Do People Use Icons?

An Investigation Into Use Of The Text-Prompt Associated With Icons

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Abstract

Graphics symbols, commonly known as icons, are becoming increasingly popular as a medium to present information about computer systems and their command operations. Since their introduction to the computer interface in the early 1980's, icons have been made out to be an overwhelming success. As icons are graphical or pictorial signs which are related to their respective referents by means of a similarity relation which holds at least for one of their constituents, icons are thought to be easy to learn and easy to use. In addition, due to their iconicity, icons are claimed to provide the inexperienced user with a better chance to implicitly acquire a model of the application system structure.

These claims are investigated, and after user testing experiments it was shown that people do use icons, but they also require use of the ToolTip for some icons. The results demonstrated that icon use is not as obvious to all users as many papers would lead you to believe. Use of the ToolTip is a requirement for the understanding of some icons, while not at all for others. Novices declared that they preferred using icons. However, they obtained the worse results, which casts doubts on those who suggest that icons are there primarily for the novice. Expert users on the other hand said they least preferred icons but obtained the best results, which suggests that there is an element of correct icon usage being associated with learning via experience and not from deciphering the pictogram correctly the first time. The implications of these results are then discussed and a conclusion, as to the validity of icons on the interface, has been included.

Keywords: Icons, ToolTips, Usability, Text-Prompt, Graphical User Interface.

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List of Abbreviations

GUI – Graphical User Interface.
RIM – Readily Inferable Meaning.
ERM – Easily Remembered Meaning.
PDA – Personal Digital Assistant.
IMM – Internally Modifiable Meaning.
WIMP – Windows, Icons, Mouse and Pull-down menus.
EUP – Experienced User Performance.
ISO – International Organisation for Standardisation.
OS – Operating System
CAD – Computer Aided Design
HCI – Human Computer Interaction

"Designing an object to be simple and clear takes at least twice as long as the usual way. It requires concentration at the outset on how a clear and simple system would work, followed by the steps required to make it come out that way –steps which are often harder and more complex than the ordinary ones. It also requires relentless pursuit of that simplicity even when obstacles appear which would seem to stand in the way of that simplicity".

T. H. Nelson, The Home Computer Revolution, 1977
(from Shneiderman 3rd edition, 1998)

Introduction

Introduction

Do users know what an icon means? Do they just make the interface more attractive or are they a useful part of an interface? Icons are perceived by many to improve the usability of the computer interface by making command actions simpler and more obvious particularly to novices and intermediates, but do people use icons? This is the question investigated by this paper, that is, whether or not icons play a useful role in the computer interface. This paper follows on from a previous research project undertaken by Conlon in which she stated that "Icons are of little more use than cosmetic value" (Conlon, 1998). This investigation attempts to determine, through a different user testing procedure, whether this statement could be confirmed -namely whether or not users needed the text prompt to determine the function of an icon.

Present Day Philosophy

With the progresses in technology, computers are becoming a common tool in all sectors of society – industrial, office, domestic, and academic. As a result, computers are now used by almost everyone, but do we (the users) ever give much thought as to how they are used? As computers are so important and a fundamental part of most peoples lives, it could be argued that the emphasis on computer design should be on usability as opposed to the hardware and trying to make them faster and smaller. This is not saying that the evolutionary development of computers is not important, on the contrary it is, but there is little point in designing a computer system that is unusable to many of its target population. This investigation will hope to show what studies have gone into usability design and testing and their resultant conclusions.

Graphical User Interface -'The' User Interface?

Changes in display technology and user interface design have resulted in the development and use of one of the most successful commercial interfaces available today called the WIMP (Windows, Icons, Mouse, Pull-down menu) interface, which is now more commonly termed a GUI, or a Graphical User Interface. In these interfaces, icons, or rather the small 32 x 32 pixel images, which are used as part of the dialogue in order to represent processes and data in the computer (Gittins, 1986), represent applications, objects, options, states and messages. Many claims for this style of interface have been made by various researchers of the advantages of using icons over text based commands in computer usability. For example the paper by Gittins suggested that icons improve usability, are easy to learn, reduce errors and complexity to name but a few (Gittins, 1986). Iconic interfacing is becoming increasingly popular as a medium to present information about computer systems and their command operations. However, is the icon a fundamental breakthrough heralding new dimensions in computer usability, or just a fad, hiding loss of productivity behind a euphoric wave of apparent "user friendliness"? Do they simplify the man-machine interface or is it just a sales argument? Maltby explained that software is big business and so development of 'good software' is vital and hence the design of good icons and menus has become an increasingly important factor in the construction of modern program user interfaces (Maltby, 1994).

Microsoft's Windows operating system is one of the better well-known GUIs. It uses icons and text to select and identify, amongst other things, software applications. A key feature of this and other Graphical User Interfaces that enable direct manipulation, is the use of pictographic (signs which convey messages pictorially) icons. These icons are then manipulated by users often by simply clicking on them, to perform a given function. Placing pictographic symbols on icons and thus making them more visible, is frequently credited with improving the user's ability to recognise the objects and functions being represented (Gittins, 1986 & Sears *et al,* 1998).

Meaning of Icons, how well are they Conveyed?

This investigation hopes to determine whether or not people use icons. How successful an icon is can be directly related to whether it is used or not. It is logical to think that icons, which are used, must convey their meaning across to the user better than those icons that are not used, as they are not understood by the user. This project is concerned with determining whether or not icons are of any use, or alternatively, are of little more than cosmetic value, as proposed by Ann Conlon (Conlon, 1998). The crux of this investigation is to determine whether or not users need the use of the small pop-up window that includes descriptive text displayed when the user moves the pointer over an icon (see Figure 1) called a ToolTip, to be able to determine the icon's function.

(i)

(ii)

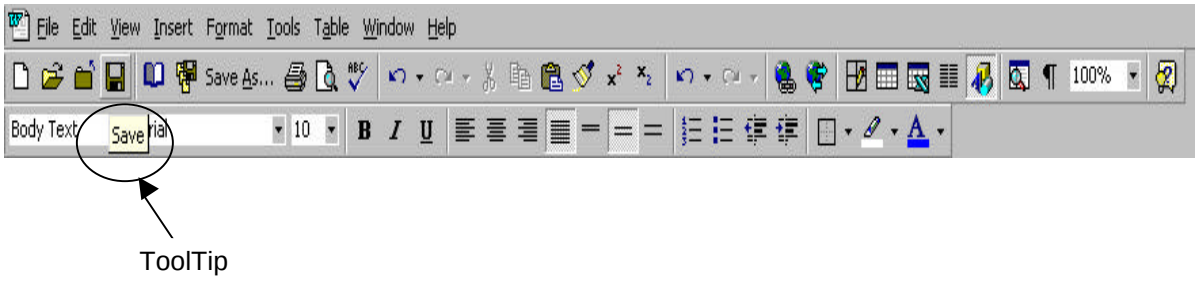


Figure 1. *(i) icon when cursor is not hovered over the 'Save' icon*
(ii) icon and displayed ToolTip when cursor is hovered over the 'Save' icon.

The ToolTip appears after a short time-out and is automatically removed when the user clicks the control or moves the pointer off the control (Microsoft Press).

Icon Definition

Gittins stated that icons are pictographic symbols which are used as part of the dialogue in order to represent processes and data in the computer, where by the user makes a selection of one or more icons on a display, in order to invoke processes and manipulate data. He said that the syntax and semantics of such a dialogue can be specified and parsed in exactly the same way as for a command or menu-based interactions. Also, the only additional operation required was the identification of icons selected at the display, and determination of "their internal tokens" (Gittins, 1986). This sounds obvious and would appear to be a relatively easy task to be achieved, but do users understand what the function of an icon is without the textual prompt?

Icons can be used anywhere you would use a word label: to activate menus, to perform actions, to select tools, to toggle between modes, to manipulate windows, to point to items on the screen, to reveal the state of the data and allow it to be changed, to represent files and directories on disks, and to provide a way to delete unneeded items. But do users wait for the text label (ToolTip) of an icon to appear before selecting it? If this is the case then it maybe deduced that icons are not as useful as developers perceive them to be and vice versa. The results of this investigation aims to answer this question of whether or not ToolTips are used more often than not and so hopes to be able to come to a conclusion as to the usefulness of computer icons.

Report Progression

Chapter One will start by going over the history of icons and iconic interfaces. I will aim to explain the reasons as to why iconic interfaces were developed in contrast to the command driven interfaces already being used successfully. Why are iconic interfaces perceived to be so much better than command driven interfaces? This is an important question to be answered as many new software products are utilising icons more and more, should it be discovered that icons are not as useful as thought to be, then this could have drastic implications on the development of future software. The report will then investigate icons more generally in terms of their classification and design in Chapter Two, after all what do current designers think constitutes a "good icon"?

After this groundwork I will summarise the literature upon the research undertaken to date investigating the usefulness of icons over text based systems in Chapter Three. To cover the differing views on the usefulness of icons, a review of the literature from both sides of the argument will be attempted.

Then, in Chapter Four, I will explain and describe the experiments carried out on human subjects investigating whether or not people use icons, or more explicitly, whether or not users require the descriptive text (ToolTip) that accompaniments the icon when it is hovered over with the cursor. To accomplish this objective, a questionnaire and two different tests were constructed and administered to 20 volunteers.

From the results (Chapter Five) obtained a suggestion will be made as to whether or not computer users require the textual prompt, which will help to deduce whether icons achieve the task that they were originally designed for.

Chapter One: The History of Icons

"There is great satisfaction in building good tools for other people to use."
Freeman Dyson, *Disturbing the universe*, 1979.

1.1 Introduction

This paper is concerned with the use of icons in the human-computer interaction (HCI). It would be very hard nowadays for any person who has used a computer to state that they have never come across an interface that utilises icons. Most of the computer applications and packages available maximise the use of the computer's graphical display. Icons are developed by designers to take advantage of the graphics ability of computers, in response to the belief by many that they make the interface more understandable. They have been applied principally to graphics-based interfaces of operating systems, networks and document-processing software. Why is it that there is so much hype in using Icons? Many people could be forgiven for thinking that this is something that Microsoft has developed recently. However, Microsoft did not create or develop icons during the early stages of their emergence. But, there can be no disagreement with the statement that Microsoft is one of the most successful companies ever and this has come about in part through the exploitation of Icons. It has achieved this by creating an idea of making the interface between humans and computers much simpler than the original method of having to type in commands, which for many new to the computing world is very intimidating.

However, before the advent of Windows, and even Apple's LISA and Xerox's STAR (the original companies/software to utilise computer Icons), pictographic symbols were one of the earliest forms of writing systems, for example Egyptian hieroglyphs. Here, the initial part of the object represented the syllable of a word in the spoken language. The Chinese language is slightly different in that it uses logograms where an icon is the actual representation of the object it describes. However, over time, the approximately 50,000 logograms have become very stylised, so that they now bear no resemblance in terms of shape. The big advantage of this type of language is that even though there are many different dialects in the spoken language, the logograms remain the same despite major differences in local dialects (Gittins, 1984). However, Chinese idiographs may illustrate what happens if there are too many icons. Jervell and Olsen stated that "There will then be so many different figures, with such a high degree of detail, that they no longer give any intuitive representation of what they stand for. The icons have become symbols. They cannot be used unless one knows the rules that explain their significance of each individual character" (Jervell and Olsen, 1985). This chapter will describe the development of the computer icon and mention some of the reasons why developers have created them, including psychological and cultural advantages.

1.2 In the Beginning…

More recently, even before the creation of computers as we know them today, icons have been used in a more limited, but successful, way in the form of national and international sign-posting for public service functions. So if it was not Microsoft that developed computer icons, then who did? Around the 1970's great advances in computer design and technology meant that computers became cheaper and so resulted in many new user groups. This made new demands on the programs, especially at the interface between the programs and the users. The programs must be easy to learn, easy to use and must give the user an understanding of what is going on (Gittins, 1986). The conventional method of interacting with a computer interface used to be via typed commands, which required of users a good understanding of file-store structure, as well as a high degree of expertise in its grammar and syntax. One of the difficulties which novice users of computers systems used to complain about, as stated by Rogers and Obourne, was that they had difficulty at first in learning and subsequently remembering command names. The vocabulary selected for those commands was frequently reported as being unfamiliar jargon, confusing, and lacking in meaningfulness. Furthermore, having learned a command set, users would often experience problems in remembering which command names related to which system functions and *vice versa* (Rogers and Obourne, 1985). This required a compromise, of the new interfaces, between two extremes: on the one hand the commands had to be simple which limited the facilities, and on the other hand a complex set of commands and parameters which were difficult to master. At this time, graphics capabilities of many (even relatively cheap) computer systems offered the interface designer the ability to use a variety of interaction media in addition to the traditional one based on text. Icons are one of these media. Therefore, Xerox used high-resolution graphics displays which held icons of objects within the file-store and the facilities available (Gittins, 1984b). Smith *et al* outlined the main goals that were pursued in designing these interfaces as follows:

- Familiar user's conceptual model
- Seeing and pointing verses remembering and typing
- What you see is what you get
- Universal commands
- Consistency
- Simplicity
- Modeless interaction
- User tailorability (Smith *et al*, 1982)

Lodding noted that this problem of trying to make the use of computers more 'user friendly' to the myriad of new users, could be achieved by using graphics displays. He stated that "it can be used as a mechanism by which we reduce the apparent complexity of the information systems tool itself" (Lodding, 1983). In 1992, Mayhew talked about the new groups of users, stating that "The user of computer technology is now often a person who is technologically uneducated, unsophisticated and unmotivated, rather than a professional technologist. Different kinds of interfaces to computing power are required for this new type of user" (Mayhew, 1992). To penetrate these new markets, he claimed

that computer companies must recognise that acceptable and appealing interfaces, as well as desirable functionality must be offered. Certain kinds of users simply would not buy systems that required too much of an investment in learning. To sell to this kind of customer, he stated that "products must be very easy to learn" (Mayhew, 1992). This is what the Microsoft Corporation would seem to have achieved where others have not. In fact, Apple did take Microsoft to court for copy-write violation, but lost. In many respects this is probably a good thing as it allowed Microsoft to standardise the visual language system developed by Apple. This resulted in the development of many different computer platforms allowing users to interact with computers and each other through computers (Honeywill, 1991). Therefore, the originators of the 'Computer Icon' are regarded to be the Xerox Corporation for their 8010/12 Office automation system and the Apple Corporation for their "LISA" personal computer (Gittins, 1984). Use and importance of graphic computer interfaces have grown since the release of the Xerox STAR and Apple LISA. Associated with them are window systems, icons representing objects (e.g. files, printers) and actions (e.g. deleting files), and a pointing device (mouse) to select and activate icons. This new philosophy in designing computer interfaces along with the decreasing cost of computer technology making it more accessible to a much wider variety of users allowed the Graphical User Interface (GUI) to be born.

1.3 Direct Manipulation

An interface in which users perform actions directly on visible object, otherwise known as 'Direct Manipulation', was therefore lauded as a good form of interface design. This has been shown to be well received by users to be a good method of interface design, you need only to look at how successful Microsoft has become, through in part via its Windows software products to see this. There are many differing forms of direct manipulation, however this report is only concerned with the aspect of icons. Mayhew has given a more precise definition as: "Generally, a direct manipulation interface is one in which users perform actions directly on visible objects. This is in contrast to interfaces in which users indirectly specify actions, parameters and objects through language (for example, command language or menu interfaces)" (Mayhew, 1992).

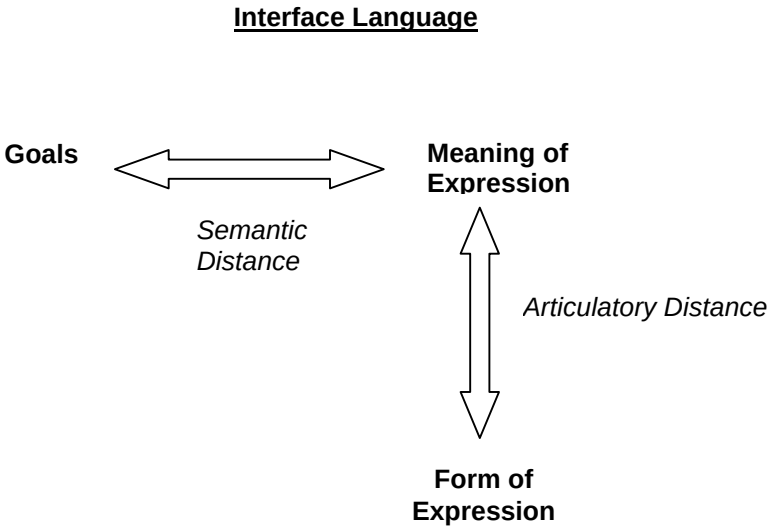
It has been argued by Shneiderman, that systems using Direct manipulation via iconic interfaces have the following beneficial attributes:

- Novices can learn basic functionality quickly, usually through a demonstration by a more experienced user.
- Experts can work extremely rapidly to carry out a wide range of tasks, even defining new functions and features.
- Knowledgeable intermittent users can retain operational concepts.
- Error messages are rarely needed.
- Users can immediately see if their actions are furthering their goals, and if not, they can simply change the direction of their activity.
- Users experience less anxiety because the system is comprehensible and because actions are so easily reversible.
- Users gain confidence and mastery because they initiate an action, feel in control, and can predict system responses (Shneiderman, 1983).

Three psychologists, Hutchins, Hollan and Norman, investigated the claim that systems which used direct manipulation (for example, icons) felt natural, in that there was no complicated coding to be learnt. Hutchins *et al* asked, "on the one hand, what is it that provides the feeling of 'directness?' Why do direct manipulation systems feel so natural? What is so compelling about the notion? On the other hand, why can using such systems seem so tedious?" (Hutchins *et al*, 1988).

They suggested that there are two distinct aspects of the feeling of *directness*. One involves a notion of the **distance** "between one's thoughts and the physical requirements of the system under use. A short distance implies that the translation is simple and straightforward, that thoughts are readily translated into the physical actions required by the system and that the system output is in a form readily interpreted in terms of the goals of interest to the user" (Hutchins *et al*, 1988). The authors used the term *directness* to refer to the "feeling that results from interaction with an interface" and the term *distance* to "describe factors which underlie the generation of the feeling of directness." The second form of directness is concerned with the qualitative feeling of **engagement**, the feeling that the user is directly manipulating the objects of interest (Hutchins *et al*, 1988).

Hutchins *et al* explained that every expression in the interface language has a meaning and a form. **Semantic distance** reflects the relationship between the user intentions and the meaning of expressions in the interface languages both for input and output. **Articulatory distance** reflects the relationship between the physical form of an expression in the interaction language and its meaning, again, both for input and output. The easier it is to go from the form or appearance of the input or output to meaning, the smaller the articulatory distance (see Figure 2) (Hutchins *et al*, 1988).



(from Hutchins, Hollan and Norman 1988)

Figure 2. *Semantic and Articulatory Distance*

The semantic distance is concerned with the relation of the meaning of an expression in the interface language to what the user wants to say. In other words, does the language support the user's conception of the task domain? Does it encode the concepts and distinctions in the domain in the same way that the user thinks about them? Conlon noted that the authors did not specifically utilise the concept of articulatory distance with direct reference to icons in any depth. Conlon then argued in her conclusion that "icons which minimise articulatory distance will display a higher degree of readily inferable meaning" (Conlon, 1998). This being the case, it would imply that users can easily identify both those that have been seen previously and those that are new. If this result was observed then it would mean that people who may or may not use icons should have no need for the ToolTip.

Shneiderman suggested that a problem users may have with direct manipulation interfaces is that users "must learn the meaning of components of the visual representation. A graphic icon may be meaningful to the designer, but may require as much or more learning time than a word" (Shneiderman, 1998). Shneiderman used airports, that serve multilingual communities and which use icons extensively as an example, where the meanings of these icons may not be obvious. He further stated that "some computer terminals designed for international use have icons in place of names, but the meaning is not always clear. Icons that appear when the cursor is over them offer only a partial solution". This is also explained by Hutchins *et al* when they stated that "Pictographic and iconic languages are examples of articulatory representation in which the form of the expression is related to its meaning. By definition, an icon is a representation that stands for its object by virtue of a resemblance to it. However, even when the form of the icon is very like its intended meaning, the mapping is not complete. Instead, certain features of the referent are abstracted and preserved in the form of the icon, while others are discarded. And even those features that are preserved may be established by convention. For example, while the international symbols for male and female may

seem imitative of fundamental distinction, they are scarcely interpretable to societies in which trousers and skirts are not worn. Even the interpretation of widely recognised icons requires background knowledge of conventions. Most icons of necessity are abstractions of the things they depict. Thus, the articulatory directness of even iconic or pictographic representations is not complete: Their interpretation requires knowledge or explanation" (Hutchins *et al*, 1988).

Secondly, Shneiderman suggested that the visual representation may be misleading. He continued saying, "Users may grasp the analogical representation rapidly, but then may draw incorrect conclusions about permissible actions. Users may overestimate or underestimate the functions of the computer-based analogy".

In conclusion Shneiderman suggested that direct manipulation interfaces should be constructed with the following principles in mind:

1. continuous representation of the objects and actions of interest with meaningful visual metaphors
2. physical actions or presses of labelled buttons, instead of complex syntax
3. rapid incremental reversible operations whose effect on the object of interest is visible immediately.

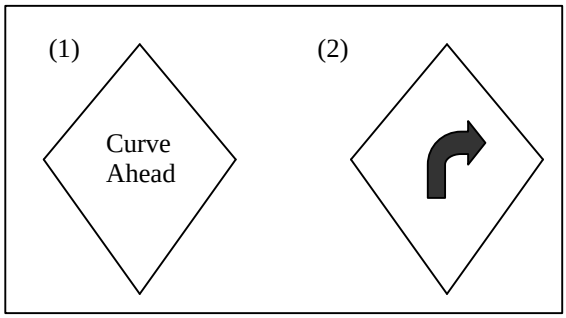
Finally he stated that ample testing must be carried out to refine the displayed objects and actions and to minimise negative side effects.

1.4 The Way Forward

So from the 1980's graphic symbols were being used more and more frequently in computer applications, as high-resolution displays with graphic capabilities became more common. Hemenway suggested that the motivations for using graphic symbols, or icons, in command menus was similar to the reasons graphic symbols have long been so popular for use on maps. This was because graphic symbols can be visually more distinctive from one another than a set of words can. So for this investigation, focussing on one particular type of graphic symbol (the icon), it can therefore be suggested that it is easier to spot an icon among other icons than it is to pick out one word among a group of words. Graphics technology, and its utilisation by icons, has come a long way since Hemenway made this almost prophetic statement. She mentioned at this time that graphic symbols can represent a lot of information in very little space, this was stressed as a very important property of icons as space is at a premium on both maps and terminal display screens (Hemmenway, 1981). This is particularly relevant in today's computing age due to the development of the PDA (Personal Digital Assistant), where large amounts of information are presented to the user on a display that is only a few square inches in size.

1.5 Richly Grounding Symbols

An old cliché “a picture paints a thousand words” is probably quite apt in the discussion of icon usability. Conlon demonstrated this very well when she mentioned Richly Grounding Symbols, using a road sign to depict a bend in the road as an example (Conlon, 1998). A picture of a curved arrow on a sign was perceived by these authors to have three separate advantages over a textual sign with ‘Curve Ahead’ written on the same sign in place of that pictograph (see Figure 3).



Excerpt taken from Ann Conlon (1998)

Figure 3. *Two signs demonstrating the difference between a (1) textual and its (2) pictographic alternative.*

But how would a ToolTip describe this difference for an icon? This is where the comparison between road signs and computer icons may break down. This will be mentioned later on in the discussion.

The advantages that the pictograph will have over its textual alternative are:

1. Readily Inferable Meaning (RIM)
2. Easily Remembered Meaning (ERM)
3. Internally Modifiable Meaning (IMM)

RIM is whereby the user will be able to deduce or translate what the meaning of the icon is when it is first encountered. ERM on the other hand deals with the memorability of the icon –will the user be able to remember the correct meaning of the icon? IMM deals with the efficiency of the sign (the amount of information it conveys). Conlon explained how the icon can convey a lot of information to the onlooker –more simply than the textual alternative. She followed on by mentioning that the meaning of the icon can be changed “in ways that are systematic and predictable”. Whereas, for the text sign, more writing would have to be added to describe the subtle details such as direction of curve and severity (Conlon, 1998).

Therefore as Conlon summarised “Images can contain a quantity and quality of information that would require considerably more space and arguably more skill to reproduce via a written language. However they offer no proof that sign 2 is actually grasped more easily and quickly than sign 1.” Whether or not an icon has RIM and ERM is not in the scope of this report and so will not be

investigated or researched into any depth because, however, this issue was addressed in some detail by Ann Conlon (1998). An icon which does have a high level of RIM and ERM would imply that use of the ToolTip would not be necessary. Therefore, for more information concerning RIM and ERM, please refer to Conlon (Conlon, 1998).

1.6 Menus Versus Icons

Menu selection was regarded as a mode well suited to human-computer interaction, especially for casual or inexperienced users. Menus were also popular because they display the functions and options available for a given system state and allow for an easy selection of that option (for example by mouse or keyboard). This would mean that the user is not required to remember which operations can be performed in a given state, but rather only has to scan a set of items and then select one of them to accomplish a required action. Arend stated that "menus are regarded to facilitate the learning of application systems and to improve their usability" (Arend, 1987). However, current approaches to user-oriented interface design emphasises the use of visual representation in general, and of icons in particular (Lodding, 1983). It was further emphasised that this "…not only reflects improvements in computer technology, but also the widely held assumption that the human mind is strongly visually oriented, and hence people are able to acquire and to manipulate complex information more efficiently by means of visual representation than by sequentially structured text" (Arend, 1987). The human interface plays an important role in information retrieval systems and so how the interface is presented to the user is of great importance, this meant that engineers were forced to design systems that would support and facilitate the human mind as it naturally operated. Visual information is a good man-machine communication medium and, as such, a visual interface therefore provides user-friendly operations (Nishiyama *et al*, 1994). Although it could be argued that any type of interface is visual – as you have to see it to select it for example, I imagine that when the authors use the term 'visual information' they are referring to pictograms or icons in particular.

1.7 The Interaction of the Human Brain and the Computer Icon

Rogers and Oborne stated that recent trends in human-computer interaction have moved towards the use of iconic representations in which information about aspects of the system is presented on the screen in pictorial form. "Such interfacing techniques have recently become implemented in a number of office automation systems, for example the Xerox Corporation's STAR… Typically the information represented in these iconic interfaces is of 'office-like' objects such as in- and out- trays, files, folders and wastepaper bins. Additionally, icons have been used to represent command operations, such as deleting, creating and printing files or sets of data" (Rogers and Oborne, 1987). But why is this? Why are icons presumed to be so much better than traditional command based systems? The answer to this could be due to the way our brain processes information.

The introduction of icon-oriented user interfaces was strongly based upon research on object-oriented programming, where computer scientists believed typical human communication to be object-centred. This view was supported by a psychological inquiry concerning memory capacity. It had been found that subjects could remember pictures far better than equivalent sentences, and that decisions based

upon pictorially mediated information could be made faster than text based commands (Blankenberger and Hahn, 1991). Lodding mentioned that the human brain processes vital visual information and language quite differently, with most of the specific processing occurring in different hemispheres. He continued to say, "…today's increased availability of graphics displays allows the inclusion of visual communication at the man-machine interface, permitting us to take advantage of the brain's image processing capabilities" (Lodding, 1983). Lodding even goes on to mention that images viewed previously may be recalled "with almost perfect accuracy". Thus, the use of graphics at the interface, in the mind of Lodding, must only benefit the user by taking advantage of the brain's image processing capabilities. This was explained by Lodding stating in his report that "text or numerals are read in a sequential manner, with the information being buffered in a short-term verbal memory, the capacity of which is quite restricted. The information is serially processed and then transferred from the short-term memory to long-term memory. Images however, are processed differently. An image is captured as a whole and is processed in a parallel manner, and the semantics are entered into long term memory" (Lodding, 1983).

The basis for believing that visio-spatial memory is particularly effective comes from several types of psychological experiments. Lansdale explained how a group of people were shown a large number of pictures and then subsequently given a memory recognition test. It was shown that these experiments produced high levels of accuracy, even with long intervals between presentation and testing. A second paradigm Lansdale mentioned involved memory tests in which the subject had used, or had been encouraged to use, some form of imagery technique. Such methods were shown to produce higher levels of recall than comparable tests in which imagery was discouraged. Lansdale suggested that these memories have become institutionalised in theories such as that proposed by Pavio, in which visual processing is seen as a distinct psychological mechanism (Lansdale, 1988). This idea has found its way beyond the realms of theoretical psychology into application. For example, Lodding, while discussing the use of icons in human-computer interaction stated:

"Currently, the primary medium of interaction at the man-machine interface is text. But today's increased availability of graphics displays allows…us to take advantage of the brain's image processing capabilities…Estimates have been made that images permit information exchange between man and machine at levels approaching one or two orders of magnitude greater than would be the case with an equivalent text message."

Corey, on discussing the utilisation of icons, suggested that "The proposal is different from any other in that it intends to use a different part of the brain. Previous systems use the language centres while graphics based systems (incorporating icons) would use the visual-manipulative centres" (Corey, 1987). From this it was implied that using pictographic means as opposed to textual means, that the complex information provided by the system could be understood by the user (novice or expert) more efficiently and effectively.

This was based on the observations that people find images natural. Also, because the human mind has powerful image memory and processing capabilities, icons can be easily learned (ERM –Easily Remembered Meaning) and recognised (RIM –Readily Inferable Meaning) and because "images can possess more universality than text" (Lodding, 1983). Lodding further implied that images permit information exchange between man and machine at levels approaching one or two orders of magnitude greater than would be the case with an equivalent text message. This supported the assumptions of psychologists who theorised that the mind is more visually oriented which is backed up by Lansdale after results from experiments showed that memory for visual information is especially good. This would mean that users are able to understand complex information more efficiently and effectively by means of visual representation than by text (Gittins, 1986 & Lodding, 1983 & Lansdale, 1988).

A psychologist working in the field of human-computer interaction, Kathleen Hemenway suggested a practical reason as to why icons are better than text. She pointed out that the amount of information in a single icon is equivalent to a description involving many words. This brings us back to the idea mentioned earlier of icons saving space, as graphic symbols can represent a lot of information in very little space and of the example of a road sign in Richly Grounding Symbols. The example she provides is of a command in a software package that draws vertical and horizontal lines one centimetre thick which is more terse or concise when represented by vertical and or horizontal line segments than by the corresponding verbal description. She further stated that "…graphic symbols are superior to words for representing variation among a set of commands on a graphic dimension (e.g., length, width, brightness) or on a dimension that is easily translated into graphic representation (e.g., representing "more" with "longer")" (Hemenway 1982).

1.8 Understanding the Icon

Charles Peirce, a semiotician, stated that the sign is "something which stands to somebody for something in some respect or capacity" (Uzilevsky and Andreev, 1986). Generally, the recognised function of an object will depend on the environment in which the object is used. Therefore, icons must be designed in consideration of the environment in which they will be used. When discussing icons at the interface, Gittins said that pictographic symbols are used to represent underlying objects in a computer system. These objects may be processes or data, and the representation can indicate their attributes, their association or their state. An important feature of icons that he mentioned, is that "they may be used to indicate characteristics of the system's objects by sharing graphic elements, even when the end-user is unfamiliar with the icon in question. In some contexts, an icon interface may substantially obviate the use of other media (such as commands) and provide a more usable dialogue because of its capacity to carry much greater descriptive information using the same, or less physical display area" (Gittins, 1986).

Benbasat and Todd suggested that in novel settings, pictorially based languages, or logographs, "…are easier for English-speaking adults to learn than new alphabetic codes. In particular, learning to recognise individual "words" was easier in an unfamiliar symbolic code than in an unfamiliar

alphabetic code. Since recognition of icons requires the learning of a new symbolic code, icons may be relatively easy to learn and possess some advantages over an unfamiliar text-based command representation" (Benbasat and Todd, 1993).

Hemenway proposed a simple model for the interpretability and effectiveness of icons. When a new icon is encountered its interpretability depends on :

(a) its comprehension (e.g. the ability to discover what the icon depicts), and
(b) its effectiveness as a retrieval cue (e.g. the ability to form a link between what is depicted and the corresponding command) (Hemmenway, 1982).

For experienced users, the effectiveness of an icon ability depends on:

(a) the ability to recognise what the icon depicts, and
(b) the ability to retrieve the link between the icon and the command from memory. It is predicted that highly familiar, conventional symbols will be easier to recall than obscure icons that lack distinguishing features (Hemmenway, 1982).

She suggested that after the initial interpretation of an icon, the ability to recall a command in response to the corresponding icon, required recognising what the icon depicted, and "retrieving from memory the 'link' between what is depicted and the command. If the user is familiar with the object or symbol depicted in the icon and it is clear and unambiguous, then it should be obvious to the user, for the first time and subsequently, what the icon depicts" (Hemmenway, 1982). As a rule, the more common, familiar or conventional the caricature or symbol is, (e.g. paintbrush or scissors), then the more likely the icons depiction is to be correctly identified.

Kaneko suggested that when users look at an icon, the knowledge that they have about the drawn object gives them clues to the icon's functional meanings. He went on to say "Accordingly, users seem to have two tasks in understanding the meaning of an icon. The first task, which we will call 'object identification', is to identify the physical object represented by the icon. The second task, 'functional recognition', is to recognise the function implied by that object". He concluded by mentioning that the two tasks are executed sequentially and that generally, "…object identification corresponds to the perceptive phase, while functional recognition corresponds to the cognitive phase." There is a difference in modes of problem solving: between spatial, demonstrative methods and those that are linguistic and symbolic. This may decide whether the use of icons is beneficial or not. Malone stated that "It is important to realise that there are huge differences in cognitive structure, in spatial ability and in working style, as typified by the degree of organisation on one's desk" (Malone, 1982).

1.9 Summary

Since this humble beginning, GUIs have empowered millions of new computers. But have we become too dependent on the GUI. Aucella stated six years ago that many text-based user interfaces are being converted into graphical user interface platforms. Ease-of-use has become of

primary importance in software product development. Users and purchasers of computer systems are concerned about reducing training and support costs, and well-designed interfaces can substantially reduce those costs. They also allow users to perform tasks more easily, reducing the number of user complaints and customer support problems. Graphical user interfaces have the potential to supply users with a more direct, intuitive means to interact with software. However, simply providing users with pull down menu's, icons and a mouse is not synonymous with an easy-to-use system. Graphical user interfaces often have hundreds of functions that make it difficult for users to find the ones that they need. Users may not understand menu labels or be able to identify icons. Users may have trouble navigating dialogue boxes or menus that are many levels deep. Selecting options can often take four or more separate actions leading users to perceive the application to be "a lot of work". Often there is no easy way to change default values to accommodate individual users. Although an interesting graphic interface may promote ease-of-use, it is not a sufficient condition for it. Some studies indicated that an iconic or windowed user interface enhanced some measures of user performance over a more traditional user interface; however, other studies did not. The differences in performance lie with high-level user interface design decisions that need to be addressed long before menu labels, icons and mouse buttons are specified (Aucella, 1994). However at present day, the fact that the majority of computer systems sold come with icon based software as well as the fact that most software contains icons would suggest that this is what users prefer over a non icon based, textual command based software.

With careful design, it was suggested by Aucella, that icons can help bridge the barriers of language and culture, which are very important commercial factors. Therefore well-designed icons should:

- ♦ Reduce translation.
- ♦ Simplify learning.
- ♦ Improve intelligibility of text.
- ♦ Give products an international look (Aucella, 1994).

If this is the case, then icons should indeed simplify usability at the computer interface. So should we all bow down to the superiority of icons…?

Chapter Two: The Classification of Icons

2.1 Introduction

There are reviews describing a family of icons or rather the existence of a taxonomy of icons. This chapter discusses the classification of icons as mentioned by various authors. It is a review of these taxonomies, as there are varying ideas and philosophies as to how to separate groups of icons. This field of research does appear to be subjective, no authors would seem to disagree with another colleagues ideas regarding icon taxonomies, but many do suggest their own methods for classification, some of which will now be discussed. Are some icons of a particular branch within a taxonomy better understood by users? If this can be proven then it should allow better designs of icons to be developed as attention to that area can be focussed. Hence the classification of icons would be a useful skill to have.

2.2 Founding Father

The American philosopher and natural scientist, Charles Sander Peirce (1839-1914) could be argued successfully as being one of the founding fathers of the field of semiotics, the science of signs. Upon this topic, he stated [about a sign that]: “It addresses somebody, that is, creates in the mind of that person an equivalent sign, or perhaps a more developed sign” (Moyes and Jordan, 1993). Indeed, Peirce did develop a taxonomy of signs, classifying them into three categories; symbol, index and icon. The first of these, **symbol**, has an essentially arbitary relationship with the object that it symbolises, for example the ISO (International Organisation for Standardisation) symbol representing the command-action ‘store’ (see Figure 4). Such pictorial symbols can be compared to characters in natural language, where there is no physical or analogous correspondence between the characters used to form words and their intended meaning. In such cases, therefore, associations must be learned (Moyes and Jordan, 1993).

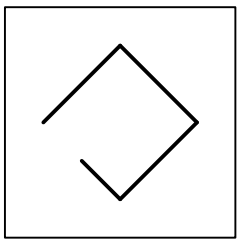


Figure 4: *The ISO symbol representing the command action ‘store’ (From Moyes and Jordan, 1993).*

The second category **index**, is characterised by being related to the associated underlying object in some non-arbitary way. The example cited by Moyes and Jordan, is of the association between smoke and fire, as in the saying “where there is smoke there is fire”, where the signal smoke implies the existence of the fire object. Another example given was of a bird’s footprints in the snow implying the presence of the object –bird.

The third category, **icon**, purposefully shares properties with the object it refers. The example given by the same authors was the icon representing the input device the mouse. Here the icon would depict a computer mouse and not the animal mouse (Moyes and Jordan, 1993).

Using this theory of signs described by Moyes and Jordan, Marcus further asserted that an icon was something that looked like what it means, in other words it is representational and easy to understand. An example is a line of ink standing for a geometric line in a textbook illustration. An index is a sign that was 'caused' by the thing or process to which it refers. The trail of muddy footprints in a front hallway is an index that the children have just entered for example. A symbol is a sign that may be completely arbitrary in appearance. "We must often learn to make the association between the symbol and its meaning, and we must agree that such a symbol will mean a certain thing. An example is the American flag standing for the United States. It may already be realised, that all of the letters that are now being red, are symbols, the kind called phonograms" (Marcus, 1992). When an icon is in the Symbol category, it can cause problems. This is because the icon does not have RIM and so the user must learn what the meaning of the icon is through either trial and error, or via use of the ToolTip. For icons in this genre I would expect a high level of ToolTip use by novices. Icons in this branch include Print Preview, Undo, Redo and Delete.

2.3 Icon Design

The semiotics of icon design is very important for making iconic interfaces more effective. In Lin's view semiotics includes three dimensions of communication: **semantics, syntactics** and **pragmatics**. In each of these dimensions, icons communicate to human viewers. The third dimension, pragmatics, is concerned with how icons are produced (icon design), consumed (icon recognition) and refers to the relationship of a visual image to user (Lin, 1994).

Earlier, Marcus applies semiotics as a guide to four levels of icon design; these included the above three, plus Lexical qualities:

1. ***Lexical qualities*** Machine-generated marks, how are the signs reproduced? –pixel shape, colour, brightness, blinking.

2. ***Syntactic qualities*** This dimension refers to the relationship of one visual image to another. How does this symbol look? How well do the parts of this symbol relate to each other? How well does this symbol relate to other symbols? Is the construction of this symbol consistent in its use of figure/ground, solid/outline, overlapping, transparency, orientation, format, scale, colour and texture? Does this symbol use a hierarchy of recognition? Are the most important elements recognised first? Does this symbol seriously contradict existing standards or conventions? Is this symbol and its elements capable of systematic application for a variety of interrelated concepts?

3. ***Semantic qualities*** Refers to the relationship of a visual image to a meaning. How well does this symbol represent the message? Do people fail to understand the message that the symbol denotes? Do people from various cultures misunderstand this symbol? Do people of various ages fail to understand this symbol? Is it difficult to learn this symbol? Has this symbol already been widely accepted? Does this symbol contain elements that are unrelated to the message?

4. ***Pragmatic qualities*** Are concerned with the relationship of a visual image to a user. Can a person see the sign? Is this symbol seriously affected by poor lighting conditions, oblique viewing angles, and other visual "noise"? does this symbol remain visible throughout the range of typical viewing distances? Is this symbol difficult to reproduce? Can this symbol be enlarged and reduced successfully? (Marcus, 1992).

Shneiderman has added a fifth level of icon design to these four:

5. **Dynamics** Receptivity of clicks –highlighting, dragging, combining. Shneiderman suggests that the dynamics might include "…a rich set of gestures with a mouse, touch-screen or pen. The gestures might indicate copy (up and down), delete (a cross), edit (a circle), and so on." (Shneiderman, 1998)

This dissertation is investigating whether or not people require the use of the textual alternative of the icon (ToolTip). Ultimately this is directly related to the Semantic qualities of an icon. Since it is the semantic quality of an icon that indicates how well an icon is likely to be recognised correctly by the user. It can therefore be deduced that if a user does not need the use of the ToolTip then the icon has good semantic qualities and *vice versa*.

2.4 Icon Classification Using Form, Type and Colour

Gittins suggested that an icon is a graphical symbol, which is used to represent objects in a computer system. These objects can be either data, or processes. An icon either manifests a characteristic of the underlying object (Associative), or serves as a cognitive key to it (Key). In both cases, the dialogue designer aims to create a display environment in which the user can identify an object from its icon. This can be termed the "mapping" of the icon to the underlying system. The classification proposed by Gittins is shown on the next page (Figure 5).

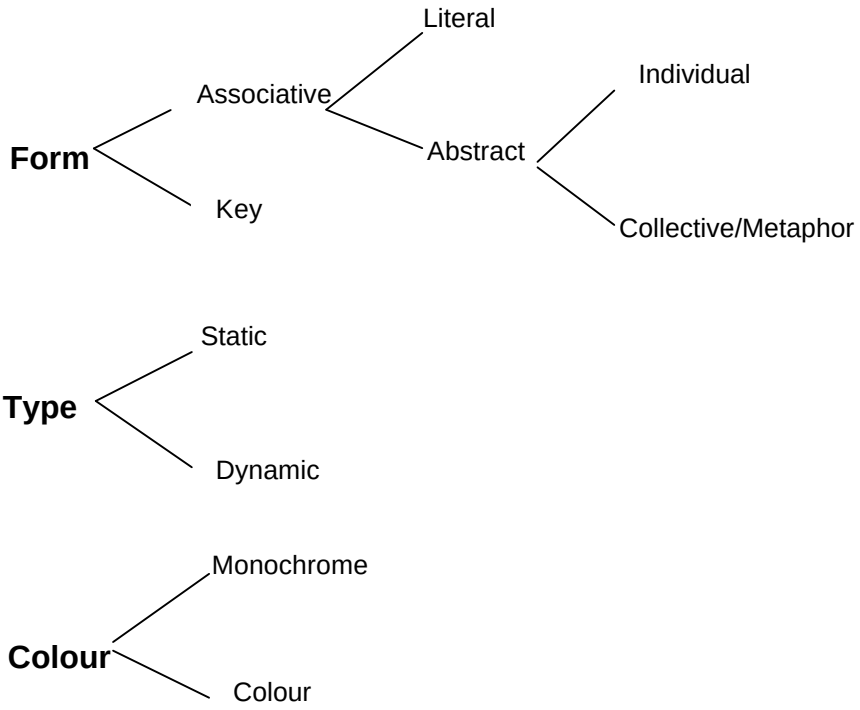


Figure 5. *Icon Classification as imagined by Gittins (Gittins, 1986).*

With associative icons, the mapping also involved an inference process. That is, the user not only identified the underlying object, but by looking at the form of the icon, can infer what its attributes are as well. The example given by Gittins is that of an e-mail system with arrows pointing into and out of the two trays representing mail trays. The user can therefore infer from this that one dealt with incoming mail, while the other dealt with mail being sent to other users. This would be achieved without any prior knowledge of the existence of the two separate processes for incoming and outgoing mail.

Gittins continued by saying that “a collection of icons may share some common design features which reinforce the effectiveness of the mapping. In this case, they are collectively known as the ‘metaphor’”.

The alternative type of icon is one that serves as a cognitive key to the underlying object. This can be either a “mnemonic” or an “arbitrary” icon. The former reminds the user of the commonly accepted name of the object, while the latter has a form of arbitrary design, from which it is not possible to infer the nature of the underlying object. This brings is back to the Symbol class of icons as previously mentioned by Marcus. An example of a mnemonic icon is of a guillotine icon, which is used to represent the “execute” process of an operating system. An example of an arbitrary icon is of the symbol used for radioactive material. These types of symbols are used as users are likely to know them already and so is able to recall them as they are a commonly used standard symbol (Gittins, 1986).

2.5 Metaphorical Design

Gittins talks about how icons can be designed to form a "metaphor". In such dialogues, the shapes of the icons correspond to real-life objects with which the user is familiar. This cognitive process, whereby the user determines the characteristics of the underlying object in the computer, by inference from the form of the icon, can be called 'mapping'. This mapping process, which is reinforced by the use of metaphors, is difficult to achieve in other media types, such as menu driven interfaces. With the advent of many new users, many whom are naïve to the understanding of computers and their commands, it was required that a detailed knowledge of data and processes is not a prerequisite for user operation of the system. This is what icons are suggested by many to be so good at, they obviate the need for familiarity with the underlying objects. The use of the metaphor, Gittins goes on to say, "…and the extra dimension of graphical form can both be used to exploit the operator's ability to infer function and attribute from a pictographic symbol". On the other hand Gittins argued that "there is some indication that there is no reason why text-based cues could not be employed in lieu of icons to represent such things as folders and documents" (Gittins, 1986). However, would a ToolTip not count as a "text-based cue"?

Metaphors have been employed for some time in computing, where end-users have required an analogical model of a system. Typically, analogy is employed in introducing the user to a computer-based system for the first time, or in explaining some new facility or service. Human factors studies in this area suggest that account must be taken of a variety of psychological factors when formulating a specific metaphor. These include the cognition of learning; differences in structuring and associating data; the distinction between users who are learning, as oppose to those experienced in system use.

In the words of Aristotle, *"The greatest thing by far is to have command of metaphor…To employ metaphors happily and effectively it is necessary to have an eye for resemblances"* (Aristotle, The Poetics). This statement should be noted when discussing the design of successful icons.

Experimental work carried out in the area of icon design (Maissel, 1990), found that the more representational an icon is, the more guessable an icon is going to be, since users are likely to discover the icon's underlying meaning faster and with fewer errors (Rogers, 1989). However, Moyes & Jordan suggest that guessability is not the only component of usability of importance. The authors conclude…"Since users of iconic interfaces may use the interfaces for long periods of time, they get a chance to interact with the icons. If they are unsure of an icon at first, the user may still be able to learn its functionality through interaction. Thus although a badly designed icon may not be guessable, it seems possible that it might support reasonable levels of learnability". By being learnable rather than guessable, the authors state that the icon still manages to convey its intended meaning and therefore can still be considered to be successful (Moyes and Jordan, 1983).

2.6 Pictorial, Symbolic or Sign?

Human-computer interfaces increasingly incorporate images as well as text. Arnheim stated that images can function as **pictures**, **symbols** and **signs**. "An image serves merely as a sign to the extent to which it stands for a particular content without reflecting its characteristics visually…Images are pictures to the extent to which they portray things located at a lower level of abstractness than they are themselves. They do their work by grasping and rendering some relevant qualities (shape, colour, movement) of the objects or activities they depict…An image acts as a symbol to the extent to which it portrays things which are at a higher level of abstractness than is the symbol itself…" (Arnheim, 1969).

Easterby and Perkins discuss perception of symbols and icons, and outline principles for drawing symbols. By using traffic signs representing falling rocks, roundabout and stop/forbidden Jervell and Ousen, illustrate the practical limitations of icons. Of these signs, the authors mentioned that only the first of the signs (that of the falling rocks) would purely intuitively give the correct representation. For the others it would be necessary to know the rules, although the pictograms do make it easy to remember them. When Lodding commented on Arnheims work, he paired each of Arnheims function with a design style, i.e. Picture, Symbol, Sign with Representational, Abstract and Arbitary respectively (Easterby, 1970 & Perkins, 1980 & Jervell and Ousen, 1985).

Web *et al* explained the differences between icons. The authors place an icon into one of three categories, namely:

Pictorial –realistic depiction of a system object or function. Reference by resemblance. Have the most detail, are the most concrete, easiest to interpret and remember, not an exact copy.

Symbolic –depicts a critical feature of the referent object or function through analogy or symbolism. Reference by symbolism. Representation is simplified, most affected by context of presentation (e.g. system metaphor employed).

Sign –no inherent, intuitive connection exists between the icon and its referent. Relationship between icon and system object or function must be learned by rote. Reference by learned association. Simplest, and most abstract (Web *et al,* 1989).

In their investigation into the definition and taxonomy of iconic communication, the authors bring up the idea of Interactive Attributes, i.e.

1. Detectability (in a group, distinguishability),
2. Legibility,
3. Interpretability,
4. Recognisability,
5. Preference.

These attributes may be affected by certain characteristics such as: Size, Contrast, Colour, Complexity (for detectability), Concreteness, Dynamism (the extent to which an icon represents an object or an action), Icon-Type, System Context and the user's Past Experience with icons.

2.7 Representational Abstract or Semi Abstract?

Blattner *et al* (1989) have classified icons as representational, abstract or semi-abstract to distinguish between the images and symbols within an icon and their related action(s). Representational icons consist of simple pictures or graphical symbols, which have properties or characteristics which are similar to the operation to be performed. The example used by Kacmar and Carey was of a picture of a printer, which might be used as the representation for performing a printing task. However, I have come across a problem with this. Does it mean print to file or print onto paper? I am sure most users would infer from this that it means paper, yet the default setting on some systems is to file. Abstract icons are composed of one or more geometric symbols, which depict a computer object or operation that cannot be represented by familiar symbols or pictures. A semi-abstract icon is a combination of characteristics from the representational and abstract categories. A semi-abstract icon may contain a well-known image, but the image is used metaphorically to depict an operation for which no 'obvious' image exists (Kacmar and Carey, 1991).

2.8 Command Related Classification.

Hemenway (1982) did some of the earliest work in attempting to classify computer icons. She said that icons differed from one another both with respect to:

a. the features of the corresponding commands that they represent and
b. how the command-features are represented.

She further mentioned that "icons directly or indirectly represent either the operations a command carries out (called 'command-operations'), or the objects operated on (called 'command objects'), or both; and the objects/operations are commonly represented by conventional or abstract symbols, or by depictions of relevant objects." Examples of command-operations, command-objects and both which are in use in the popular Microsoft Word package (given by Conlon, 1998) are of the icons representing Save, Files and Print Preview respectively (Conlon, 1998).

Icons such as File or Folder, represent the object operated on by the corresponding command i.e. open the File or Folder. Icons such as Save either directly or indirectly represent the operation(s) the command carries out, i.e. save work to disk. Most icons that represent the command-object do so via a simple depiction or caricature of that object. The representation of command-operations may not be so easy. Conventional symbols can be used and Hemenway demonstrated this by using the arrow and the "X", (i.e. movement or direction in the case of the arrow and deletion or negation in the case of the "X"). These match, to a greater or lesser extent, the operations involved in the corresponding commands. However, she mentioned that some command-operations are represented less directly: "these icons represent the operations by analogy between what the depicted tool does, and what the corresponding command does" for example, the pair of scissors that represent the operation 'cut'. The third category, that of icons that represent command-operations and command-objects are drawn using the difference between the 'before and after' objects. Copy is an example of this, where the command-object is the document being copied and the command-operation is the act of copying. An icon that contains a picture of a document, with another placed on it, just off-centre, represents this action. The 'before' state is the original document, and the 'after' state is depicted by having the second (copied) document overlaid. Icons of this type I feel work quite well most of the time, but they can run into problems, for example Paste. This icon is of a clipboard with the document to be pasted being pasted onto the clipboard. Apart from being a little obscure pictographically it runs into problems due to the way people work nowadays as for the most part, a clip board is no longer used.

2.9 Summary

One of the things that was noticed during the review of how icons have been classified to date was the apparent lack of conformity in how they are grouped. There would appear to be no clear consensus as to how this should be achieved. Although researchers tend to vary in their interpretations of which categories actually exist, all agree that at the most basic level there are completely abstract icons at one extreme, and highly representational ones at the other. It could be asked whether or not classifying icons is of any use. Kacmar and Carey argue that "By classifying an icon as a member of a particular group, developers will know immediately whether or not that icon would be an appropriate choice for a new application. For example, if one application utilises a concrete, simple, high-imagery, textual, noun icon in a selection task, user performance may be much different if an abstract, complex, low imagery, textless, verb icon is used. The ability for subjects to recognise, select, or recall menu symbols becomes increasingly difficult as the factors which influence the construction and use of menu symbols change" (Kacmar and Carey, 1991). Although there are many varying theories of how to classify icons, there would appear to be an agreement across the board that highly representational icons are most understandable to all types of computer users from most nationalities. For example, the printer icon will most likely be correctly identified to most users.

Chapter Three: Icons: An Empirical Review of Their Usefulness

> "I soon felt that the forms of ordinary language were far too diffuse….I was not long in deciding that the most favourable path to pursue was to have recourse to the language of signs. It then became necessary to contrive a notation which ought, if possible, to be at once simple and expressive, easily understood at the commencement, and capable of being readily retained in the memory."
>
> **Charles Babbage, "On a method of expressing by signs the action of machinery," 1826 (from Shneiderman 3rd edition)**

3.1 Introduction

Through the 1980s a tremendous change was witnessed in the scope and nature of the techniques available to facilitate human-computer interaction. One of the most profound changes has been the advent of graphically rich, direct manipulation interfaces such as those made popular on operating systems such as Microsoft's Windows 3.1, 95, 98, NT, Mac OS and applications such as Microsoft Word. Since this time, iconic interfaces have appeared everywhere and so may be deemed as to be a great success. But have they? There is only a limited amount of comparative literature evaluating the effectiveness of icons compared to more traditional text-based interfaces, such as commands or menus. This section will investigate the empirical research carried out to date in an attempt to determine how well icons have been received by academics, and perhaps more importantly, users themselves.

Even before the Xerox STAR and Apple LISA interfaces were 'common', Easterby had already pointed out the advantages for international use of pictographic displays over those that are language based (Easterby, 1970). Just after the release of the STAR and LISA interfaces, Lodding proclaimed that: "iconic interfaces can reduce the learning curve in both time and effort, and facilitate user performance while reducing errors" (Lodding, 1993).

Baeker suggested that there was little experimental evidence comparing and contrasting or documenting the advantages and disadvantages of icons which suggests how they could be used properly and fully. He remarked that "an icons meaning should be obvious to experienced users and self evident to novices". He concluded saying "Many icons fail to meet the former criterion and most fail to meet the latter criterion." (Baeker, 1991).

3.2 First Principles in Icon Evaluation

As mentioned at the start of this paper, the Xerox 'STAR' interface is heralded by many as one of the (if not 'The') first computer interface(s) to incorporate icons successfully. As explained by Smith *et al* these were the main goals that were persued in designing the Star user interface:

- familiar user's conceptual model
- seeing and pointing versus remembering and typing
- what you see is what you get
- universal commands
- consistency
- simplicity
- modeless interaction
- user tailorability (Smith *et al,* 1982).

Jervell and Olsen, in discussing the STAR interface, stated that "Visual representation is a central theme in this philosophy." Their goal was that objects should be understood solely on the basis of their visual characteristics, and actions on the basis of the effects they produced on the display screen. This would give users the possibility of experimenting with the system. They concluded that if this was to function, all objects and actions must be made visible and that the use of icons is of primary importance (Jervell and Olsen 1985).

Large amounts of resources went into planning and user testing on a number of icon designs before the final product was implemented. This study hoped to determine "what the icons should look like so that they would be readily identifiable, easy to learn and distinguishable" (Smith *et al*, 1982). This whole philosophy was based on Xerox (understandably) wanting to sell as many of their workstations as possible and they realised that one of the most important factors affecting how prevalent computer usage would become would be from progress in user interface design. They decided that an iconic interface would achieve this and the results that they obtained from their study supported this point of view (Smith *et al*, 1982).

Gittins was very positive about the use of icons at the interface, saying that: "An important feature of icons is that they may be used to indicate characteristics of the systems objects by showing graphic elements, even when the end-user is unfamiliar with the icon in question. In some contexts, an iconic interface may substantially obviate the use of other media (such as commands) and provide a more usable dialogue because of its capacity to carry much greater descriptive information using the same, or less physical space" (Gittins, 1986). Although the paper by Gittins offered no empirical evidence itself, he did state that although user evaluation of prototypes had been employed (such as those done by the Xerox corporation for their 'STAR' interface), such comparative usability studies were rare. Gittins offered an explanation suggesting that the complex range of factors, the variety of possible users and the requirement to monitor a considerable period of use to be representative made it difficult to study icon and window-based interfaces. He concluded by stating that "there is little work,

however, similarly to compare icon versus menu versus command interfaces to the same computer system, or to evaluate a range of icon and metaphor designs." Although this comment is over ten years old, in that time there does not appear to have been many more lengthy investigations into icon usability and how much users use the icons on the interface. However, there is a fair amount of literature on the design of icons. This would appear to be a waste of resources, as is it not pointless to learn how to design an icon if users do not use them anyway? But it could be argued that users do not use icons as they are poorly designed.

It is perceived that a successful icon also contains properties that the equivalent textual representation is unable to possess. It was stated that the interface has been made easier to learn by the advent of icons as they reduce complexity (Moyes and Jordan, 1993). Smith *et al* further said that, icons were able to present information in a more spatially condensed and holistic form. Furthermore that the introduction of icons in an interface was shown to reduce search times for those icons when compared to search times for words. Added to this the interface as a whole is made "less alien" by creating electronic analogues, in the form of concrete objects, to the physical objects of an office (e.g. icons representing papers, folders, filing cabinets and waste paper bins) (Smith *et al,* 1982).

3.3 Documented Research Showing the Advantages of Icons

Besides the attractive appeal to novices, graphic images are often regarded as a potential universal means of communication and are assumed, therefore, to be able to overcome some of the problems associated with verbal language. In particular certain types of information can sometimes be conveyed more directly and with more immediacy than a verbal equivalent, such as for in use on maps as suggested by Hemmenway and Rogers (Hemenway, 1982 & Rogers, 1986).

There is a consensus, which suggests that maximal graphical sophistication is most desirable for iconic interfaces. However as the paper by Gittins points out, there is considerable psychological and human factors evidence obtained from studies of icons and signs, which suggests that simpler icon designs are as, or more, usable than complex ones.

Is guessability important when discussing computer icons? Jordan suggest that in the case of road signs –a form of icon, guessability is an important factor, but not such an important quality for all icons in a computer based iconic interface. Indeed, he further stated that two other components of usability, namely learnability and experienced user performance (EUP) have largely been ignored. Together with guessability, these explained how a users performance on a new interface might be expected to improve before levelling out at an asymptotic level; therefore forming a typical learning curve (Jordan, 1991). However, it may be that, in the context of using computer based icons, guessability is not the only component of usability of importance. Since users of iconic interfaces may use the interfaces for long periods of time, they get a chance to interact with the icons. If they are unsure of an icon at first, the user may still be able to learn its functionality through interaction. Thus, although a badly designed icon may not be guessable, it seems possible that it might support reasonable levels of

learnability and EUP (Moyes and Jordan, 1993). The authors explain how there is already evidence to supports the view that generally, the more representational an icon is, the more guessable the icon is going to be, since users are likely to discover the icon's "underlying meaning" faster, and "with fewer errors" (Moyes and Jordan, 1993). However when they analysed their data the results did not concur with the hypothesis. The suggestion put forward was that the 45 minute intense period would not produce as accurate results as in non experimental situations, where the user performance can be measured over days or weeks. A question worth asking here is whether or not the inclusion of the ToolTip with the icon would benefit EUP? It could be hypothesised that as users select icons they are more likely to remember what an icon does correctly when they are told what the icon does via the text-prompt.

Computer Aided Design (CAD) systems, have used icons to represent choices in a menu as opposed to a list of textual alternatives. Studies of these (Hemenway 1982) menus utilising icons emphasise their value in reinforcing stimulus-response learning and recall. Whether or not these forms of menus are a good idea or not is subjective, as there is little if any empirical data investigating this. Gittins does suggest however, that psychological assessments of icon-based menus show that when compared to commands, they make the user explore more the visual relationship and organisation of objects.

When investigating usability in particular, Stotts provided evidence which indicated that graphically concrete icons are recognised faster and more accurately than graphically abstract icons. He stated that "…when creating icons, therefore, they [the icons] should be made to look as much like the object of reference as possible" (Stotts, 1998). However he gave no evidence of whether icons as such were better than other methods of user interface and so the pessimist could state that this is just 'the best of a bad bunch'. But this research was based on the evidence from Blattner *et al* which suggested that icons aided communication by using imagery that displayed "…a universality not achieved through natural language" (Blattner *et al*, 1989). This was supported by claims from Alpert (1989) who asserted that "icons themselves are expected to be self explanatory to the user" in other words have RIM. Lodding previously proclaimed that icons:

1) reduced the number of errors
2) decreased the complexity of the system
3) potentially offered the advantage of being international in their application.

A comparative study of nine text editors, including two which offered a window and icon interface indicates their general superiority over conventional text-based screen editors (Card *et al*, 1989). But why?

Gittins suggested that "…with regular users of a system, an icon interface can still offer improved performance in undertaking interactive tasks." As with menu-driven dialogues, it was shown that the use of icons reduces the user to directives which involve selection from a set of defined options, rather than specification from memory. Gittins explained how syntactic errors can not arise, because the syntax is pre-defined. What may occur, he followed, is a semantic error, because an invalid combination of icons cannot be parsed. This can be avoided by context-dependent elimination of invalid choices, so that, for example, the interface makes invalid icons non-selectable once the user has initiated icon selection.

Icons can present a visual image of a concept to a computer user. Although the image presented by an icon may be a vivid representation for an entity, misunderstanding can occur if the icon image does not match the mental image possessed by the user. Thus, "iconic menu items may be more appropriate than menu items containing text in certain disciplines such as engineering, manufactoring and simulation and for noun-oriented, concrete, high imagery, recognition tasks" (Kacmar and Carey, 1991). Although this and other experiments undertaken (Nielsen, 1990) have revealed poorer performance for icons, icon images are favoured (subjectively) by users and seem to add something to user recognition (Kacmar and Carey, 1991).

It was proposed that icons make the interface seem more familiar (Smith *et al*, 1982). Additionally, icons simplify system use by permitting the user to control the information presented on the display screen, similarly to the way they manage objects on a desktop in the real world (Stotts, 1998). Blattner *et al* suggested that icons aid communication by using imagery that displays a universality not achieved through natural language (Blattner *et al*, 1989).

Gittins enumerated numerous advantages and disadvantages for icon-based systems, but does not address the issue of why icons should make a difference in learning and performance (Gittins, 1986). An iconic interface uses images to represent actions and objects that can be invoked or manipulated by a user. There are a variety of icon types, which convey meaning in different ways. For example, representational icons are meant to represent actual physical objects and to inherit the properties of those objects, while abstract icons are meant to convey abstract concepts such as fragility (Lodding 1983). It is often argued that iconic interfaces will be easier to use because they represent a collection of familiar objects; thus inference from the icons to system functions will be facilitated. However the true advantage may come from the fact that visual cues can be processed more rapidly than text based cues and that an icon may carry more information than a text based cue. There is basic psychological evidence, which indicated that there should be a processing speed and accuracy advantage to iconic representations (Benbasat and Todd, 1993).

3.4 Documented Research Investigating the Disadvantages of Icons

After the release of the STAR interface a later holistic study comparing two iconic, one menu and four command systems in users of differing proficiencies, It was shown that all users performed better on the command and menu systems than they did on the iconic systems. The authors concluded that "the care with which an interface is crafted is more important than the style of interface chosen, at least for menu, command and iconic systems." (Potosnak, 1988).

Perhaps rather controversially, Lansdale found that in his experiments memory for the individual attributes of the icons was quite unexceptional. This is quite revealing as mentioned earlier in this report there is common belief that visual memory is, or can be exceptional, implying that icons would be particularly good at what they aim to achieve. However, Lansdale's results suggested the opposite and that iconic methods do not automatically result in high levels of performance (Lansdale, 1988).

Benbasat and Todd reported on a couple of experiments that they carried out which examined the effects of iconic and direct manipulation interfaces on the performance of casual users employing an electronic mail system. They showed that there were no advantages associated with iconic representations of actions and objects. Subjects working with direct manipulation interfaces completed the task faster than those with menu based interfaces. However, this difference in time was obviated after the experiment was re-run, suggesting that the benefits to direct manipulation might diminish after a learning period. No interface was better than others in terms of reducing error rates when interacting with the computer system (Benbasat and Todd, 1993). In the results they reported that "there were no advantages associated with iconic representations compared to text-based representations of actions and objects. Subjects working with direct manipulation interfaces completed the task **faster than those with menu-based interfaces**".

The authors pointed out however, that this difference in time was not significant when the task was repeated for a third time, indicating that the benefits to direct manipulation might diminish after a learning period. They concluded that "no interface was better than others in terms of reducing error rates when interacting with the computer system" (Benbasat and Todd, 1993). They suggested that the problems arose primarily from difficulties in implementation rather than from any inherent properties of icons: "For example, it is difficult to design icons to convey the desired meaning without invoking other connotations. As pointed out, while an icon may be worth a thousand words it is not always the particular thousand words the designer had in mind. The interpretation of a user and the intent of the designer about the meaning of icons may be quite different. When this happens, problems arise and semantic errors occur. Such ambiguity in meaning arises because there is no universal set of icons or principles to guide icon design" (Benbasat and Todd, 1993).

Another problem with icons that these authors mentioned concerned the use of the metaphor. They noted how authors such as Hemenway have stated that icons have "dysfunctional consequences" even though other papers have said that they "facilitate user learning and recall". If the metaphor used is not chosen with care they suggested that "…the user may infer unintended aspects of the

metaphor which interfere with the user's conceptualisation of the interface thus leading to errors. For example, in an earlier version of the Macintosh interface an item deposited in the "garbage can" was immediately destroyed, leading to disapointment if a user tried to retrieve it back after a short passage of time, as one could in the real world" (Benbasat and Todd, 1993). Clearly the choice of metaphor is important, as pointed out an age earlier by Aristotle.

In conjunction with this apparent belief that icons are unsuccessful, Manes asserted that icons may be "wasteful of space, and totally ineffective in dealing with large numbers of similar commands, files or concepts (Manes, 1985). Continuing with this philosophy, Gittins stated that there can be problems in finding "obvious pictographic equivalents" of computer system concepts, and "of using icons to deal with the specification of large numbers of command parameters" (Baeker, 1991 & Gittins, 1986). Kolers goes on to claim rather directly that recognising even realistic icons requires "a great deal of perceptual learning, abstracting ability, and intelligence" (Kolers, 1969).

In the realm of human-computer interaction (HCI), icons have predominated, especially since graphical user interfaces (GUIs) have become common. Usually, an icon consists of two elements: a figural image and a textual label. It has been reported that subjects processing only icons were slower than those using texts only or icons plus text, in a navigation task. Mixed modality icons have been rated as more meaningful than icons which utilise verbal or pictorial elements only, and verbal elements have been preferred over pictorial elements when mixed modality was not available. In an exploratory experiment, it was found that there was no evidence of an advantage of visually enriched icons over verbally enriched icons in an information retrieval task. In another study that assessed the usability of menu items constructed of text, icons, and text-and-icons, results indicated that the use of mixed formats and text-only formats resulted in fewer errors than use of icon only formats. No advantages were associated with the use of iconic representations versus text representations in the performance of casual users, with an electronic mail system (Choong and Salvendy, 1994).

Some specific problems with icons, which have arisen, have been documented by Gittins. He explained that there are some actions that a computer may carry out can not always have a suitable pictographc equivalent. The example he used was of compilation of a textual source file into a binary object file. This process is specific to the computing environment and gives the designer a number of problems. In these situations it is not unusual to see that the icon has a textual label associated with it. This is justified by some by suggesting it "eases the learning load on the user" if the user is moving from another command-based system (Gittins, 1986). But it could be asked why have an icon if a text label is required to understand the pictogram? Is it because a pictogram aides recall from memory more than a box with just text in it?

An important point to be made about the usability of icons was made by Soreanu, who noticed that usability of an icon was dependent on two things; the person who uses it and the person who designed it. The example he provided was of an educational software program, where a Rolodex icon was used by the designer. The designer was of the generation where rolodex's were probably

very common and well known, however, the student that the system was tested on, did not know what a rolodex was, as they are not so popular now, and so could not determine what was being represented by the icon. This is a clear breakdown in communication, which could easily be avoided if the designer thought more about the user group (Soreanu, 1998). Blankenberger and Hahn demonstrated through their experiments that icon design done by experienced users is a reasonable and valid way to get icons with some kind of visual connection to their functionality (Blankenberger and Hahn, 1991).

3.5 Icon Design

Problems can arise however in the correct depiction of icons when analogies are used, for example, Paint and Cut. Hemenway postulated that, "Assuming that the depiction is clear and unambiguous, and the depicted command-objects and implied transformations are characteristic of the command, initially discovering the link and subsequently using it to retrieve the command should be simple processes. In contrast, both icons that are conventional symbols and icons depicting common tools (that represent commands by analogy) are linked less directly to the corresponding commands: they represent the commands by drawing parallels between the features of the commands and features of familiar entities or meanings of familiar symbols". She further goes on to show that the quality of the analogy is important, "…whether the link is easy or difficult to discover initially, and whether it is subsequently retained in memory (facilitating retrieval of the command), undoubtedly depends on how good the analogy is" (Hemmenway, 1982).

In sum, in terms of the universality of the communication mode, Hemmenway suggested that the advantages of iconic systems over verbal representations are similar to the benefits of other graphic systems, such as those used for maps. Compared with a set of words, she suggested, graphical symbols can be visually more distinctive from one another and can represent variation within a set of commands more effectively (Hemmenway, 1982). For users to correctly depict an icon and its associated function it is therefore necessary that they are well designed in the beginning. Kanenko *et al* produced a paper on the matter of designing 'easy to understand icons'. They stated "Icons are usually created based on the experiences or preferences of the system developers. This style of design often results in icons whose meanings are difficult for users to intuitively understand. These icons can confuse users" (Kaneko *et al*, 1991). They suggested that to solve this problem of icon misunderstanding by users, that icons should in particular "…represent concrete objects in order to facilitate recognition of functional meaning." The authors do conclude however, that there is not at present a practical method for designing easy-to-understand icons.

3.6 Summary

The evaluation of pictographic symbols for use in roadway systems, airports and other public places is well documented. However, evaluations of pictographic symbols as visual icons in graphical user interfaces are less prevalent. Extensive studies comparing frequencies of icon use versus menu use in specific applications have not been conducted in great length. Further, studies have not been conducted that assess alternative methods of evaluating the quality of icon designs.

Jervel and Olsen implied that although icons will not be particularly useful in the day-to-day use of many systems they may have a psychological effect, and be a sales argument. They concluded saying "A user interface with well known concepts such as in-and-out baskets, filing cabinets, and the like will seem less frightening to (older?) users who may be sceptical of these new tools. The system may give the *impression* that it is easy to use and, in this way, have a positive effect on the beginners" (Jervel and Olsen, 1985).

Marchant claimed that a pictographic system such as Apple's icons required that the user learn many symbols and although they may be easier to use, as systems become more complex, the icon will become more unwieldy and arcane than in present systems (Marchant, 1985). Gittins added saying that current approaches to the design of icon-based interfaces are often limited by implementation constraints, tend to look like others already in existence, show a lack of originality, and will often reflect an ignorance of much of the relevant material from human factors, computing and graphic arts. He goes on further to suggest that many systems fail to meet the minimum requirements in terms of software engineering as well as having deficiencies in terms of usability. He concluded by saying "However sophisticated and rich the graphics of a dialogue may be, it does not necessarily follow that this alone will assure that it is an effective interface to the functions of the underlying computer system." (Gittins, 1986).

To an extent this is backed up by Buxton, who suggested that Macintosh was a victim of its own success: "the best ideas are the most dangerous because they take hold and are hardest to change. Hence the Macintosh is dangerous to the progress of user interfaces precisely because it was so well done! Designers seem to be viewing it as a measure of success rather than as a point of departure."

Since their humble beginning, Graphical User Interfaces have empowered millions of new computer users. But have we become too dependent on the GUI? As systems become more sophisticated, and as functionality continues to expand, interfaces become more complex. This was reported by Baeker to reduce the overall usability of the interface, meaning that it is also probably not easy to learn (Baeker, 1991). In the next section user testing is carried out to determine whether or not people use icons, or more specifically whether they need to use the ToolTip. If they do, they either:

a) do not understand the meaning of an icon or
b) do not use icons anyway and prefer to wait for the textual alternative.

In either case, icons can be deemed useless as opposed to useful and Conlon's (1998) statement of icons being of little more than cosmetic use will be confirmed.

Chapter Four: Experimentation

4.1 Introduction

Icons are widely used today as a visual interface in computer systems. A great deal of research has been conducted in order to find properties which determine the success of an icon (Moyes and Jordan, 1993), but very little empirical work has been carried out investigating whether or not people do actually use icons. Are people confident enough to just click on an icon purely on its graphical appearance? This is the question that this paper aims to answer. If users are confident enough to just click on the icon, without having to wait for the text prompt (ToolTip), then it can be concluded that people do use icons and that they are useful. If on the other hand, there is an element of hovering, waiting for the ToolTip to appear by the vast majority, then it could be postulated that icons for the most part are useless.

How successful an icon is can be directly related to whether an icon is used or not. It is logical to think that only icons which are used, must convey their meaning across to the user better than those icons that are not used as they are not understood by the user. Obviously, before any decision as to whether or not people use icons, experiments involving computer users is required. Therefore a human factors experiment was developed in which to test as many persons as possible irrespective of their computer capabilities.

4.2 Methodology

An investigation was carried out into the usefulness of icons at the interface using human volunteers. The question that this investigation aims to answer is “Do People Use ToolTips?” Or rather do computer users of varying proficiency levels require the use of the Text Prompt that appears while the cursor hovers over the icon, before he/she selects that icon. This follows on from an investigation carried out by Conlon (Conlon, 1998).

4.2.1 Subjects:

In all 20 unpaid test subjects between the ages of 21 and 58 were used. All but three of the subjects were students doing a postgraduate course in information processing at the University of York. Of the other three, one was a 3rd year undergraduate and the other two were recently retired professionals. The average age of the 20 subjects was 28.5. All had either good or corrected-to-good eyesight. The subjects were classified according to their computer experience, knowledge of which was ascertained from a questionnaire (see appendix A) that all subjects completed. The subjects were categorised as either being a Nearly-novice, Intermediate or Expert, of which there were four, nine and seven in each respective category. The classification was based on results obtained from the questionnaire. How long a subject had used computer systems and how frequently were taken into consideration. Broadly speaking, experts were users who had used computers regularly on a day to day basis for over ten years and had used them in a work environment. Intermediates had used computers frequently over ten years mainly for word processing, gaming and e-mailing. Nearly-novices were

familiar with computers due to infrequent exposure, but were not confident in using computer systems.

4.2.2 Materials:

So that the results were comparable, each test subject carried out the same two tasks in the same order. They were given typed (hard copy) instructions, and asked to read these carefully before the experiment started (see appendix B for actual instructions), only when they were ready were they asked to proceed with each test. The text editor used was the recent version of Microsoft Word, Word 97, developed by Microsoft (for screen dump of the word processor, see appendix C). The operating system this was run on was Microsoft Windows, version NT. Their computing ability as such was not being tested, only how they interacted with icons. This was made clear to each subject before they embarked on the test. The only skill they required was command of the computer mouse. As all subjects had at least some computing experience none had problems in using the mouse.

4.2.3 Procedure:

The first step was to get the subjects to complete a 'personal details' questionnaire in order to gain administrative information relevant to the experiment. They were then given a handout (a copy of which is available in the appendix B) summarising the aim of the experiment and describing, in general terms, the task, which they were to perform. Emphasis was placed on the fact that I was testing whether or not icons are used and not the subject.

The way this has been investigated was to ask a number of different people of differing levels of computer proficiency to be watched and have their actions recorded, as they carried out a certain number of actions using only icons to carry out those tasks. These tasks were undertaken on a text document, which was manipulated in a word processor. This word processor was used as it is fairly common, and so test subjects will not feel as though they are trying to be 'caught out'. In this text editor, it is also possible to hide the Menu Bar from the user/test subject. It was decided that this was required as the test subjects may inadvertently carry out the tasks without using the icons, for example via the pull down menus. As there was no need to use the keyboard, this was removed from view, and it could easily be noticed if the subject tried to use the 'right mouse click' as a small window appears. Therefore making these properties of the text editor unavailable to the test subject requires of the subject to only use the icons (for a full list of the icons used during the experiment, and their respective ToolTip prompts, see appendix E).

In both tests, the subjects were timed. The information returned from this measurement would allow the determination of whether or not there is a correlation between what class of experience the subjects grouped themselves in and the speed at which they accomplished the tasks. It may also be interesting to see if there is a relationship between the number of mistakes the subjects made and the speed. For example are the users who completed the tasks fastest, expert computer users, or are they just going about it in a trial and error method.

4.3 Test One

To test the subjects, it was decided that they would be asked to alter a given paragraph by using only icons. The paragraph the subjects were asked to alter is given in appendix F. They were given two versions of the document: an electronic one and a hard copy version. The goal was to alter the electronic version so that it was identical to the hard copy version, using only the icons. A number of other tasks were also set, in all, each individual was asked to:

(a) Open the document.
(b) Format the document so that it looked like the original. This required using the following icons: Bold, Italic, Underline, Centre alignment, subscript, 1.5 spacing and font colour
(c) They were then asked to save the newly amended document after checking it using the print preview function of the word processor.
(d) Next the type in bold was to be cut out and pasted into a new document.
(e) This document is then closed, without saving it.
(f) Next, returning to the document from which the type was cut, the subject must undo the edit to return back to the completed document.
(g) Then save the document under a new name.

A form was created in which to follow each test subject question (A copy of the form used is in appendix D). Whenever the subject completed a task, which involved selecting an icon, a mark was made in the appropriate column for that action. This depended upon whether or not the subject required the use of the Text prompt, which appears after the cursor is left to hover over the icon in.

4.4 Test Two

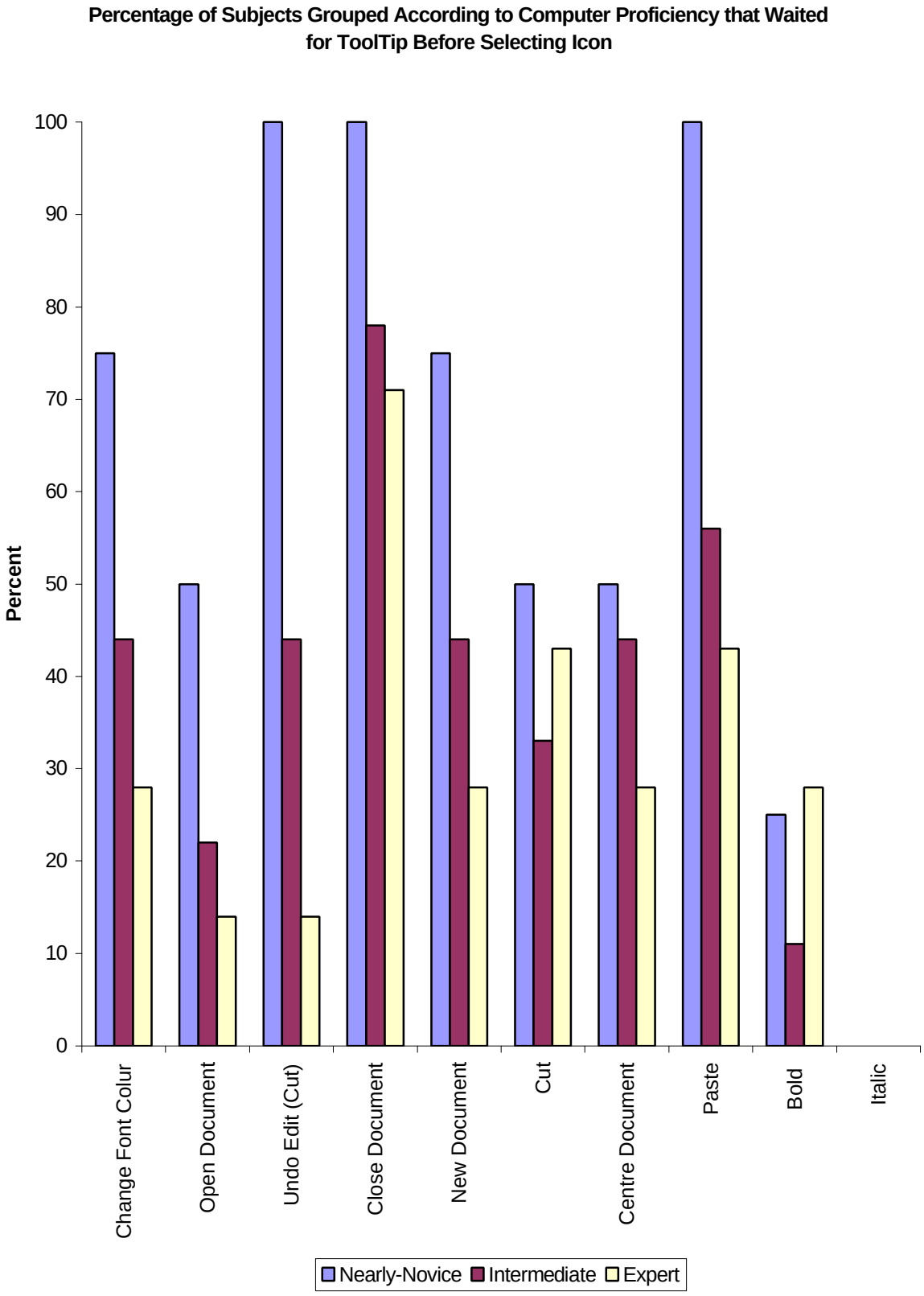
In the second test, the subjects were asked to name the icons that are used in the Microsoft Word word processor. This task was undertaken directly after the first test and was carried out as the interface used in this investigation used some icons that were subtly different from the icons they were more likely to have come across or used. For example, the “file open” icon is fairly common and probably well known, however, the “save version” or “page set up” icon are less well known, the aim was to allow fair comparison between less and better well known icons. This investigation was undertaken to help prevent wrong conclusions when interpreting the results. For example, most subjects may find that one particular icon is poorly designed and so the use of the ToolTip was required. This does not necessarily mean that people do not use icons, but rather that this particular icon is badly designed and so caused spurious results which would need to be taken into account. It will also allow the determination of whether correct icon usage is learned or intuitive, based on the pictogram.

Chapter Five: Results

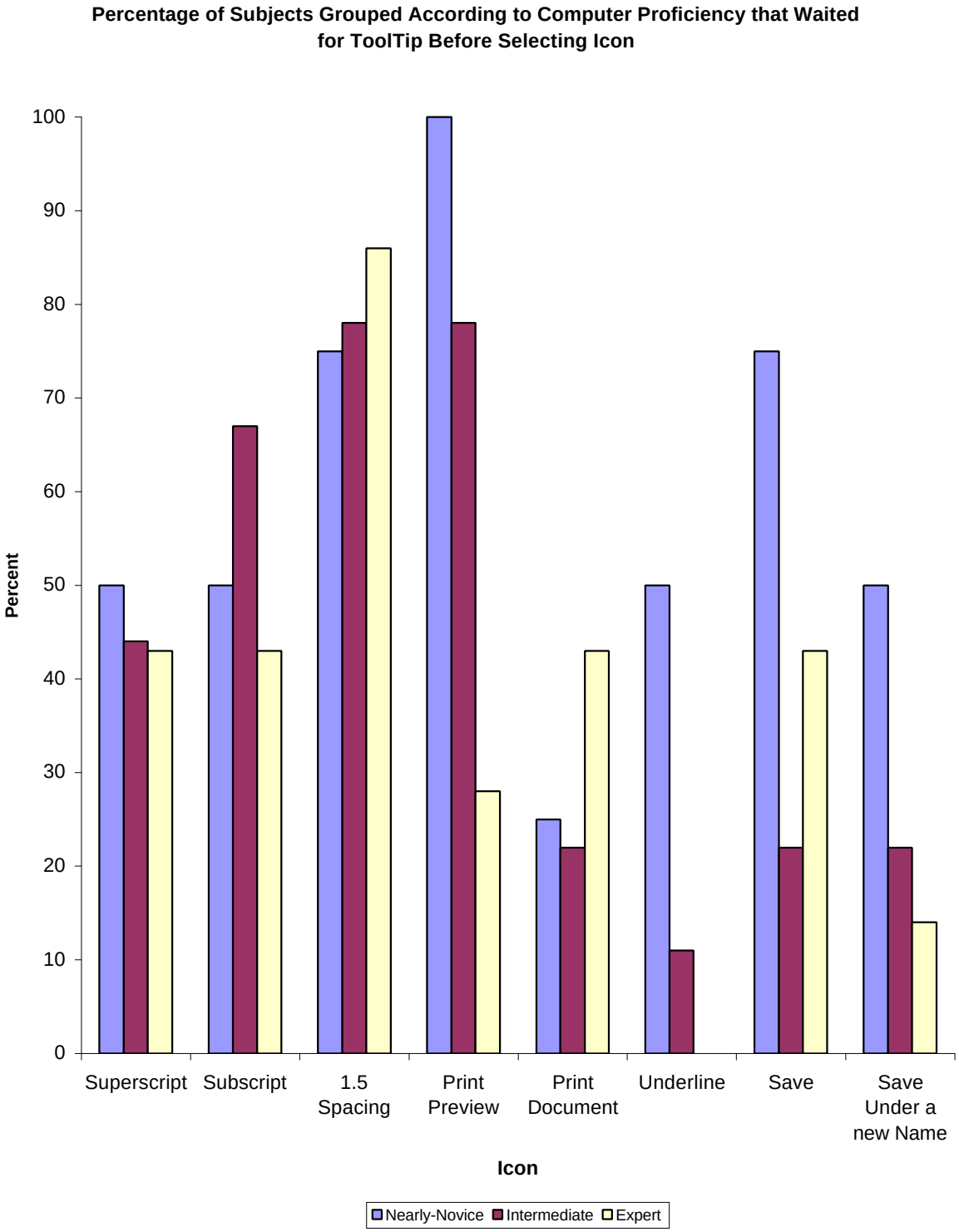
5.1 Results of Test One – Investigation Into User Hovering.

Graphs 1 and 2 display the results of the investigation concerning the percentage of subjects (grouped according to computer proficiency), that hovered over the icon, in other words waited for the ToolTip to appear, before selecting that icon.

When looking at the graphs, two observations are immediately noticeable. They are, firstly not all icons are hovered on to the same degree, and secondly, there are variances between the computing ability (i.e. nearly-novice, intermediate and expert) and the percentage of subjects that hovered on any one individual icon. Backing up this first observation can be achieved by comparing the percentage of subjects that hovered over the icons for Italic and 1.5 Spacing. In this comparison, no subjects hovered over the Italic icon, whilst, approximately 80% of test subjects hovered over the icon for 1.5 Spacing. For example looking at the function Underline, 50% of nearly-novices hovered, while only 11% of intermediates hovered and no experts hovered over the icon. This proves the second observation. As mentioned earlier, the icon for Italicising text was not hovered over by any subject in the study, indeed it was the only icon to achieve this result. This implies that this icon achieves its function rather well by all users of varying ability, further suggesting that people do use this icon. On the contrary there were some icons, namely Undo Edit, Close document, Paste and Print Preview that were hovered over 100% of the time by nearly-novices. This result can be explained in the case of the 'Close Document' icon as it was inserted into the tool bar (the part of the screen that contains all the icons) for the purpose of this investigation. However, as for the other three, all were icons that are on the default setting of the tool bar. What is interesting in the case of these four icons was that there is a relationship. As the level of experience increases, the amount of hovering decreases. This throws weight in the belief by some authors that icon usage is learned and not 'automatically' obvious. Therefore, these icons have good ERM, but poor RIM.

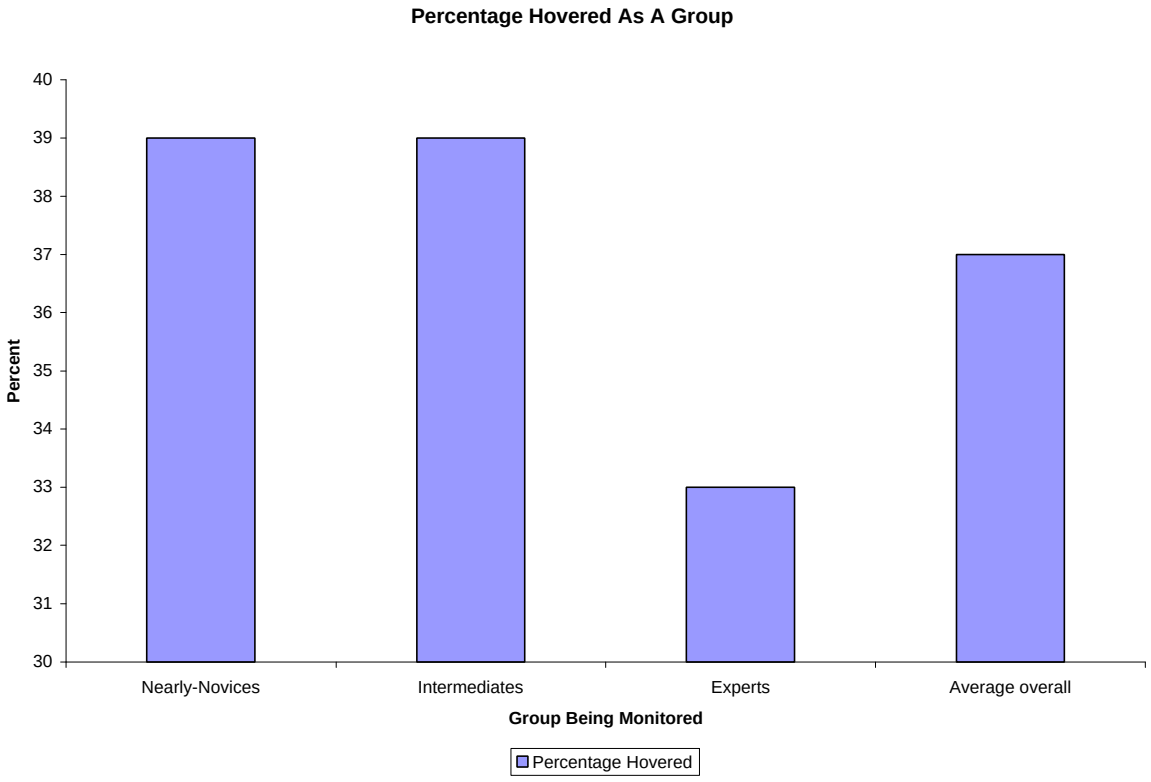


Graph 1. *Results from Test One*



Graph 2. *Results from Test One*

In interpreting the results, a problem does arise in that to what extent is it allowed for an icon to be hovered over before it is deemed un-useful by the majority. For example is it correct in concluding that an icon is declared unused if 10, 20, 30, 40, or 50 percent of test subjects had to hover over the icon and wait for the text prompt before selecting that icon? Some users temporarily move the cursor over the tool bar and then read/decide what action to carry out. While they wait the ToolTip appears as the mouse cursor is over the tool bar and not because they can not decide which icon carries out which function. This would produce inaccurate results. To help decide upon a level, an average of hovering for each group was calculated and then the mean of this result was used as the level above which icons were declared as not used or understood as the level of hovering was above the average. These results are shown below in Graph 3. The level therefore used was 37%. What is particularly interesting with this graph is how the average hovering for the nearly-novice and intermediate groups is the same, yet the average hovering for the expert groups is only 6% less. I would have expected before analysis of the results to see a much greater difference between the experts and nearly novices. This small difference may be because experts use other methods such as short-cut keys and right mouse click (as shown in the questionnaire and discussed in the next chapter) to carry out operations as opposed to using icons. Therefore as a result, they do not use icons and so may be less likely to understand them and so as a result require the ToolTip alternative.



***Graph 3**. Shows the percentage of hovering carried out in each group and the mean across all three groups.*

After deciding upon this 37% level, the graphs become more revealing in that the nearly-novice group of test subjects are all above this level except for the icons for Bold, Italic and Print. What is even more surprising is that they are all at least 10% over this level. This is a surprising observation as one of the main reasons icons are so widely used in software applications is because they are reported to be easier to learn and their functions are meant to be more obvious to novice/nearly-novice users. This result could have serious implications into the deep-rooted philosophy of icon usage.

Referring back to the 'Print Document' icon in which only 25% of the nearly-novice subjects hovered just over 20% of Intermediates hovered, but approximately 45% of experts required the ToolTip before they selected Print. An explanation can be offered in that firstly, from the questionnaire those subjects ranked as experts preferred using short-cut keys and one of the functions that they carried out using the short-cut key was 'Print'. Secondly, when printing a document, users may want to alter the printing characteristics, such as colour and number of pages. These features can only be achieved through the menu bar or by selecting an icon that is not on the default tool bar. Finally, some of the subjects would check that the copy being printed was going to the correct printer and also that it was not being printed to file. If these considerations are taken into account then the number of experts that 'had to' hover over the icon falls to below 10%.

The icon for paragraph spacing achieved on average, the highest percentage of hovering across all three groups. This may not be surprising as it is an icon that is not in the default tool bar, and so as a result, the subjects are unlikely to have come across it unless it was specifically inserted into the customised tool bar by the user.

The Save icon caused problems for the nearly-novice group where 75% hovered before selecting, as did 43% of the Expert group. This is an icon that Ann Conlon discovered in her report in which she stated "that there is a lack of success of the mapping between this [the Save icon] icon and its underlying referent." She even went on to report that many of the novice group in particular thought that it depicted a television screen, thus emphasising the significance of understanding the metaphor

Other icons that performed badly in the test were those for Close Document, Superscript and Subscript. This may be explained again, by the fact that they are new icons in that they are not in the default setting for the tool bar.

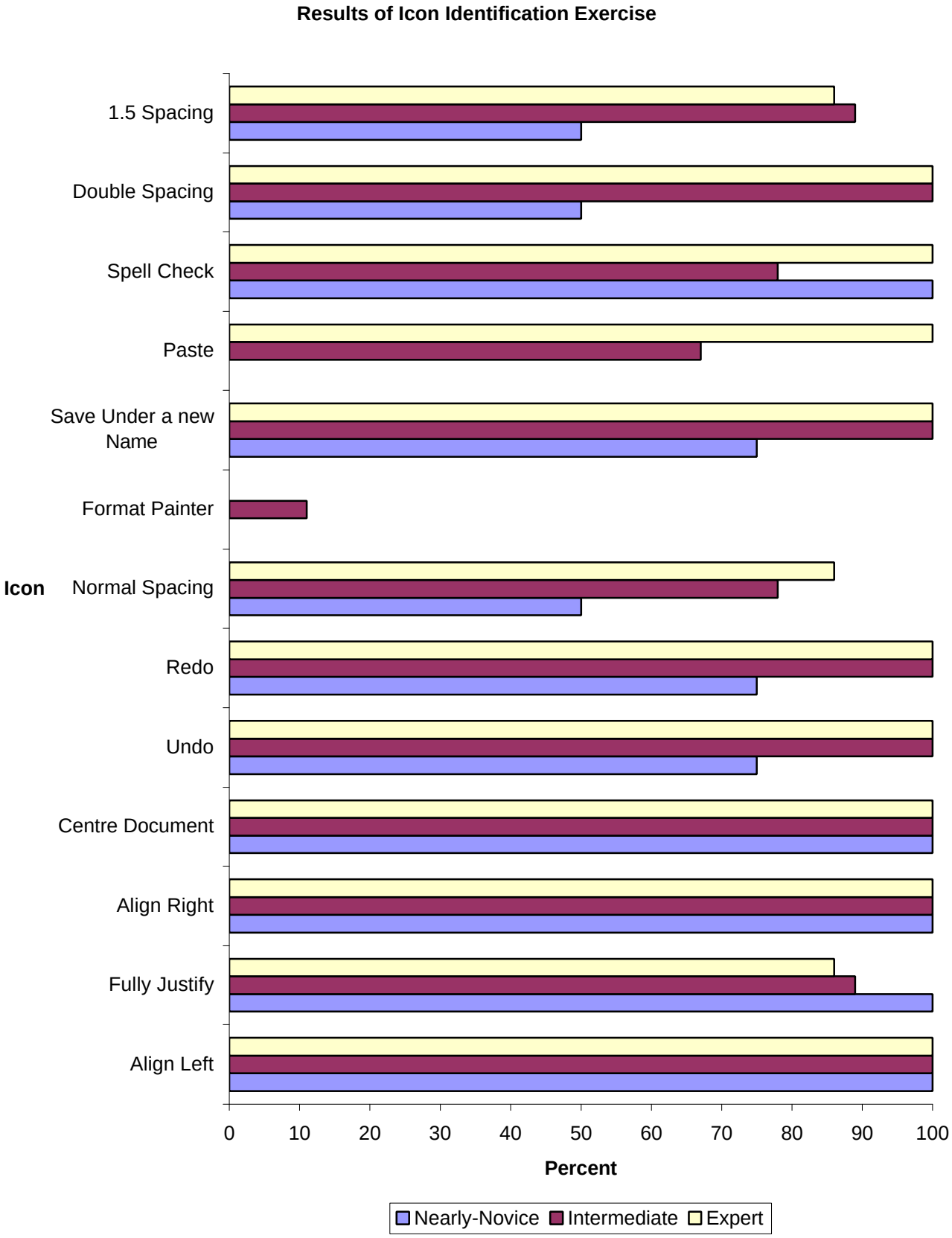
While the experiment was under way, the way in which the subjects searched for the icon was noted. Although no empirical data was recorded it was observed that for the more common icons such as Bold Italic and Underline most subjects went straight to the icon as they either knew of its presence and location or could quickly identify from the pictograph what function the icon achieved. The previous in my opinion is more likely. However, for icons such as Print Preview and Close Document, the subjects had very little idea as to what the icon should look like or where it was on the screen and often a long search was involved. In between these two extremes, of which the Paste and Save icons are members of, the subjects were aware of which part of the screen the icons were located but could

not correctly identify the icon at first hand. This was particularly noticeable in the case of the Paste icon. Whilst talking about time, it may be of interest to note that the average times taken to carry out Test One were 9.5, 7.0 and 6.4 minutes for nearly-novices, intermediates and experts respectively.

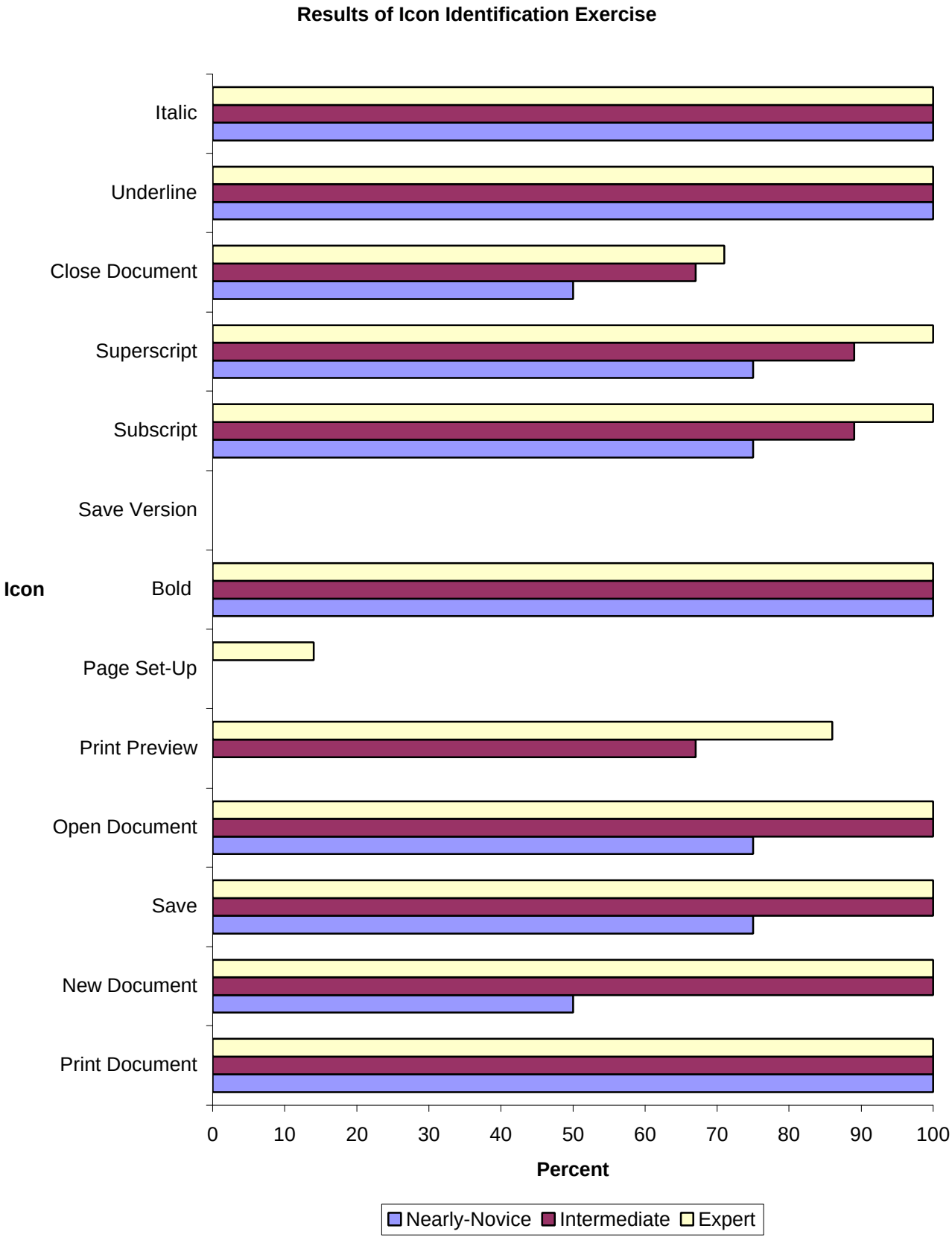
5.2 Results of Test Two – Icon Identification Exercise.

In the second task, the subjects were asked to look over a list of 26 icons and write down beside that icon what action they felt that the icon carried out. The results from this investigation are displayed in Graphs 4 and 5.

When reviewing these graphs it can be immediately noticed how different icons are identified correctly to varying degrees. In particular it is noticed that the icons for Format Painter, Page Set-Up and Save Version were either not identified correctly at all (in the case of Save Version) or identified by only 10 - 15% of just one group. The fact that the icon for Save Version was not identified correctly is not all that surprising when it is revealed that this icon is not on the default tool bar. It was only inserted as a 'red herring' to test to see if the subjects knew the 'Save' icon from similar looking icons. What is interesting, concerning this icon, is that when asked to make an educated guess as to what they felt its function was, most put down 'Save' as their answer. This demonstrates that users would appear that the floppy disk is synominous with 'save'. This is shown further by the high percentage of subjects correctly identifying the disk icon as 'Save'. This is in contrast to the results obtained by Conlon who observed that "both of the novice users thought that the icon was in fact a depiction of a television screen" (Conlon, 1998), as in these results, 75% of novices and 100% of intermediates and experts correctly identified the Save icon. However, in defence of her statement of "with regard to the mapping relation between the disc and the save function, the lack of any 'hard copy' parallel, does prove problematic. Understanding the mapping relation for this icon also requires that the user have some knowledge of computer hardware" (Conlon, 1998), this could explain why 25% of nearly-novice subjects did not correctly identify the icon. There is another problem when comparing these results to those obtained by Conlon, as it is very hard to be able to distinguish between the levels of computer proficiency between the Nearly-Novice's in this study and those of Conlon's study two years previous. The one expert that did correctly identify Page Set-Up was a surprise as again this was a 'new' icon inserted for just the testing procedure. When questioned after the test, the subject explained that she had worked previously as an Administrative Assistant and had used Word extensively. Most subject's thought that this icon represented a thesaurus based function. This is not surprising when it is considered that it looks like a book and is not for spell checking (which most subjects did correctly identify). What may have confirmed their belief that it was a thesaurus option was that it was placed next to the Spell Checking icon (on the other side was the icon for printing).



***Graph 4**. Results of Test Two: Icon Identification Exercise*



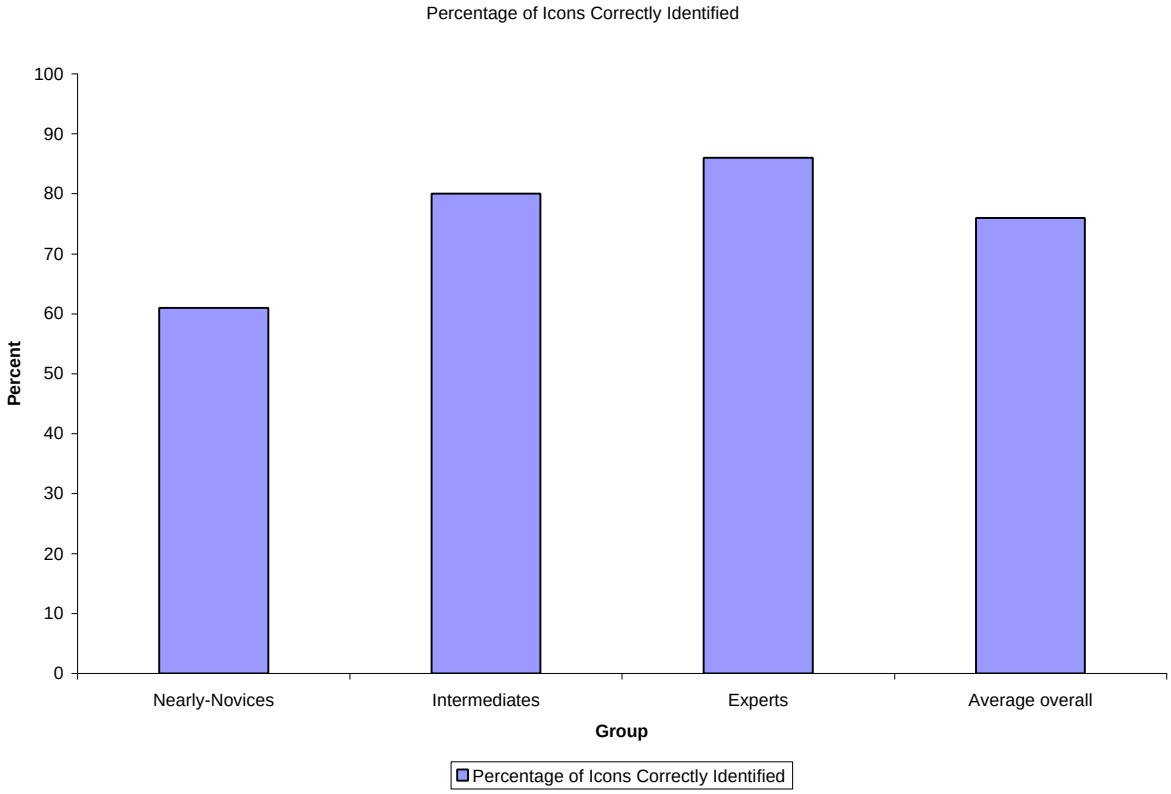
Graph 5. *Results of Test Two: Icon Identification Exercise.*

Print Preview was correctly identified by the majority of Intermediate and Expert Users, but was not correctly identified by any Nearly-Novice users. As noticed by Conlon (1998), in this investigation all the subjects whom wrongly identified the icon all attributed it to some form of magnifying function.

The following icons: Print Document, Bold Type, Underline, Italic, Align Left, Align Right and Centre Document were all correctly identified 100% by all three proficiency levels. All these icons appear to work very well and it can be deduced that users would/do use them correctly.

What this test did help to shed some light on was how users 'decode' what function an icon achieves. This statement refers to the way the users carried out the test, in that they said that they would perform much better if the icons were grouped together. It was so designed that the icons in Test 2 were not located together in their respective groups. For example, the line spacing, Bold-Italic-Underline, Open-Close and Print-Print Preview icons were all mixed up. The subjects would often attempt to look at a computer screen (which by now had been minimised to prevent this form of cheating!) as they declared that it was often perceived to be easier when they looked at the screen. It was encouraged that as the subject carried out the test, that they try to explain what was their line of thought. When for example, they came across the 1.0 line spacing, it was not uncommon for the subject to either leave it blank completely and not even associate it with paragraph spacing. Alternatively, the subject may start of describing it as something unrelated (Double Underline was not unusual) and then when the other icons (I.5 and Double Spacing) were seen, they realised what the other icon was and changed it to 1.0 spacing. This clearly demonstrates that users perhaps understand what a family of icons carry out and what they look like as a class, but did not know what the individual icon meant. Another example this was come across was with the Paste icon. The subjects knew within an icons distance of where it was but did not know which icon was paste. The subjects regularly thought that the Paint Brush was Paste (quite understandably) and interestingly, those that did wrongly identify the Paste icon, all thought it meant copy.

Looking over the graphs, it is observed that for the most part the expert group tended to correctly identify the icons more often than the nearly-novice group. In fact it was only for the Fully Justify icon that the nearly-novices correctly identified more than the experts, however, when it is considered that the difference is only 15% and that there were twice as many experts studied than nearly-novices, this observation may not be too statistically relevant. Graph 6 displays the results of the icon identification exercise as an average for each group. This graph shows quite clearly that, on average, the more experienced the user is at using computers the more likely the user is to correctly identify an icon. Therefore adding weight to the theory that icon use is learnt as opposed to being intuitive. There is a correlation between those icons people can not decipher and those that they have hovered over. Thus implying that users hover over the icons because they do not understand them and not just because they do not use them.



Graph 6. *Displaying the percentage of icons correctly identified by each group and the mean of all three groups.*

Chapter Six: Discussion

6.1 User Observations

During the testing procedure it was observed that many of the subjects would, before selecting an icon, try to determine what icon to select next, not using the ToolTip. I find it hard to believe that this is 'normal' usage of a word processor when using icons. I think it is likely that the subjects did not want to appear like novice users when using the icons during the testing procedure and so were aiming to correctly identify all the icons for each task. However the quickest users were the experts and nearly novices the slowest. Even though the intermediates and nearly novices spent longer on the test they still hovered over the icons and it was observed a few times that on occasions they did not hover, the icon they selected was the wrong one (for example this occurred many times with the Paste icon). However, this extra time could allow for the closeness between the three groups, observed in terms of percentage of hovering, after all the difference was only six percent.

After the experimentation had been completed an un-scheduled de-brief would often occur where by the subject would often discuss the procedure and what they thought of the experiment. From this, a lot of interesting information was obtained. For instance, one subject classed as an expert self proclaimed that the preferred method was of using short cut keys and not icons, however it was pointed out that there were some icons that were new to him that would be very useful, in particular those for 1.5 spacing. He declared that he was not aware of the availability of such icons and that this is a particular function that he would use a lot. He went on further stating that to change the spacing via the menu bar is a long and drawn out process, as you have to go to Format, then Paragraph and then select the spacing box. An icon he proclaimed would be much faster and more convenient in this instance.

When Word is used by most people they do not realise that the icons on the tool bar can be altered or changed. For example, the line spacing icons, users did not realise that there were such icons available with in the system, is this bad system visibility or just poor explanation to the user of the options available? This could explain why the selection of these icons was so much worse than the more common icons such as 'file open' and 'save'.

6.2 Speed of Carrying Out Task

Another expert user noted during the experiment that as he was having to use the icons that it slowed him down considerably, especially when wanting to carry out tasks as Bold, Cut, Paste, Italics, Underline and Print. Here he much preferred using short-cut keys as it allowed them to continue working without having to take his hand off the keyboard so that he may use the mouse. Shneiderman claims that for experienced typists, taking your hand off the keyboard to move a mouse over an icon may be slower than typing the relevant command. This problem is especially likely to occur if the user is familiar with a compact notation, such as arithmetic expressions, that is easy to enter from a keyboard, but may be more difficult to select with a mouse. In the minds of many users, he concludes, the keyboard remains the most effective direct-manipulation device for certain tasks.

A couple of intermediates noted that when asked whether they use the right mouse button more than icons, that it depended upon what the action to be carried out was. In retrospect, this is a fair response to the question, as the right mouse button is really used to Cut, Copy and Paste by these users. They did say that for these functions they would use the mouse click over the icon, but obviously the mouse can not be used to make text Bold for example.

6.3 Familiarity with Word

Some may argue that this investigation only tests how familiar people are with Microsoft's Word. To some extent there may be an element of truth in this and certainly if there is a subject who has used Word all their life and is very proficient with it, then they are more likely to do better in the test. However, this does not mean that they necessarily use icons, in particular there are some icons which even the experts needed to hover over before selecting it implying that there are some icons which are confusing and misleading. Also, in countering this statement, it could be argued that it is better to test users on the most popular (or most widely used) word processor. For then the results obtained would give an indication as to whether most users of word processors require the use of the ToolTip before they select the icon. Interestingly, even the experts had to use the ToolTip at some point or another.

6.4 Left or Right Brain Dominant

Studies by Mullet and Sano (1995), Arnheim (1972) and Verplank (1988) have suggested that semiotically oriented interfaces attracts users who have artistic, right-brained, holistic and intuitive personalities. This can cause a problem, challenge, or even threaten the logical, linear, text-oriented, left-brained, compulsive, rational programmers, whom Shneiderman mentions were "…at the heart of the first generation of hackers". I thought that this was an interesting statement to make and did attempt to investigate it in this study. However, when it came to testing subjects 95% of the users were right handed and so no conclusion could be made which could support or disagree with the statement made by Arnheim *et al* (Arnheim *et al*, 1972).

6.5 Icons, Types and Meaning

In Chapter Two, symbolic icons were discussed as being particularly hard to decipher for new users specifically. Looking at the results in graphs 1 and 2 for the following symbolic icons: Undo Edit and Print Preview, it would appear that these icons performed worse when compared to the others, thus confirming the suggestion that symbolic icons are not the better type of icon class. In fact all the novices and most intermediates required the use of the ToolTip. In the icon identification exercise, the nearly-novices in particular scored badly, especially in the case of the Print Preview where no novices correctly identified the icon.

When inserting a new icon into the interface all levels of users required the use of the ToolTip more than the average level, except for Saving Under a New Name, where intermediates and Experts were below the average level (But this is not a pictographic icon, it was an icon that contained text only - see appendix E. What is surprising is that it still confused some nearly-novice users). Yet in the icon

identification test, the results would imply that except for Page Set-Up, most users of varying proficiencies could correctly identify an icons meaning, i.e. they had on average better RIM. This could suggest that there is a confidence problem when selecting an icon, a new one in particular. Does this mean that users have incorrectly identified icons so much in the past that even when they do correctly identify an icons function that they still wait for the ToolTip to show exactly what the icon does. In other words, they do not trust icons. This is best illustrated in the case of the 1.5 spacing icon is that the results show that most users (over 50%) from all levels of computing ability understood that the icon meant, but yet most users still hovered and waited for the ToolTip to appear before selecting it.

This investigation did show that there are some icons, which have been around for a long period of time, and are a little obscure and confusing to the user (particularly the novice). As a result I suggest that they should be changed, in particular the Paste icon, which at present, is of a Clipboard. For novice users this did not seem to make them deduce that its function is paste. Unfortunately a paint brush, which may be better for a paste icon (for which in Test Two most subjects accredited the Paint Brush as being Paste), is already assigned to 'Format Painter'.

6.6 Learnability

If icons are so successful then it could be asked why these text labels provided by the designers? As Gittins noted about these icon labels "[the ToolTip] would seem to be an admission that the user is thought unlikely to be successful in mapping the icons to the objects they represent" (Gittins, 1986). Are the designers of Graphical User Interfaces and icons in particular been over cautious in case the odd user can not interpret correctly the odd icon? Or is it the case that icons are not as great at doing their job as they are made out to be? If all icons had excellent RIM (as perhaps originally intended) then the ToolTip would not be required and the usefulness of this paper could be put into question! As it would not be possible to determine whether an icon was selected because it had been used before, or because it was deduced due to the high RIM.

Comparing the results between computer proficiency and individual icons in the identification exercise (graphs 4 and 5) would suggest that the meaning of an icon is learned maybe through trial and error as opposed to via intuition. This is confirmed by the amount of hovering over icons undertaken, as on the whole, experts hovered less over an icon than nearly-novices and intermediates. So this may suggest that they use icons, but not all that successfully.

6.7 Descriptiveness of ToolTips

It was mentioned earlier when discussing Richly Grounding Symbols, how would a ToolTip describe an icon that was similar to others but was, sharper (in the example of a road sign), longer, darker or wider etc. I would suppose that if there was such an Icon then the ToolTip used to describe it would not be overly descriptive (as it would take up too much space), but would be rather vague and may say sharper, longer, steeper etc. Icons are normally grouped into families and so it may not need to

have a separate, more distinct ToolTip. On the contrary, if the icons are side by side then the user could compare between the two icons and chose the one required. All that matters is that the icon selected is correctly identified. For example, there is a function in Word called Auto shapes. This allows the user to place shapes in a document, which are pre-drawn. One of the families is called 'Callouts' of which there are 16 to chose from. Some are fairly distinct and have ToolTips such as 'Rounded Rectangular Callout' and 'Cloud Callout'. But, there are four called 'Line Callout', i.e. they have the same ToolTip. The icons are very similar; all that differs is the line emerging from the Callout box. To try to explain this in a ToolTip would require a sentence. So the system is confident that the user will correctly identify the icon required from a visual comparison. The ToolTip is still there, however, to make sure that the right family/type of icon is selected. Having said that ToolTips are normally preferentially short, there are some which are quite long, for example "Insert Microsoft Excel Worksheet".

Chapter Seven: Future Work

7.1 Future Work

It is optimal to test a large number of users from a population at random so that the results obtained are statistically relevant. However, this would require access to many participants who are willing to take part, unfortunately, this was not possible, mainly due to time constraints. As a result I tested as many people with whatever experience of computers they had, as time would allow. In an ideal world I was hoping for equal numbers of computer users with different levels of experience, however this is not always possible, especially considering the novice group. It is becoming increasingly difficult nowadays to find many numbers of people whom are in this category.

The interface used to test the subjects may produce different results between varying text editors. This is because, different software companies use differing icons for the same task. Some of these icons vary a great deal, for example, to print a document in Word, the icon to print is a picture of a printer. However, to print in a Macintosh Web Browser, the icon is very similar to the 'New' icon in Word, i.e. it is what looks like a sheet of blank paper. Now as these icons vary a great deal it would be reasonable to assume that using different word processors would produce different results in a test group, particularly if the package used is an uncommon one.

It may be interesting to have done the identification test with the icons presented on the paper as they are on the screen (see Figure 6 below). This screen dump would be placed at the top of the page on which the icon identification exercise is carried out. This would show whether the percentage correctly identified would increase if the subjects knew where the icons were located and the 'families' in which they are grouped.

***Figure 6**. Screen dump of the tool bars containing the icons used in the experiment.*

It may be of interest to see if users need the ToolTip every time they select a certain icon. Do users make an effort to learn the icon's meaning if at first they do not understand it, or is it just sheer laziness and they just wait for the ToolTip? This could be tested by asking the subject to select a number of tests each using the same icons as the others over a period of a few days. This may help to determine how useful the ToolTip is, would users need to see the ToolTip once to be able to remember the icons meaning for the next time it is required.

A long-term test would be to place as many icons on the interface as possible (without overcrowding the screen) to one group (1) of subjects and the normal number of icons (standard format) to another

group (2) of subjects. Then after a period of time, say six months, test the two groups with the same test that encompassed icons from those incorporated on Group two's interface. Would this group perform better? Do users explore the icons that are presented to them? Or do they stick to the methods that they already know? This could show any differences between the proficiency levels between users as well finding out whether people use icons even the more obscure ones such as close and subscript. Certainly the 'new icons' in this testing produced the worse results, so giving a group six months prior exposure would help to show whether it was just that they were new that they did not know what they were or whether it was because they had never used them. The RIM of an icon would affect the results though, as if an icon had excellent RIM then it would not matter how much previous exposure a user had.

Finally, if more subjects were tested in the original procedure, then it would be better to split the subjects into two equally sized groups containing the same number of subjects from each level of computing proficiency. Then with one of the groups, test the subjects on Test One and then Test Two. With the other group, test the subjects on Test Two and then Test One. When the results from the two groups are compared, any problems with the testing procedure concerning what users have learned from the previous test would be highlighted. For instance, if they carry out Test One the subject may hover over an icon and then remember what it does for Test Two, when previously they had no idea what action the icon carried out.

Chapter Eight: Conclusion

8.1 Conclusion

One of the most commonly used word processors is Microsoft Word. But when using this software package, are people using the icons or are they using other methods/shortcuts such as via the keyboard, e.g. press and hold “Ctrl” and “P” to print off a document, or via right mouse clicking of the mouse to cut and paste for example, or via the traditional menu bar?

The results of this investigation would imply that users do use some icons, but that they are not the great success normally hailed to be. What is interesting, is that icons are implied to be most beneficial for the novice user, yet this group, whom in the questionnaire said that they used icons the most, actually achieved worse results than the expert users. The expert group, however, stated that they used icons the least, and yet were shown to use the ToolTip the least. The main reason that the expert users did not like to use the icons was because they were perceived as being unwieldy and slow when compared to short cut keys.

The question “Do People Use ToolTips?” would best be answered by comparing icon types (for example representational, symbolic etc.) or on an icon-by-icon basis, as it is unfair to group all the icons together and then decide whether or not they are of any use. This is because as demonstrated in the user testing some icons performed very well, such as Print, Bold, Italic and Underline. While icons such as Print Preview did not perform so well.

So if ToolTips are useful then this would indicate that icons are useless (or rather not as good as they are hyped up to be). Therefore in conclusion, I agree to an extent with Conlon’s statement of icons being “…of little more than cosmetic value” (Conlon, 1998). But perhaps it would be fairer to say ‘**some** icons are only of cosmetic value’ as users only had to use the textual prompt to understand **some** pictograms. This was observed in the user testing in which some icons were selected without the need of the associated text while for others the ToolTip was required.

Having icons on the interface would seem to make the novice user more relaxed when interacting with the interface. So having small boxes with just text, even if they are found to have a higher degree of RIM, may not be beneficial as they could make the interface less interesting and more intimidating. Therefore it could be suggested that the fact that icons are of cosmetic value is a bonus and so very useful in that sense.

Most GUIs are fairly powerful and allow a task to be carried out by many means; either icons, mouse, menu or keyboard, and so as long as this is allowed icons will always remain. Certainly they make novice users happier, more confident and they do appear to use icons the most (though they are not the group that performs the best in using icons) and even some experts confessed to using some icons sometimes.

The results would suggest that if people could understand the pictogram and relate that to the intended command action then icons would be widely used –without the need for the ToolTip. Certainly nearly-novice users and intermediates would use them the most, but even expert users would use some icons as not all actions can be selected through the keyboard (for example 1.5 spacing).

So on the whole icons clearly are a valuable element of modern user interfaces, but they are not a universal cure or a cure for a bad interface design. What is required is a more in-depth study into the designing of ‘easy-to-use and understand’ icons.

Appendix A

Subject Questionnaire

All information given by you will be treated as highly confidential and will not be distributed to any other party without your prior consent. You may end the test and leave at any stage should you wish. There is no obligation what so ever for you to feel that you must complete all the tasks if at any stage you start to become uncomfortable with the testing procedure. Statistical results will be published in a manner that is anonymous.

1. Subject ID:_____

2. Name:_____

3. Age:_____

4. Gender: Male/Female

5. Are you Right or Left Handed?_____

6. Highest Educational Qualification:_____

7. Have you ever used a computer before? Yes / No

8. If yes for how long have you been using a computer? _____

9. For what purposes do you use a computer?

- E-mail ☐
- Word Processing ☐
- Gaming ☐
- Spreadsheets (eg Excel) ☐
- Programming ☐
- For surfing the WWW ☐
- Other ☐
- (for what exactly) _____

10. Which Operating Systems do you mostly use? _____

11. How often do you use a computer? _____

12. Have you ever used Microsoft Word? Yes / No

13. If Yes, how often do you use it? _____

14. Have you used any Software packages (not mentioned above), on a regular basis, that contain in part or whole, iconic interfaces? Yes / No

15. If Yes, can you please name them: _____

16. How would you rank the following in frequency of use? Where 1 is the method most employed and 4 is the least used method.

Pull Down Menus ☐
Icons ☐
Shortcuts Using Keys ☐
Right mouse click ☐

17. Briefly, please say why that is your most (1) & least (4) preferred methods:

Most (1):_____
Least (4):_____

18. If you were to use short cut key, for which actions do you carry out via the keys?

_____

19. Would you say that you waited for the text prompt to appear before you selected that icon or menu item? Yes / No / Sometimes

20. In relation to the above question, number (16), In your opinion, which do you think someone else may perceive as requiring the most skill and why (briefly)?

_____

_____

21. Which do you think is quickest and why (briefly)?

_____

_____

22. How well do you recognise an icons identity? (please circle)

(Every time)	(most of the time)	(about 50% of the time)	(some of the time)	(hardly ever)
1	2	3	4	5

22. How would you group yourself in terms of computer experience? (Please Circle)

Novice Intermediate Expert

Appendix B

Scenario for Test One as given to test subject.

Scenario:

You will be given a floppy disk with a document named ‘Icon Experiment’. You will be placed in front of a computer screen which will have a word processor running on the screen. This word processor will be called Microsoft Word ‘97. Do not worry if you have not seen or used this word processor before, in fact it may even be beneficial for this investigation if you have not come across this package before. The aim of the experiment is for you to use only icons to interact with the interface for all the tasks that are required of you. You MUST NOT use any short cut keys, menus, or mouse functions to carry out any of the tasks. You will be timed, but try not to be concerned with completing the task as fast as possible. Attempt to complete the task in your own time as you would normally. There are no prizes for the fastest users! However it is better if you can be as accurate as you can, you may go over and check what you have done, if you have made a mistake then you may attempt to correct that error.

The aim of this experiment is to test the usability of icons and whether or not their meaning is well understood by users. You as an individual are not been compared to other test subjects. All information will be held in the strictest of confidence and will only be published in an anonymous manner together with the other data obtained.

Test One:

Part One

1. Open the document named ‘Icon Experiment’ using ONLY the ICONS.

2. You will see displayed, an extract from a book. The extract is duplicated, in that the top and bottom versions are identical in content, but the format is not. The aim is to make the top extract identical to the bottom one, in terms of its format. This is to be achieved by using ONLY the ICONS of the word processor. It does not matter in which order you carry out this editing. This requires using the following icons: Bold, Italic, Underline, Centre alignment, subscript, superscript and 1.5 spacing. When you are carrying out this exercise, please do not place the cursor on the already formatted document to see which icons are highlighted to carry out this test.

Part Two

3. Now save the newly amended document (under the original name).

4. Just to check that the document looks as it should, select print preview. It should be fine, so after checking it, close print preview by selecting the “close box” icon.

5. The document should return back to the version before print preview was selected. Print this off.

6. Next the type in bold must be cut out and pasted into a new document.

7. Close this new document. Do not bother saving it. The screen should return to the amended document (from which the type in bold was removed).

8. Restore the document back to its original state but NOT by pasting the heading back in, but rather, by going back to the document before the heading was cut out.

9. Then save the document under a new name of your choice.

Thank you, that is this experiment finished.

Test Two:

Now, because this word processor is possibly new to you and some of the icons may be different, I would like to see what you think each icon means. Simply look at the sheet with the icons on (Test Two) and beside each icon, write down (as brief as possible) what action you think selecting that icon achieves –as easy as that! Again your results will remain confidential.

Test Two

Icon Identification Test

Subject No: ________

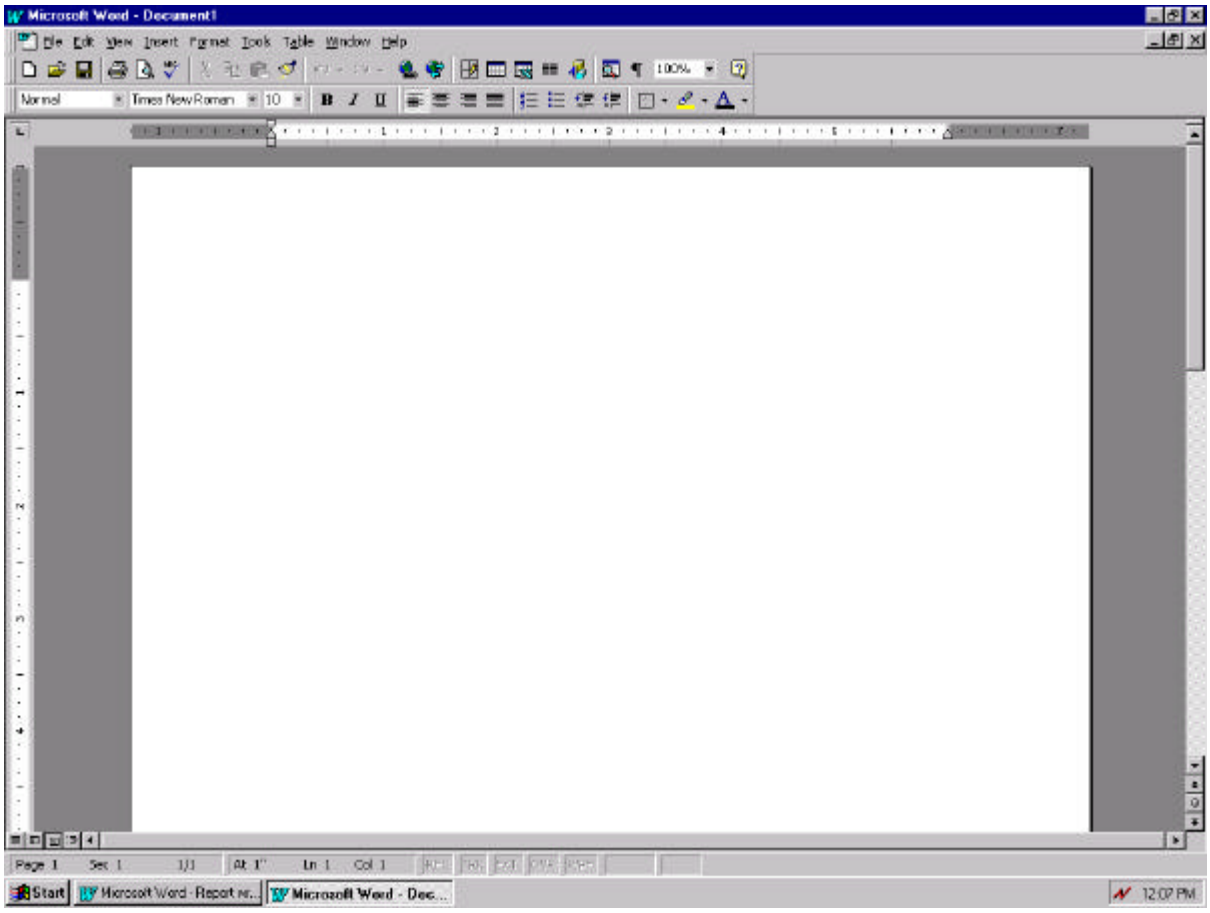
Subject Name: ________________________________

Time Taken: ________min

Beside each icon please write what action you believe the icon carries out. If the icon is new to you, please circle the icon in question. Please do not leave any blanks, if the icon is new to you and you do not know its meaning please make an informed guess. N.B. Subjects were given a colour version.

Appendix C

The interface that is used in the experimentation – Microsoft Word 97, looks like this:



The layout of the icons can be seen and the format in which the ToolTips are presented can also be noted from this screen dump. Note also how the menu bar can not be seen by the test subject.

Appendix D

Results of Experimentation

Icon Selected	Hovered (IE ToolTip appeared)	Did not Hover
Change Font Colour		
Open Document		
Undo Edit		
Close Document		
New Document		
Cut		
Copy		
Paste		
Bold		
Italic		
Superscript		
Subscript		
1.5 Spacing		
Print Preview		
Print document		
Underline		
Save		
Save under a new name		

Time taken to complete the task:_____

Appendix E

Icons used in Test One and their respective ToolTip.

	Print		Bold
	Font Colour (Auto)		Cut
	Print Preview		Close
	New		Copy
	Save		Underline
	Italic		Superscript
	Subscript		1.5 Space
	Save As		Paste
	Undo (edit)		Open

Appendix F

The subject was asked to open up a document from disk. When opened, the following document was presented to the subject

This is what each subject was given:

20th July 2000

DEATH IS MISSING –
PRESUMED … ER… GONE.

Which leads to the kind of chaos you
always get when an important public
Service is withdrawn.

Meanwhile, on a little farm far, far
away, a tall dark stranger is turning
out to be really good with a scythe.
There's a harvest to be gathered in…Terry Pratchett

20th July 2000 [1]

DEATH IS MISSING –

PRESUMED … ER… GONE.

Which leads to the kind of chaos you
always get when an important public
Service is withdrawn.

Meanwhile, on a little farm far, far
away, a tall dark stranger is turning
out to be really good with a scythe.
There's a harvest to be gathered in…Terry Pratchett

This paragraph is an excerpt from 'Reaper Man' by Terry Pratchett.

On a hard copy, the subject was given the instructions that were to be carried out.

[1] The date font had to be changed from black to the colour blue using the appropriate icon.

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