**Interface Understood as Communicating
Entities – a Semiotic perspective**

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Abstract

Some proposals based on Semiotics are being addressed in HCI literature as a complement to the traditional cognitive approaches to interface design. In such approaches the interface is understood as a collection of messages sent by the designer to the user. This paper discusses the main Semiotic proposals to software design and proposes a new understanding for interface design which makes explicit the communication among the entities that inhabit the interface. The proposal is illustrated by observing results of users in game playing situation.

Keywords: Interface, semiotics, design, user.

1 - INTRODUCTION

The tradition that characterized the research in Human-Computer Interaction and mainly software design has been cognitive. Cognition refers to the process trough which we become conscious of things and also the way we acquire knowledge. This includes understanding, memorizing, reasoning, attention, learning, creation of new ideas, etc.. The main objective of the research in this field has been to understand and to represent the way human beings interact with computers, in terms of the way knowledge is exchanged among them.

The theoretical basis for this approach rests on Cognitive Psychology and explains how human beings reach their objectives. Such goal-oriented activity comprizes performing cognitive tasks which involve information processing. Humans are characterized as information processors. Anything felt (seen, heard, smelled, tasted, touched) is considered an information processed by the mind. The basic idea is that the information enters and leaves the human mind through an orderly series of processing steps [16].

The human model as a processor of information has influenced the development of several models of Human-Computer Interaction as, for example, GOMS [4] and the

Theory of Action [14]. Interaction between Human and Computer is seen as being composed by two processing units: the human and the computational. The output of one processing unit is the input of the other. In other words, the Human-Computer interaction can be described as a loop [9] with several advantages: first it provides a coherent description of the whole interaction system in the perspective of information processing. Second, aspects of the Human-Computer interaction can be easily located in this outline, as for example the presentation of information to a user, user's perception, his mental model of the task, user's attention on the system and I/O devices, etc..

The cognitive approach has been applied with success to many problems in Human-Computer Interaction. However, there is an emergent consensus that this approach has its limitations. The information loop is closed, so it is difficult to take into consideration phenomena that are out of it [9]. For example the purely cognitive approach doesn't provide a basis to take into consideration phenomena of linguistic nature and of group interaction. Considering the semiotics perspective, computers are seen as media [2] in the same way as books, cinema, theatre and television, for instance. The computer is a medium through which messages are represented to be interpreted.

This paper aims to present the contribution brought by Semiotics to software design, by discussing the main semiotic approaches and highlighting a new concept of interface based on communicating entities.

2 - SEMIOTICS AND COMPUTATIONAL SEMIOTICS

The discipline of Semiotics has been known for approximately two thousand years [5]. However, its development as it is known nowadays began with the work of Charles Sanders Peirce (1839-1914), a North American philosopher, and with the work of the Swiss linguist Ferdinand de Saussure (1857-1915). Semiotics aims to study signs and signs systems. A sign is something that stands for another thing for somebody under certain aspects or capacities [15]. Any mark, physical movement, symbol, token etc., used to indicate and convey thoughts, information and commands constitute a sign [19]. A photo is a sign which, stands for the elements represented in it, for somebody who interprets it. And, if somebody's interpretation, the word "yellow" stands for the yellow colour, red spots in the face stands for the measles, the "horse" pronunciation stands for the animal horse, smoke stands for fire, the drawing of a printer in the computer screen stands for print, waving the hand in a certain way stands for good-bye, a certain perfume stands for a rose, then, yellow, red spots in the face, the horse pronunciation, smoke, the drawing of the printer, waving the hand and the perfume of a rose are all examples of signs. One must observe that, without signs, our communication in the world would be very poor, as we would be forced to communicate making use of the object which we want refer to.

For Peirce [15] the sign is a genuine triadic relationship among the elements: the representamen, the object and the interpretant (fig. 2). The representamen refers to the material aspect of the sign and represents the object under certain aspects or "capacities". The sign only means so because the representamen can represent another thing: the object. The interpretant doesn't refer to the interpreter of the sign but it refers to a relational process occurring in the interpreter's mind, associating representamen and object.
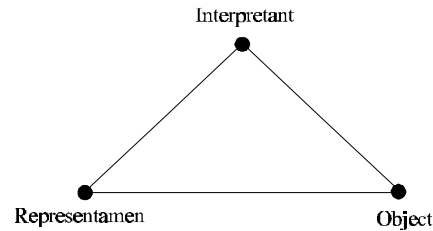

Fig. 1: The sign as a triadic relation

Santaella [17] argues that Semiotics proposes a view the world as a language. She doesn't only refer to the spoken or written verbal languages, but to all other types of language: the deaf-and-dumb language, the dance, the cookery, the fashion, the rituals of primitive tribes, the music, the sculptures, the scenography, the hieroglyph, the dreams, the wind etc.. Semiotics investigates all possible languages as a phenomenon of producing meaning. Its scope is vast, going from the study of the communication in non-human communities to the social study of ideologies; the study of moral, political, economic, religious and military codes. We know today that, even our notion of life as something with certain characteristics and reproduction capacity, presupposes the existence of information encoded inside the biological system: the DNA. It is a language and we could say that without language there is no life. Any sign produced or interpreted by us, human beings, or by other animals, plants, protozoa, fungi and bacteria or by an engine developed by some entity like a robot, or a supernatural entity represented in man's prayer can be understood as a semiotic process [19]. The notion of culture itself (and that of society) needs to be reformulated when one tries to study the universe phenomena, from its very beginning to present animals and plants, as a manifestation of language, i.e., under a semiotics sphere - the semiosphere [7].

Computers can be understood as media just as books, theatre and cinema. We are not referring only to communication-based applications like electronic mail, video-conference, or applications classified as Groupware and CSCW (Computer Supported Cooperative Work), for which the media role becomes evident. We mean any type of software: a paintbrush of a drawing software, represented by a collection of pixels in the screen, is a sign for a paintbrush. Under certain capacities it stands for a paintbrush, it conveys the meaning of a paintbrush as the word "paintbrush" written in a book does.

Semiotics is an old science when compared to Computer Science and a lot has been written about its application in several fields of the human knowledge. When we associate to the computer the media role, we get the possibility of transferring to Computer Science a strong theoretical basis known through Semiotics from other media: theatre [6], cinema [12], analysis of paintings [18], magazines, newspapers and television [3]. After all, computers are media in which signs are conveyed: machines which generate interpretation. This has motivated the development of a Computational Semiotics.

Computational Semiotics is a discipline that studies the nature and use of computer-based signs[1]. The object of study in Computational Semiotics is not only directed to software design. System programming and modelling can also be understood using the semiotics point of view. Programming and modelling are not only engineering but also activities of sign creation, comparable to the writer's, the director's (of theatre, cinema, television) or the painter´s activities: their aim is to create meaning.

3 - HOW SEMIOTIC APPROACHES "INFORM" THE INTERFACE DESIGN

Nadin [13] introduces one of the first attempts of applying Semiotics to the interface design, based on Peirce's theory. Andersen [1] has found in the European School, created by Saussure and developed by Hjelmslev, the theoretical substratum that allowed to propose a Computational Semiotics. Andersen [1] is a renewed edition of a vast work, first published on 1990, that applies Semiotics not only to the design of interfaces but also to software programming, analysis and project.

The interface is defined by Andersen as a collection of computer-based signs, i. e., the software parts which can be seen or heard, used and interpreted by a community of users. The interface design should emerge of its patterns of use, i. e., from the way the user makes use of the dialect based on the computer. The design is seen as an iterative process in which proposals are continually developed, used and evaluated. It is presupposed that in each iteration of the design cycle, there is a set of signs to be analyzed. The structuralist Semiotics of Hjelmslev supports this design method because it is descriptive and analytic. Thus, the relationships among the units composing the language can be analysed and modifications can be proposed with the objective of adapting the design of the interface signs to the computer-based dialect.

Souza [20] proposes a Semiotic Engineering for the design of user interface languages. In her approach the interface is a meta-communication artefact. The interface is composed by messages sent from the designer to the user in such way that each message itself can send and receive the user's messages. In this sense, the interface has two roles: (1) to communicate the application functionality (things the interface represents, types of problems it is prepared to solve) and the interaction model (the way a problem can be solved); (2) to facilitate the exchange of messages between user and application.

Souza uses Eco's theory of the sign production [5], in particular its four parameters of sign production, to define four basic principles to develop the signs of the user's interface. One could say that while Andersen's approach is descriptive and analytic, Souza's approach is generative, focusing on the sign production.

In the semiotic approaches which understand the interface as an intermediary, the designer develops signs to compose the interface and the user interprets those signs. Under this view, besides the user-system interaction, everything happens as if the user's role was to match an indirect monologue of the designer.

Good computer systems should create in the user a feeling of first person when he is interacting with the computer [10]. The user projects himself into the interface and he finds himself dialoguing with the entities of the interface, experiencing a feeling of *directness* [8]. To the user, to be dialoguing with the entities of the interface and to be capable of attending and understanding the established dialogue among the entities of the interface is a fundamental condition to reach *directness*. In this paper we propose a Semiotic perspective to accommodate the current phenomena of the inter-relationship among the entities of the interface.

4 - INTERFACE AS COMMUNICATING ENTITIES

Winograd defines software not only as a device for users interaction with the computer but also as a place in which the user lives. *When an architect designs a home or an office building, a structure is being specified. More significantly, though, the patterns of life for its inhabitants are being shaped. People are thought of as inhabitants rather than as users of buildings. ... we approach software users as inhabitants, focusing on how they live in the spaces that designers create* [21, p. xvii]. Thus, the interface should be understood as being composed of entities with communicative capacity, including human beings (users).

With the aim of investigating semiotic aspects of interface communication, we led an informal observation of people playing computer games. Some results presented here has been extracted from "think aloud" protocols of graduate students playing with Grand Prix II[1].

We could observe from the user-interface interaction that the users' speeches reveal a feeling of first person or, as Winograd suggests [21], the user seems to inhabit the interface:
- *I'm going to curve in third gear.*
- *I pressed the brake too late* (referring to a curve).

[1] Grand Prix II is a game marketed by Spectrum HoloByte, Inc..

The user perceives other entities also inhabiting the interface and they live together:

- *There is not anybody behind.*
- *I am in first. As always Schumacher is in second.*
- *Yellow flag. Accident ahead. ... I didn't see where it was. I didn't see car out of the track. They have already removed the car. When they wave yellow flag, they remove the car of the track.*

In the first bullet, when saying *There is not anybody behind*, the user reveals that recognizes other entities in the interface; in this case, other cars and its drivers. A driver, Schumacher, is the entity evidenced by the user in the second bullet. The last bullet indicates several entities: the yellow flag, the possible car out of the track, the fiscal of track who waves the yellow flag, the people responsible for the operation of removing accidented cars.

The entities of the interface can communicate by means of one or several languages. And this communication occurs through a complex of relationships of three types, as illustrated by figure 2.

An entity *A* communicates something to an entity *B* through its form, color, texture, voice tone, noise produced, a smell in the air, a way of acting, a way of moving, its personality etc.. Thus, each entity can work itself as a sign (fig. 2-a). It is especially this communication type that allows the user, or users, to recognize and interpret the meaning of such entities as track, straight line, curves, other cars and drivers. This is illustrated in the following speeches:

- *Curves ahead.*
- *That's a stone box.*
- *In this game each driver has an own personality. Michael Schumacher doesn't wait you to do anything. Those weaker* (in reference to other drivers), *it seems that they are of smaller teams, they respect you.*

Some entities are capable to emit sentences in a certain language. An entity *A* with such capacity, can communicate something to an entity *B* by means of sentences in a language (fig. 2-b):

- *Yellow flag. Accident ahead...* (i.e., track fiscals waive yellow flags).
- *... in this Schumacher's time passed* (an adversary driver) *and I didn't see* (he refers to the time he is from his closer adversary, informed by his team, exhibited in the panel of his car).

The first sentence shows yellow flags, waved by track fiscals, communicating to the drivers, one of which is the user, a situation of "attention", "danger" or "possible accident ahead". The second sentence indicates that the user's team communicates him

how long he is of his closer adversary. The team makes this by means of signs exhibited in the panel of the user's car.

Two entities *A* and *B* interact (physically, chemically, socially etc.) and the result of this interaction communicates something to an entity *C* (fig. 2-c):

- *I have the sensation of the tire to be more and more flat. You slip more and more. If the car is heavy* (that is, plenty of fuel) *it flees a little* (that is, tends to skid in the curves).
- *You get impression that car vacuum seems to be pushing you* (referring to the sensation of the effects of the vacuum that a driver experiences when he approaches another car which is in high-speed).

Here, "tire" and "asphalt" interact with each other provoking the progressive waste of the first. Thus "flat tire", represented somehow in the interface, is a sign for the lack of adherence of the car to the track. Or still, a car in high-speed interacts with the air, forming vacuum. This vacuum is sign for extra acceleration for a car when it gets closer the vacuum.
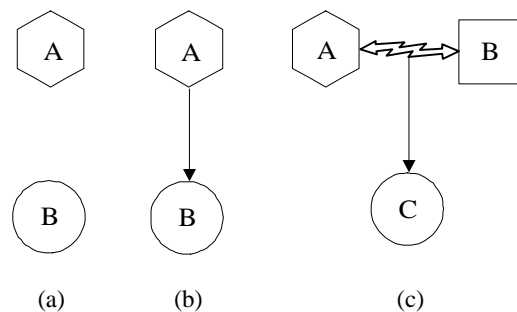

Figure 2: Communication types among the entities of the interface

In a first moment, it seems strange to consider the user's relationship with an entity in the interface similar to the relationship that he has with other objects of the world. However we can find arguments to explain this phenomenon in Semiotics. *As we are symbolic by nature, our life on the world and our sensitive access to it is always hindered by a crust of signs which, although supply us with a means of understanding, transforming and planning the world while at the same time usurps us from a direct, immediate, sensual and tangible existence with the sensitive* [17, p. 52]. But if on one hand we are condemned not to get into direct contact with the world, on the other hand we can feel it in different manners. The moment in which the user is disposed to drive a race car of the interface he lives a driver life and he starts to live together with other drivers, fiscal of track and team companions, inside of an environment that is a race of automobiles. We do not refer to a traditional race with traditional cars. We refer to another race type, with different car types. For the user, this experience is as real as it is real to drive a traditional car.

What are the implications of this? Considering the way the interface is understood, it switches the interface understanding from "the thing in between", of many interface characterisations[2] [11] [13] and of "the thing to be read" [1] [20], to "the thing to be inhabited".

The interface involves a complex net of communication: entities communicate meaning and an entity, as sign, also communicates something to other entities. Under this perspective, to design the interface implies in developing the design of the underlying languages of this communication net. This involves the accomplishment of the design of each entity, while meaning carrier, the design of the languages used in the direct communication between two or more entities and the design of the underlying languages to the interaction among the entities. Our understanding of the interface allows us to make explicit an entire range of semiotic phenomena which are not apparent in other approaches (fig. 3).
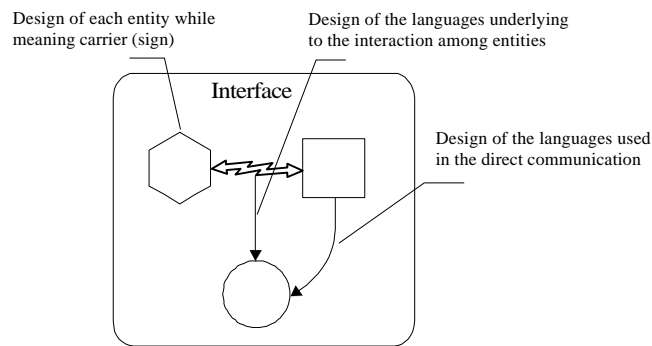

Figure 3: Work perspectives in design

Understanding the user (or users) as entities that inhabit the interface, our proposal naturally supports the phenomena occurring in the new interfaces for groupware, CSCW and virtual reality, without leaving outside phenomena of the traditional desktop interfaces.

5 - DISCUSSION AND CONCLUSION

The development of cognitive theories on Human-Computer Interaction brought us a vision of the computer as a cognitive tool enabling people to enlarge their understanding, memorization and decision-making capacities. Semiotic approaches to software design allow to consider not only the immediate aspects of Human-Computer Interaction but, also, the underlying aspects of the cultural and social context in which the interaction happens.

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[2] Interface has been defined, for several researches, as "the contact surface of a thing".

We argue that the cognitive and the semiotic perspectives represent different pictures of the same object. The traditional cognitive approaches focus on human interacting with the interface, his motor system, his perception, learning and other mental processes. The semiotic approaches facilitate an interpersonal, social, cultural perspective, focusing on the expression and interpretation of the elements in the software interface.

The semiotic theories motivate us to understand the interface as an environment inhabited by entities which communicate with each others. In computer games it is very common to hear sentences like: "I caught the sword and I killed the dragon". To be in the driver's feet in a car racing of "Grand Prix II" game or in the place of the hero in the "Dark Castle" game is a demonstration that a layer of signs intermediate our relationship with the world. The dragon in Dark Castle is not an animal but stands for it. As soon as we put ourselves in the driver's place we start to live his life, with the other drivers and their cars in racing tracks and curves of a racing environment. The interface becomes an environment we inhabit with other drivers and several other entities.

In this paper we pointed out a new understanding of interface in which the user inhabits the interface with a group of communicating entities. The user interprets what is happening by observing the communication among other entities that inhabit the interface. At the same time, he/she interferes in the running history, by communicating with one or more of the other entities. Thus, we have proposed to understand the semiotic relationships among the interface entities, and as such we intend to apply semiotic theories in the communication design among these entities. This approach moves the focus from the designer-user relationship to the relationship among the interface entities.

Typical desktop interfaces can also be understood, developed and evaluated under the perspective of being composed of communicating entities. The apparent difference among these interfaces and Grand Prix II game like interfaces is due, especially, to the behavior of the entities inside of the environment. Desktop interfaces, by their own nature, are replete of passive entities (desk, rubber, pencil, paintbrush etc.) that always react in agreement with the users' desire. On the other hand, the entities of a Grand Prix II game like interfaces are active in the sense that they seem to have conscience and self determination.

Understanding design as an iterative process, where proposals are continually elaborated and evaluated, we are developing a methodology for interface design that applies Semiotics in the way suggested. This methodology is being experimented in the design of a software prototype for creation of plays, especially driven by children, TC–Theatre in Computer. In the TC environment children live as authors and directors of plays. The TC plays can be created individually or collaboratively and asynchronously by children through the Internet.

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