone applications making it more difficult to incorporate usability into the design.
- On the web there is such variety that users will have other options readily open to them.

The International Standards Organisation provides the following definition for usability:

> *A system can be said to be usable when specified users, in specified circumstances, with specified goals, can use it with effectiveness, efficiency and satisfaction.*
>
> ***Corporate Solutions Consulting (Feb 2001)***

Usability is about much more than making web pages easier to use. The key to website usability is to ensure that the site is not only usable by the intended audience but that it is also useful to the user. Usability starts even before the design of the

pages begins. Usability should control the early stages of projects before the designers are brought in (Nielsen and Tahir, 2000). It should define what the system should do, what features it should encompass, and how users' tasks will be supported. If these elements are not correct at the start then no amount of application of good design principles will make the system a success.

Usability is one of the most important aspects of websites, yet it is often the most neglected. If users can't use your site they will quickly leave and seldom come back (Murray et al., 1999). Too many developers take shortcuts and are tempted to shorten the development lifecycle and head straight for design. More and more websites are being published in a rush and need to be updated immediately and constantly. Designers have had to become experts at constructing fast designs and getting sites up quickly. Often the user is forgotten in this quick process and the end result is a website that users do not find useful or enjoyable.

Most users consider that a usable web interface should be clear, simple, easy to navigate, consistent, accessible and allow them to make mistakes (Neilsen, 2000). Lack of implementation of usability principles will mean users cannot find the information or sections they need. A well-designed and usable system will minimise the cost of training and support.

Up to now the greatest usability barrier has been the use of flashy designs that were difficult to use. This has started to change. Companies are now paying more attention to websites. Their website has to meet the purpose intended and not just look good. Their public sites must be easy to use so that users will not leave. The

aim now is to make it easy for customers to do business (IBM, April 2001). Intranets are focusing on making the employee more productive so they are being redesigned to be simpler and easier to use. More and more companies are focusing on the user and are paying attention to their usability needs.

4.3.1 Define Target Audience

To design a usable site, designers must have as much knowledge and understanding of their intended audience as possible. First the designers will have to try and identify their target audience (Murray et al., 1999). They then have to try to find out about their needs, characteristics and abilities. This will be discussed further in the design process.

4.3.2 User Centred Design

The key to building a useful and usable website is to involve the user in the development process from the beginning (Murray et al., 1999). The most important factor in any website is the user. All good designers must place the user at the centre as they develop, whether they are developing an Intranet database application or an ordinary website. It is important to try and understand these users so that designers can build websites/applications that support their desired behaviours (IBM, Feb 2001). Understanding users is important for any systems development but is especially important on the web, as users have little patience with problems.

Good user centred design will anticipate problems the users will have and provide for them beforehand and will also involve the users throughout the design process. It

will also ensure that the site is as easy to learn as possible and that the final product fulfils the users' wants and needs. Usability can cut training costs by 75% (Nielsen and Pernice, 2001).

4.3.2.1 Sites Visits

Before setting down to design your web-based application, developers should first try to learn as much as possible about the user. It is good practice to observe users in their natural environments (IBM, Feb 2001). This will help identify the exact needs of the users, and the tasks that need to be accomplished. Developers can watch the way users presently do their tasks and then see ways to improve on it. Observation will help identify and prioritise the tasks users are trying to accomplish and will also identify which issues need resolving. Site visits will also allow the developer to evaluate the usability of existing sites and examine how they support the user tasks. They can then determine which aspects need improvement or redesign and which are working correctly.

4.3.2.2 Participatory Design

It is important to remember when designing a site that what is obvious and simple to you, an experienced user, may not be quite as simple to your users. The more instruction and navigational aids you give them, the better their experience will be. Developers can sometimes find it difficult to get past their own beliefs and biases. One way around this is to adopt participatory design where the users become involved in every step of the design process and have an actual input into it. It is important that the users review the

system, as it is being designed and developed. This will allow developers to save time in the overall design and development of the system as problems can quickly be spotted and easily rectified. This user-centred approach focuses on the user's requirements. It is important that users requirements are identified, defined and validated as early as possible as requirement errors are the hardest and most expensive to fix.

User centred design will result in much more effective system. It will also greatly increase user satisfaction as users will feel part ownership of the system and also that they are adequately supported in their jobs. As the user was involved in the development process they will be familiar with the end product and will therefore need less training. Also the system will be designed to match the way they perform their tasks so it will be easier to learn. Good user centred design will also ensure that the system is monitored throughout its lifecycle and that user feedback is responded to (IBM, Sept 2000b)

4.3.3 Prototyping

Prototypes are useful in designing, analysing and understanding the user interface of a computer system. Prototypes should be designed early on in the design process and shown to users throughout the process to test the design (Klee, 2000). Prototypes can range from simple paper sketches of the proposed screens to much more complex prototypes with mock screen designs that look like the finished product (IBM, Feb 2001b).

Usually a prototype, no matter how much it looks like the finished product, will have limited functionality. They are designed to obtain feedback from users and to let them get a feel for the system (Farrell, 2001 b). Users will test the prototypes and their performance and the designers will note any comments they make. Based on this, the designers may make alterations to the prototype. The prototype will be tested after all modifications are made and then will be retested until users and designers are happy with the design. Prototypes provide a quick way to obtain direct feedback from real users (Klee, 2000).

Paper prototypes have an advantage of being quick, easy and cheap to prepare. Also changes can be made immediately to a design during a test and immediate feedback obtained (Farrell, 2001 b). This will save a great deal of time overall. Users also feel more comfortable being critical of a paper prototype as they feel that not as much work has been put into it and it is less formal (Klee, 2000).

When designers are happy with the design they will go on to develop a pre-release or beta version of the system. This version will have all the functionality of the final system. The beta version will be given to users for their evaluation, before being extensively tested for errors.

Prototyping saves time and money. Users will be much more honest about an unfinished product than they would about a final version as they feel it is too late to make a change. They will make suggestions more comfortably if they know work still needs to be carried out regardless. Different versions can be quickly tested and

decided on by the user. This will allow users to be more experimental and also feel they have had a part to play in the system design (Farrell, 2001b).

4.3.4 Usability Inspections

Usability evaluations and inspections can be carried out at intervals in the design process. This will involve having an evaluator inspect individual interfaces and identify problems in the designs. They can also analyse the usability of the system as a whole. Sometimes the severity of usability problems will also be determined (Murray et al., 1999). The person evaluating the site is usually a usability specialist or a high level developer. Evaluation by an expert can sometimes identify as many problems as testing with real users but should not replace this type of testing (Murray et al., 1999).

Usability inspections can be carried out from early on in the development cycle, right through to the end product. They do not need to be carried out on a working system, but instead they can examine prototypes, either computer or paper. These inspections are cheap and are a simple way of spotting problems early on. A high level of expertise is not required and one member of the development team can be easily trained to carry out these inspections (Murray et al., 1999).

When trying to evaluate a website, usually a small group of people will be used. Interfaces are then examined against a recognised set of principles. These principles are generally known as heuristics. Alternatively they may develop a customised set

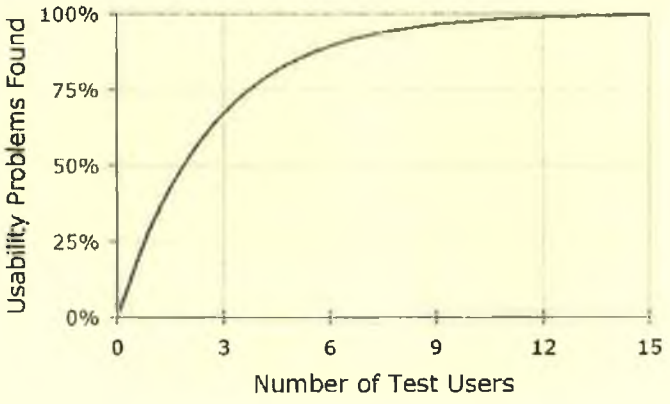
of principles that will deal with specific area of interest or issues. Problems that are found are then rated according to severity.

4.3.5 Usability Testing and Evaluation techniques

Software developers would never release any type of software without first performing thorough and extensive testing. Yet, many develop websites and do not take the time to do usability or user testing. Many designers consider user testing expensive and time-consuming and too difficult for them to do (Murray et al., 1999).

Testing does not have to involve a large amount of time or expense and a small number of users/testers can be successfully used. Jakob Nielsen recommends the use of about five evaluators, but certainly at least three, as different testers tend to find different problems (Nielsen, 1994 a). He has also recommended that the best results come from testing with no more than 5 users and running as many small tests as you can afford (Nielsen, 2000). (see figure 4.1)

Figure 4.1 **Percentage of usability problems found with different numbers of test users.**



Source: ***Why You Only Need to Test With 5 Users, Jakob Nielsen (2000)***

To perform accurate tests on a site, users who are representative of the target audience should always be used. These users should test by performing real tasks and they should explain all decisions and thoughts out loud (Murray et al., 1999). The results should be examined carefully. This will give designers a valuable insight to and feedback from the site and will identify trends and behaviour patterns that are likely to cause problems in the future (Murray et al., 1999). It will quickly identify problems that users run into and will show their areas of likes and dislikes and areas they have difficulty understanding or following. Users should be observed while testing the site, preferably in their natural environment. It is usually more beneficial to use an outsider, or someone not so familiar with the site to observe, as they can be more objective (Murray et al., 1999).

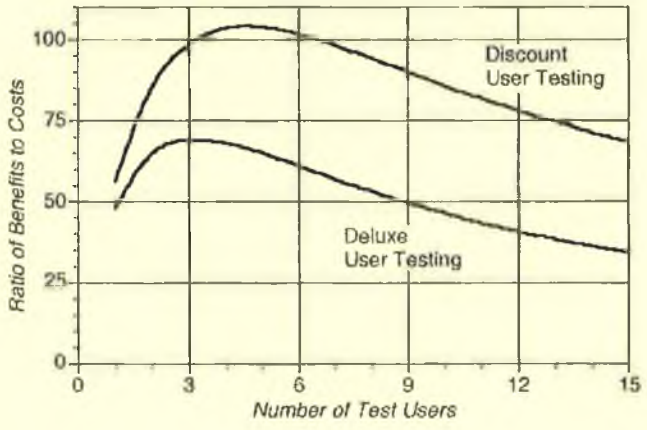
Testing should be carried out from the very start to get the best impact. The first user tests should be done on paper designs or mock screens that have no functionality. The more often you run design tests the more successful your site will be.

Testing should continue to be carried out even after the site has gone live. This should take the form of user feedback. Users should always be given the opportunity to and be encouraged to provide feedback. Electronic mail or an on-line questionnaire can be used to do this. All comments and the overall user satisfaction should be continually monitored. This form of feedback is effective at giving general indications of user satisfaction and can identify problem areas that can be further researched.

It is also possible to monitor a site by tracking file and server traffic. Log files will contain information such as the pages viewed, how long viewed for, where the user went from there etc. (Murray et al., 1999). It will also sometimes give information regarding the type of user browser and what sites they were in before and how they found your site e.g. search engine, typing the URL etc.

Large and more complex sites will need more complex testing. Testing of these sites will usually be done using a more traditional software testing methodology and more elaborate testing methods such as special usability labs, eye tracing etc. The results will be much more detailed and thorough. Elaborate testing will involve much higher expenditure but the benefits will still always outweigh the costs. The following figure 4.2 depicts the ratio of benefits to costs for both discount user testing and the more thorough deluxe user testing with different numbers of users. The highest benefits for both types of testing came when 3 - 6 testers were used.

Figure 4.2 **Cost Benefit curve for a typical project**



Source: ***Guerrilla HCI, Jakob Nielsen, (1994 b)***

4.3.5.1 Usability Engineering

Usability Engineering takes up a considerable portion of testing. Designers and developers should always have in place a measurable set of definitions by which the quality or the suitability of all deliverables can be judged (Corporate Solutions Consulting (UK) Ltd, 2001). It is equally important for both designers and the purchaser to have suitable quality measures defined. These definitions are known as usability criteria. They will list items such as who the users of the system will be, how and when the system will be used, the goals of the system, the quantity and levels of work the system must be able to process sufficiently (Corporate Solutions Consulting (UK) Ltd, 2001). These criteria will enable assessments to be made of whether a system passes the required levels of usability.

When quantifiable usability criteria have been drawn up, it is possible to perform usability engineering. Targets will be set and then the site will be tested against these targets and the design will be modified depending on the outcome and then retested until all targets are met. A lot of developers still do not use usability engineering as they see it as too time consuming and expensive and feel that the techniques are often too complex.

4.3.5.2 Usability Criteria

Corporate Solutions Consulting (UK) Ltd (2001) group usability criteria into five groups - productivity, learnability, user satisfaction, memorability and error rates. Alan Dix (et al., 1998) divides usability criteria into three main

categories - learnability, flexibility and robustness (Dix et al., 1998). These criteria are described in the following sections.

i. Productivity - This will look at how much work the system will be able to accomplish in a given time and how much faster will users be carrying out their tasks.

ii. Learnability - This will examine how much training the users will require before they will be able to proficiently use the system and the ease with which new users can begin effective interaction and achieve top performance.

iii. Flexibility - refers to the multiplicity of ways the end-user and the system exchange information. Users should be free from artificial constraints and be able to complete more than one task at a time. Flexibility also refers to the customisability of the system.

iv. User Satisfaction - This will look at how the users react and feel about using the system and whether they perceive any benefits.

v. Memorability - This will look at how quickly users will become familiar with the system and how easy the use of the system is to remember - will intermittent users find it easy to use after periods of non-use.

vi. Robustness - the level of support provided to the user in determining successful achievement and assessment of goals. This will cover the responsiveness of the system, how easily the user can recover after error, and the degree to which the system services supports the user's task and the users ability to understand them.

vii. Error Rates - This will look at the performance and accuracy of the system and examine the amount of allowable error rates, if any. Is the system prone to human error?

These criteria should be closely followed and monitored throughout the design and development to make sure the system is reaching its objectives. For usability criteria to be successful they should always be quantifiable.

4.3.5.3 Heuristic Evaluation

Heuristic evaluation involves having a small set of evaluators who will examine the interface check for specific usability principles. More than one person should carry out heuristic evaluation, as it is difficult for one individual to be able to find every usability problem in an interface. Involving multiple evaluators will greatly improve effectiveness, as different people will find different usability problems. The normal amount of evaluators is between 3 to 5 people (Nielsen, 1994a). Each evaluator will inspect the interface individually. After every evaluator has performed their check they will meet to aggregate their findings. This will ensure unbiased evaluations from each person.

During an evaluation, the evaluator will go through the interface numerous times and examine various dialogue elements and compare them to a set list of usability principles. The evaluator will also look at the overall interface and can add any observations that may not relate to the list. It is possible to

perform heuristic evaluations on single interfaces and on paper versions as the evaluator will not be performing tasks on the system.

After the heuristic evaluation has taken place, a list will be drawn up of all the usability problems in the interface and a reference to the usability principle that was violated. If there are a number of problems with a particular element they should be listed separately. Heuristic evaluation identifies the problems but does not offer a solution, but it is often easy to fix the problems identified by paying attention to the guideline that was violated.

4.3.5.4 Using Tracking devices to monitor users

The following information on tracking devices draws strongly from the articles referenced from the Heinrich Hertz Institutes Website (Nov 2001a). Eye tracking can be used to monitor user's behaviour when viewing a website therefore it can be successfully used to test websites. Eye tracking works by bouncing infrared light off a user's eyes and following the reflections to determine where the eyes are looking (Pastoor, Nov 2001b). This can tell us a number of things about the user's behaviour. Eye tracking can determine exactly where users are looking and can detect whether users are reading the web page or just scanning. It can determine how long a user will look at particular part. Eye tracking will be able to tell whether a user is searching for a specific item as the diameter of the pupil increases when users are not sure what words they are looking for. It can also learn the scan strategies of users. Studies have shown that this does not tend to vary much from user to user. Also there is little difference between users new to the web and experienced

users. Users generally scanned from centre to left and then right. Animation and bright colours will attract the users gaze. Users also tend not to look at the bottom of a screen. If they see information they want in this area they will scroll it up to the middle of the screen (IBM, March 2001).

There are limitations with eye tracking, as it cannot determine whether a user actually sees something, only that its gaze was on that area for a short time. Users may also see something that they did not look directly at through their peripheral vision. This will not be accounted for when using eye tracking. Eye tracking cannot be used on certain segments of the population such as those who wear glasses or hard contact lenses, people with wandering eyes or people who smiled often as this causes the eyes to squint.

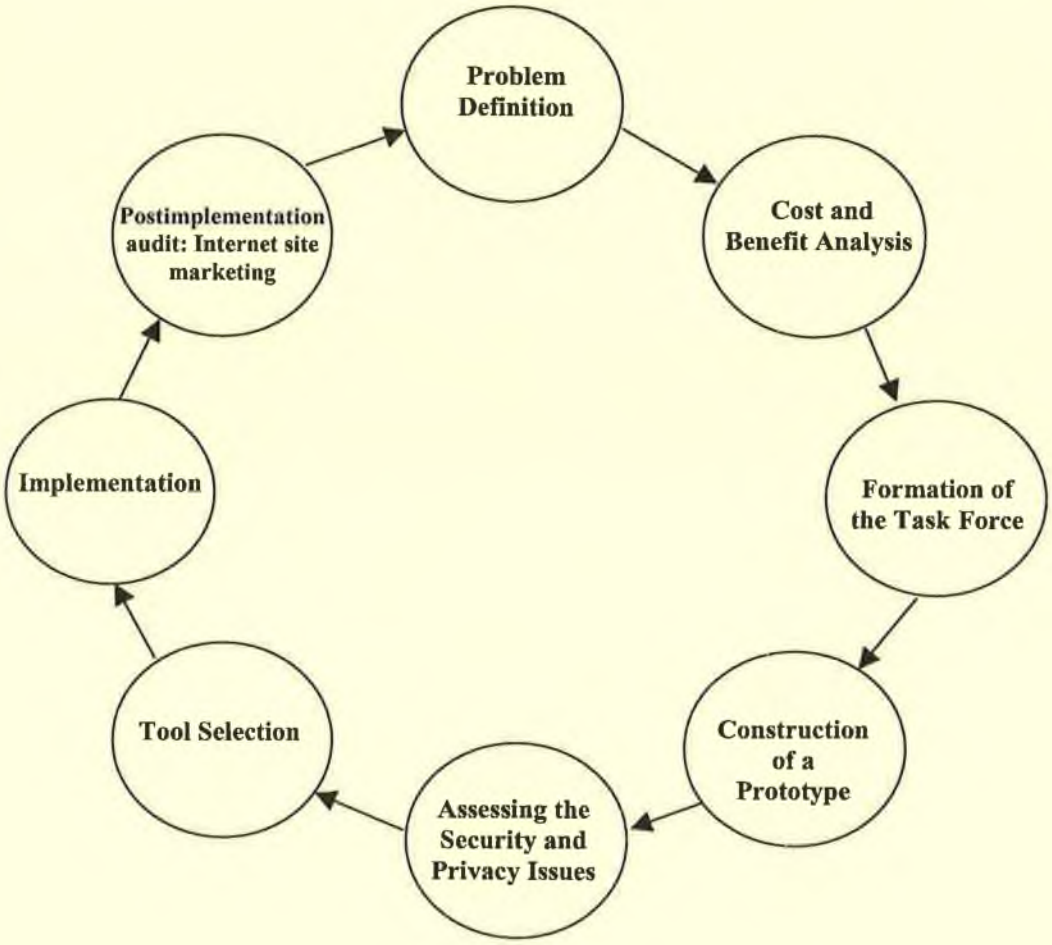
4.4 HCI Lifecycle for Web Design

Developing a website application or an intranet site is similar to other information systems in that a formal life-cycle approach should be followed. This life cycle will be slightly different from the traditional life cycle as web applications have many differences than traditional information systems (Bidgoli, 1999). There are many different frameworks or methodologies that can be used in the development lifecycle of a website or application. Most methodologies follow a similar process or set of steps. Designers will usually adopt a methodology that can also be used in the design of a stand-alone application and make alterations to it.

The main steps taken in the design process are the same as designing a website/application and a stand-alone software application but there are also a

number of different considerations that will be discussed later. The steps in the lifecycle are usually iterative, with designers returning to earlier stages for some part of the system design (Dix et al., 1998). Most methodologies used will usually take a similar format to the one below. It is important to remember that a well-defined design process that is specifically geared to producing quality results is the best way to ensure quality user interface design (Common Front Group, 1995).

Figure 4.3 Phases Used for Developing an Internet Site



Source: ***An Integrated Model for Introducing Intranets, Bidgoli (1999)***

4.4.1 Design Preparation

4.4.1.1 Define Goals

Before you start your design process it is vital that you have defined a set of goals and have a clear picture of what you are trying to achieve (IBM, March 2001). You must decide what do you want your site to accomplish. If this is not properly thought through at the start the project will run off course or may not accomplish what was intended. These goals should be quantifiable such as 20% increase in workload, 10% increase in sales (Gilmour, 2001). Gilmour (2001) lists a number of questions that should be asked when defining the goals of your site.

- What is the site about?
- What is the site for?
- Who is the audience?
- What is the competition?
- Is the Web the right medium for me?

Goals should be kept as simple and focused as possible. It may be better to start small and build on later. The question - 'what is the site about' should be able to be answered straight away. Decide what your long-term goals are for the site. Do you want to make money from the site or is it just for advertising and promotion for your company. It is important to identify your audience and see what unique content you can offer them. Input and feedback should be obtained from your target audience and on your ideas and alterations and changes made (IBM, March 2001). Research should be

carried out to see if there are already successful sites on this area. When you have clearly defined your goals, reconsider whether or not the web is the best solution for your company.

4.4.1.2 Draw up Objectives

After the main goals have been defined, a set of clear and measurable objectives should be drawn up. This will expand on the goals already set down. These objectives will be used later to measure the success of the website/application (IBM, March 2001). A time period for these objectives to be achieved should also be laid out.

4.4.1.3 Identify Target Audience

After the purpose and objectives have been outlined the next step is to identify your target audience so that the site can be designed to suit their needs and wants. It is impossible to appeal to all users so a particular segment of the population may be chosen and focused upon (IBM, March 2001). This segment can be determined by looking at who will be interested or will benefit from the content of your site. Users may vary greatly ranging from novice users to expert users. Designers must identify whether the audience is internal or outside the company, what industry they work in, characteristics such as location and age etc. (IBM, March 2001). Systems may be orientated towards one particular group but if it is well designed it should also be able to accommodate a range of user skills and interests.

When the users and target audience has been identified they must be closely examined to determine their characteristics. The following questions should be answered: (IBM, March 2001):

- Why are they accessing the site?
- How experienced are they in this type of application?
- What are they looking for?
- What type of hardware do they have e.g. screen size, connection speed?
- What browsers will be in predominant use?
- How will they view the information - onscreen or in print format?

Usually this information is obtained by using surveys, questionnaires, interviews, focus groups and by observing users (IBM, March 2001). If this information cannot be obtained then certain assumptions will need to be made.

4.4.1.4 Outline Business Problems

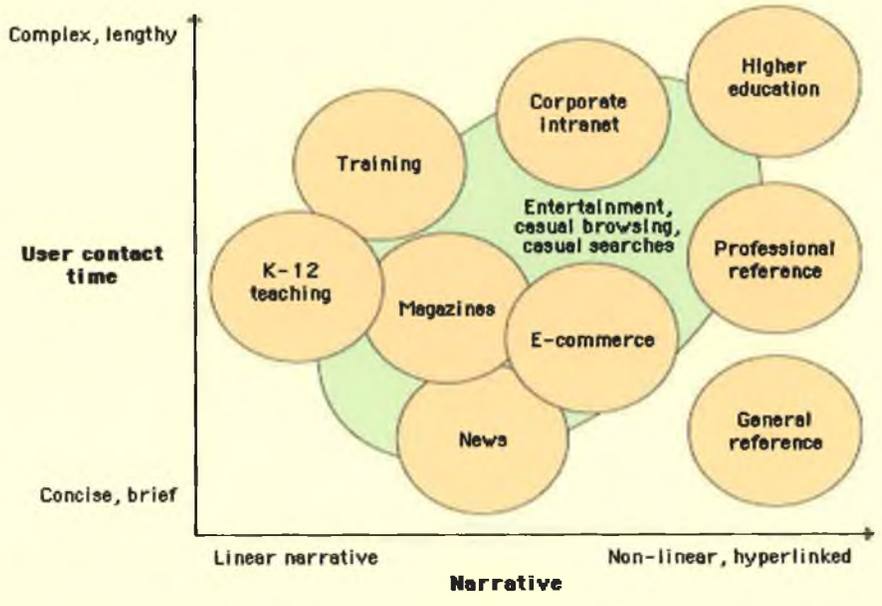
The next step in the preparation for the design process is to determine what the business problems are that need to be addressed. Also the critical success factors should be outlined already (IBM, March 2001). This information is usually gathered by interviewing the people involved with the system and also by reviewing the old system and any relevant documentation. When all this information has been collected you must define the scope of the project. This will involve reviewing the information you have gathered and deciding what aspects need to be addressed and what can remain the same.

If the preparation stage is not completed properly, the whole system will not be successful no matter how well it is designed. It will not meet the objectives outlined at the start of the project and will leave users dissatisfied.

4.4.2 Design Strategies

The type of site to be designing, the target audience, and the objectives outlined previously will all govern the design strategy that is adopted (Lynch and Horton 1997a). The clearer and more specific the strategy, the more successful it will be in achieving objectives (IBM, March 2001). A strategy should include such things as what is the overall message you wish to get across and what way will this message be presented? Next a tone will be selected ranging from formal to informal. The level of information and detail that will be given will be decided on and the amount of visual aids that will be used (IBM, March 2001). The type of pages and how information will be presented will also be determined depending on the users wants and needs. According to Lynch and Horton (1999) websites can be classified into five types: browsing, training, teaching, educational and reference. The following figure 4.4 plots these five different types of websites against two variables and examines how linear the structure of each should be, and how long the typical user contact time will be.

Figure 4.4 **Types of Design Strategies**



Source*:** ***Web Style Guide ,Lynch, P.J., (1995)

Browsing: Users who are just browsing usually enter your website without any agenda or purpose. They quickly leave if they don't see anything to grab their attention immediately. Techniques must be employed to entice these users to stay and explore. They tend not to delve very deeply into a site.

Training: Web-based training applications will be very linear in design. The user follows a set path and there is little opportunity to stray from this path. In a training application, the aim should be for all users to see the same presentation and to make sure that the whole application is viewed. To aid this, links should be kept to next and previous and users should not be offered any outside links. Most training sessions are of a fixed duration and restricting users paths will allow more accurate predications of how much the user has been able to view.

Teaching: Teaching applications also tend to be linear in nature but unlike training applications the user usually has more opportunity to deviate from the main

path of the website. Information is usually much more in-depth than a training application and users tend to spend much more time using and exploring the site. If users are deviating from the main path of the website too quickly, one method to solve this may be to put all links on a separate page. This will help to ensure that users are not distracted from the main presentation as they go through the site.

Education: Educational sites, unlike teaching sites are designed for self-directed learning and the users are usually of a highly educated standard. These users will not stand for a highly restrictive linear site. They will look for flexible and interactive sites that will allow them to search for the information they require. These sites usually contain large amounts of links to information elsewhere in the site and to other external informational sites. As the users are mostly expert frequent users, text based links will be best as they will be the fastest.

Reference: Reference sites are extremely non-linear. Users enter with a specific purpose usually looking for particular information. As soon as they find what they are looking for they will download or print the information and leave the site. Contact time is usually short. If a user cannot find what they are looking for quickly they will leave and try another reference site. The site must be designed to allow for fast search and retrieval. If the site contains references to a very large amount of information a search facility should be used.

4.4.3 Design Process

During the design process schedules and requirements are set, formats are decided upon and the actual system is constructed. The system will need to be prototyped as it progresses and is tested. These steps are discussed in more detail below.

4.4.3.1 Setting up Budgets and Schedules

After users have been interviewed and all information needed collected from the various sources, estimates will be developed for the development, training, and maintenance of the system. Schedules should be set to help ensure that you meet your development deadline (IBM, March 2001). These should contain milestones and review stages identified so that you can keep track of the progress being made. All the requirements of the system should be defined including such things as security issues, integrity constraints, etc.. Agreement must then be obtained from management and users of the system before you take any further steps.

4.4.3.2 Designing Display Elements and Messages

The next stage in the design will be to decide on the display formats and to create syntax for the actions of the system. Error messages and handling will also be decided on. Feedback must be decided on and designed for each action. Feedback should be visual as well as audible (Lynch and Horton, 1999). The system must be designed so that it will format correctly in different browsers. The URL that will be used should now be determined and reserved. The user help systems and reference manuals will also be designed at this stage.

4.4.3.3 Designing the Information Content

Information content must be identified and this information must then be structured so that it is meaningful to the user (Bevan, 1997). This can be achieved with the help of representative users, who will help organise the

information into a structure that is logical and most beneficial to them. It is important to remember that most information on the web is read non-sequentially. If possible information should be organised into short chunks so that information can be scanned and located quickly. Research has shown that reading from computer screens is about 25% slower than reading from paper (Nielsen, 2000). Nielsen also lists three main guidelines for writing for the Web: (Nielsen 2000)

- Be succinct. Write no more that 50% of the text you would have used to cover the same material in a print publication.
- Write for scannability. Don't require users to read long continuous blocks of text; instead, use short paragraphs, subheadings, and bulleted lists.
- Use hypertext to split up long information into multiple pages.

4.4.3.4 Designing the Structure

The structure should be as flat as possible i.e. no more than three levels deep otherwise users tend to get lost (Orubeondo, 2000). Flow diagrams will be drawn up to outline the site structure, show all the pages within the site and depict the sequence of these screens. These diagrams will also show the flow of control of the system. Input, output, help and all other possible screens will be charted in this diagram (Whitten et al., 2001). If the diagram becomes too big it can be broken down into different sections. After the flow chart has been completed a list of elements and links should be drawn up for each page on the diagram (IBM, March 2001). The structure and navigational design should now be tested to ensure that the users can find the information they need easily.

4.4.3.5 Designing the Textual Layout

When designing the text it should be made as concise and scannable as possible (Nielsen, 1997a). Users tend to scan text and pick out keywords, sentences and paragraphs of interest (Nielsen, 2000). Headings should clearly communicate the contents of each section (Bevan, 1997). This will make it much easier and quicker for users to find exactly what they are looking for. Web users don't take the time to read through blocks of information, therefore, it is important to start each page with the conclusion. Important material should be presented first, using the inverted pyramid principle (Nielsen, 2000). This will allow users to tell at a glance what the page is about.

Too much detail should not be put on the initial pages. Content should account for at least half of a page's design and preferably closer to 80% (Nielsen 2000). Users should be given the opportunity to obtain further information if required. Too many links must not be added to the main body of text, as this will prohibit scanning. Links can be added at the bottom of paragraphs (Bevan, 1997). With regards to navigation, Nielsen also states that it should be kept below 20% of the space for destination pages, although navigation options may account for much higher proportions of home pages and intermediate navigation pages (Nielsen, 2000). Nielsen also recommends the following points for designing for scannability: (Nielsen, 2000)

- Designers should structure articles with two, or even three, levels of headlines.

- Use meaningful rather than "cute" headings. Reading a heading should tell the user what the page or section is about.
- Bulleted lists and similar design elements should be used to break the flow of uniform text blocks.
- Highlighting and emphasis should be used for important words to catch the user's eye. Care should be taken when highlighting words that they look distinct from the link colours, otherwise users will be confused and will try to click on the highlighted words thinking they are links.

After the text layout, size colour etc. has to be decided on. It is important to remember that different browsers display different default font types. Text should be kept flush left, as it is much easier to read. It will also flow better in different browser window frames. Text should be checked for readability on a number of different systems and monitor types.

4.4.3.6 Designing Graphics and Images

Care must be taken when designing images. Image file sizes must be kept to a minimum so that the site will download at an acceptable speed (Lynch and Horton, 1999). Files should be limited in size to approximately 5k, and the total size of all the images on any single page should be less than 20k. GIF format is usually used for the Web, as it is smaller and will download faster than JPEGs, however JPEF formats are better for images like photographs which contain a large number of changes in colour tonality.

Care should be taken to ensure that colours look good on a variety of platforms and monitors. It is best to keep to a colour palette of 216 colours. This is often referred to as a Web safe colour palette. Where possible re-use images as once they are loaded into the browser's cache, they will display faster (Tognazzini, 1998). It is better to use interlaced GIFs on the web as users can decipher the image must faster and choose whether to continue downloading the image. Interlaced GIFs appears initially as a fully but unfocused picture. Non-interlaced GIFs appears section by section on the screen.

4.4.3.7 Designing the Navigation

Navigation should be as clear and simple as possible. Links should be clearly labelled so that the user has a good idea of where it will take them (Hobart, 2000). Users should at all times be aware of where they are in a site. Visual as well as audio feedback should be given. Links to the homepage and high-level categories should be placed consistently on every page.

4.4.3.8 Prototyping the System

Prototypes of the system must be designed to show to users and management. The prototypes should be studied to see if some screens need to be revised (Whitten et al., 2001). Issues such as colour, buttons, menus etc. should be decided on. Users and management should then review these prototypes and again feedback and consent must be obtained before moving further.

If possible the users should be allowed to experiment and test the interface design. Analysts can observe this testing and watch for common mistakes being made. Much more valuable information will be obtained by watching the user than by simply questioning them after they have experimented. When analysing users experimenting with the design, designers should try to ascertain the following: (IBM, March 2001)

- Whether the users can find what they need
- Whether the users know exactly where they are in the site
- Do they know which sections they have previously looked at
- Can they return to points they have previously visited etc.

The design specifications should then be reviewed, evaluated and revised at this stage based on the feedback obtained from the users and management.

4.4.3.9 Determining the Physical Devices

The physical devices for the system should be decided on. This looks at hardware requirements such as computer specifications, monitor size and resolution etc (Common Front Group, 2001). The communication equipment that will be required must be decided on, i.e. modem speed, type of telephone line - ISDN, normal etc. Working environment should be checked to see if it would have any impact on the hardware options chosen. The development tools and technologies to be used will also be decided upon. Technologies should be selected on the basis of what will best accomplish your goals and on the skills and resources you have to work with.

4.4.3.10 Directory Structure and File Naming Conventions

The directory structure and file naming conventions to be used must be decided on before the actual construction of the system. Having the file named and the directory structure predefined will make it easier when constructing the site (Lynch and Horton, 1999). It will be faster and easier to locate files and will also aid in the long-term maintenance of the site. All file names should be kept in lower case where possible, as some servers are case-sensitive, and this will help prevent the problem of broken links. It is usually better to use file names that can be used on all platforms unless you know the exact platform your users will have. It is usually safest to limit all file names to eight characters, as this will be supported by older systems. Names should also suggest what their content contains.

4.4.3.11 Construction

The next step is the actual development of the system. Emphasis should be placed on modifiability and maintainability. It is better to use a page template approach to the construction as this will help ensure layout consistency throughout the site (IBM, 2000a). Page templates also separate the content from the interface. This will allow changes to be made in one without directly affecting the other. The same text can be used in different versions of the site without any modification. All links used should be relative links as it is easier to move than an absolute link (IBM, March 2001). Absolute links will have the complete address e.g. http://www.smiths.com/intro/images/example.jpg' whereas relative links would just contain 'images/example.jpg'. Ensuring all links are relative will

allow the site to be tested on a local computer before uploading it onto the server without making any modifications.

4.4.3.12 Development of System Documentation

System documentation and online help must also be developed. The system should still be reviewed continually with feedback being obtained constantly from the users of the system (Whitten et al., 2001). This will help identify flaws in the design early on and save time and money, as it is easier to modify the design during the development stage than to wait until the system is completed and testing has begun.

4.4.3.13 Testing

The functioning of the system is then thoroughly tested and it must also be tested on different browsers, browser versions and platforms (IBM, March 2001). User testing must also be carried out. Training and consultation must be given to the users. The system will then be reviewed and any changes required will be implemented before the system goes live. After the system has gone live it must still be monitored to see that it reaches the objectives set out in the planning stage. Users should be given the opportunity to suggest improvements and give feedback (Whitten et al., 2001). System error and user-error frequencies should also be tracked. After going live, the system will need ongoing maintenance and refinement. A maintenance plan should be designed to accommodate this. Revisions should be scheduled regularly.

The more time and money invested during the planning and design stages can dramatically reduce the overall development time and costs of the system. A system that is well designed will have a much longer life span, have lower maintenance costs and fewer errors. Major restructuring and revisions will not be needed if the design was well completed. The overall result of good design is better user-task performance, better user satisfaction, less errors, shortened user learning times and lower costs over the life span of the system.

4.5 Key Differences Between Web Design and GUI Design

Designing screens that will be viewed on Web browsers has a lot of similarities with designing traditional software interfaces but there are also a great many differences. A lot of companies do not put much thought into developing their Websites. They employ the standards that apply to traditional GUI's and expect the site/application to be a success. There are a lot more variables that need to be considered when developing a successful Website/application such as the type of users, the type of computers they are using, and how they are connected to the Web. If any of these elements are not considered your Web interface will be unsuccessful.

When designing traditional software interfaces, designers will know exactly how the end result will look on all the user screens. The designer has control over how every pixel on the screen will appear (Nielsen, 1997b). Unlike designing for the Web, designers will know what type of systems the users will be using, what fonts will be installed etc. This does not happen on the web. What you see is not what you get. Users may be accessing the site application from different browsers, computer types

etc. They may not have the graphic or other capabilities needed to properly view the page. The site/application may also be viewed from a laptop computer, TV, palm top etc. Depending on all these elements, the site may appear very differently then intended. The traditional 'what you see is what you get' (WYSIWYG) that applies to traditional GUI's does not apply to the Web (Nielsen, 1997b). On the Web, pages need to be able to download to any platform type, unlike the traditional GUI interfaces, which are designed for a specific platform. This means that designers lose total control and the look of their pages will be determined by a combination of page specifications, setting etc. This makes designing for the Web much more difficult. It also means that web applications will need much more thorough testing than traditional software applications.

With the Web the user is an active participant in the user interface. Nearly all web browsers have some levels of customisation (Nielsen 1995b). This can be anything from how users view data, the size and type styles of fonts and the size of the window the application will be viewed in. These elements can cause the whole Web page to reformat, so it is critical that these possibilities are taken into consideration when designing the interface.

Another major difference between Web design and GUI design is the way the user will navigate through the application. The designer controls where the user goes in traditional GUI design. This can be achieved by limiting where the user can go by greying out menu options at certain stages, presenting modal dialog boxes etc. This will force the user along a certain path and is very restricting. This never happens on the Web. The user of the Web is much freer and can choose where they wish to go.

Users can take any combination of paths and may not even visit the first page/screen. They can leave and come back to the same point at any time. Some designers try to force users through a certain path but this only leads to user frustration. Users of the Web are used to freedom and have come to expect it. The requirements for simple and clear navigation are much more important on the web than with traditional interfaces. Designers have to make sure that users always know where they are on the Website/application and should make sure that users do not become lost. One method of overcoming this is to place a logo on a certain place on each page so that users can go back to the main page.

Another difference between Web design and traditional GUI design is the amount of time a user will spend on each. With traditional applications users tend to spend a long period of time using and becoming familiar with the application. In general they are only using that one application and not constantly switching between applications. On the other hand, web users tend to spend much less time. They will move between different sites, following hyperlinks, at a rapid pace. At the end of a session users have generally used more than one site. There are so many sites on every topic on the Web that it is easy to loose your reader if they become bored, frustrated or lost. Web applications are unable to handle multimedia elements as well as more traditional applications. The sites that work best are those that keep graphics and icons small as possible and make sure the site downloads fast.

4.6 Problems with poorly designed sites

Despite the increase in the Webs popularity, it is very surprising that few sites/applications exhibit good interface design. Many sites will look good but do not work well because a graphic artist has designed them (Schaffer 2000). Systems-orientated designers with little or no knowledge of user friendly websites create others. Once a user leaves a Website due to dissatisfaction they will rarely come back (Murray et al., 1999). There are many problems that need to be tackled in relation to web design. 80% of Internet home pages reviewed by Human Factors International revealed 15 to 20 problems for users (Schaffer, 2000). Nielsen says of the Web "It is obvious that a new paradigm is needed to handle this world of information overload" (Walsh, 1997). A survey carried out by Amárach reveals the reasons why users make repeat visits to a website: (Amárach, Feb 2002)

Reasons for Returning	**%**
Useful content	38%
Ease of navigation	23%
Recent content	20%
Irish content	6%
Animation	4%
Pleasant design	3%
e-Commerce capability	3%
Sound	1%
Something else	2%

The following sections detail some of the main problems with poorly designed sites:

4.6.1 Display of Information

It can be very difficult for designers to know exactly what the user will see when looking at a website/application (Sullivan 1998). The way it will be displayed will depend on many factors. People view sites on different computers with different graphics settings, monitor resolutions, settings and sizes, video cards, sound cards etc.

4.6.1.1 Browsers and Platforms

The most significant thing that will change the way a website looks and runs is the browser that is used. There are many different browsers in use today ranging from text only browsers to browsers with full graphics and plug-in capabilities. New versions of browsers are being constantly introduced. Designers often make the mistake of designing sites to run on these newer versions, not fully realising that there is often a slow uptake speed (Sullivan, 1997a). This may be due to the users inability to update their browser or they may choose not to update immediately due to bugs and inconsistencies in newer advanced browsers. Generally it takes one year for a new browser to propagate, and another for the public to catch up with the latest features (Helinski, 1997). Designers should recognise the fact that many users are still using old technology and will be for some time. Sites should not be designed to run on one particular browser and should always be tested on as many browsers as possible.

4.6.1.2 Graphic/Non Graphic Browsers

Most websites/applications are designed for graphic enabled browsers. There are a large percentage of people who use non-graphic browsers. This may be due to choice or because they are unable to use graphics due to machine limitations (Sullivan, 1997a). Designers often do not take this into account and pages will not run on text-only browsers. As there is an increasing move towards intranet, extranets and complex applications delivered over the web, there is a greater need to further develop and go beyond the present browser.

4.6.1.3 HTML and Scripting Languages

HTML is a structural mark-up language therefore it defines the structure of a document rather than specifying its layout (Sullivan, 1997a). HTML only has basic formatting and alignment tags and these are often misused (IBM, March 2001). Some browsers do not support all HTML tags. Scripting languages can behave differently on different browsers and on different versions (IBM, March 2001). Older browsers cannot read scripting therefore it should always be optional and used with care.

4.6.2 Frames

Frames can cause problems for users and are considered a bad design feature (IBM, March 2001). Frames can confuse the users. They make printing extremely difficult, as many browsers cannot print framed pages appropriately. With frames it is common to have the Print command result in the printing of a single frame (Nielsen, 2000). Frames also make it impossible to bookmark the current page and return to it

later, as the bookmark will point to another version of the frameset (Nielsen, 1996). Frames are not supported by older browsers and some search engines. They also prevent users from e-mailing a recommended URL to other users. The addressing information shown at the top of the browser no longer constitutes a complete specification of the information shown in the window (Nielsen, 2000).

4.6.3 Overloading of Functions

Websites/applications are featuring more and more functions. Many web developers are falling into the trap of overloading the toolbar with buttons that are seldom used or trying to put everything on the first screen. Only features that will be used frequently should be readily available (Nielsen, 2000). All other features should be hidden behind drop down menus etc. They should be accessible only when needed and not cluttering up the screen. Applications should be customisable so that users who use a particular function often can add it to the main toolbar.

4.6.4 Text

Websites/applications often contain very small text or the text is displayed in a hard to read font. This makes the information hard to read and causes a strain on the users. Font colours used with a similar coloured background can also make text difficult to read.

4.6.5 Bleeding Edge Technologies

Some designers get carried away with new technologies and features. Often they just leave the user frustrated, such as windows that automatically pop up when you load a page (Sullivan, 1997 a). This can be interesting the first time a user enters or uses a site but soon gets tiresome and slows and frustrates the user. After the user has seen new technology hundreds of times it can become tiresome and no longer impressive. Most users care more about how useful the content is. Scrolling text, marquees and constantly running animation will attract the user's eyes and take away from the page's readability (Nielsen, 1999c). As their use has increased, users have started associating them with pure advertising and tend to ignore them. Important content should not be highlighted using these technologies, as users will immediately think that it is not relevant to their task without properly reviewing the information. As the web develops, users have less patience for new technology. Always use new technologies and features sparingly.

4.6.6 Plug-ins

Designers should always try and avoid plug-ins. It is impossible to tell whether the intended audience will have the required plug-in. If the user does not have the required plug-in they will be directed to the download page. This can usually be up to seven steps long and will often require the user to reboot the machine (Helinski, 1997). Most users will have left the site before this. Plug-in files, if used, should be optional and the size of the file should always be given. Java, JavaScript and VBScript should be treated in the same way as plug-ins (Helinski 1997).

4.6.7 Long Scrolling Pages

Pages are often overloaded with text and graphics. This slows down the download time of the page and turn off users (Nielsen, 1997a). Studies carried out by Nielsen showed that only around 10% of users scroll beyond the information that was visible in the window when the page was displayed. This number has risen in more recent times but users still do not enjoy scrolling (Nielsen, 2000). Pages should be designed to download fast. Limiting the number and size of graphics and also the amount of text can help this. Hyperlinks to more information is much better than throwing all the information on the first page (Helinski, 1997). Scrolling should be avoided if possible. Most users never scroll down a page, therefore, the most interesting and important information should be kept to the top 640 x 480 pixels of the page (Helinski, 1997). This will allow it to be seen on most monitors.

4.6.8 Complex URL's

Usability studies carried out by Nielsen show that users rely on reading URL's when they try to decipher the structure of a site (Nielsen, 2000). Website URL's should be simple, short and easy to remember. Machine level addressing should never be used. (Nielsen, 1999c). Nielsen lists the following rules for URLs: Nielsen (2000)

- Make the URL as short as possible as long URL increases the possibility of making mistakes.
- Use common natural language words and make sure that they are easy to spell.
- Always use lower case characters. If mixed case is used, users are likely to get confused and forget which parts are in uppercase, leading to errors.

- Avoid using special characters as much as possible as many people will be unable to type them.

Users will find it easier to locate particular sites and product information if the product information is placed within your company domain, e.g. www.companyname.com/product. Studies carried out by IBM on 69 web users revealed that when asked what URL they would expect to use to find information about the Acme Widget the following results were found: (IBM, March 2001)

- 38 participants listed the URL of the company home page,
- 21 participants listed a product page URL with the company name appearing before the product name
- Only one participant listed a product page URL that excluded the company name.

When these respondents were asked to create a preferred URL for the Acme Widget, 54 out of 69 participants placed the company name before the product name e.g. www.acme.com/widget.

4.6.9 Orphan Pages

Pages should always have a clear indication of what website they belong to. Pages can be accessed directly and if not properly named the user will have no idea what site they are actually on. Every page should contain a link to the main page.

4.6.10 Slow Download Times

Some websites take too long to download. Often users do not wait to see the site. They quickly move onto another site. It is important that pages be designed so that they download in about 10 seconds to hold users interest. The maximum time a page should take to download is 15 seconds (Nielsen, 1999c).

4.6.11 Difficulty Finding Information

Often users have difficulty finding information on sites. Websites and applications should be designed so that the user knows where they are at all times and where they can go. In Web Usability studies, users were able to find the correct answers to test questions only 42% of the time (Spool, 1997). Large and complex sites should include a search feature (User Interface Engineering, April 2001). According to Jeff Walsh "web browsers are sometimes credited with simplifying computers with their easy intuitive interfaces, but without additional navigation and help they are merely gateways into complex, unstructured worlds" (Walsh, 1997).

4.6.12 Non-standard Link Colours

Designers sometimes change the colour of links to better suit the colour scheme of their pages. The colour for standard links is blue and when they have been viewed is purple or red. When this is changed it can confuse users and they will not know where they have visited (Nielsen, 2000). Designers should have consistency in colours throughout the site. As the frequency of non-standard link colours increases, users are getting confused and associate any underlining of words with links.

4.6.13 Integration Problems

Often there are problems integrating the Internet with legacy and backend systems. This can be a difficult and slow process even for experienced programmers (Dreyfus, 1998a).

4.6.14 Animated Images

Animations destroy a pages' readability and are distracting to the user (Sullivan, 1998). It is impossible to know how fast they will run as it will depend on the configuration of the system they are running on.

4.6.15 Dead/Broken Links

Users have come to expect that a few dead links are inevitable but if a site has a large amount of broken links, this shows it is not being maintained and the user will leave and not return (Sullivan, 1997a).

Studies carried out by Nielsen shows that slow download times are the greatest design mistake being made. He surveyed twenty prominent sites to see what design mistakes they violated and came up with the following results.

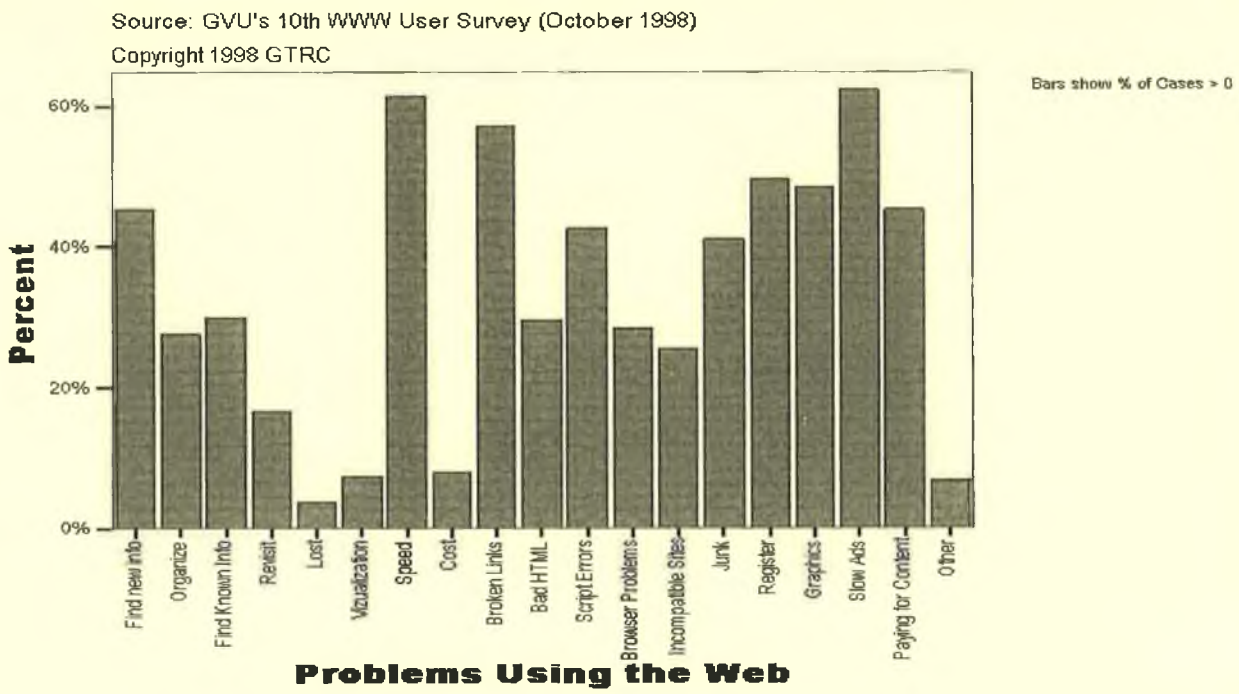
Table 4-5 **Design Mistakes Most Commonly Being Made.**

Design Mistake	Violation Score
Slow download times	84%
Non-standard link colours	17%
Long scrolling navigation pages	15%
Scrolling text or looping animation	12%
Frames	11%
Orphan pages	10%
Bleeding-edge technology	7%
Complex URL's	6%
Lack of navigation support	4%
Outdated information	1%
Average	**16%**

Source: ***Who Commits The "Top Ten Mistakes" of Web Design?, Jakob Nielsen (1999b)***

The GVU's 10th WWW User Survey (October 1998) also found that speed was the greatest problem that users had. This was followed by broken links and finding new information. The full results are as follows:

Figure 4.5 **Problems Users Encounter When Using the Internet**



4.7 Future of the Interface

There are many advances and ongoing research being carried out to solve the problems mentioned previously. Shneiderman (1998) states, "*the ultimate goal is to produce a design that is comprehensible, predictable, and controllable*". These areas include natural language processing, intelligent agents, 3D real things interface and gaze tracking. PC World (April 2001) predicts, "With high-speed access, new services, and graphics-rich interfaces coming soon, the Net will truly be a part of everything you do". They also predict that in the future the Web will no longer exist as a separate medium but instead will become part of everything we do.

4.7.1 Natural Language Processing and Speech Recognition

The following sections draws heavily from Ed Bierman (1998). The idea and use of speech and natural language as a means of communicating with computers is not a new concept, but is still an area of much research. The main goal of Natural Language Processing is to make using computers as simple and efficient as possible. This would in turn minimise the amount of training that users would require. Using natural language as a method of information retrieval has advanced slowly over the years. These advances include automatic truncation. Some applications can recognise phrases, word variations etc. They can then look for similar words or phrases that are similar. This concept is often used in search engine software. Whether or not the use of Natural Language in user interface design actually benefits and increases the performance of the user is still to be proved.

So far computers can be programmed to recognise speech or text that adheres to a particular pattern. Up to now the development of speech recognition systems has met only limited success. Voice recognition software can interpret and carry out some well-defined tasks such as opening or closing documents. One of the main problems with speech recognition is the complexity of languages. Other problems include background noises, variations between different users, accents, etc. Speech recognitions can greatly benefit people with visual or physical disabilities. Most systems can be tuned to understand a single user. Problems start to arise when new users have different inflections, causing the system to perform poorly.

4.7.2 Intelligent Agents

Intelligent Agents are computers that are able to carry out user-defined tasks independent of the users (Bierman, 1998). The user specifies how the task is performed, then schedules the task. Usually intelligent agents have some decision-making capabilities. They would have the ability to make deductions from a given situation and then pick the best strategy for carrying out the scheduled tasks. Intelligent Agent systems are becoming more and more advanced.

4.7.3 Real Things Interfaces

The following section draws heavily from the IBM Website (March 2001). Traditional graphical human-computer interfaces use a combination of windows, icons, menus, and mouse pointers. These elements were a major leap in the simplifying of computer programs compared to the text-oriented interfaces of old. However, today's 2D interfaces still display restrictions. As computer interfaces

move forward, 3D displays are being experimented with and are being combined with the increasing use of multimedia. 3D dimensions could make it much easier for users to understand complex information structures. In studies undertaken it was found that true 3D viewing can increase the size of a graph that can be understood by a factor of three (Ware, Franck, 1994).

Real Things is a design approach being developed by IBM (IBM, Sept 2001) that uses computer graphics in combination with elements that resemble familiar, real-world devices. This design approach would replace today's computer based user interface mechanisms with a more natural and intuitive interface. The Real Things approach is based on the idea that people enjoy and feel comfortable relating with on-screen objects that resemble real-life objects in a literal way (IBM, Sept 2001). The aim is to simplify the user interaction. The techniques of 3D interfaces have already been widely used in games, modelling, simulations, and data visualisations. IBM hopes that these techniques can be transferred to use in a 3D-user environment that will support enterprise business applications.

The approach using simulation of real-world interaction mechanisms will be particularly useful for new and novice computer users as well as the more advanced users. An example of this technique is a 3D image of a phone. Clicking the handset will cause it to come off the hook and this will enable answering or making a call. Users will intuitively be able to understand the functions of the phone without needing any instructions or labels. Another example is if a book is brought 'dragged' to a shelf it would be captured by the shelf and placed in an appropriate position. Visual cues and effects must be provided to let the user be clear as to what has

happened. As processor speed increases it will be possible to render 3D objects in real time thus allowing alternate viewing points.

It is vital that real things be immediately recognisable by the user and also be accompanied by sound. Also animation should be used to convey relationships between components. Care should be taken not to over use animations or use it for longer than needed as it will become an annoyance. Design should not be constrained by including only those functions available in the real world. The computer's capabilities should also be incorporated. The 3D object does not need to be fully visible at all times, different levels based on functionality can be used e.g. a low level minimal view that provides only the very basic functions but can be expanded into a full function view that shows all features including functions not frequently used. Shortcuts should be provided for tasks that users do frequently. Real thing interfaces should coexist with other applications where it benefits the user.

4.7.4 3D Visual Displays with Video Trackers

Future interfaces may well be non-conventional and far away from the command based direct-manipulation interfaces we have seen up to now. Research is being carried out into interfaces that have intelligent interface agents and sensors so they can constantly observe the user. The interface agent will interpret the user's intentions and carry out commands. This would relieve the user of routine actions. This type of interface is based on the concepts of both object-oriented programming and visual programming. The system uses 3D visualisation techniques and together with an interactive HCI (Pastoor, Nov 2001). The computer will be able to interpret

the user's intentions and anticipate their wishes immediately, without waiting for a direct command from a keyboard or mouse pointer.

The Heinrich-Hertz Institute in Berlin has developed this prototype system (Pastoor, Nov 2001). Its key elements are an autostereoscopic 3D display, a visual 3D operating system and a camera to sense the heads position and motion, and a system to record the direction of the user's gaze. A simple movement of the user's head is sufficient to open a document. Looking at documents in the background can bring them to the foreground. The motion camera tracks each head movement and enable the computer to control the orientation and position of the display. Looking at a hypertext item on a web page for a certain amount of time automatically downloads the hyperlinked document. The document that was previously being viewed will move backwards, thus indicating the search path to the current document. If you wish to return to the previous document then looking at it in the background will bring it closer. Simply moving the head can change the viewing position, and this will unblock any obstructed documents. This type of display is regarded as a key to next-generation human-computer interfaces.

Figure 4.6 Implementation of a Web browser

Source: ***3D Visual Os (VOS), Heinrich-Hertz-Institute, (Nov 2001b)***

4.8 Summary and Conclusion

Designing good GUIs is a critical skill for application developers regardless of the GUI platform for which they are designing. To develop a good GUI developers must know the basic design principles and be able to apply them. A good designer or developer needs not only good technical skills but they must also have good communication skills. They must also be able to communicate with users and obtain feedback from them. No matter how good the design is it will not succeed unless the users are happy with it.

Next to the development of the GUI, the development of the World Wide Web has left a tremendous mark already on user access to information (Bierman, 1998). Poorly designed websites are hard to navigate and understand and often hide important functions. The user does not know why the system responds in the way it does. The interfaces are frequently inconsistent. This leaves the user frustrated and confused. Users will also be frustrated by systems that offer little or no feedback. The current Web just scratches the surface relative to what's possible (Nielsen, 2000). According to Nielsen the current web browsers are an "abomination and have not improved significantly since 1993". He predicts that the future of the Web will be very different from our current reality (Nielsen, 2000).

It is impossible to design a perfect user interface. The best interfaces are the ones that are as flexible as possible and that can be adjusted to the needs of the user. Shneiderman (1997a) says that the best systems "will continue to be comprehensible,

predictable, and controllable while understanding that the ultimate goal is to meet the need of providing information to the user".

The Internet of the future will have to overcome many obstacles if it is to be truly successful. If the web is to be a major information resource for the future, the effectiveness of its use must be improved. Access will be one of the major problems standing in its way. Improvements that need to be made include better mechanisms for managing bookmarks, improvements in the indexing structures of the major Web search engines and a method for viewing the site structure through multiple viewing windows. Advances in the areas of natural language processing, intelligent agents, real things interfaces and 3D visual displays will improve the users experience of using the Web.

Chapter 5

The Research Question and Design Methodology

5.1 Introduction

Chapter two, three and four have placed this study on the critical issues of human computer interface design in its historical and associative perspective. The critical issues of traditional interface design have been highlighted along with the growing issues of interface design as focus is shifting from stand-alone applications towards web-based applications. The research is designed to test the prevailing perceptions among Irish software developers regarding human computer interface design and to determine the usage and commitment to involving users in the design phase.

5.2 The Survey - Population

The survey target consists of software developers who design stand-alone applications, web-based applications, websites or a mixture of all three. A random sample of software development houses was obtained from the National Software Directory. In deciding on the sample size it is assumed that each population is generally homogeneous; very little variability exists in the product or in techniques that are applied in producing those products. The survey required a statistically significant sample from the population. In light of time and financial constraints it was decided to aim for a sample of 60 valid responses. This is a statistically valid sample, which would allow extrapolation of results to the target population and allow comparison of sub groups where appropriate

5.3 Research Objective

The research is designed to survey the critical issues of human computer interface design from an Irish perspective. The research objectives are discerned as a primary objective, which answers the research question, and secondary objectives, which qualify the answer.

5.3.1 The Primary Objectives

The primary objective of this research is to identify:

> *The critical issues of human computer interface design, and their application in an Irish context, as focus is shifting from stand-alone alone applications towards web-based applications.*

It is planned to achieve this objective by qualifying and quantifying the critical issues of human computer interface design and examining how these have been affected or changed with the introduction of the Internet and the move towards web-based applications.

5.3.2 The Secondary Objectives

The secondary research objectives are presented in similar sequence to their related questions in the questionnaires. These are as follows:

- *To outline the evolution of human computer interface design*
- *To outline the evolution of the internet*
- *To identify and qualify the expanding set of human computer interface design issues as web-based applications grow in prominence*

These objectives will be achieved through a literature review focusing on books, articles, scientific papers and the Internet.

- *To describe the current usage of hypermedia and multimedia in human computer interface design*
- *To prescribe for the expedient use of hypermedia and multimedia in human computer interface design*
- *To determine the direction of human computer interface design in the future*
- *To identify areas for further research*

These objectives will be achieved through the analysis of the responses received from the questionnaire sent to respondents.

5.4 The Research Method

Having determined the overall goals of the study, the need to identify a research method was apparent. While considerable debate surrounds the choice of paradigms that might provide the best guidance for conducting research, two paradigms in particular have earned widespread use, the Positivist (Quantitative) and Phenomenology (Qualitative) approach.

Hoepfl (1997) describes qualitative methods as follows:

> *"Phenomenological inquiry, or qualitative research, uses a naturalistic approach that seeks to understand phenomena in context-specific settings"*

Qualitative research relies on transforming information from observations, reports and recordings into data in the form of written words. Techniques used by researches

using a qualitative approach include, Case Studies, In-depth interviewing, Participant observation and Diary Methods.

Hoepfl (1997) describes quantitative methods as follows:

> *"Logical positivism, or quantitative research, uses experimental methods and quantitative measures to test hypothetical generalizations"*

Quantitative research aims to measure phenomena so that they can be transformed into numbers. The main method used to collect quantitative data include, Interviews, Tests/Measures, Observation and Questionnaires.

The quantitative-qualitative classification is dependent on three criteria: (Kumar, 1996)

1. the purpose of the study
2. how the variables are measured
3. how the information is analysed

The purpose of qualitative research is to describe a situation or event. The information is gathered through the use of variables measured on nominal or ordinal scales. Analysis is not compulsory but if carried out examines the variation in a situation without quantifying it. An example would be the description of the living conditions of a community. If the information that is gathered is analysed and the magnitude of the variation is examined the study is said to be quantitative in nature. An example of this type of research would be – how many people have a particular problem. Both qualitative and quantitative approaches have advantages and

disadvantages. According to Ackroyd and Hughes (1992) "Neither one is markedly superior to the other in all respects".

When selecting a method of data collection it is important to know as much about the characteristics of the study population as possible (Kumar, 1996). Some populations will respond better to one particular method of data collection. The three main ways of collecting data are observation, interviews and questionnaires. When choosing a method of data collection the administrative or resource factors, questionnaire issues and data-quality issues must be considered (Czaja et al., 1996). It is important to consider how much time there is to do the research and how much money is available. The kinds of questions that need to be asked must be looked at. It is important to consider whether respondents will cooperate with one method rather than another.

The respondents for this study are software designers. It was decided that observation as a method of data collection was unsuitable for this study. The benefits of interviews and questionnaires were examined. According to Kumar (1996) the selection between an interview and a questionnaire should be based upon the following criteria: the nature of the investigation, the geographical distribution of the study population and the type of study population. Due to the large geographical distribution of the population and to limited resources it was felt that a questionnaire would be the most practical option. Also after examining the population it was felt that due to the time demands on software designers that they would be more likely to respond to a questionnaire rather than to agree to an interview.

The next step was to examine the different ways of administering the questionnaire. The merits and disadvantages of both e-mail and mail surveys was considered. According to studies carried out by Mehta and Sivadas (1995) there is a major time advantage for e-mail over postal methods. They received half of their e-mail questionnaires returned within three days compared with three weeks to receive a comparable proportion of postal questionnaires. Their study also found evidence of higher quality of responses and also pointed out the significant cost savings of the method. A study carried out by Esomar (1996) found that significantly higher levels of response completeness were obtained from e-mail surveys as opposed to postal surveys. Another advantage of using e-mail is that all responders can be identified and non-responders can be followed up. Another benefit of e-mail surveys is the ease with which it can be quickly modified (Watt, 1997). Early returns may suggest additional questions that should be asked. It was also felt that as the population to be tested were all computer users, they would be more likely to respond to an e-mailed questionnaire than a postal questionnaire.

It was decided to use an e-mail questionnaire to elicit the required information from the target populations. This approach is considered as the most feasible because of the large number of responses sought, and the detail of the information required. For the purpose of the survey it was decided to dispatch 500 questionnaires to a random sample of software development houses registered with the National Software Directory. Each developer was assigned a number and then a random generator was used to generate five hundred non-repeating numbers between one and number of entries in the directorate, which was slightly in excess of 1,300.

5.5 The Research Instrument

The questionnaire was designed in consideration, and in strict line with the research objectives. Each question was designed in light of the relevant literature, so that respondents were offered a choice from a near optimal subset of alternatives. Because it was felt that project managers normally operate under substantial time pressures, the following three design criteria were decided upon. Firstly, to offer 'tick the appropriate box' type questions whenever possible. Secondly, that the technical content should be presented in such a way as to draw the respondents from simple to more complex concepts, and thirdly to leave textual replies to the latter end of the questionnaire when the respondent had visible indications that the questionnaire was almost complete.

5.5.1 The Questionnaire Content

The questionnaire content is summarised in table 5-1:

Table 5-1 Summary of Questionnaire Content

Question Purpose	Question Numbers
To develop an organisational profile.	1 to 3
To characterise the average type of information system developed by the organisation i.e. nature and complexity	4 to 7
To determine the % effort applied to the different functional areas of HCI	8 -10
To determine the usage and the importance of user interface prototyping	11, 16 to 17
To rate the importance of the critical design principles of HCI	12
To determine the importance of Multimedia and Hypermedia	13
To determine the usage and type of methodologies	14 to 15
To determine the use of user interface elements	18
To determine the use and approach to usability and evaluation	19 to 22
To identify any standards and guidelines that are followed	23

To determine the compatibility of the average system across different platforms.	24 to 26
To qualify the use and perceived effectiveness of usability testing and usability criteria	27 to 31
To determine the use and effectiveness of User Centred Design	32 to 36
To rate and determine the frequency of problems users have with different system types	37 to 38
To qualify the use of new technologies and any alternatives offered	39 - 44
To determine the importance of HCI as part of the overall development process	45

The questionnaire is presented in Appendix B.

5.5.2 Pretesting the Questionnaire

The questionnaire was pretested by three project managers. They were asked to offer an evaluation of the questionnaire with particular emphasis on the following:

- The scope and content of the questionnaire, i.e. are any important issues or factors neglected.
- The relevance of the questions, are they meaningful to practitioners
- The relevance of the survey
- The length of the questions.

Comments from the evaluators have resulted in only minor changes to the questionnaire content. All of the evaluators felt that the questionnaire was long and predicted a low response rate. This was taken into consideration in determining the administration strategy.

5.5.3 Questionnaire Administration

The questionnaires were e-mailed, along with two covering letters (See Appendix A) to 500 software development houses. The first covering letter was from the research supervisor and certified the research. The second was from the researcher and introduced the research and the questionnaire. The potential respondents were assured of the importance of the research and the value of their support. Assurances were given that all information would be treated in the strictest of confidence and that the thesis would report its findings in aggregate form only. All respondents were offered a summary of the findings.

Thirty replies were received within the first three weeks. Ten of these stated that the information requested was too confidential in nature to give out. Three stated that they did not develop their own software. Thirty e-mails never reached their target and were returned by the mail server as undeliverable. These companies were contacted to see if they had changed their e-mail address. Five of these companies had and the other 25 no longer existed. A random selection of 25 more companies were chosen from the National Software Directory to replace these companies. It was decided to solicit responses by phone until a quota of 60 completed questionnaires was secured. As a result 87 calls were made to slow or non-respondents resulting in the receipt of 38 more questionnaires. Finally, 60 completed and valid questionnaires were received. The overall response rate was 12%, 4.5% directly and 7.5% after follow up.

5.6 Strategy for Research Bias

Research bias was minimised as follows. Firstly, each population was randomly sampled. Secondly, responses were elicited from a number of randomly chosen and what would almost certainly have been 'non-responders'. After 'persuasive follow up' 12% were received. These tactics ensured that results could be generalised with a reasonable level of confidence to the larger populations. Concern for non-response bias was alleviated by the inclusion of 'would be non-responders'. This ensured that any statistical significance difference occurring between these and 'responders' is captured and reflected the research results. (This strategy for reducing non-response bias is strongly recommended in the literature (Cochran, 1977))

5.7 Limitations of the Research Design

This research is subject to the limitations imposed by sole use of an e-mail questionnaire, and in particular, respondents lack of understanding of the questions. The usefulness of the research is very dependent on the target population's understanding of the term "Human Computer Interface Design". Most of the questions were straightforward and involved the categorisation of organisational attributes or the identification of methodologies, techniques and tools, the respondents understanding of the questions is not perceived as a serious limitation. Respondents were asked to rate the effectiveness of alternative development techniques, however, subjective ratings were expected. The results are not interpreted in a definitive manner. They are used to qualify the subjects pre-disposition towards the various techniques. This is not a serious limitation as the research is inquiring

into the prevailing perceptions of the critical issues of HCI, rather than objectively judging its effectiveness.

Limitations were imposed by the need to classify data. This reduces the richness of the resultant data by assuming homogeneity between similar organisations. However, this is a platform study providing a panoramic view and suggesting areas where more focused research is warranted.

5.8 The Contribution of the Research

The contribution of this survey is envisaged as follow:

- A first time evaluation of the use of Human Computer Interface design techniques for stand-alone systems, web-based systems and websites developed in Ireland.
- An evaluation of the different HCI principles applied by Irish Software developers.
- A comparative evaluation between the tools and techniques used by developers of stand-alone systems, web-based systems and websites.
- An evaluation on the use of User Centred Design techniques by Irish software developers
- The identification and ranking of the main problems users have as perceived by Irish software developers
- A platform for future research in this area.

Chapter 6

The Research Findings

6.1 Introduction

The research findings based on the analysis of the questionnaires are presented in this chapter. A profile of Irish software development houses is followed by a discussion on the qualifying characteristics (such as cost and complexity) of typical information systems developed by them. The primary research question is addressed in terms of the perception of developers of the important issues of Human Computer Interface Design, and the involvement of users in the design process. Finally, the research is concluded as several areas for further research are suggested.

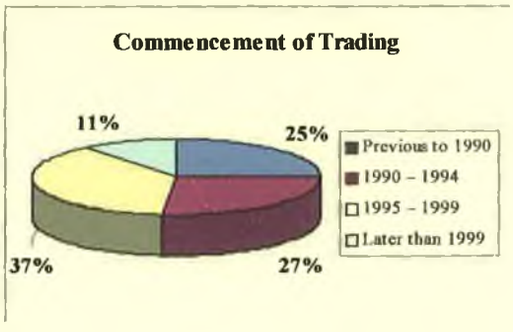
The questionnaire was generally divided into three sections as follows:
Section one, two and three were designed to elicit information from developers of stand-alone systems, web-based applications and static websites respectively. A definition of these system types is presented in Appendix A.

6.2 The Target Population – A Preliminary Description

6.2.1 Commencement of Trading

All respondent organisations responded to the question on primary function. As Figure 6.1 indicates 25% of respondents commenced trading previous to 1990, 27% between 1990 and 1994, 37% between 1995 and 1999 and 11% started trading later than 1999.

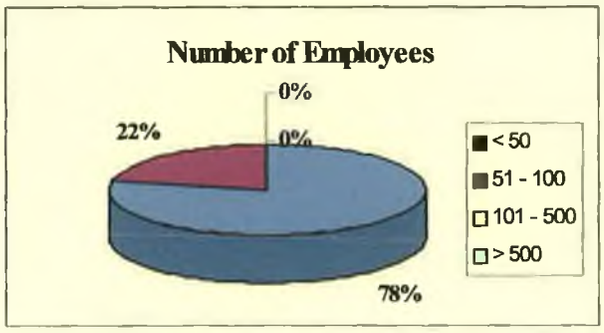
Figure 6.1 Commencement of Trading



6.2.2 Number of Employees

All companies responded to the question relating to the number of employees working in their organisation. The sample mean is 14 and the sample standard deviation is 20. As figure 6.2 indicates, the majority of organisations (78%) employ less than 50 people. Twenty two percent of employers employed between 51 and 100 people. No respondents employed more than 100 employees.

Figure 6.2 Number of Employees



6.2.3 Development Effort

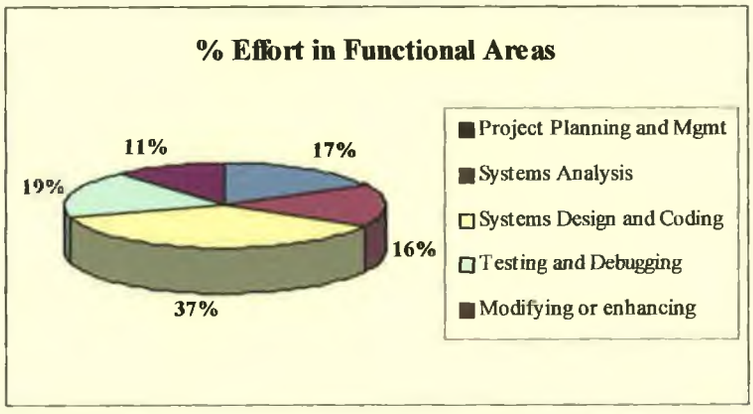
All respondents responded to question four. This relates to the development effort applied in each functional area; project planning and management, systems analysis, systems design and coding, testing and debugging and modifying or enhancing systems previously developed. Table 6-1 reports the average number of employees working within each of these functional areas; respondents have the highest concentration of staff in the area of system design and coding. This reduces through system analysis, and marginally through testing and debugging and project planning and management. The lowest concentration of staff is in the area of modifying or enhancing systems.

Table 6-1 Responsibility of Development Staff

Functional Area	*Average*
Project Planning and Mgmt	2
Systems Analysis	2
Systems Design and Coding	4
Testing and Debugging	2
Modifying or enhancing	2
Other	2
Total	14

Figure 6.3 depicts the percentage effort applied across the specified functional areas. All respondents answered the relevant question.

Figure 6.3 Percentage of Development Effort in Functional Areas



Respondents expend 37% of their development effort on systems design and coding, 19% on testing and debugging, 17% on project planning and management, 16% on systems analysis and 11% on modifying or enhancing.

When the percentage effort within each functional area is examined, based on the number of employees working there, and the perceived percentage effort is compared the following results can be seen (see table 6-2). The results suggest that developers expend less effort in the functional area of systems design and coding then they perceive to be spending. In contrast to this, more effort is being spent in the area of modifying or enhancing and into the analysis stages than is generally realised.

Table 6-2 Comparison between the actual percentage effort applied and the perceived percentage effort applied

Functional Area	Actual Effort	Perceived Effort
Project Planning and Mgmt	18%	17%
Systems Analysis	19%	16%
Systems Design and Coding	31%	37%
Testing and Debugging	18%	19%
Modify or Enhancing	15%	11%

Designers have a strong perception of the importance of the design and coding phases but do not seem to realise the full importance and time required to complete the

analysis stages. Developers also tend to under estimate the time requirements for modifications and enhancements after the system has been designed.

6.3 Systems Developed – The Nature, Cost and Complexity

This section reports the findings with respect to the following aspects of systems developed by respondent organisations:

1) The nature of systems developed.
2) The average cost or value of systems developed over the past five years.
3) The rated complexity of systems with respect to required functionality, data structure and user interface.

6.3.1 The Nature of Systems Developed

Systems developers was asked to specify the percentage of systems developed by them, which were predominantly stand-alone systems, web-based systems or static websites. As depicted in figure 6.4, stand-alone systems are the main type of system developed, accounting for an average of 46% of system development. Static websites account for an average of 32% of systems and web-based systems account for an average of 22% of systems developed.

Figure 6.4 Predominant Nature of Systems Developed

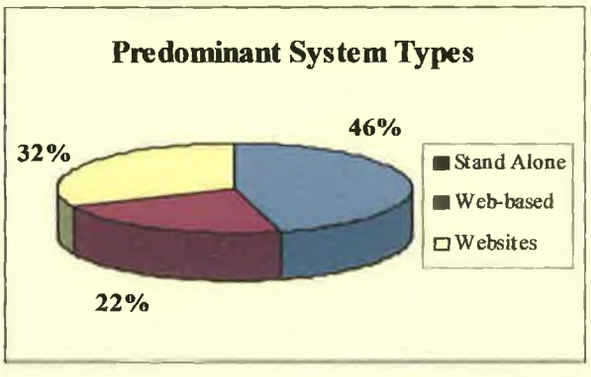
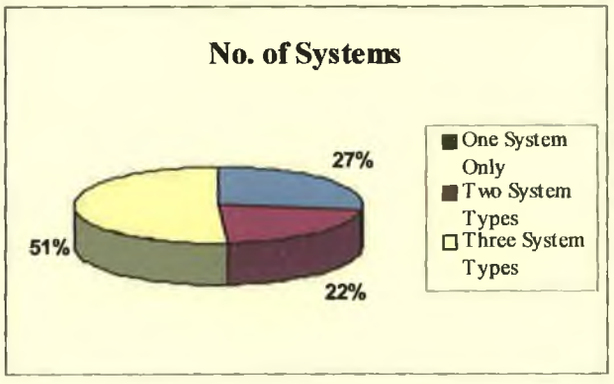
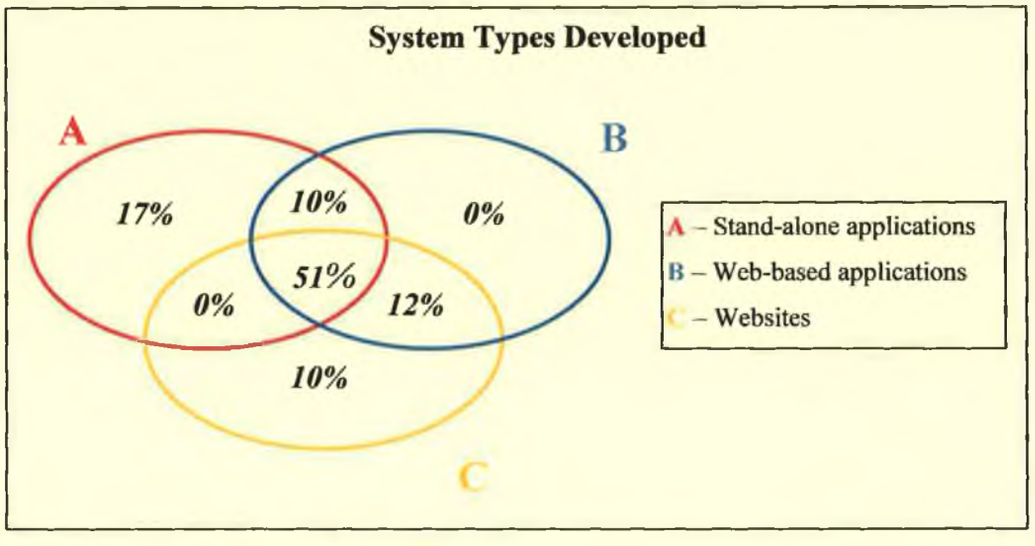


Figure 6.5 **Number of Respondents who develop one or more system type**



Many of the respondents develop more than one type of system. As Figure 6.5 depicts, 51 percent of respondents develop all three system types and 73 percent of organisations develop more than one type. Figure 6.6 depicts the breakdown of the types of systems developed.

Figure 6.6 **Types of System Developed**



No respondents develop web-based applications only. Of those who develop web-based applications, 12% also develop static websites, and 10% develop stand-alone applications also. Seventeen percent of respondents develop stand-alone applications only. The majority (61%) of respondents who develop stand-alone systems also develop other system types. This identifies a migration toward web requirements. Ten percent of respondents develop websites only. No respondents develop a combination of stand-alone applications and websites exclusively.

Data from respondents indicate an increasing demand for web-based systems. As depicted in table 6-3, 54% of respondents noted that web-based systems were increasing as part of the overall proportion of systems developed by them. Forty two percent felt that they had remained the same. In contrast only 22% of respondents felt that stand-alone systems were increasing with 46% stating that there was little or no change

Table 6-3 Organisations Noting Changing Proportions of System Types.

	Stand-Alone	Web-based	Websites
Decreasing Proportion	32%	4%	4%
Unchanging Proportion	46%	42%	58%
Increasing Proportion	22%	54%	38%

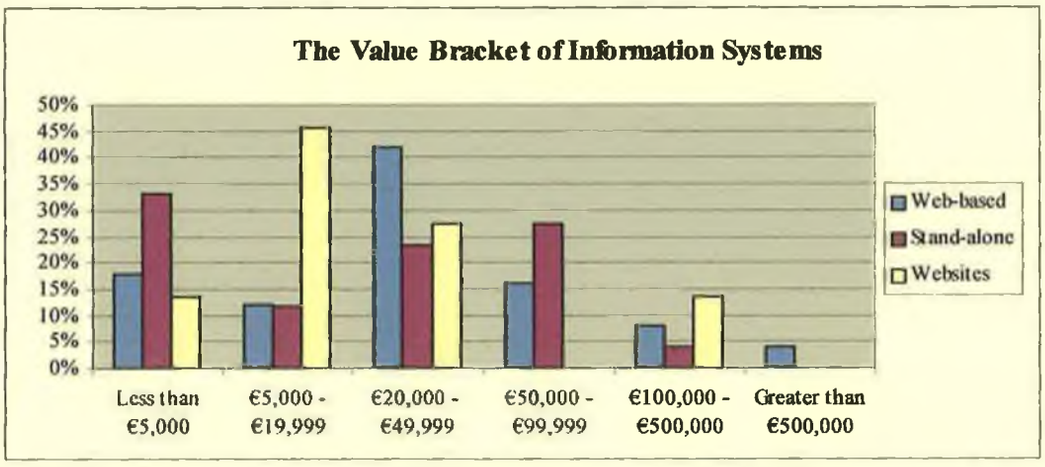
The majority of developers (58%) feel that static websites are unchanging as the proportion of systems developed. Thirty eight percent feel they are increasing. These results clearly identify an increased demand for web-based systems.

6.3.2 The Value of Systems Developed

Figure 6.7 depicts the value brackets into which respondents placed the average system developed by them over the past five years. Thirty three percent of organisations developing stand-alone systems place the value of their systems at less than €5,000. Twenty seven percent are placed in the €50,000 - €99,999 bracket, 24% in the €20,000 - €49,999, 12% in the €5,000 - €19,999 bracket and only 4% in the €100,000 -

€500,000 bracket. No respondents develop systems in the higher bracket of over €500,000.

Figure 6.7 The Average Value Bracket of Systems Developed by Respondent Organisations.



Forty two percent of organisations developing web-based systems place the value of their systems in the €20,000 - €49-000 bracket. This is followed by 18% in the less than €5,000 bracket, 16% in the €50,000 - €99,999, 12% in the €5,000 - €19,999 and 8% in the €100,000 - €500,000 bracket. Respondents who develop Web-based systems are the only respondents who develop systems that are valued at greater than €500,000.

Forty five percent of organisations developing static websites place their systems in the €5,000 - €19,000 bracket. Twenty seven percent are in the €20,0000 - €49,999 bracket, and 14% in the €100,000 - €500,000 and less than €5,000 brackets respectively.

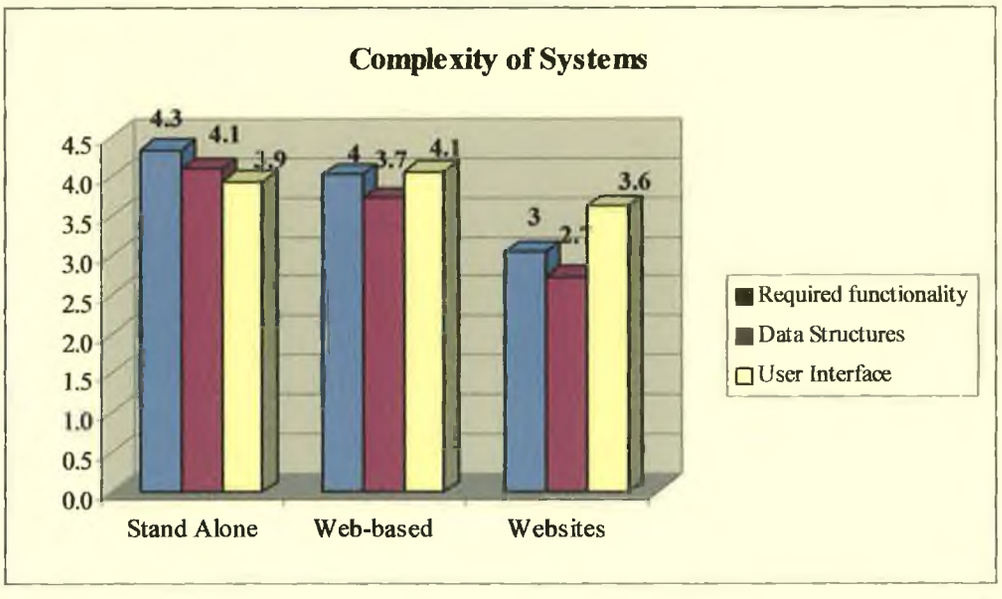
6.3.3 The Complexity of Systems Developed

Respondents were asked to rate the following on a scale of one to five with one presenting 'not complex' and five representing 'extremely complex';

- The *functional complexity* of the average information system developed by them.
- The *data structure complexity* of the average information system developed by them.
- The *user interface complexity* of the average information system developed by them.

All respondents answered this question. The results are presented in figure 6.8. Respondents rate 'required functionality' as very complex (4.3) for stand-alone applications with web-based applications rated at four. 'Required functionality' is considered to be of medium importance for websites.

Figure 6.8 The Average Complexity Rating for Information Systems



'Data structures' is considered to be the most complex for stand-alone applications with a rating of 4.1. This was again followed by web-based applications with a rating of 3.7. 'Data structures' is considered the least important for websites (2.7).

The 'user interface' is considered to be the most complex for web-based applications with a rating of 4.1. This is followed by stand-alone applications (3.9). The 'user interface' is considered to be of less complexity for websites than for the other system types but it is considered to be more complex than 'required functionality' and 'data structures' for websites.

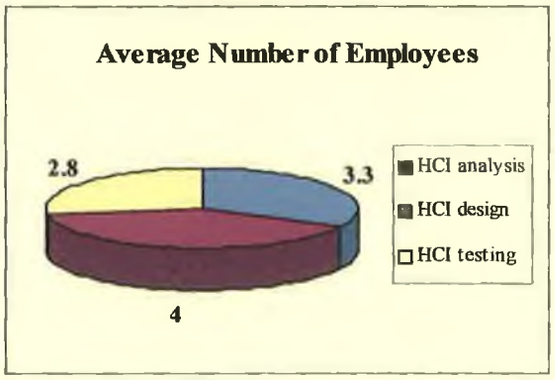
6.4 The Approach to Human Computer Interface Design

The following section reports on the approach of system developers to Human Computer Interface (HCI) Design. It examines the number of employees and the percentage effort applied to different aspects of HCI design. It also explores the training of employees in this area. All respondents answered the relevant questions.

6.4.1 Effort Applied to Different HCI Functional Areas

Respondents were asked to specify the number of employees with some responsibility within the following HCI areas: HCI analysis, HCI design and HCI testing. Figure 6.9 depicts the percentage of employees with some responsibility within the different functional areas of HCI. In total there is an average of 10

Figure 6.9 Average Number of Employees Within Each Area of HCI

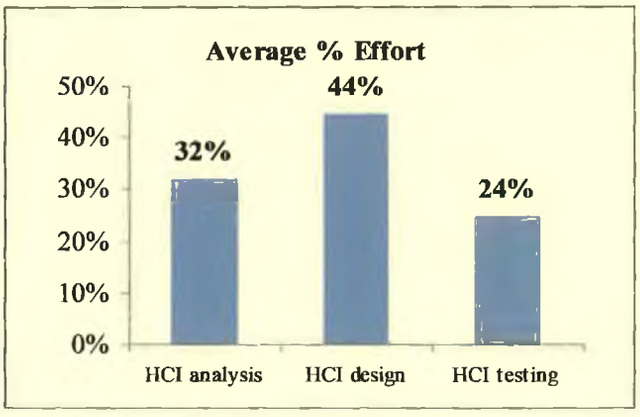


employees per organisation with some responsibility within the different HCI areas. HCI design has an average of four employees per organisation, which is the highest, and accounts for 40% of the overall employees within the area of HCI. HCI analysis has an average of 3.3 employees per organisation or 33% overall, and testing has the least number of employees with an average of 2.8, which was 28% of the total number of employees in the area of HCI.

The total number within the area of HCI corresponds to a very high proportion (83%) of the total number of employees working within the functional areas; project planning and management, analysis design and coding, testing and debugging and modifying or enhancing systems previously developed. The number of employees within the HCI area also corresponds to 71% of the average number of employees with the organisations.

Respondents were asked to estimate the percentage of their overall software development effort expended within each of the areas; HCI analysis, HCI design and HCI testing. Forty four percent of overall development effort is expended in system design. This is high considering that the complexity of data structures and functionality is considered higher than the complexity of the user interfaces for all system types developed. Yet, 44% of the overall software

Figure 6.10 Estimated Percentage Overall Software Development Effort Expended Within each HCI Functional Area



development effort is expended on the design of user interfaces, 32% on HCI analysis and 24% on HCI testing.

6.4.2 Professional HCI Designers

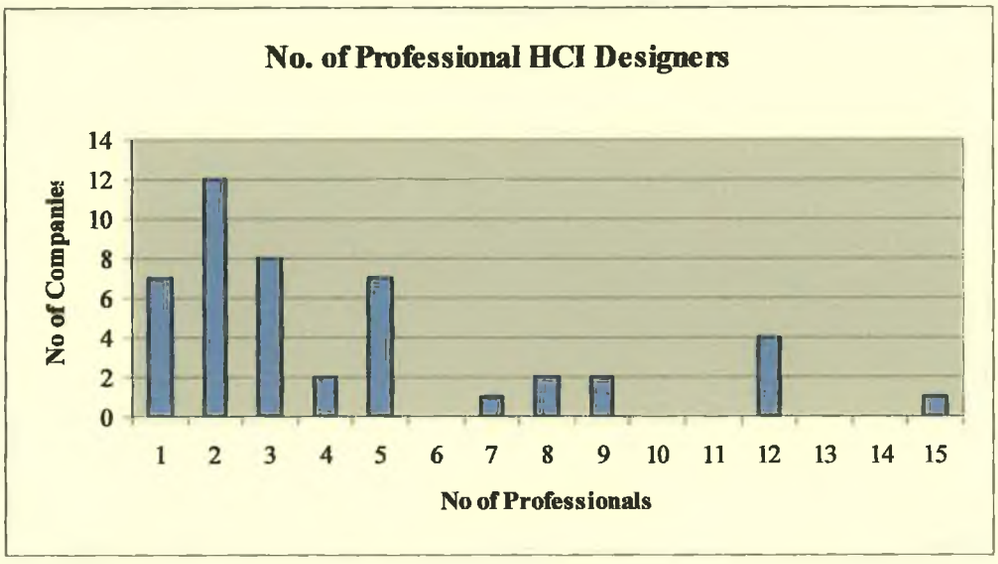
Companies were asked to specify the number of employees qualified as professional HCI designers. The average number of employees, qualified as professional HCI designers is four. The highest number of HCI professional designers within one organisation is 15 with some companies employing no qualified professional HCI designers. The most frequently occurring value or the mode is two. The summary statistics are depicted in table 6-4

Table 6-4 **Summary Statistics for Number of Employees Employed as Professional HCI Designers.**

Mean	4
Standard Error	1
Median	3
Mode	2
Standard Deviation	4
Sample Variance	13
Kurtosis	1
Skewness	1
Range	15
Minimum	0
Maximum	15
Sum	202
Count	51

While the average number employed as qualified professional HCI designers is four, 10% of companies employ none. Figure 6.11 depicts the inconsistency between the numbers of HCI designers employed in each company. There is no significant correlation between the number of employees in each organisation and the number employed as professional HCI designers.

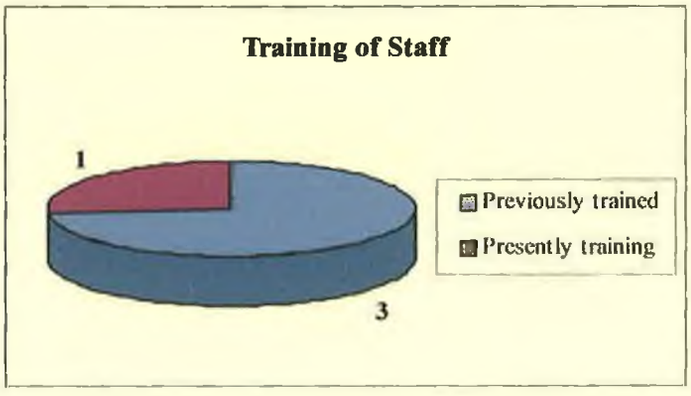
Figure 6.11 Number of Employees Employed as Professional HCI Designers



6.4.3 Training of Employees in HCI Design

Respondents were asked to specify the number of employees who had previously undergone specific training in HCI design and the number that were presently undergoing specific training in HCI design.

Figure 6.12 Average Number of Staff Currently and Previously Trained in the Area of HCI.



The average number of employees per company who have previously received training is three. The average number of employees who are presently being trained in the area is one.

The design of interfaces for stand-alone applications differs considerably to web-based systems and static websites. Many of the older trained staff would need retraining in these areas yet, 14% of companies have no employees who have previously been

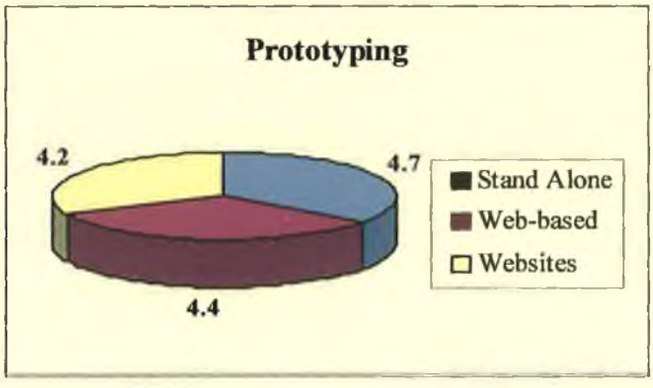
trained and 23% of companies have no employees presently in training. This indicates that companies do not see the benefits that ensue from ongoing training in HCI design. Eighteen (1999) states that more organisations appear to view IT training as a cost rather than an investment. Also, companies do not perceive the design of web-based systems and static websites as different from the traditional user interfaces of stand-alone systems. Another reason for the lack of formal training may be obtained from research carried out by Taylor et al., (1999) which found that 95 percent of IT practitioners felt that actual hands-on experience of web site development activities was the more appropriate method for developing Website development skills and knowledge. These finding are in line with research carried out by Russo and Graham (1998) who noted that few website developers receive formal training in development tools and languages.

6.5 User Interface Prototyping

6.5.1 Importance of User Interface Prototyping

Respondents were asked to rate the importance of user interface prototyping as part of the design process for each system type. The scale ranged from one to five with one representing 'unimportant' and five representing 'extremely important'. Figure 6.13 depicts the results. User Interface prototyping is seen by all respondents as an important part of the design process for all three types of systems.

Figure 6.13 **Importance of User Interface Prototyping as Part of the Design Process.**



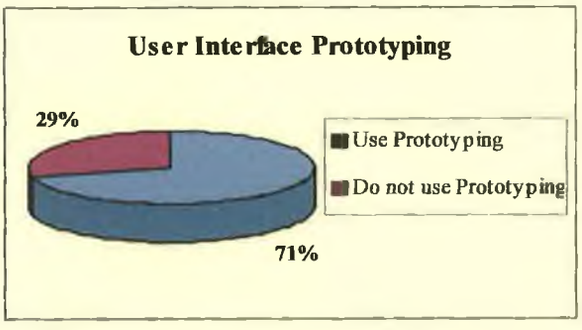
The average rating given for stand-alone applications is close to five with the average for web-based applications and websites marginally less at 4.4 and 4.2 respectively.

6.5.2 Usage of User Interface Prototyping

Respondents were asked to specify whether or not they used user interface prototyping as part of the design process. The results are depicted in figure 6.14. The majority (71%) of respondents use user interface prototyping as part of the design process.

The proportion of respondents who do not employ user interface prototyping at all is high considering the high importance rated to it for all systems types in the previous question (see figure 6.13).

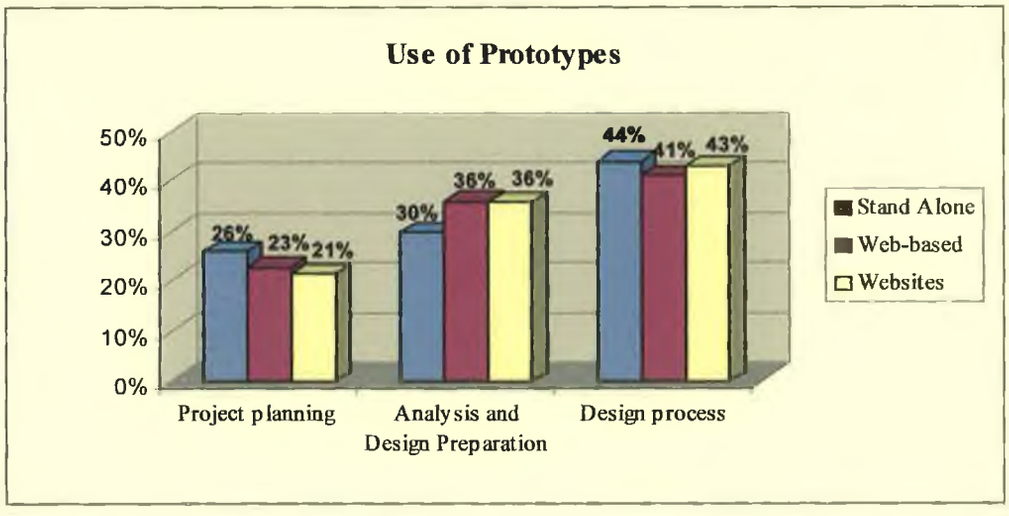
Figure 6.14 Usage of User Interface Prototyping



The training effort of those who do not utilise user interface prototyping was examined. This segment has an average of one employee currently undergoing training. Those respondents who do employ user interface prototyping have an average of four employees per organisation who are presently being trained. The number of employees previously trained is the same for both segments. The reason for 29% of respondents not utilising user interface prototyping may be due to the lack of necessary skills.

The respondents who use user interface prototyping as part of the design process were asked to specify the stages of the development process for which they develop prototypes. Respondents were required to respond separately for each system type. The results are depicted in figure 6.15.

Figure 6.15 Percentage Usage of User Interface Prototypes for Each Stage of the Development Process.



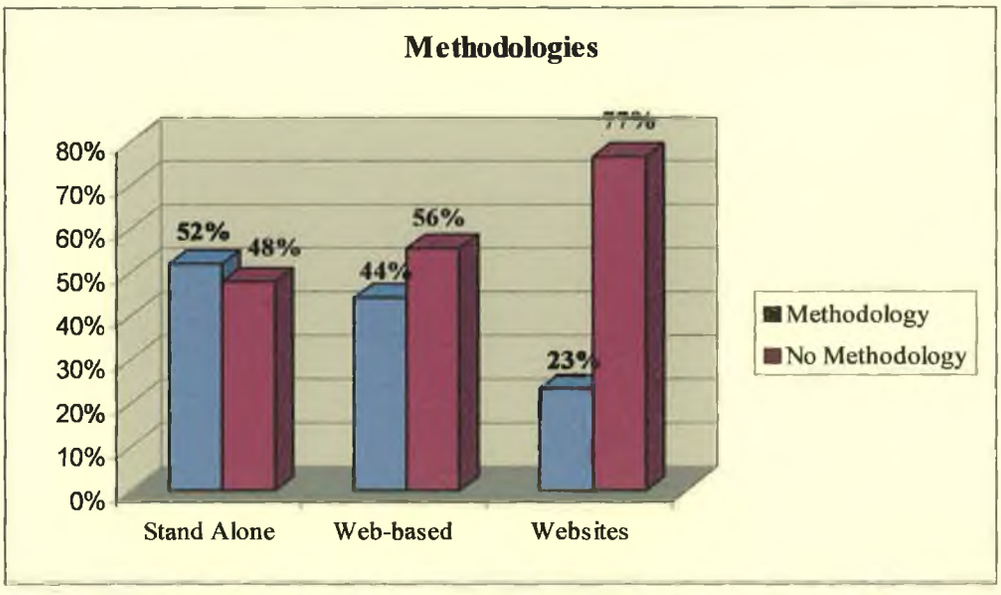
User interface prototyping is used primarily during the design process, the analysis and the design preparation and the project planning phase, in descending order of use, for all system types. For the design process, there is only a marginal difference in use of prototyping between the different types of systems. Prototyping is used equally (36%) during the analysis and design stages for both web-based applications and static websites. Prototype usage during the project stage, which has the lowest usage, is highest for stand-alone applications at 26%, followed by web-based applications with 23% and static websites with 21%.

6.6 Formal Methodologies

6.6.1 Use of Formal Methodologies

Respondents were asked to specify whether or not they use a formal methodology for each system type they develop. The results are depicted in figure 6.16.

Figure 6.16 Use of Formal Methodologies for Each System Type



Fifty two percent of companies use a formal methodology during the design process for stand-alone applications and 44% for web-based applications. The proportion of companies who use a formal methodology for static websites is very low at 23%. Respondents were asked to identify the formal methodologies used by them during the development process for each system type. Only 29 respondents answered the relevant question for stand-alone applications, 23 for web-based applications and 16 for static websites.

6.6.1.1 Methodologies Used for Stand-alone Applications

The most common formal methodology used for stand-alone applications is User Centred Design (UCD). This accounts for 33% of the overall methodologies used. Evolutionary Prototyping is the least used methodology with only five percent of respondents utilising it. The overall results are presented in table 6-5.

Table 6-5 Types of Formal Methodologies Used For Stand-Alone Applications

Methodologies	Percentage
UCD	33%
RAD	29%
FDD	19%
XP	19%
DSDM	14%
UML	10%
Waterfall Approach	10%
Evolutionary Prototyping	5%

6.6.1.2 Methodologies Used for Web-based applications

User Centred Design is the most commonly used methodology for the design of web-based applications and accounts for 37% of the overall methodologies used for web-based applications. The overall results are presented in table 6-6

Table 6-6 Types of Formal Methodologies Used For Web-based Applications

Methodologies	Percentage
UCD	37%
RAD	21%
DSDM	16%
FDD	11%
UML	11%
Waterfall Approach	11%
XP	11%
Evolutionary Prototyping	5%

6.6.1.3 Methodologies Used for Static Websites

As with stand-alone system and web-based systems, user centred design is the most commonly used methodology for the development of static websites accounting for 58% of the total methodologies used. The overall results are presented in table 6-7.

Table 6-7 Types of Formal Methodologies Used For Websites

Methodologies	Percentage
UCD	58%
FDD	17%
UML	17%
Waterfall Approach	17%
XP	17%
RAD	8%
DSDM	0%
Evolutionary Prototyping	0%

6.7 Standards and Guidelines

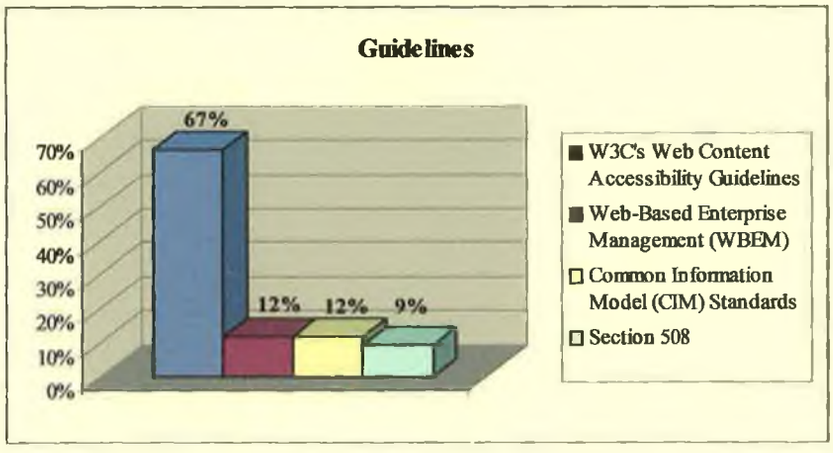
There are a number of different organisations and institutes that provide standards and guidelines that can be followed and adhered to during the design process. Such standards are provided in an effort to improve interface design and to help organisations avoid common pitfalls. A number of common guidelines are used. Seventy three percent of companies responded to the relevant questions.

6.7.1 Standard and Guideline Usage

Respondents were asked to indicate which set of guidelines, if any, they prescribed to when designing their information system. A list of common standards and guidelines were listed with a section for respondents to add to the list. Figure 6.17 depicts the result. Respondents selected a total of three of the six guidelines listed. The most

common guideline used is W3C's Web Content Accessibility Guidelines accounting for 67% of the total. Web-Based Enterprise Management (WBEM) guidelines and Common Information Model (CIM) standards account for 12% respectively.

Figure 6.17 Standard and Guidelines Prescribed To When Designing Systems.



Section 508, which was not specified in the original list, is used by 9% of organisations.

6.8 Multimedia and Hypermedia

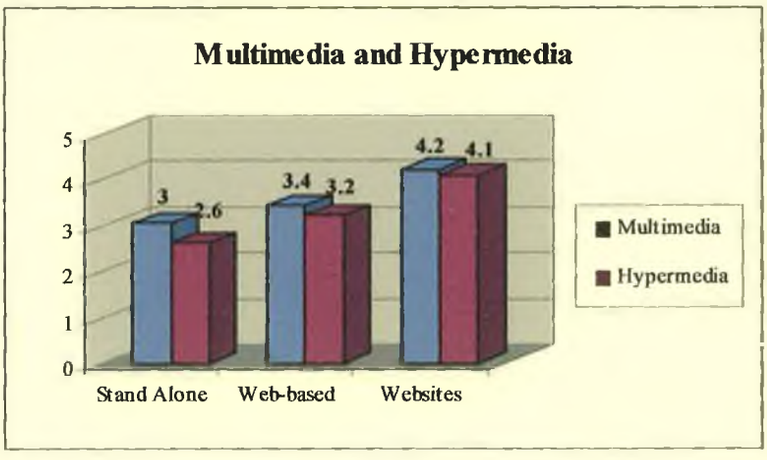
The use of multimedia and hypermedia to enhance HCI effectiveness is rapidly increasing. This increase in use is possibly explained by the reducing cost of the equipment needed to run multimedia systems. Multimedia and Hypermedia are increasingly used on the WWW. The following section deals with designer's attitudes to the importance of such a growing area. All respondents answered the relevant questions.

6.8.1 Importance of Multimedia and Hypermedia.

Respondents were asked to rate the importance they placed on the use of multimedia and hypermedia for all three application types. A scale of one to five was provided with one indicating 'not important' and five indicating 'extremely important'.

The results for each system type are presented graphically in figure 6.18.

Figure 6.18 Average Importance of Multimedia and Hypermedia for each system type



Companies rated the use of multimedia as being very important for static websites, with an average rating of 4.2. The use of multimedia is rated at slightly above average importance for web-based applications and stand-alone applications with a rating of 3.4 and 3 respectively. The use of multimedia is especially important when designing for the web. Users expect to see a combination of graphics, text and even sound otherwise they will leave a site and may not return.

The use of Hypermedia is rated high for static websites with an average rating of 4.1. This was followed by web-based applications at 3.2 and stand-alone applications at 2.6.

6.9 Design Principles

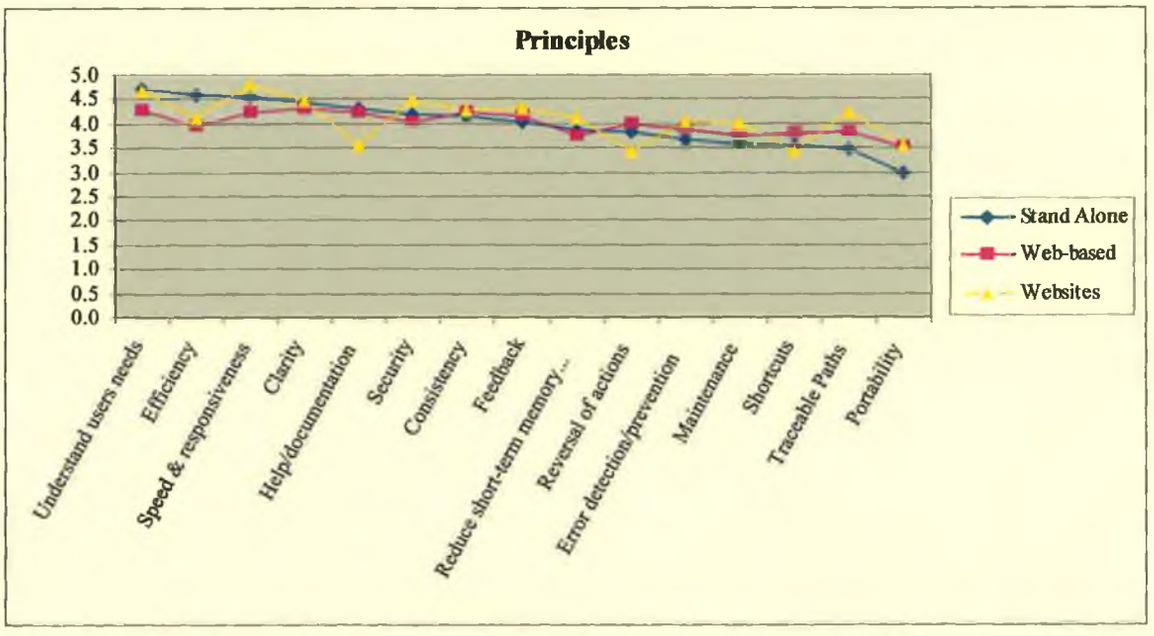
Design principles differ for different types of systems. Principles that are extremely important for stand-alone applications may be less important for static websites. A good understanding of the importance of the various design principles is vital for the successful development of any type of system. The following section reviews the perception of developers to different design principles with designers rating them in order of importance for each system type. All respondents answered the relevant questions.

6.9.1 Importance of Design Principles

Respondents were asked to rate the importance of, and the effectiveness of applying different design principles for each system type. A list of design principles was provided with the opportunity to add any additional design principles that respondents felt were important. A scale of one to five was provided with one representing 'little importance' and five representing 'extreme importance'.

Figure 6.19 depicts the results for all three system types. The results suggest that there is no significant difference between the perceived importance of the application of the principles for each system type.

Figure 6.19 Average Rating for Design Principles



6.9.1.1. Importance of Design Principles for Stand-alone Applications

Respondents feel that *understanding the user needs* is the most important design principle for stand-alone systems with an extremely high ranking of 4.7. This is in line with current literature, which states that to build a well designed system the user must be involved (Murray and Constanzo, 1999). According to Murray and Costanzo the most important factor in systems design is the user and the key to building successful systems is to involve the user in the entire development process from the beginning.

Efficiency of the design of system is also considered very important (4.6), followed by *speed and responsiveness*, which was marginally lower with a ranking of 4.5. According to Nielsen (2001), the limit of the users ability to keep their attention focused while waiting is ten seconds. Therefore, if a system is slow and doesn't respond quickly enough the user will move to

another site. *Clarity* and *help and documentation* are also perceived as very important with rankings of 4.5 and 4.3 respectively. The overall results are presented in table 6-8.

Table 6-8 Average Ratings for Design Principles for Stand-Alone Applications

Principles	Average
Understand users needs	4.7
Design for efficiency	4.6
Speed & responsiveness	4.5
Clarity	4.5
Help and documentation	4.3
Security	4.2
Consistency	4.2
Offer informative feedback	4.0
Reduce short-term memory load	3.9
Permit easy reversal of actions	3.8
Offer error detection and prevention	3.7
Maintenance	3.6
Enable frequent users to use shortcuts	3.6
Provide traceable paths	3.5
Portability across different platforms	3.0

6.9.1.2. Importance of Design Principles for Web-based Systems

Companies consider the *clarity* of a system as important for web-based systems, giving it an average of 4.3. The importance of *understanding the users needs* is also considered high (4.3). The complete results are presented in table 6-9.

Table 6-9 Average Ratings for Design Principles for Web-based Applications

Principles	Average
Clarity	4.3
Understand users needs	4.3
Help and documentation	4.2
Speed & responsiveness	4.2
Consistency	4.2
Offer informative feedback	4.2
Security	4.0
Permit easy reversal of actions	4.0
Design for efficiency	4.0
Offer error detection and prevention	3.9
Provide traceable paths	3.8
Enable frequent users to use shortcuts	3.8
Maintenance	3.7
Reduce short-term memory load	3.7
Portability across different platforms	3.5

6.9.1.3. Importance of Design Principles for Static Websites

Respondents rate *speed and responsiveness* extremely high for static websites. This is consistent with research carried out by Nielsen (1996) who found that on the web, users have come to expect delays and slow downloads, and are more tolerant of it. He suggests that response times for websites can be increased from 10 to 15 seconds. If a system does not respond within this timeframe, users will browse to another site and may not return. With so much choice on the web, users have little loyalty, and will frequently browse from site to site to find the information they require. Therefore, it is vital that websites are fast and dynamic enough to hold the users attention.

As with web-based and stand-alone systems, *understanding user needs* is also rated very high. The *clarity* of a website is considered extremely important. The ranked results and rankings are presented in table 6-10.

Table 6-10 Average Ratings for Design Principles for Websites

Principles	Average
Speed & responsiveness	4.8
Understand users needs	4.7
Clarity	4.5
Security	4.5
Offer informative feedback	4.3
Consistency	4.3
Provide traceable paths	4.2
Design for efficiency	4.1
Reduce short-term memory load	4.1
Offer error detection and prevention	4.0
Maintenance	4.0
Help and documentation	3.6
Portability across different platforms	3.6
Permit easy reversal of actions	3.4
Enable frequent users to use shortcuts	3.4

The principles – *understanding users needs*, *speed and responsiveness* and *clarity* are ranked within the top four for all types of systems. *Understanding users needs* is considered extremely important for each system type. This is consistent with the findings of Murray and Costanzo (1999) who suggest that it is important for designers to know exactly who will be accessing their site or application. It is impossible to design correctly for unknown users. They also advise, that the key to building a useful and usable website, is to involve the user in the development process from the beginning.

Shneiderman (1997a) states that it is vital for designers of websites to know who their users will be and whether or not the typical user is a casual visitor. If users have come to a site to view something of specific interest to them, they will tolerate lengthy download times and more demanding site interaction. According to IBM (Feb 2001) it

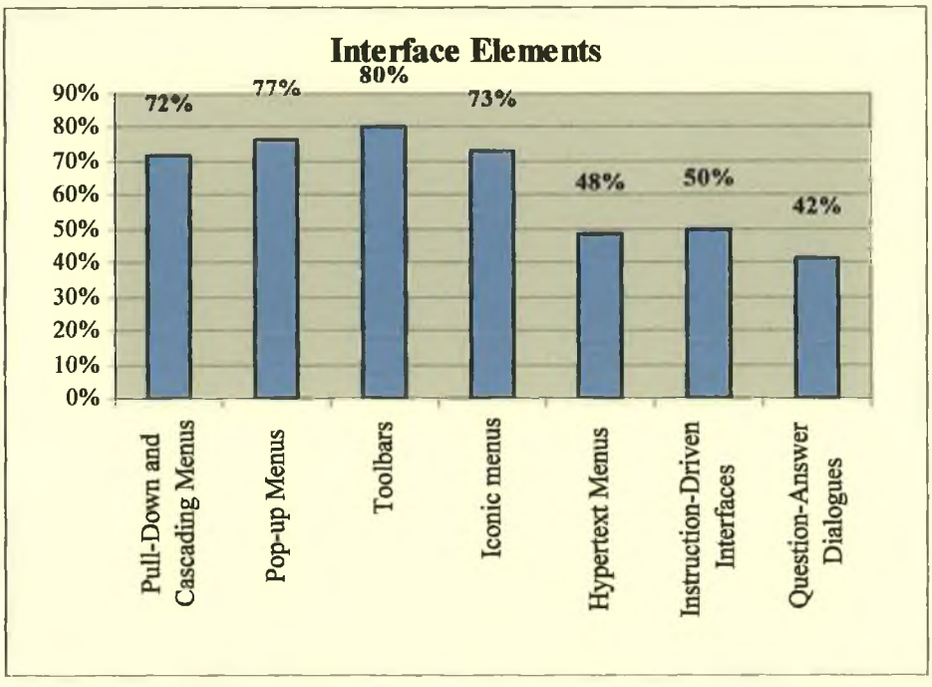
is important to try and understand users so that designers can build websites/applications that support their desired behaviours

Clarity is also considered highly important for each system type. This is consistent with the principles appropriated by prominent writers and organisations in the area. According to IBM (March 2001) a good interface design will allow the user to quickly see their options and do their work. Less important information or objects should be hidden, but obtainable, so as not to distract the user. Skaalid (1999b) states that designers should be careful not to provide too many features that do not add to the user interface, as an interface cluttered with many functions will only serve to distract the user from accomplishing their everyday tasks. Skaalid (1999b) also states that a well-organised interface will support the user's tasks and allow them to work efficiently. Nielsen (1997) advocates the use of as little text and graphics as possible to get the message across. He also recommends keeping the look of the site simple as too many graphics can obstruct the users understanding, and also the use of too many colours and fonts distracts the user.

6.10 User Interface Elements

Respondents were asked to choose which interface elements they used in the design of their systems. A number of the most common interface elements were given with the opportunity for respondents to add additional interface elements. All respondents answered this question, with each respondent specifying the use of one or more interface elements. The results are depicted in figure 6.20.

Figure 6.20 Percentages of the Total User Interface Elements Used By Designers



Toolbars are the most commonly used user interface element with 80% of respondents using them. This is followed by pop-up menus and iconic menus, which are used by 77% and 73% of respondents respectively. Questions and answer dialogues are the least used with 42% of respondents using them.

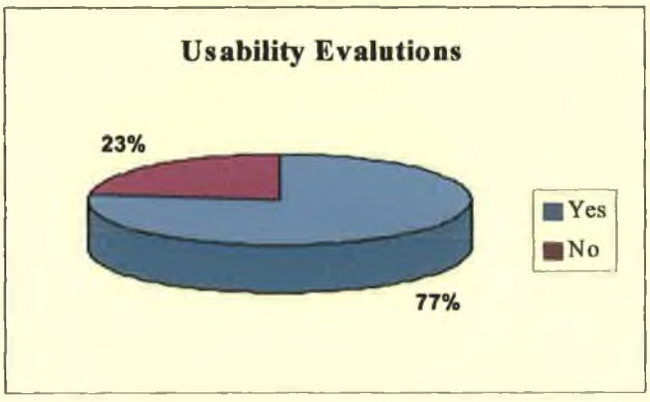
6.11 Usability

Usability is a very important concept in Human Computer Interface Design. This is especially true with static websites. There is so much choice on the Web, users tend to be impatient and insist of instant gratification (Nielsen, 2000). The following section reports on the finding based on usability inspections and usability testing. All respondents answered the relevant questions.

6.11.1 Evaluation (Usability) Inspections

Respondents were asked to specify whether they perform evaluations or usability inspections during the design process. The results are shown in figure 6.21. The majority (77%) of respondents indicated that they carry out usability inspections during the design process.

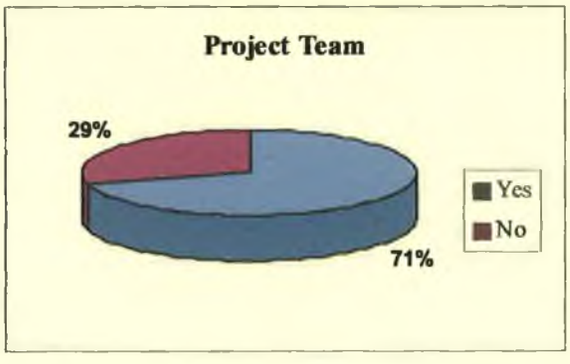
Figure 6.21 Percentage Carrying out Usability Inspections During the Design Process.



The respondents were subsequently asked whether or not an internal member of the organisation carried out the usability inspections. In all cases responses were affirmative.

Respondents were asked to specify whether the person who carried out the usability inspections was a member of the project team. The majority of respondents (71%) stated that it was.

Figure 6.22 Percentage of Project Team Who Carry Out Usability Inspections

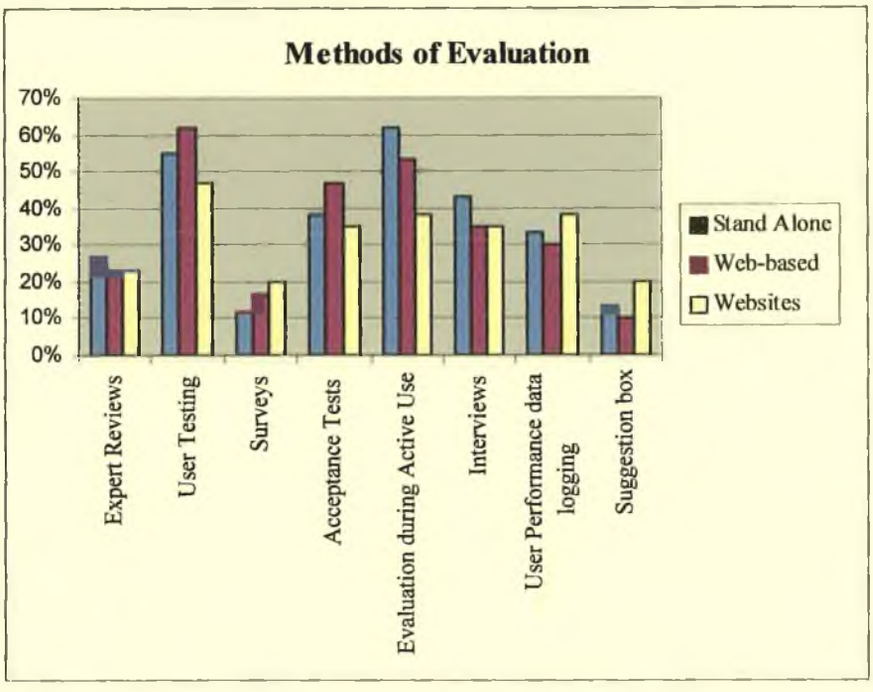


6.11.2 Methods of Evaluation

Respondents were asked to specify which method(s) of evaluation they use for each system type. A list of methods was provided with the opportunity to add additional

methods. All respondents use more than one method of evaluation. Figure 6.23 presents an overview of the most commonly used methods.

Figure 6.23 Methods of Evaluation Used for All System Type



6.11.2.1 Methods of Evaluation for Stand-Alone Systems

Evaluation during active use is the most popular form of evaluation for stand-alone applications with 62% of respondents using this method. Surveys are the least used method of evaluation with only 12% of respondents using them. The overall results are presented in table 6-11.

Table 6-11 Methods of Evaluation Used for Stand-alone Systems

Evaluation Methods	*Percentage*
Evaluation during active use	62%
User Testing	55%
Interviews	43%
Acceptance Tests	38%
User Performance data logging	33%
Expert Reviews	27%
Suggestion box	13%
Surveys	12%

6.11.2.2 Methods of Evaluation for Web-Based Systems

User testing is the most used method of evaluation for web-based applications with 62% of companies using it. This is followed by evaluation during active use at 53% and acceptance tests at 47%. The complete results are presented in table 6-12.

Table 6-12 Methods of Evaluation Used for Web-based Systems

Evaluation Methods	*Percentage*
User Testing	62%
Evaluation during active use	53%
Acceptance Tests	47%
Interviews	35%
User Performance data logging	30%
Expert Reviews	23%
Surveys	17%
Suggestion box	10%

6.11.2.3 Methods of Evaluation for Static Websites

User testing is the most used method of evaluation for static websites with 47% of respondents using it. Surveys are the lowest used method of evaluation with only 20% of respondents using them. Table 6-13 presents the overall results for each method of evaluation.

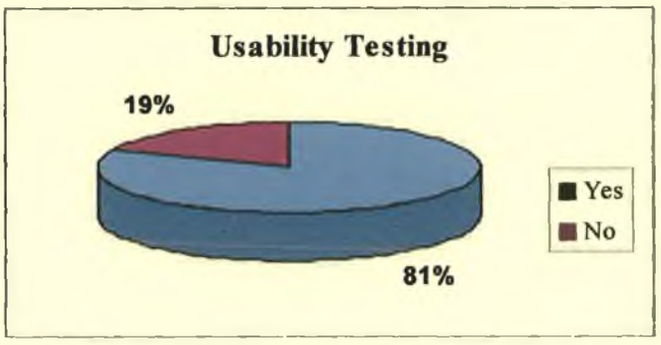
Table 6-13 Methods of Evaluation Used for Web-based Systems

Evaluation Methods	*Percentage*
User Testing	47%
Evaluation during active use	38%
User Performance data logging	38%
Acceptance Tests	35%
Interviews	35%
Expert Reviews	23%
Suggestion box	20%
Surveys	20%

6.11.3 Usability Testing

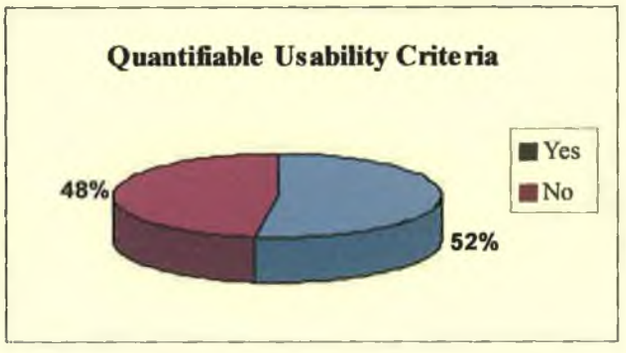
Respondents were asked to specify whether or not they carried out some type of usability testing. The majority (81%) of respondents carry out usability testing. The number of respondents who fail to carry out any type of usability testing at all is high at 19% considering the importance of usability testing.

Figure 6.24 Percentage Carrying Out Usability Testing



Respondents were then asked to specify whether or not they have any predefined quantifiable usability criteria. When carrying out usability testing, a measurable set of definitions by which the quality or the suitability of all deliverables can be judged, should be drawn up (Corporate Solutions Consulting (UK) Ltd 2001). These definitions are known as usability criteria and contain factors such as the quantity and levels of work the system must be able to process sufficiently. Without such criteria, assessments cannot be properly made as to whether a system passes the required levels of usability.

Figure 6.25 Percentage with Predefined Quantifiable Usability Criteria

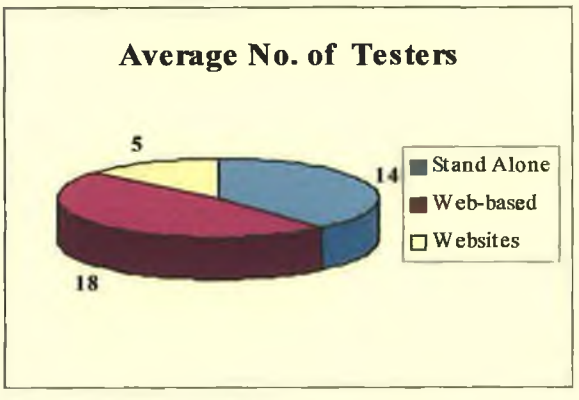


Only a slight majority (52%) of respondents have a set of predefined quantifiable usability criteria. This is significantly low as such criteria are essential to the objective

evaluation of usability. The remaining 48% have no such criteria in place. This can lead to problems determining whether the system can reach its required level of usability.

Respondents were subsequently asked to specify how many users they felt were needed to get a valid result when carrying out usability testing for each system type they develop. The results as depicted in figure 6.26 show that respondents feel that a greater number of testers (18) are needed for web-based applications than for the other type of systems. The average number of testers that respondents feel are necessary for stand-alone applications is 14. This result is surprising considering that respondents rate the average complexity of stand-alone systems higher than that of web-based system (see figure 6.8). The findings are in line with Taylor et al., (2001) who states that testing of web-based systems is more complex than the testing required for other types of IT systems due to the complex navigational structures encountered in Web-based system and the need to cater for different Internet browsers/navigators and versions. The reason for a higher number of testers necessary for web-based applications may also be due to designers having more experience with stand-alone systems. Also the principles for stand-alone systems are longer in place and better understood. Web-based systems are only gaining maturity in the last 10 years. The lowest number of testers that respondents consider were needed for all application types is two. The maximum number of testers respondents felt were needed for stand-

Figure 6.26 Average Number of Testers Needed to Get a Proper Result With Usability Testing

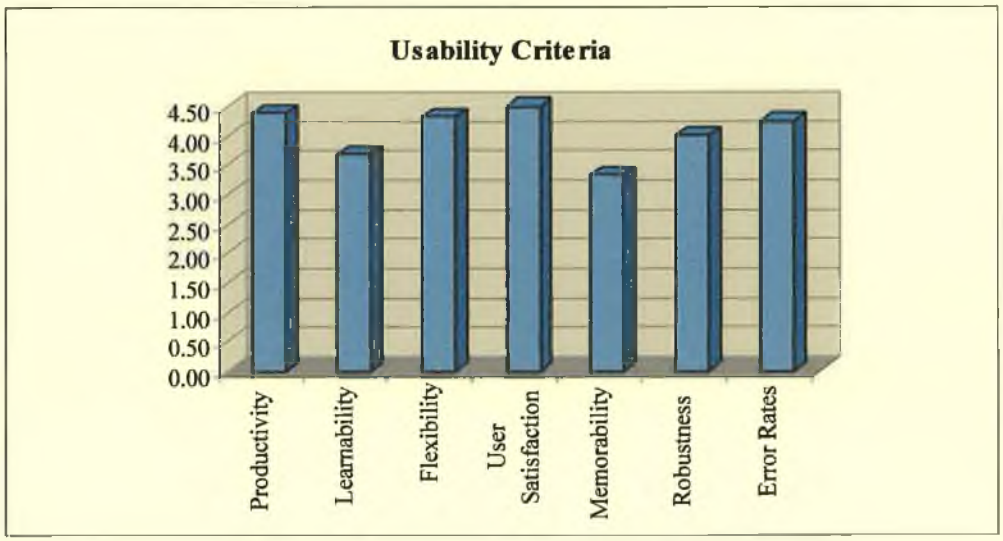


alone applications is 50. The relevant figures for web-based applications and static web sties are 100 and 30 respectively.

6.11.4 Usability Criteria

Respondents were presented with a list of common usability criteria and were asked to rate them on a scale of one to five with one representing 'not important' and five representing 'very important'. Respondents also had an opportunity to add their own usability criteria to this list. The results are presented in figure 6.27.

Figure 6.27 Importance of Usability Criteria

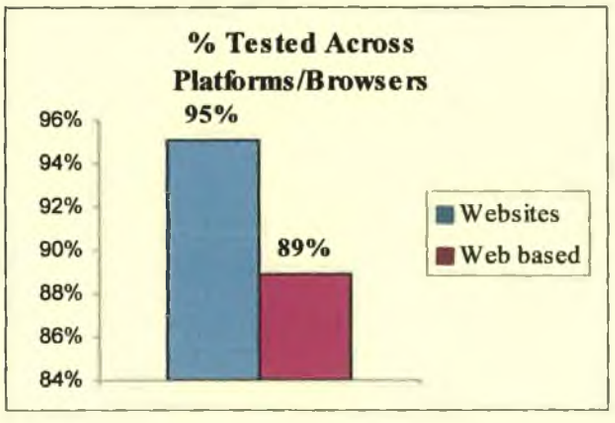


All the usability criteria were rated by respondents. The level of *user satisfaction* is considered an extremely important usability criterion with the highest rating of 4.5. *Productivity levels* are also extremely high at 4.4. *Flexibility* and *error rates* are marginally lower at 4.3. *Robustness* is next at 4, *learnability* at 3.7 and *memorability* is lowest at 3.3.

6.11.5 Types of Browsers/Platforms Tested On

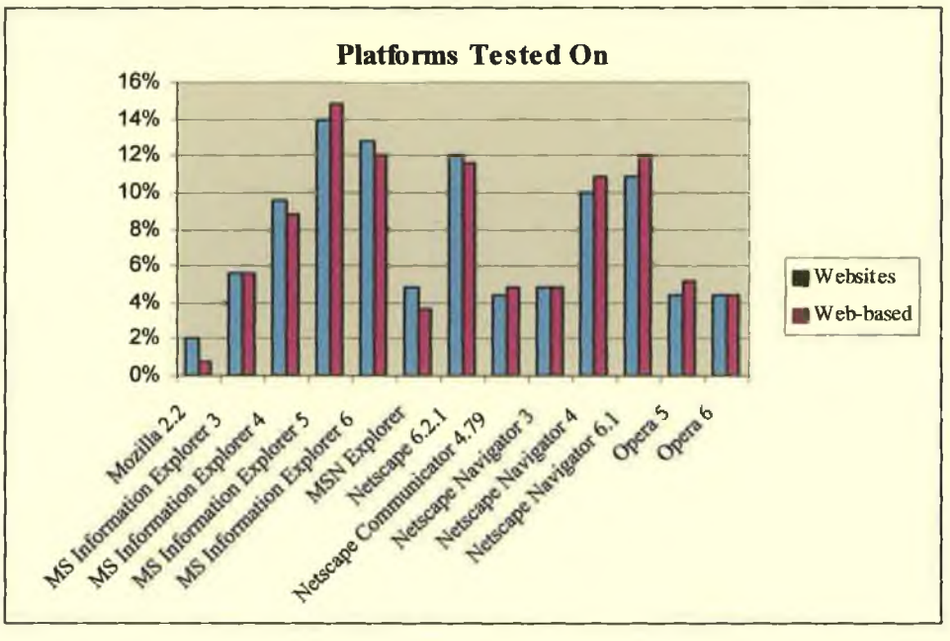
Respondents were asked to specify whether or not they tested static websites and web-based applications on different browsers. The results as shown in figure 6.28 show clearly that the vast majority of respondents test their systems across different platforms and browsers. A total of 95% of static websites are tested across different platforms. This result is slightly lower for web-based systems at 89%.

Figure 6.28 Testing of System Across Platforms



Respondents were subsequently requested to indicate which platforms or browsers they tested their system on. The results are depicted in figure 6.29. MS Internet Explorer 5 and 6 are the main browsers used for both web-based applications and static websites.

Figure 6.29 Browsers/Platforms Systems are Tested On

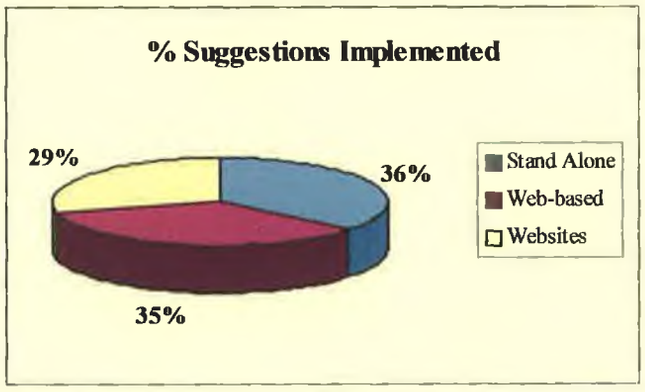


This is followed closely by Netscape Navigator 6.2.1 and Netscape Navigator 6.1. Systems are tested far less on older browsers. This may be due to the fact that updates are so freely available.

6.11.6 Implementation of User Suggestions

Respondents were asked to approximate the percentage of users suggestions they would normally implement on completion of usability testing. The average number of user suggestions that are implemented for stand-alone applications is 36%. This is followed closely by web-based applications where 35% of suggestions are implemented. Twenty nine percent of suggestions are implemented for static websites. These results are surprising considering that all respondents rated understanding user needs as extremely important (See figure 6.19). The low level of user suggestions that are implemented may be due to the fact that developers are aware of good HCI design principles and feel that the suggestions from users may contradict these.

Figure 6.30 Percentage of User Suggestions Normally Implemented on Completion of User Testing.



6.12 User Centred Design

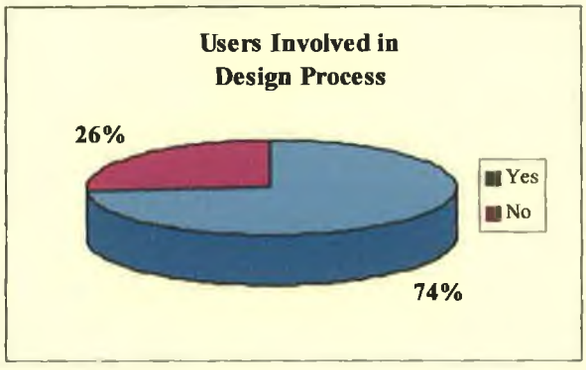
User centred design is important for the successful completion of information systems. User centred design, applied properly will help anticipate and avoid problems users may have. Involving the users throughout the design process helps ensure that the

final product fulfils the users' requirements and can cut training costs by up to 75% (Nielsen et al., 2001). All respondents answered the relevant questions.

6.12.1 Usage and Importance of User Centred Design

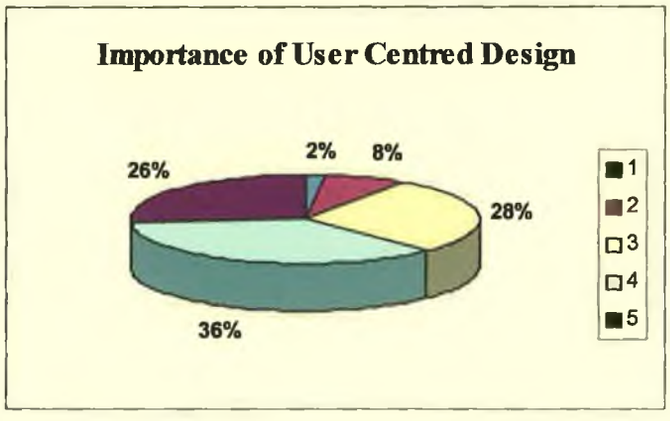
Respondents were asked to specify whether they involve users during the design process. The majority of respondents (74%) do involve users. It is surprising that a quarter of developers do not involve users at all in the design process. User involvement is such an important aspect of design and a high level of user input is needed to ensure a successful system. The reason for some respondents not involving users in the design process may be due to the fact that they are developing off the shelf systems.

Figure 6.31 Percentage of Users Involved During the Design Process.



Respondents were subsequently requested to specify, on a scale of one to five, how important they considered user centred design to be, with one representing 'little importance' and five representing 'extreme importance'. Thirty six percent of respondents rate 'user centred design' as very important with a rating of four out of five. Twenty eight percent of respondents rate it at three and 26%

Figure 6.32 Importance of User Centred Design

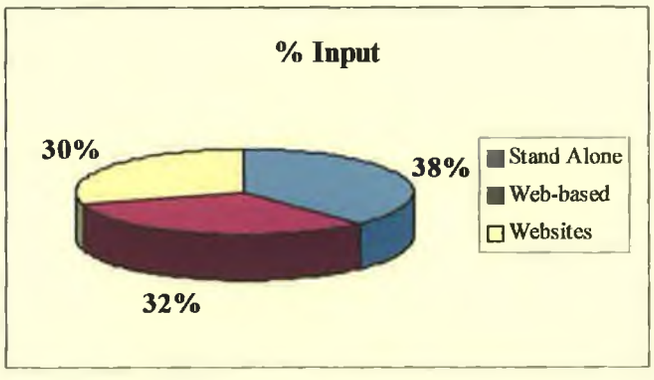


rate it extremely highly at five. Very few respondents rate 'user centred design' lower than three with only 8% rating it at two and 2% at one. Respondents seem to feel that user centred design is very important and that understanding the users need is extremely important (See figure 6.19) yet a quarter of respondents do not involve users in the design process (see figure 6.31).

6.12.2 Input of Users

Respondents were asked to approximate the percentage input the user has into the interface design process for each system type developed by them.

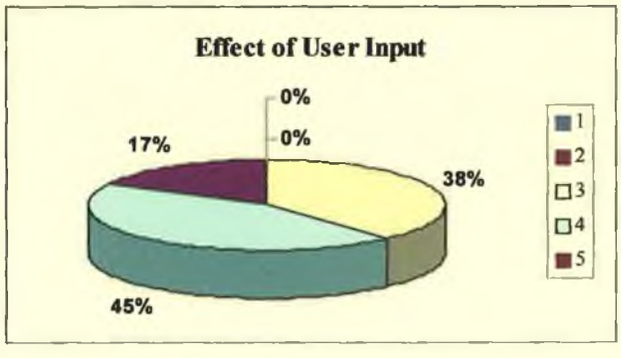
Figure 6.33 Input of Users Into the User Interface Design Process



Users have a 38% impact into the design process of the user interface for stand-alone system. Users have 32% input into web-based applications and 30% input into static websites.

Users were asked how they would rate the average effect of the user input on the finished product. The effect was measured on a scale of one to five with one representing 'little effect' and five representing 'extremely strong effect'. As Figure 6.34 depicts, a large number of respondents

Figure 6.34 Effect of User Input on Finished Product

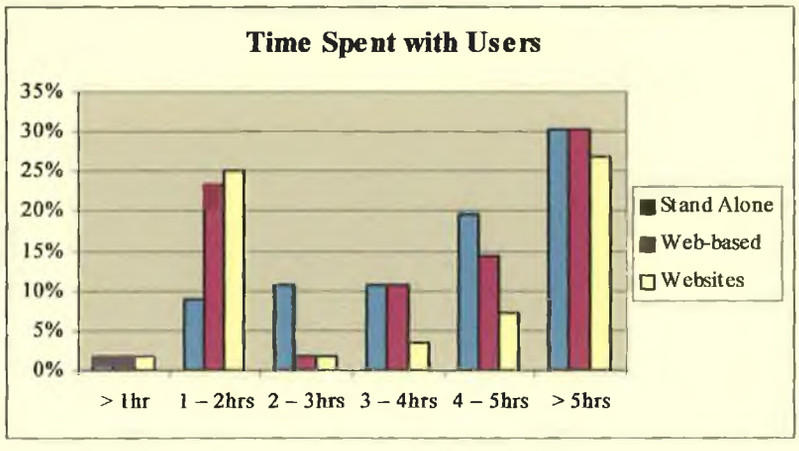


(45%) rate the effect users had on the finished product at four, which is very high. Thirty eight percent of respondents rate the effect of user input at three. Seventeen percent feel that users have a extremely strong effect on the finished product and rate it at its highest of five. No respondents rate the effect of the users on the finished product as lower than three. This would indicate that designers realise the importance of involving users throughout the design process and designing system that suits their wants and needs.

6.12.3 Time Spent With Users

Respondents were asked to estimate the approximate consultation time they spent with users. The results as shown in figure 6.35 indicate that a large proportion of respondents spend more than five hours with users for all three system types. Thirty percent of respondents spend more than five hours with users when designing stand-alone applications and web-based application. This figure is 27% for static websites

Figure 6.35 Approximate Time Spent With Users



More time is spent with users for stand-alone applications with 50% of developers spending in excess of four hours.

As with stand-alone systems, 30% of developers spend more than 5 hours with users when designing web-based applications. However there are a much greater proportion (23%) of users in the one to two hours category. This is due to the fact that 42% of developers estimated that the average costs of the systems they develop are less than €5,000 (see figure 6.7).

Static websites have a large percentage (27%) of respondents spending more than five hours with users. Again this can be explained by the fact that 14% of developers placed the cost of the websites they design in the €100,000 - €500,000 bracket. Static websites also have the largest percentages in the lower time frames with 25% spending between one to two hours. Again this correlates to the cost of the systems they develop with 44% of developers designing systems in the €5,000 to €19,000 bracket (see figure 6.7).

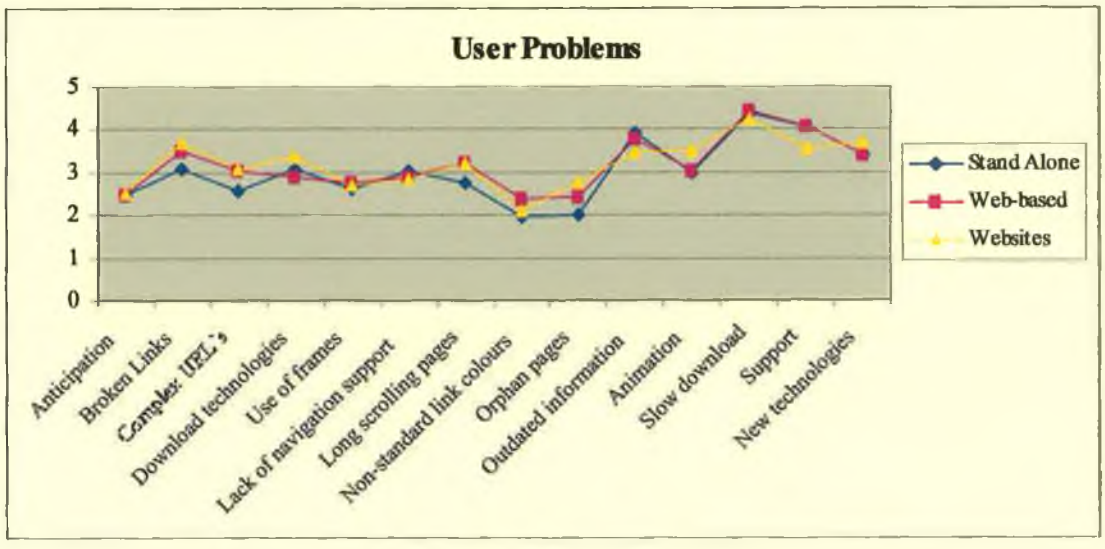
6.13 Problems Users Encounter

The following two sections deal with the problems users encounter when using applications or websites and how often these problems occur. All respondents answered the relevant questions.

6.13.1 Severity of User Problems

Respondents were asked to rate a number of design problems they felt users experience on a scale of one to five with one representing a 'minor problem' and five representing a 'severe problem'. All respondents answered these questions. Figure 6.36 displays a comparison between users problems for the different system types.

Figure 6.36 Severity of User Problems for Each Systems Types



6.13.1.1 Severity of User Problems for Stand-alone Systems

The greatest problem designer's identified users as having with stand-alone applications is *lack of support*, which received a very high rating of 4.1. This is followed by *navigational support*, which received a rating of 3.3. Table 6-14 displays the complete list of problems designers feel users have, grouped in descending order.

Table 6-14 Severity of Problems Encountered by Users of Stand-alone Systems

User Problems	Stand Alone
Support	4.1
Lack of navigation support	3.3
Anticipation	3.0
Long scrolling pages	2.1
Animation	2.0
New technologies	2.0
Outdated information	2.0
Slow download	2.0
Broken Links	1.0
Complex URL's	1.0
Download technologies	1.0
Non-standard link colours	1.0
Orphan pages	1.0
Use of frames	1.0

6.13.1.2 *Severity of User Problems for Web-based Systems*

Designers suggest that *slow download times* is a major problem for users of web-based systems giving it an average of 4.4. *Lack of support* is also seen as a large problem for users with designers giving it an average of four. The complete listings of problems that designers feel are experienced by users and their average rating is shown in table 6-15.

Table 6-15 Severity of Problems Encountered by Users of Web-based Systems

User Problems	Web-based
Slow download	4.4
Support	4.0
Outdated information	3.8
Broken Links	3.5
New technologies	3.4
Long scrolling pages	3.2
Complex URL's	3.0
Animation	3.0
Download technologies	2.9
Lack of navigation support	2.9
Use of frames	2.7
Anticipation	2.5
Orphan pages	2.4
Non-standard link colours	2.4

6.13.1.3 *Severity of User Problems for Static Websites*

Slow download times is also considered the greatest problem for users of static websites with designers giving it an average rating of 4.3. This is just marginally lower than the average rating given for web-based system. *Broken links* and users having to download new technologies are also considered a large problem for users with an average of 3.7 each. The complete listing of problem and their average rating can be seen in Table 6-16.

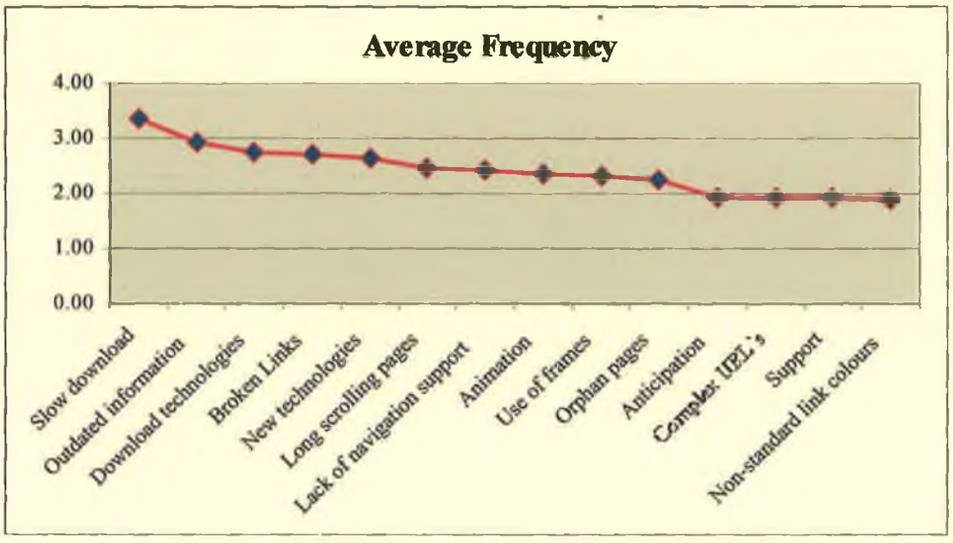
Table 6-16 Severity of Problems Encountered by Users of Static WebSites.

User Problems	Websites
Slow download	4.3
Broken Links	3.7
New technologies	3.7
Support	3.5
Animation	3.5
Outdated information	3.5
Download technologies	3.4
Long scrolling pages	3.2
Complex URL's	3.1
Lack of navigation support	2.8
Orphan pages	2.7
Use of frames	2.7
Anticipation	2.5
Non-standard link colours	2.1

6.13.2 Occurrence of User Problems

Respondents were asked to rate the design problems identified in the previous question on a scale of one to five with one representing 'infrequent occurrence' and five representing 'very frequent occurrence'. Figure 6.37 depicts the average frequency of design problems.

Figure 6.37 Average Frequency of Design Problems



Slow download time is considered by designers to be the greatest and most frequently occurring problem, with designers giving it an average of 3.4. This is followed by *outdated information* with an average of 2.9 and the need to *download technologies* with an average of 2.8.

One reason for the continuous occurrence of these problems could be attributed to the lack of training and retraining of employees. Designers are repeating the same mistakes over and over again. They need to be trained and enabled to avoid the common pitfalls so that users have a trouble free system that suits their needs.

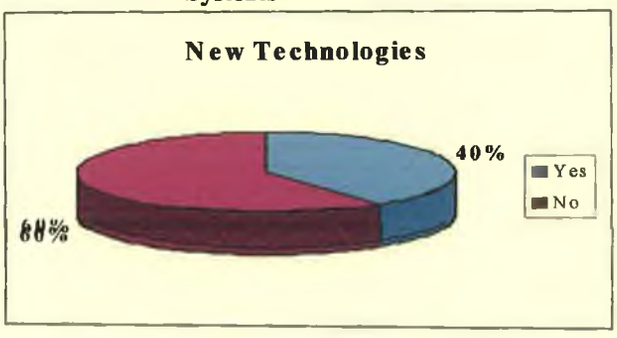
6.14 New Technologies

The next section deals with the incorporation and use of new technologies and research being carried out by respondents into this area.

6.14.1 Incorporation of New Technologies

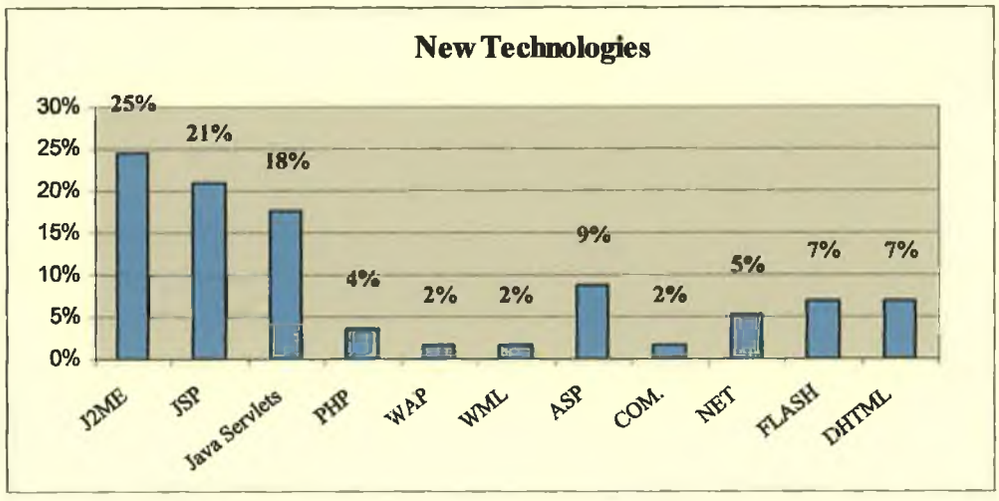
Respondents were asked to specify whether or not they incorporate new technologies into their information systems. All respondents answered this question. Forty percent of respondents stated they incorporate new technologies into their systems.

Figure 6.38 New Technologies Incorporated Into Systems



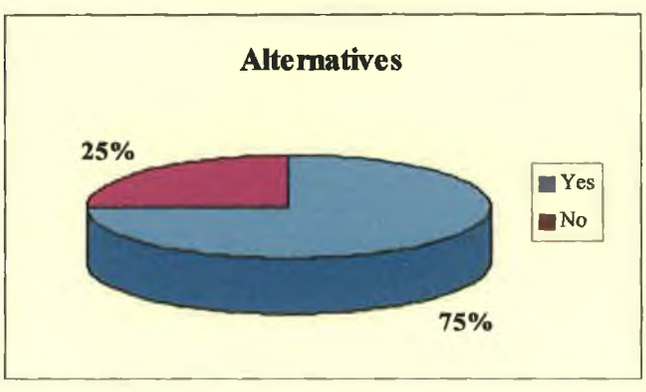
These respondents were asked to specify which technologies they used. Only 75% answered the relevant question. Figure 6.39 shows the percentage usage of the technologies given.

Figure 6.39 New Technologies Incorporated Into Systems



6.14.2 Alternative to New Technologies

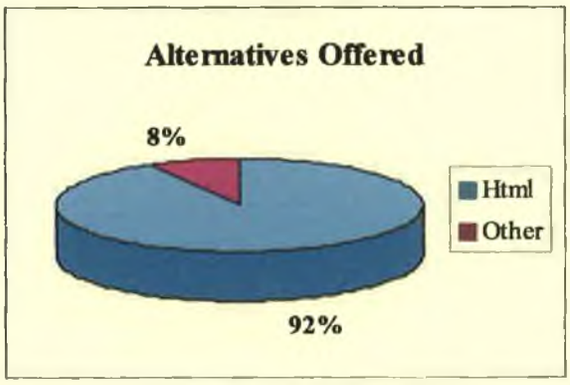
Figure 6.40 Percentage Who Offer an Alternative to New Technologies



The 40% of respondents who incorporate new technologies into their systems were asked to specify whether or not they offer users an alternative to these new technologies. These alternatives would allow users to view the system/site without the need to download additional technologies. The majority (75%) of respondents stated that they do offer an alternative with only 25% of respondents not offering any type of alternative.

The respondents who offer an alternative to new technologies were asked to specify what alternatives they offered. Fifty percent of companies answered this question. The main alternative offered was a HTML version of the site/system with 92%of respondents offering it.

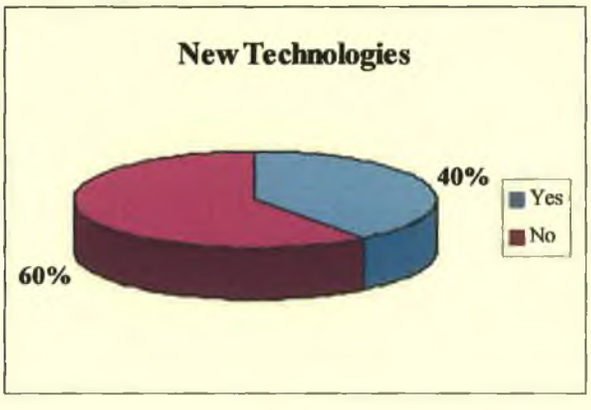
Figure 6.41 Alternative Offered to New Technologies.



6.14.3 Research into New Technologies

Respondents were asked to specify whether or not they carry out research into new techniques and technologies. Sixty percent of respondents stated that they do carry out such research. Forty percent of respondents do not carry out any research into new techniques and technologies.

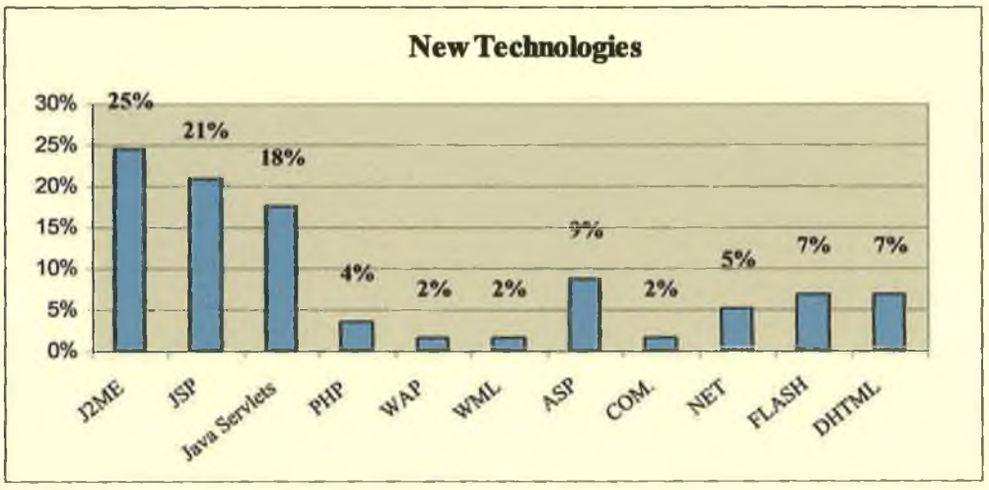
Figure 6.42 Percentage Carrying Out Research Into New Technologies



Respondents were asked to specify what new techniques and technologies they have researched or are currently researching. Forty percent of respondent answered this question.

The results as outlined in figure 6.43 show that most research (25%) is being carried out into J2ME. This was followed by JSP, which is being researched by an average of 21%.

Figure 6.43 Research Techniques and Technologies

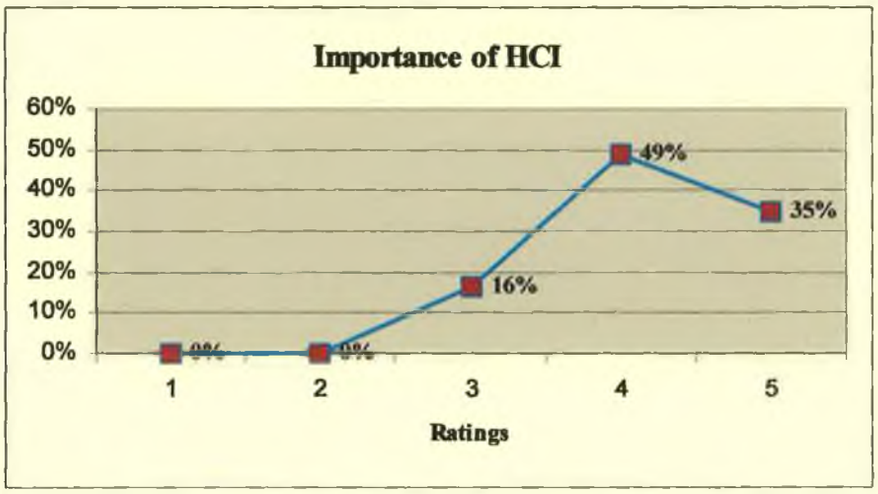


This suggests that developers are constantly seeking new tools, which may increase productivity.

6.15 Importance of HCI Design

The final question was concerned with designer's perception of the importance of Human Computer Interfaces. Designers were asked to specify how important they felt HCI design is as part of the overall development process. A scale of one to five was provided with one representing of 'little or no importance' and five representing 'extremely important'.

Figure 6.44 Perceived Importance of HCI Design as Part of the Overall Development Process



The results as depicted in figure 6.44 show that half of software design companies feel that HCI design is very important giving an average rating of four out of five. Thirty-five percent of respondents feel that HCI is extremely important as part of the overall software development process and gave it an average rating of five. The lowest average rating given is three and this rating is given by small proportion (16%) of companies. This may relate to systems with a minor HCI element e.g. batch processing systems or automated systems.

Designers were asked to specify why they assigned the above ratings to the importance of HCI as part of the overall development process. The following table 6-17 includes the comments received from respondents.

Table 6-17 Reasons why developers feel HCI is important.

"HCI is absolutely pivotal to the success of any software or service"
"User perceptions to any software product begin within the initial package or view and a defined track must be adhered to for the company and its products to expected perceptions by customers, viewers etc."
"A common user design enables end users to instinctively use a product such as a standalone application or even a website without much effort."
"Keep clients and end users happy and loyal to our work."
"In our case, the HCI element of our websites is important, in that the information needs to be easily accessible, and navigation should also be simple."
"HCI is not a priority area for us as we mainly develop websites for in-house or project requirements. Obviously, our aim is to make them usable etc., but beyond that, they are primarily information resources."
"Because it is the interface with which people interact and everything else should be simply a black box!"
"Clients are influenced by user interface design, but their primary concern is to have a bug-free solution delivered before their deadline."
"Because it's ultimately the user interface, your branding and a significant part of your differentiation"

6.16 Summary and Conclusions

This section presents a summary of the research results. Subsequent to a descriptive review of the target populations, the primary findings of the research are summarised and the conclusions are presented. Finally, suggestions for further research are presented.

6.16.1 Summary of the Findings

Of the respondents, 78% employ less than 50 personnel with 22% employing between 51 and 100. No respondents have more than 100 employees. A large proportion of respondents (46%) develop stand-alone applications predominantly, 32% developed static websites predominantly and 22% develop web-based applications predominantly. Fifty one percent of respondent develop all three system types, 22% develop two types of systems and the remaining 27% develop only one system types. Results suggest that there has been an increase in the development of web-based applications. Fifty four percent of respondents note an increase within the last five years. This is low considering the growth of the Internet during this period. Thirty eight percent of respondents note an increase in the amount of static websites being developed. The increase in stand-alone applications is not as high with only 22% of respondents noting any increase. This shows a general trend of movement toward web-based applications and static websites and away from the more traditional stand-alone applications.

Respondents feel that the use of user interface prototyping is very important with an average rating of 4.7 out of five given for stand-alone applications, 4.4 for web-based

applications and 4.2 given for static websites. The vast majority of respondents (71%) use some type of prototyping when developing systems. Most of these use user interface prototyping during the design phase, followed by the analysis and design preparation and finally during project planning.

Multimedia and Hypermedia are seen as very important to the development of static websites with an average rating of 4.2 and 4.1 out of five respectively. They are both considered important for web-based system with ratings of 3.4 and 3.2 respectively. Both are of average importance for stand-alone applications with an average of 3 and 2.6 respectively. Overall multimedia is rated more important than hypermedia.

Respondents are very aware of the importance of design principles with the majority rating them at four out of five and upward. Respondents stated that the principle, *understanding the users needs*, is extremely important for all systems types. This corresponds to the results received to the question about the involvement of users in the design process with a majority of 74% of respondents involving users. The majority of respondents stated that users have a strong input on the finished product with 36% giving it a rating of four and 26% giving it a rating of five. Designers spend considerable time with users and are aware of the main problems users have with systems. Designers identify *slow download* and *lack of support* as the two greatest problems facing users. The results suggest that while new research is being carried out, this has not yet resulted in the implementation of new technologies.

6.16.2 Conclusions

Human Computer Interface Design has been around for a long time but it is only in recent years that designers have realised that the most important aspect of Human Computer Interface Design is to understand users' needs and requirements. The results suggest that designers are aware of the importance of HCI design. All respondents rate HCI design as important or extremely important.

With regard to HCI design, the following conclusions are drawn from the research.

- The majority are employed in and the most effort goes into HCI design, followed by HCI analysis and HCI testing.
- A very high proportion of employees involved in the overall development of systems have input into the area of HCI with an average of 83% having some responsibility within the following HCI areas: HCI analysis, HCI design and HCI testing.
- The majority of companies consider user centred design as very important with 26% giving it a maximum rating and 36% giving an average rating of four out of five.
- The majority of respondents do not consider the training of employees in the area of HCI as very important.

With regard to HCI training the following results were found.

- Only an average of three employees per organisation have been previously trained in the area of interface design.
- Ten percent of companies do not employ any professional HCI designer.

- Ten percent of companies have no employees who have received training previously in the area of HCI.
- Twenty three percent of companies have no employees presently training in the area of HCI.

The reason for such low numbers being trained in the area of HCI and the low importance rated to it could be due to the fact designers may not see HCI as a discreet profession. The low numbers would also indicate that designers do not fully realise that the same principles applied to traditional graphic user interfaces cannot be applied to web-based applications and static websites. As the percentage of web-based applications and static websites increase in proportion the importance of training and re-training becomes much more important (See table 6-3).

A large proportion (62%) considers user centred design as very important, rating it at four or above. The remainder (28%) of the companies rate it at three. Seventy four percent of companies involve users in the design process and estimate that the average input of users is 38% for stand-alone applications, 32% for web-based applications and 30% for static websites. Users also have a substantial effect on the overall finished product with the majority of respondents rating their effect as being very strong (45%), 17% gave the highest rating of extremely strong and 38% gave a rating of strong.

The majority (77%) of companies carry out usability evaluations and 88% carry out usability testing. Although the majority of companies do carry out usability testing only 52% of them have a set of predefined quantifiable usability criteria, which are essential to measure the success of a system. This can impact negatively on the

effectiveness of the results obtained during usability testing. There is a large difference when asked the average numbers of testers needed to get a proper result for usability testing. For stand-alone applications the number given ranged from two to 50. The average number was 14. For web-based applications the number ranged from two to 100 with the average being 18. For static websites the average number ranged from two to 150 and the average was 5.

Designer's rate *understanding users needs* as one of the most important design principles for all system types. They also see *speed and responsiveness* and *clarity* as very important design principles.

Designers seem to be aware of the importance of user interface prototyping for all system types with all three receiving a rating of extremely important. Nearly all respondents use prototyping with only 29% stating that they did not use it. The majority of companies use prototyping predominately in the design process followed by analysis and design preparation and finally project planning.

Formal methodologies are used mainly for stand-alone applications. However, with reference to stand-alone applications, only 52% of software design companies indicate that they use them. The relevant figure is less for web-based applications with 44% and 23% of website designers using a formal methodology. No methodology stands out as dominant but respondents indicate that user centred design and rapid application development are the most used.

All designers are aware of the importance of multimedia. They see it as most important for static websites giving it an average rating above four. This is followed by web-based applications and stand-alone applications with an average rating of three or above. Hypermedia is seen as important for static websites with an average rating of four, followed by web-based applications with an average just above three and stand-alone applications with an average of three. Overall, multimedia is seen as more important than hypermedia.

Most designers see the lack of system support as the greatest problems experienced by users of stand-alone applications and web-based systems. Lack of navigational support is a large problem for stand-alone problems. -Slow download times was identified as a major problem for both web-based applications and static websites. The need for users to download new technologies and broken links are also seen as major problems for static websites.

The following are just some of the comments designers made in relation to HCI:

- *"A good HCI is pivotal to the success of software system and for enabling users to be able to instinctively use a product."*
- *"Because it is the interface with which people interact and everything else should be simply a black box!"*
- *"Because it's ultimately the user interface, your branding and a significant part of your differentiation"*

Some felt that the HCI was the actual branding for the package and a good HCI can keep users happy and encourage loyalty.

6.16.3 Suggestions for Further Research

This thesis constitutes a platform study and as such is descriptive and exploratory by nature. As the research progressed, several areas deserving more focused investigation surfaced. The most conspicuous of these is determination of the reason or reasons why a large proportion of companies do not employ professional HCI personnel or any personnel who have had some training in the area. The research also suggests that adequate training is not being provided to present employees. **The levels of awareness among software developers of the need to provide employees with constant training in such a rapidly evolving field needs to be examined.**

While the majority of respondents did use user interface prototyping (71%), the proportion of respondent who did not use any type of user interface prototyping was higher than expected at 29% even though the average rating given for prototyping was high for all system types (between 4.2 and 4.7). **The levels of awareness among Small-Medium Enterprises of the importance of user interface prototyping, as part of the design process needs further qualification.**

The reasons for respondents not utilising any type of user interface prototyping need to be investigated.

The use of formal methodologies among respondents is low with only 52% of designers using one for stand-alone applications and only 44% of respondents using a formal methodology for web-based applications. **The levels of awareness among software developers of the benefits to be obtained by utilising a formal methodology as part of their design process needs to be examined.** Also, **the**

design process of those who have no formal methodology compared to those incorporating a formal methodology needs investigating.

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APPENDIX A

Accompanying Letters and Definitions

Institiúid Teicneolaíochta na Gaillimhe-Maigh Eo

Galway-Mayo Institute of Technology

Kevin Heffernan,
Department of Business Studies,
The Galway Mayo Institute of Technology,
Dublin Road Galway,

Phone: 091 742356

1st May 2002

To whom it may concern,

Clare O'Connor is a Research Student at the Department of Business Studies at the Galway Mayo Institute of Technology. Clare is currently undertaking some vital research in the area of Human Computer Interface Design. While I am aware of ever increasing demands on your time, I would very much appreciate your support, which is absolutely vital for completion this research. The relevant questionnaire can be completed in approximately 10 minutes as most questions involve ticking an appropriate box. In anticipation of your support, please accept my thanks on behalf of the institute.

Yours Faithfully

Kevin Heffernan

Re: Attached Questionnaire

Dear Sir/Madam

I am currently undertaking research in the area of Human Computer Interface Design. The principal objective of this research is to identify the critical issues of human computer interface design, and their application in an Irish context, as focus is shifting from stand-alone applications towards web-based applications

The above-mentioned research can only be undertaken with your assistance. A high response rate is essential for valid results. I am totally dependent on your co-operation. I will be pleased to offer you a copy of the findings and make myself available for any queries you may have. Most of the questions require a "tick-the-appropriate-box" answer so the questionnaire can be completed in less that 10 minutes.

Please be assured that any information received from you will be treated in the strictest confidence. This study is only concerned with aggregate data and the thesis will report its findings in aggregate form only, and may I reiterate that the results, which will be of practical as well as academic interest, will be available to you on request. I would be obliged if you could return this questionnaire by Friday 24th May.

Yours Faithfully

Clare O Connor
Business Studies Department
GMIT
Tel: 753161 Ext. 2396

DEFINITIONS

Human Computer Interface Design (HCI)

HCI design can be described as the study, planning and design of the interaction between a computer and user. It can be described as a combination of three elements, the user, the computer, and the ways they work together.

System Types

The majority of questions require separate answers for three different system types: stand-alone applications, web-based applications and websites. The following is a definition of each system type.

Stand-alone Applications: applications that are based on an internal server in a company. They can be viewed on many computers but cannot be viewed over the web.

Web-based Applications: applications that are based on a server that is attached to the web and can be viewed and downloaded by anyone attached to the web. Web-based applications can also be applications that may be held on an internal server but can only be viewed using a web browser.

Websites: These are mostly static in nature and make up the majority of sites on the web. Any website that has an application running behind it will be classed as a web-based application.

New Technologies

The term 'new technologies' as used in the questionnaire covers any technology that is needed to view a site/application that is not part of the default web software. This can include plug-ins or applications that will need to be downloaded for the user to view the site or applications.

Appendix B

Questionnaire

Questionnaire

1. When did your company start trading?

Previous to 1990	
1990 – 1994	
1995 – 1999	
Later than 1999	

Please tick appropriate box

2 Please indicate the number of employees in your organisation:

< 50	51 - 100	101 – 500	> 500

Please tick appropriate box

3. Approximately into what bracket would you put the average cost of each of the following developed over the past 5 years.
   (a) Web-based information systems
   (b) Stand-alone information systems and
   (c) Websites

	(a) Web-based Information Systems	**(b) Stand-alone information systems**	**(c) Websites**
Less than €5,000			
€5,000 - €19,999			
€20,000 - €49,999			
€49,000 - €99,999			
€100,000 - €500,000			
Greater than €500,000			

Please tick appropriate boxes

4. With regard to the average project developed by you, please
   (a) specify the number of employees with some responsibility within each of the following areas, and
   (b) estimate the percentage of your overall development effort expended within each of the same areas.

Functional Area	**(a) No. of Employees**	**(b) % Effort**
Project planning and management		
Systems analysis		
Systems design and coding		
Testing and debugging new information systems		
Modifying or enhancing systems previously developed		
Total		**100%**

Please insert appropriate numbers in each box

5. What percentage of systems being developed by your organisation are predominantly:
   (a) Stand-alone applications
   (b) Web-based applications
   (c) Websites

Information System Type	**Percentage of systems developed**
Stand-alone applications	%
Web-based applications	%
Websites	%
Total	**100%**

Please insert the approximate percentages in each box

6. Please indicate whether or not (a) stand-alone applications, (b) web-based applications & (c) websites are
   i. Decreasing as a proportion of overall systems developed by you,
   ii. Remaining stable as a proportion of overall systems developed by you,
   iii. Increasing as a proportion of over systems developed by you.

	(i) Decreasing	**(ii) Unchanging**	**(iii) Increasing**
Stand-alone applications			
Web-based applications			
Websites			

Please tick (i), (ii) or (iii) for each system type.

7. For the average system developed by you, please rate the complexity on a scale of one to five, with respect to:
   (a) Required functionality
   (b) Data Structures
   (c) User Interface

   (1 – Not Complex, 5 - Extremely Complex)

	Stand-alone Applications					**Web-based Applications**					**Websites**				
	1	*2*	*3*	*4*	*5*	*1*	*2*	*3*	*4*	*5*	*1*	*2*	*3*	*4*	*5*
(a) Required functionality															
(b) Data Structures															
(c) User Interface															

8. Please
   (a) specify the number of employees with some responsibility within each of the following areas, and
   (b) estimate the percentage of your overall software development effort expended within each of the same areas.

Functional Area	**No. of employees**	**% effort**
HCI analysis		
HCI design		
HCI testing		
Total		**100%**

Please insert appropriate number in each box

9. Please specify the number of employees employed as professional HCI designers?

No. of Employees	

10. Please specify the number of employees who:
    i. have previously undergone specific training in the area of HCI
    ii. are presently undergoing specific training in the area of HCI

	No of Employees
i. Previously trained	
ii. Presently training	

Please enter the appropriate numbers

11. How important would you rate user interface prototyping as part of the design process for each of the following: ***(1 = Not Important, 5 = Extremely Important)***

(a) Stand-alone applications
(b) Web-based applications
(c) Websites

	1	*2*	*3*	*4*	*5*
(a) Stand-alone applications					
(b) Web-based applications					
(c) Websites					

Please tick appropriate box for each system type

12. For each system type developed by you, please rate the following design principles on a scale of 1 – 5.
(1 = Not important, 5 = Extremely important.)

	Stand-alone Applications					**Web-based Applications**					**Websites**				
	1	*2*	*3*	*4*	*5*	*1*	*2*	*3*	*4*	*5*	*1*	*2*	*3*	*4*	*5*
Clarity															
Consistency															
Design for efficiency															
Enable frequent users to use shortcuts															
Help and documentation															
Maintenance															
Offer error detection and prevention															
Offer informative feedback															
Permit easy reversal of actions															
Portability across different platforms															
Provide traceable paths															
Reduce short-term memory load															
Security															
Speed & responsiveness															
Understand users needs															
Other - Please specify															

13. How important would you rate the use of (i) Multimedia and (ii) Hypermedia in:
    (a) Stand-Alone Applications
    (b) Web-based Applications
    (c) Websites
    (1 = Not important, 5 = Extremely important.)

	(a) Stand-alone Applications					**(b) Web-based Applications**					**(c) Websites**				
	1	*2*	*3*	*4*	*5*	*1*	*2*	*3*	*4*	*5*	*1*	*2*	*3*	*4*	*5*
(i) Importance of Multimedia															
(ii) Importance of Hypermedia															

14. Do you use a Formal Methodology for the following:
    (a) Stand-Alone Applications
    (b) Web-based Applications
    (c) Websites

	Yes	**No**
(a) Stand-alone applications		
(b) Web-based applications		
(c) Websites		

Please tick yes or no each system type.

15. If a formal methodology is used please list for each system type

	Formal Methodology
Stand-alone applications	
Web-based applications	
Websites	

Please list methodology(s) used for each system type

16. Do you use user interface prototyping as part of the design process? Yes _____ No _____
    (If no go to Q18)

17. During which stages of the development process do you develop user interface prototypes?

Stage	Stand-alone Applications	Web-based Applications	Websites
Project planning			
Analysis and Design Preparation			
Design process			
Other Please specify:			

Please tick appropriate boxes for each system type

18. Please specify which of the following user interface elements you use in your designs:

Interface Elements	
Pull-Down and Cascading Menus	
Pop-up Menus	
Toolbars	
Iconic menus	
Hypertext Menus	
Instruction-Driven Interfaces	
Question-Answer Dialogues	
Other: Please specify	

Please tick appropriate boxes

19. Do you perform evaluation (usability) inspections during the design process?

Yes ___ No ___

(If no go to Q22).

20. Does an internal member of the organisation carry out the usability inspections?

Yes ___ No ___

21. If internal, is the person carrying out the usability inspections a member of the project team?

Yes ___ No ___

22. Which method(s) of evaluation do you use for each system type?

Method of Evaluation	Stand-alone Applications	Web-based Applications	Websites
Expert Reviews			
User Testing			
Surveys			
Acceptance Tests			
Evaluation during Active Use			
Interviews			
User Performance data logging			
Suggestion box			
Other Please specify:			

Please tick the appropriate boxes for each system type

23. Do you prescribe to any of the following standards and guidelines?

Guideline	Used
W3C's Web Content Accessibility Guidelines	
Web-Based Enterprise Management (WBEM)	
Common Information Model (CIM) Standards	
DMI Standards	
Directory Enabled Network (DEN) Initiative	
Directory Enabled Network (DEN) Initiative	
Other Please Specify	

Please tick the appropriate boxes for each system type

24. Do you test Websites on different browsers/platforms? Yes ____ No____

25. Do you test Web-based applications on different browsers/platforms? Yes ____ No____

26. For each system type developed by you, please indicate which browsers/platforms you test on?

Browsers Type	Version	Web-based applications	Websites
Mozilla	2.2		
MS Information Explorer	3		
MS Information Explorer	4		
MS Information Explorer	5		
MS Information Explorer	6		
MSN Explorer			
Netscape	6.2.1		
Netscape Communicator	4.79		
Netscape Navigator	3		
Netscape Navigator	4		
Netscape Navigator	6.1		
Opera	5.0		
Opera	6		
UltraBrowser	6.0		
ViOS			
w3m			
Other: Please specify			

27. Do you carry out usability testing? Yes____ No ____

28. Do you have predefined quantifiable usability criteria? Yes____ No ____

29. For each system type developed by you, how many users do you feel are needed to get a proper result?

System Type	No. of Users
Stand-alone applications	
Web-based applications	
Websites	

30. For each system type developed by you, approximately what percentage of users suggestions would you normally implement on completion of usability testing?

System Type	%
Stand-alone applications	
Web-based applications	
Websites	

31. On a scale of 1 - 5 how important would you rate the following Usability Criteria?
(1 = Not important, 5 = Very important)

Usability Criteria	*1*	*2*	*3*	*4*	*5*
Productivity					
Learnability					
Flexibility					
User Satisfaction					
Memorability					
Robustness					
Error Rates					
Other Please Specify:					

Please tick the appropriate boxes for each Usability Criteria

32. Are users involved throughout the design process? Yes____ No ____

33. How important do you consider User Centred Design to be?

Place X on appropriate point on line.

Not Important 1 |.....2.....| ..... 3.....|.....4.....|.....5..... Extremely Important

34. For each system type developed by you, approximately what percentage input does the user have into the interface design process?

System Type	% Input
Stand-alone applications	
Web-based applications	
Websites	

35. On a scale of 1 to 5 how would you rate the effect of user input on the finished product?

Place X on appropriate point on line.

Little Effect 1 |.....2.....|.....3.....|.....4.....|.....5..... Strong Effect

36. Approximately how much consultation time do you spend with users?

Time Spent	Stand-alone Applications	Web-based Applications	Websites
> 1hr			
1 – 2hrs			
2 – 3hrs			
3 – 4hrs			
4 – 5hrs			
> 5hrs			

Please tick the appropriate boxes

37. For each system type, how would you rate to following problems users have on a scale of 1-5? ***(1=Low, 5=Severe)***

	Stand-alone Applications					Web-based Applications					Websites				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Anticipation															
Broken Links															
Complex URL's															
Downloading new technologies (patches or upgrades)															
Use of frames															
Lack of navigation support															
Long scrolling navigation pages															
Non-standard link colours															
Orphan pages															
Outdated information															
Scrolling text or looping animation															
Slow download times															

Support															
Using new technologies															
Other: Please Specify															

38. Please rank the following design problems in order of those that occur most often.
(1 = Never, 5 = Very Frequent)

Design Problems	*1*	*2*	*3*	*4*	*5*
Anticipation					
Broken Links					
Complex URL's					
Downloading new technologies (patches or upgrades)					
Use of frames					
Lack of navigation support					
Long scrolling navigation pages					
Non-standard link colours					
Orphan pages					
Outdated information					
Scrolling text or looping animation					
Slow download times					
Support					
Using new technologies					
Other: Please Specify					

39. Do you incorporate new technologies, such as Java Servlets and JSP, in your information systems? Yes ___ No ___
(If no go to Q43)

40. Please specify the new technologies you incorporate:

Technologies

41. Do you offer the user an alternative to the new technologies e.g. simple HTML version?
Yes___ No ___
(If no go to Q43)

42. What alternative do you offer?

43. Do you carry out research into new techniques and technologies Yes ___ No ___

44. If yes, please specify these new techniques and technologies.

45. How important do you feel HCI is as part of the overall development process?

Place X on appropriate point on line.

Not Important 1 |.....2 .....|..... 3.....|.....4 ..... |.....5 Extremely Important

b. Please specify why you assigned the above rating to the importance of HCI as part of the overall development process.

Thank you for completing this questionnaire.

APPENDIX C

Original Proposal for the WWW by Tim Berners Lee

A hand conversion to HTML of the original MacWord (or Word for Mac?) document written in March 1989 and later redistributed unchanged apart from the date added in May 1990. Provided for historical interest only. The diagrams are a bit dotty, but available in versions linked below. The text has not been changed, even to correct errors such as misnumbered figures or unfinished references.

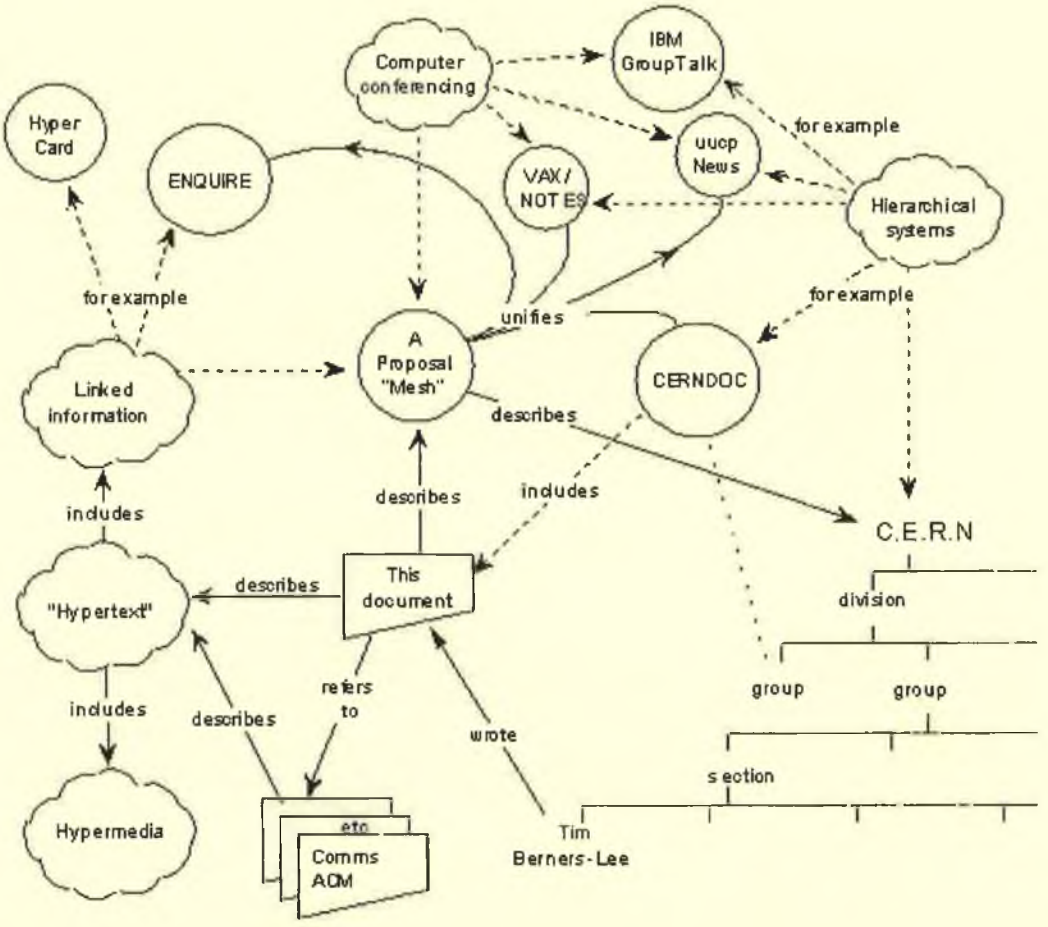
This document was an attempt to persuade CERN management that a global hypertext system was in CERN's interests. Note that the only name I had for it at this time was "Mesh" -- I decided on "World Wide Web" when writing the code in 1990.

Information Management: A Proposal

Tim Berners-Lee, CERN

March 1989, May 1990

This proposal concerns the management of general information about accelerators and experiments at CERN. It discusses the problems of loss of information about complex evolving systems and derives a solution based on a distributed hypertext system.



Overview

Many of the discussions of the future at CERN and the LHC era end with the question - "Yes, but how will we ever keep track of such a large project?" This proposal provides an answer to such questions. Firstly, it discusses the problem of information access at CERN. Then, it introduces the idea of linked information systems, and compares them with less flexible ways of finding information.

It then summarises my short experience with non-linear text systems known as "hypertext", describes what CERN needs from such a system, and what industry may provide. Finally, it suggests steps we should take to involve ourselves with hypertext now, so that individually and collectively we may understand what we are creating.

Losing Information at CERN

CERN is a wonderful organisation. It involves several thousand people, many of them very creative, all working toward common goals. Although they are nominally organised into a hierarchical management structure,this does not constrain the way people will communicate, and share information, equipment and software across groups.

The actual observed working structure of the organisation is a multiply connected "web" whose interconnections evolve with time. In this environment, a new person arriving, or someone taking on a new task, is normally given a few hints as to who would be useful people to talk to. Information about what facilities exist and how to find out about them travels in the corridor gossip and occasional newsletters, and the details about what is required to be done spread in a similar way. All things considered, the result is remarkably successful, despite occasional misunderstandings and duplicated effort.

A problem, however, is the high turnover of people. When two years is a typical length of stay, information is constantly being lost. The introduction of the new people demands a fair amount of their time and that of others before they have any idea of what goes on. The technical details of past projects are sometimes lost forever, or only recovered after a detective investigation in an emergency. Often, the information has been recorded, it just cannot be found.

If a CERN experiment were a static once-only development, all the information could be written in a big book. As it is, CERN is constantly changing as new ideas are produced, as new technology becomes available, and in order to get around unforeseen technical problems. When a change is necessary, it normally affects only a small part of the organisation. A local reason arises for changing a part of the experiment or detector. At this point, one has to dig around to find out what other parts and people will be affected. Keeping a book up to date becomes impractical, and the structure of the book needs to be constantly revised.

The sort of information we are discussing answers, for example, questions like

- Where is this module used?
- Who wrote this code? Where does he work?
- What documents exist about that concept?
- Which laboratories are included in that project?
- Which systems depend on this device?
- What documents refer to this one?

The problems of information loss may be particularly acute at CERN, but in this case (as in certain others), CERN is a model in miniature of the rest of world in a few years time. CERN meets now some problems which the rest of the world will have to face soon. In 10 years, there may be many commercial solutions to the problems above, while today we need something to allow us to continue.

Linked information systems

In providing a system for manipulating this sort of information, the hope would be to allow a pool of information to develop which could grow and evolve with the organisation and the projects it describes. For this to be possible, the method of storage must not place its own restraints on the information. This is why a "web" of notes with links (like references) between them is far more useful than a fixed hierarchical system. When describing a complex system, many people resort to diagrams with circles and arrows. Circles and arrows leave one free to describe the interrelationships between things in a way that tables, for example, do not. The system we need is like a diagram of circles and arrows, where circles and arrows can stand for anything.

We can call the circles nodes, and the arrows links. Suppose each node is like a small note, summary article, or comment. I'm not over concerned here with whether it has text or graphics or both. Ideally, it represents or describes one particular person or object.

Examples of nodes can be

- People
- Software modules
- Groups of people
- Projects
- Concepts
- Documents
- Types of hardware
- Specific hardware objects

The arrows which links circle A to circle B can mean, for example, that A...

- depends on B
- is part of B
- made B
- refers to B
- uses B
- is an example of B

These circles and arrows, nodes and links, have different significance in various sorts of conventional diagrams:

Diagram	Nodes are	Arrows mean
Family tree	People	"Is parent of"
Dataflow diagram	Software modules"	Passes data to"
Dependency	Module	"Depends on"
PERT chart	Tasks	"Must be done before"
Organisational chart	People	"Reports to"

The system must allow any sort of information to be entered. Another person must be able to find the information, sometimes without knowing what he is looking for.

In practice, it is useful for the system to be aware of the generic types of the links between items (dependences, for example), and the types of nodes (people, things, documents..) without imposing any limitations.

The problem with trees

Many systems are organised hierarchically. The CERNDOC documentation system is an example, as is the Unix file system, and the VMS/HELP system. A tree has the practical advantage of giving every node a unique name. However, it does not allow the system to model the real world. For example, in a hierarchical HELP system such as VMS/HELP, one often gets to a leaf on a tree such as

HELP COMPILER SOURCE_FORMAT PRAGMAS DEFAULTS

only to find a reference to another leaf: "Please see

HELP COMPILER COMMAND OPTIONS DEFAULTS PRAGMAS"

and it is necessary to leave the system and re-enter it. What was needed was a link from one node to another, because in this case the information was not naturally organised into a tree.

Another example of a tree-structured system is the uucp News system (try 'rn' under Unix). This is a hierarchical system of discussions ("newsgroups") each containing articles contributed by many people. It is a very useful method of pooling expertise, but suffers from the inflexibility of a tree. Typically, a discussion under one newsgroup will develop into a different topic, at which point it ought to be in a different part of the tree. (See Fig 1).

From mcvax!uunet!pyrdc!pyrnj!rutgers!bellcore!geppetto!duncan Thu Mar...
Article 93 of alt.hypertext:
Path: cernvax!mcvax!uunet!pyrdc!pyrnj!rutgers!bellcore!geppetto!duncan
>From: duncan@geppetto.ctt.bellcore.com (Scott Duncan)
Newsgroups: alt.hypertext
Subject: Re: Threat to free information networks
Message-ID: <14646@bellcore.bellcore.com>
Date: 10 Mar 89 21:00:44 GMT
References: <1784.2416BB47@isishq.FIDONET.ORG> <3437@uhccux.uhcc...
Sender: news@bellcore.bellcore.com
Reply-To: duncan@ctt.bellcore.com (Scott Duncan)
Organization: Computer Technology Transfer, Bellcore
Lines: 18

Doug Thompson has written what I felt was a thoughtful article on
censorship -- my acceptance or rejection of its points is not
particularly germane to this posting, however.

In reply Greg Lee has somewhat tersely objected.

My question (and reason for this posting) is to ask where we might
logically take this subject for more discussion. Somehow alt.hypertext
does not seem to be the proper place.

Would people feel it appropriate to move to alt.individualism or even
one of the soc groups. I am not so much concerned with the specific
issue of censorship of rec.humor.funny, but the views presented in
Greg's article.

Speaking only for myself, of course, I am...
Scott P. Duncan (duncan@ctt.bellcore.com OR ...!bellcore!ctt!duncan)
(Bellcore, 444 Hoes Lane RRC 1H-210, Piscataway, NJ...)
(201-699-3910 (w) 201-463-3683 (h))

Fig 1. An article in the UUCP News scheme.

The Subject field allows notes on the same topic to be linked together within a "newsgroup". The name of the newsgroup (alt.hypertext) is a hierarchical name. This

particular note is expresses a problem with the strict tree structure of the scheme: this discussion is related to several areas. Note that the "References", "From" and "Subject" fields can all be used to generate links.

The problem with keywords

Keywords are a common method of accessing data for which one does not have the exact coordinates. The usual problem with keywords, however, is that two people never chose the same keywords. The keywords then become useful only to people who already know the application well.

Practical keyword systems (such as that of VAX/NOTES for example) require keywords to be registered. This is already a step in the right direction. A linked system takes this to the next logical step. Keywords can be nodes which stand for a concept. A keyword node is then no different from any other node. One can link documents, etc., to keywords. One can then find keywords by finding any node to which they are related. In this way, documents on similar topics are indirectly linked, through their key concepts. A keyword search then becomes a search starting from a small number of named nodes, and finding nodes which are close to all of them.

It was for these reasons that I first made a small linked information system, not realising that a term had already been coined for the idea: "hypertext".

A solution: Hypertext

Personal Experience with Hypertext

In 1980, I wrote a program for keeping track of software with which I was involved in the PS control system. Called Enquire, it allowed one to store snippets of information, and to link related pieces together in any way. To find information, one progressed via the links from one sheet to another, rather like in the old computer game "adventure". I used this for my personal record of people and modules. It was similar to the application Hypercard produced more recently by Apple for the

Macintosh. A difference was that Enquire, although lacking the fancy graphics, ran on a multiuser system, and allowed many people to access the same data.

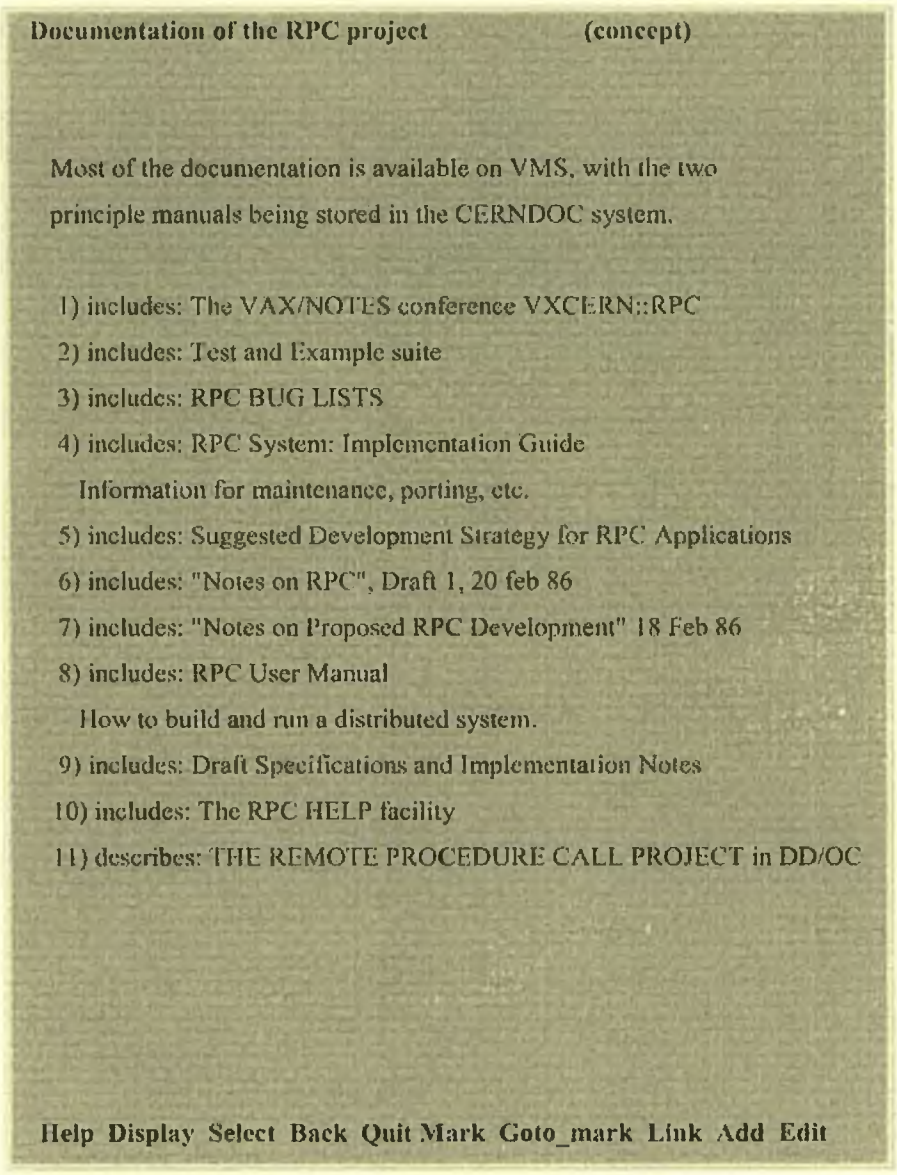


Fig 2. A screen in an Enquire scheme.

This example is basically a list, so the list of links is more important than the text on the node itself. Note that each link has a type ("includes" for example) and may also have comment associated with it. (The bottom line is a menu bar.)

Soon after my re-arrival at CERN in the DD division, I found that the environment was similar to that in PS, and I missed Enquire. I therefore produced a version for the VMS, and have used it to keep track of projects, people, groups, experiments,

software modules and hardware devices with which I have worked. I have found it personally very useful. I have made no effort to make it suitable for general consumption, but have found that a few people have successfully used it to browse through the projects and find out all sorts of things of their own accord.

Hot spots

Meanwhile, several programs have been made exploring these ideas, both commercially and academically. Most of them use "hot spots" in documents, like icons, or highlighted phrases, as sensitive areas. touching a hot spot with a mouse brings up the relevant information, or expands the text on the screen to include it Imagine, then, the references in this document, all being associated with the network address of the thing to which they referred, so that while reading this document you could skip to them with a click of the mouse.

"Hypertext" is a term coined in the 1950s by Ted Nelson [...], which has become popular for these systems, although it is used to embrace two different ideas. One idea (which is relevant to this problem) is the concept: "Hypertext": Human-readable information linked together in an unconstrained way.

The other idea, which is independent and largely a question of technology and time, is of multimedia documents which include graphics, speech and video. I will not discuss this latter aspect further here, although I will use the word "Hypermedia" to indicate that one is not bound to text.
It has been difficult to assess the effect of a large hypermedia system on an organisation, often because these systems never had seriously large-scale use. For this reason, we require large amounts of existing information should be accessible using any new information management system.

CERN Requirements

To be a practical system in the CERN environment, there are a number of clear practical requirements.

Remote access across networks.

CERN is distributed, and access from remote machines is essential.

Heterogeneity

Access is required to the same data from different types of system (VM/CMS, Macintosh, VAX/VMS, Unix)

Non-Centralisation

Information systems start small and grow. They also start isolated and then merge. A new system must allow existing systems to be linked together without requiring any central control or coordination.

Access to existing data

If we provide access to existing databases as though they were in hypertext form, the system will get off the ground quicker. This is discussed further below.

Private links

One must be able to add one's own private links to and from public information. One must also be able to annotate links, as well as nodes, privately.

Bells and Whistles

Storage of ASCII text, and display on 24x80 screens, is in the short term sufficient, and essential. Addition of graphics would be an optional extra with very much less penetration for the moment.

Data analysis

An intriguing possibility, given a large hypertext database with typed links, is that it allows some degree of automatic analysis. It is possible to search, for example, for anomalies such as undocumented software or divisions which contain no people. It is possible to generate lists of people or devices for other purposes, such as mailing lists

of people to be informed of changes. It is also possible to look at the topology of an organisation or a project, and draw conclusions about how it should be managed, and how it could evolve. This is particularly useful when the database becomes very large, and groups of projects, for example, so interwoven as to make it difficult to see the wood for the trees.

In a complex place like CERN, it's not always obvious how to divide people into groups. Imagine making a large three-dimensional model, with people represented by little spheres, and strings between people who have something in common at work. Now imagine picking up the structure and shaking it, until you make some sense of the tangle: perhaps, you see tightly knit groups in some places, and in some places weak areas of communication spanned by only a few people. Perhaps a linked information system will allow us to see the real structure of the organisation in which we work.

Live links

The data to which a link (or a hot spot) refers may be very static, or it may be temporary. In many cases at CERN information about the state of systems is changing all the time. Hypertext allows documents to be linked into "live" data so that every time the link is followed, the information is retrieved. If one sacrifices portability, it is possible so make following a link fire up a special application, so that diagnostic programs, for example, could be linked directly into the maintenance guide.

Non requirements

Discussions on Hypertext have sometimes tackled the problem of copyright enforcement and data security. These are of secondary importance at CERN, where information exchange is still more important than secrecy. Authorisation and accounting systems for hypertext could conceivably be designed which are very sophisticated, but they are not proposed here.

In cases where reference must be made to data which is in fact protected, existing file protection systems should be sufficient.

Specific Applications

The following are three examples of specific places in which the proposed system would be immediately useful. There are many others.

Development Project Documentation.

The Remote procedure Call project has a skeleton description using Enquire. Although limited, it is very useful for recording who did what, where they are, what documents exist, etc. Also, one can keep track of users, and can easily append any extra little bits of information which come to hand and have nowhere else to be put. Cross-links to other projects, and to databases which contain information on people and documents would be very useful, and save duplication of information.

Document retrieval.

The CERNDOC system provides the mechanics of storing and printing documents. A linked system would allow one to browse through concepts, documents, systems and authors, also allowing references between documents to be stored. (Once a document had been found, the existing machinery could be invoked to print it or display it).

The "Personal Skills Inventory".

Personal skills and experience are just the sort of thing which need hypertext flexibility. People can be linked to projects they have worked on, which in turn can be linked to particular machines, programming languages, etc.

The State of the Art in Hypermedia

An increasing amount of work is being done into hypermedia research at universities and commercial research labs, and some commercial systems have resulted. There have been two conferences, Hypertext '87 and '88, and in Washington DC, the

National Institute of Standards and Technology (NST) hosted a workshop on standardisation in hypertext, a followup of which will occur during 1990.

The Communications of the ACM special issue on Hypertext contains many references to hypertext papers. A bibliography on hypertext is given in [NIST90], and a uucp newsgroup alt.hypertext exists. I do not, therefore, give a list here.

Browsing techniques

Much of the academic research is into the human interface side of browsing through a complex information space. Problems addressed are those of making navigation easy, and avoiding a feeling of being "lost in hyperspace". Whilst the results of the research are interesting, many users at CERN will be accessing the system using primitive terminals, and so advanced window styles are not so important for us now.

Interconnection or publication?

Most systems available today use a single database. This is accessed by many users by using a distributed file system. There are few products which take Ted Nelson's idea of a wide "docuverse" literally by allowing links between nodes in different databases. In order to do this, some standardisation would be necessary. However, at the standardisation workshop, the emphasis was on standardisation of the format for exchangeable media, nor for networking. This is prompted by the strong push toward publishing of hypermedia information, for example on optical disk. There seems to be a general consensus about the abstract data model which a hypertext system should use.

Many systems have been put together with little or no regard for portability, unfortunately. Some others, although published, are proprietary software which is not for external release. However, there are several interesting projects and more are appearing all the time. Digital's "Compound Document Architecture" (CDA) , for example, is a data model which may be extendible into a hypermedia model, and there are rumours that this is a way Digital would like to go.

Incentives and CALS

The US Department of Defence has given a big incentive to hypermedia research by, in effect, specifying hypermedia documentation for future procurement. This means that all manuals for parts for defence equipment must be provided in hypermedia form. The acronym CALS stands for [a]Computer-aided Acquisition and Logistic Support).

There is also much support from the publishing industry, and from librarians whose job it is to organise information.

What will the system look like?

Let us see what components a hypertext system at CERN must have. The only way in which sufficient flexibility can be incorporated is to separate the information storage software from the information display software, with a well defined interface between them. Given the requirement for network access, it is natural to let this clean interface coincide with the physical division between the user and the remote database machine.

This division also is important in order to allow the heterogeneity which is required at CERN (and would be a boon for the world in general).

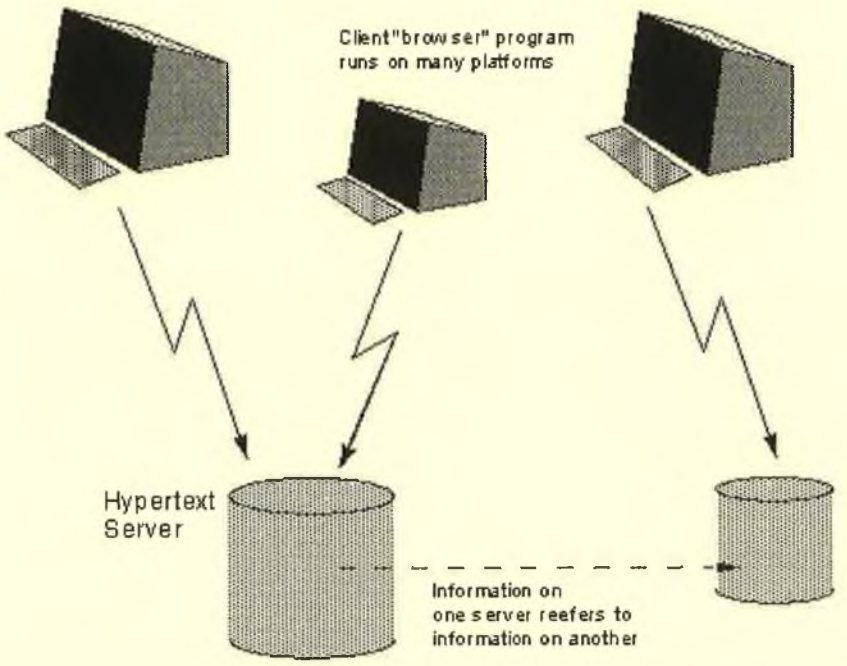


Fig 2. A client/server model for a distributed hypertext system.

Therefore, an important phase in the design of the system is to define this interface. After that, the development of various forms of display program and of database server can proceed in parallel. This will have been done well if many different information sources, past, present and future, can be mapped onto the definition, and if many different human interface programs can be written over the years to take advantage of new technology and standards.

Accessing Existing Data

The system must achieve a critical usefulness early on. Existing hypertext systems have had to justify themselves solely on new data. If, however, there was an existing base of data of personnel, for example, to which new data could be linked, the value of each new piece of data would be greater.

What is required is a gateway program which will map an existing structure onto the hypertext model, and allow limited (perhaps read-only) access to it. This takes the form of a hypertext server written to provide existing information in a form matching the standard interface. One would not imagine the server actually generating a

hypertext database from and existing one: rather, it would generate a hypertext view of an existing database.

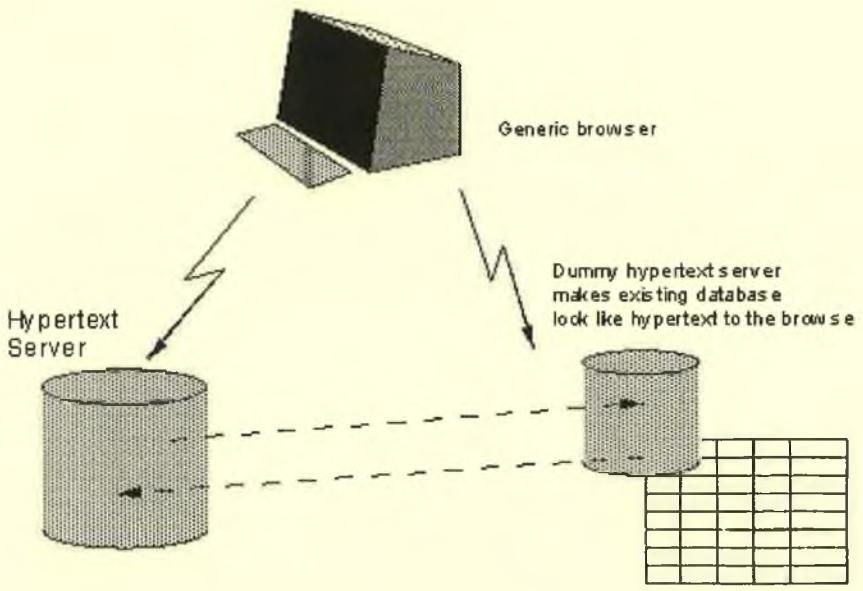


Fig 3. A hypertext gateway allows existing data to be seen in hypertext form by a hypertext browser.

Some examples of systems which could be connected in this way are

uucp News

This is a Unix electronic conferencing system. A server for uucp news could makes links between notes on the same subject, as well as showing the structure of the conferences.

VAX/Notes

This is Digital's electronic conferencing system. It has a fairly wide following in FermiLab, but much less in CERN. The topology of a conference is quite restricting.

CERNDOC

This is a document registration and distribution system running on CERN's VM machine. As well as documents, categories and projects, keywords and authors lend themselves to representation as hypertext nodes.

File systems

This would allow any file to be linked to from other hypertext documents.

The Telephone Book

Even this could even be viewed as hypertext, with links between people and sections, sections and groups, people and floors of buildings, etc.

The unix manual

This is a large body of computer-readable text, currently organised in a flat way, but which also contains link information in a standard format ("See also..").

Databases

A generic tool could perhaps be made to allow any database which uses a commercial DBMS to be displayed as a hypertext view.

In some cases, writing these servers would mean unscrambling or obtaining details of the existing protocols and/or file formats. It may not be practical to provide the full functionality of the original system through hypertext. In general, it will be more important to allow read access to the general public: it may be that there is a limited number of people who are providing the information, and that they are content to use the existing facilities.

It is sometimes possible to enhance an existing storage system by coding hypertext information in, if one knows that a server will be generating a hypertext representation. In 'news' articles, for example, one could use (in the text) a standard format for a reference to another article. This would be picked out by the hypertext gateway and used to generate a link to that note. This sort of enhancement will allow greater integration between old and new systems.

There will always be a large number of information management systems - we get a lot of added usefulness from being able to cross-link them. However, we will lose out if we try to constrain them, as we will exclude systems and hamper the evolution of hypertext in general.

Conclusion

We should work toward a universal linked information system, in which generality and portability are more important than fancy graphics techniques and complex extra facilities.

The aim would be to allow a place to be found for any information or reference which one felt was important, and a way of finding it afterwards. The result should be sufficiently attractive to use that it the information contained would grow past a critical threshold, so that the usefulness the scheme would in turn encourage its increased use.

The passing of this threshold accelerated by allowing large existing databases to be linked together and with new ones.

A Practical Project

Here I suggest the practical steps to go to in order to find a real solution at CERN. After a preliminary discussion of the requirements listed above, a survey of what is available from industry is obviously required. At this stage, we will be looking for a systems which are future-proof:

- portable, or supported on many platforms,
- Extendible to new data formats.

We may find that with a little adaptation, pars of the system we need can be combined from various sources: for example, a browser from one source with a database from another.
I imagine that two people for 6 to 12 months would be sufficient for this phase of the project.

A second phase would almost certainly involve some programming in order to set up a real system at CERN on many machines. An important part of this, discussed below, is the integration of a hypertext system with existing data, so as to provide a universal system, and to achieve critical usefulness at an early stage.

(... and yes, this would provide an excellent project with which to try our new object oriented programming techniques!) TBL March 1989, May 1990

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[SMISH88]

Smish, J.B and Weiss, S.F,"An Overview of Hypertext",in Communications of the ACM, July 1988 Vol 31, No. 7,and other articles in the same special "Hypertext" issue.

[CAMP88]

Campbell, B and Goodman, J,"HAM: a general purpose Hypertext Abstract Machine",in Communications of the ACM July 1988 Vol 31, No. 7

[ASKCYN88]

Akscyn, R.M, McCracken, D and Yoder E.A,"KMS: A distributed hypermedia system for managing knowledge in originations", in Communications of the ACM , July 1988 Vol 31, No. 7

[HYP88]

Hypertext on Hypertext, a hypertext version of the special Comms of the ACM edition, is avialble from the ACM for the Macintosh or PC.

[RN]

Under unix, type man rn to find out about the rn command which is used for reading uucp news.

[NOTES]

Under VMS, type HELP NOTES to find out about the VAX/NOTES system

[CERNDOC]

On CERNVM, type FIND DOCFIND for information about how to access the CERNDOC programs.

[NIST90]

J. Moline et. al. (ed.) Proceedings of the Hypertext Standardisation Workshop January 16-18, 1990, National Institute of Standards and Technology, pub. U.S. Dept. of Commerce