Icon design for the user interface

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The use of icons in the user interface is becoming increasingly prevalent. Some researchers believe that they may make the tasks easier and quicker and that they are clearly superior to conventional methods of depiction such as text and menu bars. However, the use of icons introduces difficulties in the design and use of the interface. This paper focuses on the strengths and weaknesses of this form of representation and the possible usability problems associated with the use of icons. The paper discusses the use of icons in the various forms of computer systems including desktops, PCs, and mobile devices and gives an indication of the use of icons inside of computer systems such as phones, and other consumer electronics. It also examines the use of icons in the interface and the use of natural icons with icons. Finally, some future trends are suggested.

1. Introduction

During the last few years there have been many changes in the human-computer interface. In particular, there has been a shift towards the use of graphically oriented devices consisting of windows, menus, icons and scrollbars. Behind this development is the idea that by presenting essentially abstract information in a graphical form the computer system's apparent complexity can be reduced, making it easier to learn and use. The general assumption underlying this notion is that since we live in a socially and spatially organized environment we are more comfortable in using interfaces that also use visual and spatial information representations (e.g., Ludwig 1993, Smith et al. 1982). For example, many commercial system operating environments, such as Apple's Macintosh and Digital Equipment's OS/2, currently employ an extensive range of graphic images as a way of simplifying the operation of the system.

One of the main areas of concern which has arisen from this research is the use of icons in the interface. These are graphical symbols, generally the size of a postage stamp, which are displayed on the screen. Their use is to represent underlying system objects, data structures and processes in a form which corresponds to the real world. They can be highly pictorial representations, being a close resemblance to a familiar object associated with the task (e.g., a desktop, file, sheet of paper), or analogy to the actual process (e.g., the use of scissors to represent 'cut', the use of an eraser to represent 'rub'). Icon designers often use different shapes to represent various system states. Examples of the various icons are illustrated in figure 1.
2. Historical background

Some were incorporated as part of the user interface for the Xerox "STAR" office workstation (Duffy et al., 1982). As part of the design philosophy for the new product it was decided to design an interface based on the metaphor of an actual physical office. The idea was that by representing the electronic "world" as an electronic mirror of the physical components of the office, it would make the operating space seem "more familiar, user-friendly and require less training". Hence electronic counterparts of the physical objects of an office were created in the form of icons. These included paper, folders, file cabinets and mail boxes (see figure 2).
The icons were designed to be used by a mouse-driven system. Icons were selected by first choosing the type of action, then clicking on a mouse button. Once selected they were then selected by clicking on another mouse button. For example, moving a document was considered to be the screen version of picking up a piece of paper and placing it elsewhere.

The nature of the "pointing, selecting and moving" action was intended to give the impression of moving an actual system. Hence, unlike traditional programming languages where interaction with the system is through abstract elements such as routines, values and variables, the actions of moving, linking, and invoking icons have been done in a direct manner. Thus, the icons offer a means to communicate with the system as if they were carrying out actual activities. Furthermore, the icons offer a means to communicate with the system as if they were carrying out actual activities. Thus, the icons offer a means to communicate with the system as if they were carrying out actual activities. Furthermore, the icons offer a means to communicate with the system as if they were carrying out actual activities. Thus, the icons offer a means to communicate with the system as if they were carrying out actual activities. Further, the icons offer a means to communicate with the system as if they were carrying out actual activities. Thus, the icons offer a means to communicate with the system as if they were carrying out actual activities. Furthermore, the icons offer a means to communicate with the system as if they were carrying out actual activities. Thus, the icons offer a means to communicate with the system as if they were carrying out actual activities.

3. Advantages of iconic interfaces

3.1. Unambiguity

One of the main arguments used in support of iconic interfaces is that users find it more natural to understand and manipulate icons representing system information than to use other programming languages. Undeniably, the assumption that iconographic representation is, in general, a more universal means of communication and hence able to transcend the limitations imposed by a verbal language. In particular, it is often considered that the power of pictorial communication comes from its inherent meaningfulness. For example, for those who know the code, a picture of a pair of scissors looks like a pair of scissors in English, French, Chinese and Arabic, even though they are called by a different name in each of those languages.

The use of graphic symbols as a means of conveying messages is in fact already well established for public information and road signs, warning labels for toxic materials, procedures for washing dishes, and instructions for industrial and commercial equipment; the idea is that they can be universally understood across cultures. More recently, they have been used as a way of discriminating between the non-increasing range of images available with the new generation of semi-automatic tools such as washing machines, cameras, ovens and video recorders. Many of these products are geared to a universal market and, therefore, it is used by a universal language that is easily understood. It comes as no surprise that just as the major success of a large-scale television commercial presupposes in the viewer's unconscious store of images that has been tagged a "language factor," the use of graphic symbols as a computer interface can be seen as a more concrete means of linking a non-expert to the operation of a large computer system. This time, the problem is one of "computer literacy," in which there is an increasing number of people who need and want to use computers but do not have the necessary programming skills.

3.2. Comprehensibility

One of the main advantages of using graphic symbols is their alternative form of signifying that, because of their inherent comprehensibility, they can be presented in a more easily understood form (Dawson and Dower 1978). For example, the pictograms of a telephone set are able to convey the location of telephone facilities more quickly than words can (Momma 1980). In addition, they can sometimes present certain types of complex information more effectively. For instance, a highly successful use of symbolic images was of the programs used for the Montreal Olympic Games, which portrayed artistic events very effectively. The images were used for simplifying complex and abstract concepts associated with the sport. Not only were the designs easily identifiable, but they were also able to embody more abstract underlying patterns of events, such as intensity, strength, motion and movement, thus enabling them to be powerful means of representing various qualities of the sporting event (see Figure 3).

Figure 3. Icons based on those used for the Montreal Olympic Games.

3.3. Recognition

Human factor research has also demonstrated that graphic symbols can be recognized more readily and are legible at a greater distance (Dawson et al. 1976, Ellis and Dower 1978, Wickes et al. 1980). Besides having an essentially mnemonic function, these same graphic symbols can also be effective when used for procedural and operational purposes. In particular, they have become an integral part of our road signs, warning labels and instructions of hazards ahead. For these types of messages the most efficient signs tend to be those that embody graphic images that correspond to real-world objects associated with the message, e.g., traffic lights, slippery road, humpback bridge, the main advantage being that they can be interpreted as a more effective way and more directly than words (Ballinger and Bellinger 1972).

3.4. Comprehensibility

Studies of the comprehensibility of graphic symbols intended for other settings, e.g. traffic and farm implements (Purcell 1947, Cattell 1970), fire safety symbols (Coltins and Lerner 1942) and automotive applications (Green and Pee 1978) have also shown...
that, providing the symbols have been well designed, they can act as an efficient means of communication.

Findings such as these suggest that it is possible to use symbols efficiently to convey information to enhance an system's ability, can be prevented if an appropriate graphical symbol at the computer interface should make it easier for new users to understand the concepts and often element nature of the underlying system functioning.

4. Disadvantages

One of the main difficulties with iconic communication is that the meaning of a symbol may be interpreted in different ways. Unlike verbal language, in which there is a set of syntactic and semantic rules which provide us with a means of disambiguating the meaning of verbal language, pictorial language has as yet no equivalent universal rules underlying its comprehension. Similarly, when words or sentences are ambiguous, they often convey the content in which they are used misleading or inaccurate.

This is not necessarily the case with pictorial information. For example, we are able to determine the intended meaning of a word which has more than one meaning (e.g., book) from the context in which it is used (e.g., the book jumped onto the bed and stood alone). On the other hand, when we look at a picture depicting a male sitting on a bench, we cannot determine whether the man has jumped out of the water or is about to jump into the water. Moreover, there are several other possible things that the man might be doing. These differences are not always clear in the language, which can be shown in a picture.

An important factor which can help convey information pertaining to understanding pictures, however, is a person's prior knowledge and experiences of the domain for which the picture is intended. Hence, successful comprehension of a set of icons will depend on our ability to make the link between the pictorial code used in the icon and our knowledge of the task domain and the underlying system operations. For those who have a good knowledge, the link between the two may be obvious; for those who have limited understanding of the domain, the link will be very difficult to comprehend. In this sense icons are impressive because they can represent different things to different people.

Since we do not have a clearly defined set of rules by which to interpret the meaning of symbols, it may be the case, therefore, that icons are actually a poor substitute for the preciseness of language. In particular, if users are forced to look up the meaning of icons in a manual to understand what they mean or to get a more accurate description, then clearly the type of communication has failed. Indeed, the icons have become a set of pictograms which offer no advantage over other coding mechanisms (Green and Olson, 1985).

A picture is not considered as a general form of communication such as a verbal one may be. For example, the few attempts at developing a complete pictorial language which could be read in all languages (e.g., Bliss 1965, Oka 1970) have met with little success because of their lack of precision, versatility and flexibility. In relation to the specific use for which icons are intended, i.e., as labels of certain types of actions or as indicators of underlying states and messages, it is not necessarily true, the reason being that the specific domain for which iconic inter-

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5. Classification of icons

In order that iconic interfaces are designed so that they are universally understood, it is important that some form of classification scheme is developed. Originally, for et al. (1982) proposed that the icons designed for the Xerox Star should be classified into two high-level categories: data icons and function icons. Data icons are defined as objects representing objects on which actions are performed (e.g., documents, folders: mouse icons). Function icons represent objects that perform actions (e.g., the draw-er or menu icons). Calculated. The two categories also differ as follows:

1. anything that can be done to data icons can be done to all; e.g., all data icons can be moved, copied, deleted, etc.;
2. most function icons will accept data icons, e.g., you cannot move a file drawer.

Since this initial dictionary, there have been a number of other classification schemes suggested which have attempted to distinguish further the different types of data and function icons (e.g., Lodding 1982, Jewell and Olson 1985, Grünke 1989). The main classification that has evolved has been to make the distinction between the form and function of the icons.

5.1. Form

The form of an icon is the type of representation that is used in the depiction. Generally this can consist of (1) geometric objects, e.g., lines, circles, squares, etc., (2) mathematical formulas, and (3) combinations of a picture and a label. The form can be classified further into the way in which it represents the underlying concept, i.e., the reference. These can be either through:

1. three-dimensional
2. two-dimensional
3. symbolic
4. arbitrary.
5.1.2. Relevance to user. Semantically icons are those which depict the underlying reference through an analogic image. A good example is the red light for "traffic light" (see figure 4a).

5.1.3. Example icons. An example icon is one which serves as a typical example for a general class of objects. For example, the klaxon and fork used in the public information signs to represent "restaurant services" (see figure 4b). Within the context of newspaper headlines, the depiction of a very simple image is very powerful as it shows the most salient attributes associated with what one does in a restaurant in the Western world, i.e., eat.

5.1.4. Symbolic icons. Symbolic icons are used to convey the underlying reference at a higher level of abstraction than the image itself. For example, the picture of a wine glass with a feature in it is intended to convey the concept of "fugitive" (see figure 4c). Again, when used in the appropriate context, such as on the side of a box containing fragile goods, the image can be quite effective for what is a highly abstract concept.

5.1.5. Arbitrary icons. An arbitrary icon is one that is constructed that been no relationship to the reference, hence the association must be learned. The backboard sign is an example (see figure 4d). In this sense it is a completely arbitrary form of coding such as the letters that have been developed in verbal language, there is no relationship between the words and their intended meaning.

![Figure 4. Different forms that icons can take: (a) resemblance; (b) example; (c) symbolic; (d) arbitrary.](image)

5.2. Functions

Icons can also be classified in terms of their function in relation to the task demands and their intended communication. The functions of pictorial symbols used in case study settings has mainly been for service and identification purposes. For example, they have been used widely and successfully used to display information that require rapid comprehension, such as those shown on road signs or weather maps. In addition, they have been particularly effective in providing information regarding object location, i.e., the public information signs at airports.

Icons intended for use at interfaces, however, are expected to have a number of different functions. Table 1 provides a summary of some.

<table>
<thead>
<tr>
<th>Table 1. Range of functions underlying various icons.</th>
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<tr>
<td>Function</td>
</tr>
<tr>
<td>labeling</td>
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<tr>
<td>indicating</td>
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<td>manipulating</td>
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<td>commanding</td>
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Although there is a number of possible functions icons can have, it is possible identify the common and distinct relationships between the icons and actions they are being represented. For example, similar to Smith et al.'s (1982) classification, various functions that an icon can take can be characterized as to whether it is used to objects or actions (e.g. manipulating icons) or as objects which are activated upon (e.g., the warning). A further distinction is made which action occurs between objects and actions but are not to provide information (i.e., idioms). This type of syntactical analysis is very useful when developing a set icons to ensure that the icons are readily distinguishable. As yet, there has been no systematic attempt to incorporate such analysis into the design of icons.

5.3. The Referent

The other aspect of icons which we have not yet considered is the underlying nature the referent. The type of information and the psychological attributes which will play an important role in determining the success of any referential form. Most communicative systems have a complex structure, consisting of a range of referential systems, data structures and control operations. The question is to which extent these types of features can be represented in an iconic form that is meaningful and will facilitate the learning and memory of the system functioning. Research in the psychological aspects of memory has shown that although abstract concepts can be represented in a meaningful form, it becomes more difficult to represent the more abstract symbols because Fogg (1982). When asked to generate strategies for a set of abstract verbs, similar to the type of commands used in the context
interface, subjects found it much easier to produce drawings for high imagery verbs than for low imagery verbs (Rogers and Chace 1992). Furthermore, the drawings produced for the high imagery verbs were considered to be the most representative and also had the highest stereotypy strength. On the other hand, a drawing of draw-

ings produced for the low imagery verb was considered to be the most unrepresentative and also had the lowest stereotypy strength. On the other hand, a drawing of draw-

5.4. Icon-relevant mappings

So far we have looked at the form and function of an icon on the surface of the underlying referent. In order to define effective icons, however, the mapping, i.e., the relationship between these two aspects needs to be considered. In general, it is assumed that the more direct the mapping between the surface form of an icon and an underlying referent, the more effective the icon in other words, the easier it will be to understand, learn and use (Hannesey 1982, Gaver 1986, Rogers 1985).

The more direct the mappings are those which represent the underlying referent as images of that information, for example, the depiction of a file for the data object of a file. For more abstract concepts where there is no obvious resemblance between surface form and referent, it has been found that the most direct form of mapping is one which departs concerns about being perceived in the context with abstract symbols (Rogers 1985). The function of the latter is to provide an indication of the type of action. For example, the command operations, such as ‘go to top’ of a page are most effectively conveyed through the depiction of a piece of paper with writing on together with an arrow pointing downwards and upwards respectively (see Figure 5). The most direct mappings have been found to consist of abstract symbols in which there is an arbitrary relationship between the icon and referent.

Another type of mapping is one based on analogical connections where the mapping makes use of the similarity between the icon being represented and the referent. These can be either physical or semantic associations. An example of a physically based mapping is the depiction of a pair of scissors to portray the operation to cut, where the action of cutting is most commonly performed with a pair of scissors. An example of a semantically based analogy with no physical connection is of a spinning top used in some CAD systems to represent the operation ‘go to the top’. Here the connection is based on the metonymy of the word ‘top’. In some cases this type of semantic change can be quite effective, especially if the link is bias.

On the other hand, if the link is rather incomplete and not made explicit to the user, it is actually counterproductive. For example, Rogers (1985) found that the use of a mapping based on similar analytics were the most difficult to understand, learn new relationships for a range of verbal and non-verbal performance tasks in a word process environment. As a result, the icons included a watchtower with bricks for ‘go operation ‘go new’ or a person with their arms in the air representing the operation ‘go out’. The other mappings which were compared included those based on other symbols, concrete objects and combinations of these.

6. Icon versus Names

In order to show that icons can be an effective form of communication at the interface, it is important to establish that this mode of representation is more advantageous if other forms of communication for the task involved. Within the psychology literature there is a large body of studies which have compared the process of picturing and words for a variety of tasks. Much of the earlier research (e.g., Jank et al. 1986, Parris and Campbell 1966, Nelson and Brooks 1973) demonstrated a superiority of icons over words in a number of different tasks. The reason for this is considered to be that pictures are processed more than the equivalent words, making them more meaningful. The most pervasive theory behind this notion is the concept of dual coding theory (Parris 1971, 1986), which proposes that there are two distinct memory systems: one, a visual store, in which information about the picture or object appearance is stored in an analogous form, having spatial and configurational properties similar to the physical form, and a verbal store, in which verbal material is stored. Therefore, the theory is that pictures are remembered better than words because pictures are more likely to be represented in both stores. It also assumes that the image storage system is the most effective (Parris and Capon 1973). Indeed, various studies conducted in parallel with memory for pictures have shown that the capacity for remembering them may be unlimited and extremely accurate. For example, after presenting 2000 pictures individually over a number of days, near 90% of them were subsequently correctly identified in a memory task (Standing et al. 1970).

In relation to the user interface, there have been relatively few studies which have compared the effectiveness of icons with named names. An early study by Hinds et al. (1981) comparing user performance for command, menu and icon, multimedia of the icons in some interface actually took longer to complete the tasks than for the verbal cue. From this result, it appears that subsequent more time consuming. However, this difference in performance may be due for other reasons, however, may have been caused by other factors besides the form of representation per se. In particular, it was reported that one of the icons used encountered with the icon interface was that they found it difficult to order the icons because of a problem in the icons rather than the interface. Hence, the reason for the order performance time for the iconic interface may have been more due to the type of interaction than the form of representation.
7. Shared attributes in command sets

One of the main differences between the traditional use of pictorial symbols as a means of communicating visual information, etc., and the use in the text as an interface, is that pictorial symbols are often displayed as individual signs whereas icons are generally displayed as a set. Most commonly, icons are used to represent a set of menu items, like system operations or objects, or as a set of tools for a given application. The point is that there is a big difference between using icons in isolation and as a group or as an individual entity only to be able to represent the underlying relevant information efficiently whereas a set of icons needs also to discriminate efficiently between the various references.

Command-sets icons are usually structured in the same way that they can often have something in common with each other. For example, in a user editing domain many of the commands share attributes (e.g., delete a line of text, delete a character, delete a paragraph) while retaining distinctive features. In terms of command language, if the system has suggested that appropriate icons can be selected which can reflect this structure. He suggests that a good name is one in which there is a high degree of similarity between the name and the underlying operation. Furthermore, an optimal command name will maximize the similarity, i.e., the mapping of features between operations and its name, and minimize the similarity between different names. Hence names whose underlying psychological attributes map closely to the psychological attributes of the command operations, but which are also abstractions from the other names within the set, are considered to be the most in tune and reasonable.
8. Considerations for icon design

When deciding on the suitability and design of icons at the user interface, a number of factors should be considered. These include high-level considerations such as task demands and low-level ones such as the choice of shape and colour.

8.1. Task demands

The types of domains and tasks for which icons will be most suitable will depend on the characteristics of the domain and the cognitive processes that are required to perform the tasks. For tasks which require the user to specify and to retrieve information, as is the case in the electronic data bases, it would seem more compatible for the domain to be represented at the interface in a verbal form, since this would correspond more to the sequential and hierarchical structures often found in this kind of data base. To represent this type of information graphically could actually make the task of retrieving information more difficult, since it might be more cognitively demanding for the user to have to associate visual with verbal forms that may not have much in common. For example, if people want to access specific bibliographic records, it is more natural and efficient for them to do so by asking the system in natural language rather than to have to search for an icon that relates to the "result" in which they are interested. Moreover, as the results come up slowly at first, if the material is highly abstracted it would be very difficult to design meaningful and distinguishable icons in such a way that they would be able effectively to map onto this type of information.

On the other hand, the use of visual images for other types of verbal mental tasks may sometimes be more helpful. For instance, when one is unsure of the precise nature of information, icons may prove useful as cues to guide one's search. An example might be a videotape data base consisting of recipes, whose users are not sure of their requirements. Using pictures as the interface to represent the recipes may be a more effective way to help guide selection. This type of task differs from the previous case in that it involves not so much cognitive processes of recognition, which may be less demanding.

Other domains where iconic interfacing may prove to be beneficial are those which require the user to make visual judgements (like the design of layout designs) or to detect simple shape and size differences from which large amounts of information have to be readily identifiable (such as printed text which would almost be used as mnemonics maps). Iconic interfacing may also be an effective dialogue for tasks which require a large number of operations to be performed, especially if they are manipulative processes. For example, the numerical drawing and painting techniques necessary for graphical design tasks may be best represented as "icon modes" where each icon refers to a specific manipulative drawing process. Other domains where they may be effective are those which consist of categories of operations that share similar relations between actions and elements.

9.2. Concept types

For applications which are essentially object oriented (e.g., CAD/CAM), designing effective icons to represent the underlying systems is a fairly straightforward task. Isomorphic representations, where there is a direct structural relation to some of the properties of the real object being represented, are relatively easy to construct.

As a higher level of abstraction, icons may also prove to be effective in representing categories of system objects. For example, as emphasized by Benach (1973, 1979) people readily associate superordinate categories of objects (e.g., furniture, tables) with the most typical member of that category (i.e., chair and apple, respectively). Hence for applications which comprise a large number of objects that fall into cognitively compatible categories it may be possible to find preexistent members which could be iconically represented as instances of each category. For example, videophone data bases (e.g., electronic medical services like PRETEST) and applications consisting of a wide range of operations (e.g., architectural and electronic design systems) may benefit from this approach since they tend to consist of categories of related functions or actions. If in the case that a preexistent member can readily be associated with each category, then it may be possible to represent these superordinate categories in a meaningful way.

Another potential benefit of category icons is that they could facilitate recognition and search processes integrated in data base querying activities. Muster and Maynes (1984), for example, reported that the inclusion of graphics in a videoconferencing system greatly reduced the number of errors made when making a selection. Although the research was not directed towards explicitly investigating the efficacy of preexistent categories, it is interesting to note that the icons of graphics used in the study were of typical members of categories. For example, a chair used in a represent furniture, a coat for clothing and a knife for applications.

Another factor which affects the ability with which an abstract concept can be encapsulated in an iconic form is the underlying isomorphism awareness and association with the system concept, and how this relates to the actual visible output of a command operation at the screen (Rogers 1980). For example, the command "go to the top of the text" can be very effective when represented in iconic form. But the reason for this was considered to be because the outcome of the operation is directly visible on the screen and hence could be readily mapped onto an iconic form. On the other hand, commands like "go to page 5 and last" are much more difficult to accomplish in iconic form. This is because the actions are much more difficult to visualize; having no direct output at the screen, and hence no direct mapping between the iconic form and underlying operation.

The reason why some types of commands are easier to comprehend in iconic form has also been suggested by Dieh (1986) to be a function of the structural nature of the command. By this he refers to commands that are abstract, have a poor object-action connection.
8.3. Shape

An important factor at the practical level of icon design is the actual visual characteristics of the icons. One of the main criteria for good design is that the shape of which are intended to be part of a menu display when the user will be required to one way in which the shape of the low-res-facility menu determines among

![Diagram of icons]

- Icon 1
- Icon 2
- Icon 3
- Icon 4

Figure 2: Example of the icons used as icons in a survey by [Author et al.] (1982), which were distinct and easy to identify. The icons, though, also need to be meaningful and semantically correct, to avoid ambiguity in the interpretation of the mapping between the icons and the underlying semantic. Thus, it is important to correctly show the mapping between the icons and their corresponding semantic concepts. As an alternative, one can create an icon with a different shape and then use a different shape for each icon, thus making it easier to distinguish between the icons.

8.4. Simplicity

Given the limited space of icons when displayed on a screen, they should be designed to be as simple as possible. Moreover, the design must convey a unique and easily recognizable meaning. Simple outline icons are more effective in conveying the intended meaning. For example, a simple icon with a small circle in the center can be used to represent a particular function. As an alternative, one can use a more complex shape to make it easier to identify. The advantage of this is that it makes the shape more recognizable (see figure 3).

8.5. The use of color

Colors can be used to convey additional information. The use of color can help to distinguish between different shapes, making it easier to identify the correct icon. For example, different colors can be used to represent different functions.
Iron design for the user interface

Identification purposes (Lancadire 1928). For example, tagging one set of iron documents with a blue dot and another with a green dot could greatly facilitate the visual identification of a single document. The user, having associated an individual user with a blue dot, would only need to scan through the blue-tagged files, eliminating the need to search through all the other colour-coded files.

To be most effective, only a limited number of colours should be used since too many colours will increase search time. The combination of colours on a screen is also critical. Various combinations of colours can be very difficult for the observer to discriminate, especially if they are highly saturated (e.g. red against blue).

Figure 2. The contrast-boundary sensitivity effect (based on Lighty 1972).

Searching for a particular icon from a whole set of individually coloured icons may prove to be as difficult as finding the icon in the first place. The reason has been shown that colour does not assist, psychological research on object recognition has shown that colour does not improve their discriminability and can actually hinder search time. On the other hand, simple and clear icons can be used as a useful form of coding. In a recent study (Shortall and Morris 1986) showed that colour can be used most effectively to divide a display into separate regions that can be used to identify the presence or absence of a particular object. In the future, colour can be used in a coding mechanism to distinguish between icons that are related to each other, e.g. similar icons that are related to each other may be used to coding system. The future design, colour could be used for identifying particular objects in a display, without colour for icons which represent warning messages and an on-screen guide for users.
short description of what they think it means. For this to be a useful method, howeve-
er, it is important that the subjects have some prior knowledge of the underlying
decision to ensure that they actually understand the instructions and can perform the task.

The next step, in which subjects' speed of response for identifying items is evaluated,
can also be used. These are very useful for evaluating sets of items that are being
designed to improve user interface navigation. For example, in the task of designing a
set of icons for a software application, a set of fast responders can be used to identify
the most intuitively obvious icons. This can be very effective in practice because
they may be able to articulate the reasons why certain icons are selected over others.

In summary, the use of evaluation techniques such as the icon assessment can provide
insight into user preferences and guide the design process. However, it is important
to consider the limitations of these methods and to use them in conjunction with other
tools for a comprehensive understanding of user preferences.

9. Evaluation

Having decided on the initial interface, a set of icons must be designed that are
compatible with the selected form of interaction. For this purpose, the designer
made extensive use of natural language and visual representations to ensure
that the set of icons would be intuitive and easy to understand. The icons
were designed to be simple and to conform to established conventions, while
also being distinct enough to be easily recognized and remembered.

The first stage of the process involves the selection of a set of icons that
provide a basis for the design of the interface. This is followed by the creation
of visual representations of the icons, which are used to test the effectiveness
of the design. The icons are then refined and optimized based on user feedback,
resulting in a final set of icons that are both functional and visually appealing.

A second stage involves the testing of the icons in a real-world setting. This
involves creating a prototype of the interface and testing it with users.

The results of these tests are then analyzed to determine the effectiveness
of the design. This is achieved by gathering feedback from users and
tracking changes in user behavior. The icons are then refined and optimized
based on this feedback, resulting in a final set of icons that are both
effective and user-friendly.

As a conclusion, it is important to remember that the design of an interface
is a complex process that involves many different factors. The use of evaluation
techniques such as icon assessment can provide valuable insights into
user preferences and guide the design process. However, it is important
to consider the limitations of these methods and to use them in conjunction with other
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Another advantage of testing actual performance in different types of interfaces can be compared. For example, Whitfield et al. (1981) were able to compute learning rates and performance measures of mental models, menus, and interface. In comparison, Rogers (1988), they evaluated performances using very global measures. These included time to complete the task and the user's subjective assessment of how easy they found the task with the different interfaces. While not able to highlight specific problems with the user interface, these measures were able to provide a comparative index of the case of use of different interfaces.

Clearly, the above methods available for instructor. Unlike resources and time available, it will be important to perform these all. A method should be adopted, therefore, which will provide a reliable measure of meaningfulness and give some indication of how easy the users will be to learn and use the interface.

10. Innovations design for the future

Icons have become standardized in most designer's minds as small static pictures that are of a specified rectangular size and are on an area in a vertical or horizontal manner. But there is no reason why the computer cannot be extended beyond this form of display. For example, it may prove to be more effective for icons to be combined in a way that is consistent in a 'holographic,' structure or otherwise. Recent research has investigated the positions of visual labels in a menu has found that users of a system learn more quickly and more accurately when they are positioned on a pie chart like the numbers on a clock face rather than in a linear order (Calabrese et al. 1986). Hence it may prove that using different shapes and positioning of icons may also be more effective in terms of ease and accuracy of design.

As soon as we see the system functionality becomes increasingly sophisticated, it may also be possible to develop even more informative graphical. In particular, one approach which is still very much at the research stage is the use of dynamic icons. For example, icons depicting a particular task function such as a mag- netizing glass, when clicked on, could provide a short dynamic demonstration of what its function is. Sound could also be used to supplement auditory cues. Instead of having to go elsewhere to learn and find out the meaning of operations, the user could learn while actually performing a task. All they would need to know is how to “read” the icons to receive a demonstration and subsequently how to activate the function.

Icons "anomalous" by themselves are currently being developed as an alternative form of testing. Gaver (1988) suggests that sound icons should be well suited to demonstrating dynamic data in which the magnitude of a value to be "heard" can be used to represent the levels of an icon. For example, a representation of a different sound would result in an "anomalous" sound. Instead of the user moving an icon to "insert" a large object or processing job and a "small" object or processing job. Other users could use sound as one of the sound of the interface clicking when mail has arrived.

Another feature which could prove to be effective is the use of visual feedback after icons have been selected. This idea has already been implemented in a limited way with some of the more advanced icons. For example, while watching for a particular operation to be executed, an icon of a watch appears in which a pair of hands move. The idea is to indicate through the moving hands that a process is currently being executed. Another example is the "blip." When a file has been deleted, this is indicated by the file expanding with a "blip" box. The user knows that the file has been deleted but can still tell it is the file and if necessary can be recovered. Progress bars also have been interpreted at the interface to show the relative state of a process and how it is progressing.

The use of these additional visual cues is that they provide the user with visual feedback which can help to reduce ambiguity. In the visual example, the feedback informs the user that the system is doing something rather than appearing to be completely out of use. Clearly this type of information is of great value to users, especially cautious, to inform them of the system's response in the course of the changes between the user and the system.

11. Summary

The use of icons at the interface is clearly here to stay. The main problem is knowing when best to use them and what form they should take. This paper has outlined some of the main issues that need to be considered when designing icons. In particular, it has shown how there are both advantages and disadvantages with icon interfaces; and that the effectiveness will depend on the type of application and tasks that have been performed. Other characteristics such as the use of shape, colouring, the special positioning and combined textual labels were also discussed. In conclusion, it must be stressed that icons should not be viewed as a paradigm for interface design, but if used appropriately they can provide a powerful means of communication.

References


