The Semiotics of User Interface Redesign

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Abstract

User interface design is still more of an art than a science. Interface design and redesign is mostly based on empirical studies or prototypes but there is still surprisingly little theoretical or engineering understanding of how to go about the design process and produce good designs the first time around. We present a semiotic analysis that explains features of some user interface redesigns taken from the literature and propose that our semiotic analysis can help designers explain the changes they make to potentially help them produce user interfaces that will require less redesign.

Keywords: semiotics, user interface, sign, icon, index, symbol

1 Introduction

Today the user interface is a very important part of a computer system. Since the use of computers has become more commonplace, the proportion of non-technical users has grown accordingly and the types of users are more varied. Consequently, the interaction style and interpretability of the user interface determines its success. Industry's concern with successful interfaces is reflected in the budgets of their software projects. Myers and Rosson (1992) have reported that almost fifty percent of a project's code constitutes the user interface and at a minimum, a substantial 29% of the budget is devoted to its development (Dray 1995). User interfaces that are good at communicating to the user what it is used for, should need less redesigning and less resources as a consequence.

Redesigning an interface usually takes place once it has been tested on users or has been exposed to expert evaluation, but once these have been performed it is only clear that parts of the interface need to improve. There is very little theory about why the usability problems exist and how to redesign to improve the situation.

Semiotics can help the designer improve their communication power (Barbosa, de Souza & Prates 2001). In this paper we show how semiotic analysis can give insights into user interface design issues and why some designs do a better job of communicating its meaning to the users than others. In particular, we look at how the sign type of user interface components change as they are redesigned.

In section 2 we give a basic introduction to semiotics and justify in section 3 the application of semiotic theory to user interface design. In section 4 we analyse some user interface redesigns found in examples from the literature, using the semiotic framework. The results of the analysis are discussed in more detail in section 5 with limitations and possible future work considered in section 6. The conclusions are finally presented in section 7.

2 Semiotics

Semiotics is the doctrine of *signs*. The sign is the most important building block of semiotic study and it is defined as anything that stands for something else to some interpreter (Peirce 1932). Hence, a sign is not a sign unless it is interpreted as such. The two major figures in the history of semiotics, from which the European and American traditions are derived, are the Swiss linguist Ferdinand de Saussure (1857–1913) and the American scientist and philosopher Charles Sanders Peirce (1839–1914). The study in this paper uses the Peircean model as many others have identified it as a good model for studying computer based signs (Nadin (1990) and Orliaguet (2002) are two examples). Peirce's model consists of a triadic relationship containing three parts: the *representamen*, the *object* and the *interpretant* (see figure 1). The representamen stands to somebody for something in some respect or capacity. It addresses somebody and creates in the mind of that person an equivalent, or perhaps more developed sign. The object is the actual thing the sign stands for (Peirce 1932). The interpretant is therefore the sign created in the mind of the perceiver or the reaction caused by the object in the perceiver (Andersen & Nowack 2002).

Peirce classified signs into thousands of categories, but acknowledged that the three most fundamental sign divisions are the icon, index and symbol. The category a sign belongs to depends on the relationship between the object and the representamen.

If the representamen resembles, or in some way imitates, the object then the sign can be interpreted as an iconic sign[1]; as in figure 1.

[1] Throughout the paper, in order to make a clear distinction between icons as signs in the user interface and the Peircean notion of iconic sign, we will use the word 'icon' and 'iconic sign' to refer to these concepts respectively.

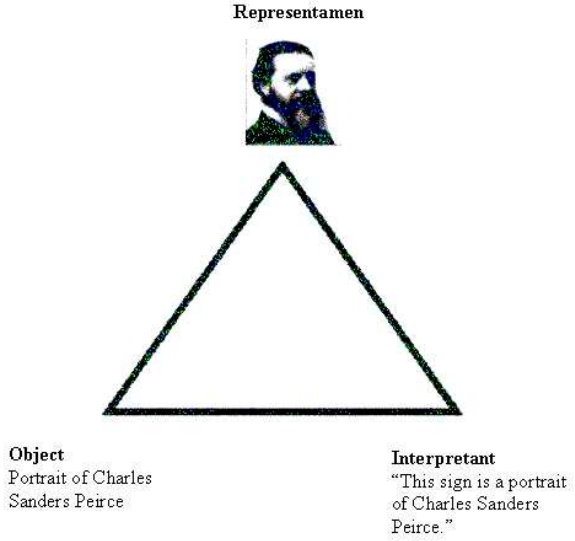

Figure 1: Iconic sign

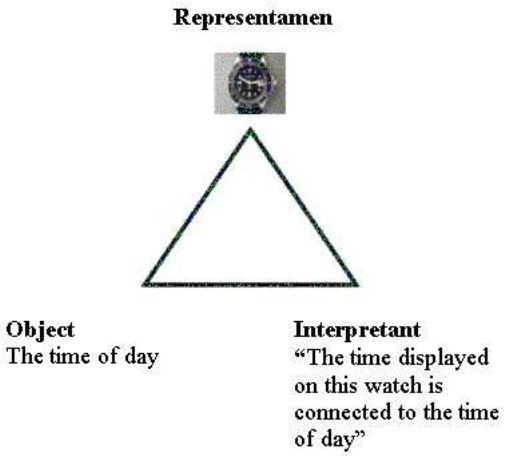

Figure 2: Indexical sign

Here the representamen resembles the portrait of Charles Sanders Peirce and the perceiver of the sign can interpret this as such precisely because the representamen resembles him enough to be recognisable. According to the triadic model, this sign is only fully formed when the perceiver (interpreter) interprets the sign as standing for a portrait of Charles Sanders Peirce.

Indexical signs exist because of a causal relationship between representamen and object. In this case the sign does not represent its object but the representamen creates a link between it and the object in the mind of the perceiver. In figure 2 the time display on the wrist watch is an index of the time of day because the perceiver must perform a referential action: the time displayed on the watch must be understood as referring to the time of day.

If the relationship between the object and the representamen is a purely conventional one that must be learned by the perceiver, then the sign is symbolic.

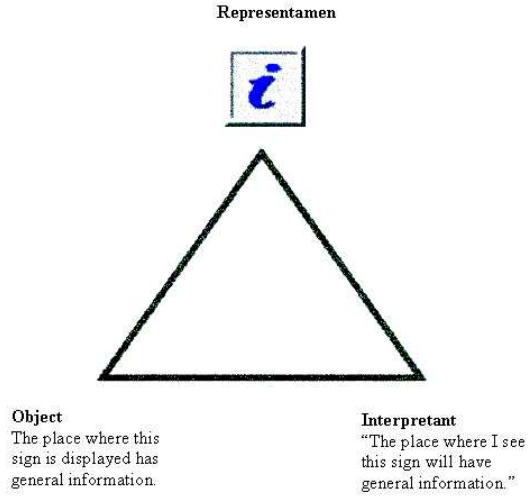

Figure 3: Symbolic sign

An example is given in figure 3. It is by learning to associate this symbol with a place where information can be obtained, that this specific interpretant is generated in the mind of the perceiver when this sign is encountered. Learning is necessary because there is nothing in the representamen that resembles or allows the perceiver to infer the notion of information. We can say that the relationship between the representamen and the object is arbitrary. At this point we stress that the three divisions are not mutually exclusive. Most signs contain elements of iconicity, indexicality and symbolism in varying measures. It is very rare, and some argue impossible, to find signs in the real world that belong to solely one division. A well known example of a sign that can belong to all three categories is the photograph. While it is an icon in that it looks like the objects it represents, it is also an index of light on photographic emulsion (Chandler 2001), which is a sign of an event that has taken place at some point in time. Lindekens (1971) would argue that the photograph is symbolic, as the camera can never make an exact replica of events, due to technological constraints.

Another instance where signs may belong to more than one category is in the case of indexical signs. An indexical sign may not be able to be interpreted as such unless the iconic representation of the sign is understood. For example, if the perceiver is unable to identify a footprint as that of a human being, it would be impossible to go on to infer that the footprint is an index of human presence. However, it is notable that some relationship between the object and representamen will tend to dominate in the sign and then it can be said that the sign type is primarily of that relationship which dominates.

3 Semiotics and User Interface Design

As Andersen (1992) notes, the designer builds the user interface so it can be used to tell people something. So from a semiotic perspective, the designer combines various signs to make up the interface in order to convey its intended meaning to the user. Further, Nadin (1990)

maintains that to *design* means to structure systems of signs in such a way as to make possible the achievement of human goals, one of which is communication. The communication referred to here is that between the user and the designer (Nadin 1988). The user interface can be seen as a complex sign made up of many smaller signs (buttons, scroll bars, images, etc.) all contributing to the process of communication, with each of the smaller signs having their own triadic relation (see figure 4): the representamen corresponds to the form that the sign takes in the interface, the object corresponds to the underlying functionality of the sign and the interpretant corresponds to the sign generated in the mind of the user. This implies that users are required to guess at the object of the sign when interacting with the interface. Signs designed to convey specific objects (as is the case with user interface signs) are intentional signs because they are intentionally created to stand for something. Due to this property signs can be said to be successful when the user's interpretant matches the object of the sign, and unsuccessful otherwise (Barr et al. 2002).

Given that designing the user interface is a semiotic activity, it makes sense to examine usability problems and subsequent redesigns of the user interface in terms of semiotics.

One potential problem with applying semiotic analysis to computer signs is imagining that all the signs in the user interface are indexical, since all signs found in the interface necessarily have an underlying functionality. (This assumes that the interface is the most economic collection of signs that allows the user to perform all the tasks required.) Assuming indexicality is somewhat justified seeing as when the user activates[2] a sign in the interface this almost always results in some action on the part of the system — indicating a causal relation between the representamen and the object. But this would be ignoring the representation relationship (Nadin 1988) between these two; more specifically, the visual elements of the representamen and how this relates to what functionality it is signifying. An example is the document icon found in many desktop applications. Figure 4 shows the triadic relation between the representamen, object and interpretant of the document sign. Selecting this sign on the desktop results in a new document being created for the user to edit. Clearly there is a cause (the creation of a new document) and we may assume the sign is indexical, but when the visual elements of the representamen is considered in relation to its object, we realise that this sign (the image of a paper based document) resembles the system concept of a document. Thus, it is an iconic sign. Only when this representational aspect is considered can the signs of the interface be classified as belonging to any of Peirce's three main divisions and not just to the group of indexical signs.

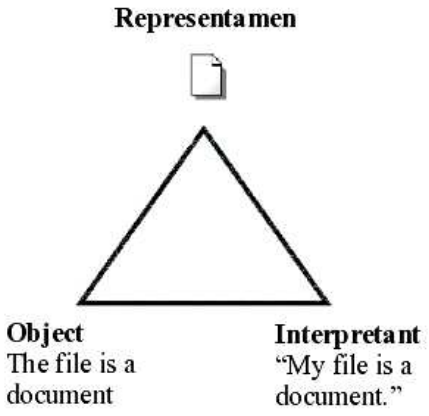

Figure 4: A triadic view of the document icon

4 Semiotic Analysis of User Interface Redesign

This section examines interface redesigns that we have come across in the literature and they are analysed according to the triadic model of the sign. It was striking how few examples of comparative studies of the interface before and after redesign exist. Hence, the examples discussed below had to be picked from a very small body of adequate studies. The first two are from a usability case study of the graphical user interface of the V9 Graphing Tools in SAS/GRAPH® - a component of SAS software used for client side data visualisation (Wimmer 2004). The third example compares the redesigns of Microsoft® Word user interfaces, available in the vast number of sources that deal with this popular software.

4.1 Cascading Menus

Figure 5 shows the cascading menus that the user needs to navigate through when making changes to a graph. In the figure, the user has selected the 'Decrease' menu option in order to decrease the width of the bars of the graph.

4.1.1 Usability Problems

The usability study showed two problems with this menu design. The first was that the user was required to be quite accurate in the mouse movements. If the cursor was to venture too far from the region surrounding the menu, the menu would collapse and the process would have to start all over again. Navigating through five layers of submenus is also quite cumbersome. The second problem was that the amount by which the bars on the graph could be increased or decreased could not be specified by the user. Therefore, the user is required to navigate through the five levels of cascading menus repeatedly until the satisfactory width is achieved.

[2] Note that a user can *activate* a sign in various ways: single or double mouse click, keyboard input or any form of manipulation of what is presented in the user interface.

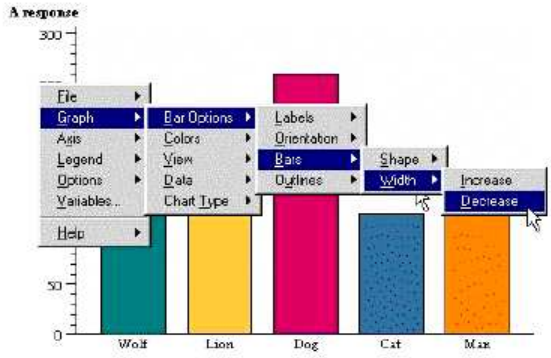

Figure 5: SAS version 8.1 Cascading menus

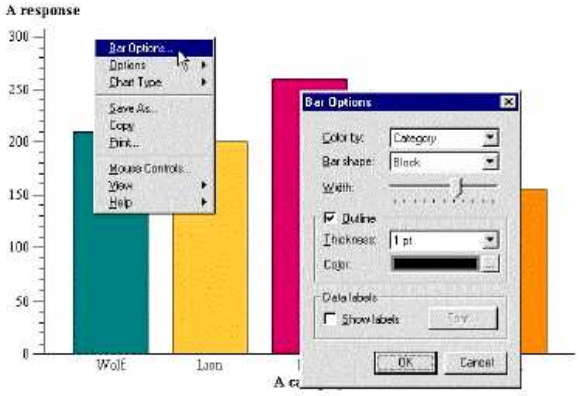

Figure 6: SAS version 8.2 Slider

4.1.2 Semiotic Analysis

Applying Peirce's notion of sign categories to this interface sign, it is clearly both symbolic and indexical. This sign is strongly symbolic because it is by pure convention among computer users that cascading menus are used to allow access to certain functionality within an interface. Users learn that there are certain choices offered by the menus and over time they can memorise how the menu is structured. Novice users may not be able to navigate directly to the functionality they require (the option to decrease the bar widths in this example) because it must be learned. The symbolic sign requires them to experiment and learn by trial and error how to perform their task using this sign. It is indexical because once the user has cascaded through the menu and selected the decrease option this causes a decrease in the width of the bars. This change appears visually to the user, who may then decide that the width has decreased by an adequate amount, or they may decide to decrease again or to change back to the size it was before.

4.1.3 Redesign

After the usability study, the cascading menus were replaced by adjusting a slider in the dialogue box in figure 6. This immediately frees the user to determine the width of the bars in a more hands on fashion — as they adjust the slider, the bars widen or become narrower. Now the process of changing bar widths involves an indexical sign, in the form of the slider. The user can perceive the changing bar widths as the position of the slider changes, so the effects perceived by the user are more immediate and the sign is more interactive. Additionally, the results of the interaction are visible during the interaction, not after it as in the cascading menus.

4.1.4 Summary

In this example the usability problem involved a mainly symbolic sign (the cascading menu). The functionality was the resizing of the widths of the bars in a graph. The redesign replaced this symbolic sign with a more indexical one (the slider).

4.2 Magnifying Glass

In figure 7, the magnifying glass icon represented the graph resizing functionality, supposedly suggesting that the graph was made smaller by zooming out, and larger by zooming in (Wimmer 2004).

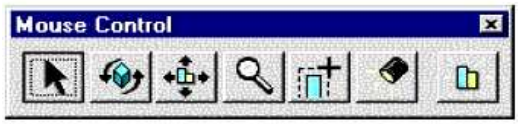

Figure 7: SAS version 8.2 Magnifying Glass Icon

4.2.1 Usability Problems

The usability study showed that users were confused by the zoom metaphor. Many applications, such as Acrobat Reader and Konqueror, use the magnifying glass to represent functionality that allows a user to zoom in or out of a document, without changing its actual size. This may be the behaviour the users in the usability test expected and it clashed with the behaviour implemented by the designers of SAS/GRAPH®.

4.2.2 Semiotic Analysis

The user's interpretant of the magnifying glass icon did not match the object that the designer had intended with this sign. Even though both the designer and the user would agree that the picture on the button fourth from the left on the 'Mouse Control' tool bar is a magnifying glass, the confusion lies with what functionality the user interprets the magnifying glass to represent. Since many popular applications (Acrobat Reader and Konqueror for example) make use of the magnifying glass to represent the functionality of zooming in and out of objects on screen, this may be the functionality the users taking part in the usability test would have assumed the magnifying glass in the SAS/GRAPH® interface to have. The magnifying glass is a symbolic sign in this case because the link between the magnifying glass and the resizing functionality is made arbitrary by the fact that a magnifying glass can not change the actual size of an object.

4.2.3 Redesign

The button fourth from the left in figure 8 shows the replacement button for the resizing functionality. This is a more iconic representation of resizing the graph due to the resemblance that exists between the image on the button and the resizing functionality it represents. This is in accordance with Barr et al.'s (2002) heuristic that proposes that icons representing qualities or system objects should be iconic signs. This helps to ensure that there is a better chance of the designer and the user agreeing on what functionality the icon represents. In fact Peirce makes this statement himself: "Since a quality is whatever it is positively in itself, a quality can only denote an object by virtue of some common ingredient or similarity." (Peirce 1931–1958). If graph size can be seen as a quality then an iconic representation could be more desirable.

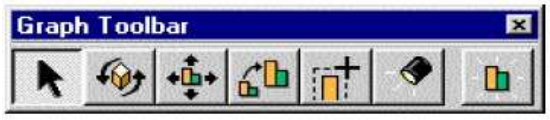

Figure 8: SAS version 8.2 Resize Graph Icon

4.2.4 Summary

As in section 4.1, in this example the usability problem again involved a symbolic sign (the magnifying glass). The underlying functionality was to resize the graph, with the size of the graph seen as a quality. The redesign replaced this symbolic sign with a more iconic sign (the button showing the bars of a graph being resized).

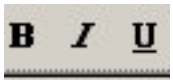

Figure 9: Microsoft® Word (2002) text format styles: bold, italic, underline

4.3 Microsoft® Word Text Styles

In Microsoft® Word Version 3 (Hoffman 1987) the options for setting the font style in a document were structured as part of a menu system[3]. There were no usability studies available to explain whether users experienced problems with this menu system, but since the successive versions of Microsoft® Word are easily accessed, either in the literature or on a computer, it is still possible to do an analysis of the redesigns.

4.3.1 Semiotic Analysis

As discussed in section 4.1, text based menu systems are symbolic signs. Not only do users have to learn to associate the terminology used by the interface designer with certain functionality, they are also required to learn the structure of the menu system.

[3] In fact all the word processing functionality available in this version had to be accessed from a menu system.

4.3.2 Redesign

By version 5 the icons in figure 9 were available for placing on the toolbar. These are iconic signs because the button for making text bold, resembles bold text. Similarly the italicised *I* and the underlined U resemble the result when applied to selected text in the document. This is another instance of redesigning a representation of functionality from being a symbolic sign to becoming a more iconic sign. These format styles can be seen as qualities of the text in a document and the same discussion as in section 4.2.3 applies here. The reasons for the bold, italic and underline options to be represented on the toolbar may be many, but obviously the user needs a shorter route to functionality that will be used frequently. Considering that Microsoft® Word is used as a word processor, the actions of bolding, italicising and underlining text are frequent actions and the user benefits from being able to access them with a single mouse click.

4.3.3 Summary

Again there is a move from a symbolic sign (menus) to iconic signs (iconic representations of bold, italic and underlined text) for a functionality that modifies a quality of the text.

5 Discussion

In the above examples, we discussed the shifts between Peirce's different sign divisions in the user interface as it is redesigned. It is interesting to note how the shift tended to be away from symbolic signs towards indexical signs, in the case of the slider for adjusting the widths of the bars in SAS/GRAPH®, and towards iconic signs in the other examples. This would seem to suggest that irrespective of the evaluation method performed on the interface itself, when there is a necessity for redesign, the design tends to be away from symbolic signs, toward iconic or indexical representations. Hence, during the initial design of the interface, this should be considered in order to prevent the usability problems that can arise, such as was discussed in section 4.

There is evidence that users tend to interpret computer signs as being iconic, i.e., that they resemble their underlying functionality. Nielsen and Sano (1994) present an "Icon Intuitiveness Test" where images were presented to users, who were then asked to indicate what functionality they thought the icons represented. For the most part the users seemed to respond to the question in a way that made it clear that they were interpreting the sign iconically. (See figure 10). If the Intended Meaning of the icon is equated with the object of that sign and the Test User's Interpretant equated with its interpretant, then Peirce's triadic model can be reconstructed for each individual icon.

On a larger scale there has been research in the area of making a whole interface resemble the object in the real world whose functionality it represents. IBM aims to create interfaces that are more natural and intuitive by designing the interface to resemble a real world artefact (IBM Corporation 2004).

	*Intended Meaning:* Geographic view of the company (branch offices in different locations).	*Test Users' Interpretations:* World, global view, planet, the world, Earth.
	*Intended Meaning:* Benefits.	*Test Users' Interpretations:* Health field, money, health care is expensive, Clinton's health plan, hospital, don't know, benefits.
	*Intended Meaning:* Public relations (TV with commercial).	*Test Users' Interpretations:* TV set, video, TV, TV, TV.
	*Intended Meaning:* Product catalog.	*Test Users' Interpretations:* System oriented, disk, CD, Computer, CD-ROM, CD-ROM.
	*Intended Meaning:* Specialized tools (toolbox).	*Test Users' Interpretations:* Briefcase, personal info, briefcase, toolbox, briefcase.
	*Intended Meaning:* What's new (bulletin board).	*Test Users' Interpretations:* Bulletin board, bulletin board, bulletin board, laundry.
	*Intended Meaning:* World Wide Web.	*Test Users' Interpretations:* Networking on a world scale, map, location, dimensions of the planet, networking around the world, geography, global.

Figure 10: Results of SunWeb's Icon Usability Test

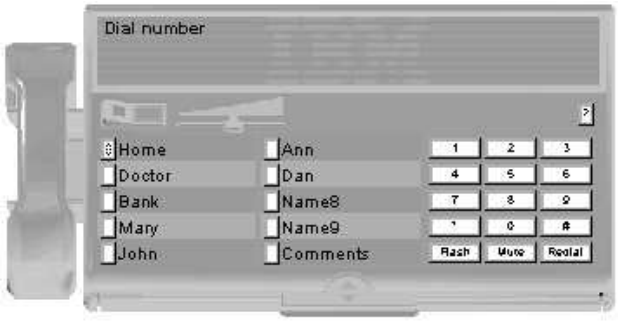

Figure 11: IBM's example of a RealThing

Their term for these interfaces is RealThings and one example from their website is shown in figure 11.

Whether this iconic representation inherent in RealThings interfaces has the same benefits as iconic signs in the interface will not be known until results of usability studies are made available.

6 Limitations and Future Work

There are two limitations to the study presented in this paper. The first is that the number of cases examined is rather small. Unfortunately this constraint was imposed by the scarcity of the literature on interface redesign. A number of further examples would be needed support the evidence found so far that certain usability problems can be solved by redesigning symbolic signs in terms of indexical or iconic signs. More studies could also shed light on what type of sign best represents which interaction. Barr et. al. (2002) have taken a step in this direction with their heuristics proposed in their paper for icons.

The second limitation is that there was no evidence of usability tests performed for the redesigns discussed above. Hence, while it is logically plausible that redesigning a problematic symbolic sign in terms of indexical or iconic signs should alleviate the problem, further investigation is required and we hope to perform these tests in the near future.

7 Conclusions

Based on the idea that the user interface is a complex sign built up from many smaller signs, we propose that examining interface redesigns can provide meaningful insights to designers. Semiotic analysis is an effective tool for analysing the communicability and interpretability of signs in the user interface, so we applied the Peircean model in analysing the signs that were redesigned. This analysis provides a better understanding of redesigns and can potentially aid designers in designing better interfaces in the future. The major insight gained from this study is that the redesign tended to change the sign from a symbolic sign into an indexical or iconic sign. This should make designers aware of the possible benefits of iconic or indexical representations of functionality in the user interface. Research into the intuitiveness of computer icons tends to support the move away from symbolic signs and indicates that users tend to interpret the signs they see as iconic signs. These are interesting conclusions but this is an avenue not yet adequately explored. More studies (yet to be undertaken by the authors) are needed to confirm that the conclusions are applicable in a more general sense.

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