A semiotic analysis of sounds in personal computers: Toward a semiotic model of human-computer interaction

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Abstract

We compared three types of auditory interface in personal computing environments: verbal messages, earcons, and auditory icons. We applied Peirce’s sign theory to the three auditory interfaces to conceptualize verbal messages as “dicent symbol legisigns,” earcons as “dicent indexical legisigns,” and auditory icons as “remantic iconic sinsigns.” Based on theories of the triple triangle model for sign production (Kim 2000), we suggested that (a) the three auditory interfaces demand different levels of mental effort for interpretation and (b) the extent to which users are able to interpret the auditory signs of a computer correctly correlates to the communicability of its interface.

Keywords: Human-Computer Interaction (HCI); auditory interfaces; semiotics; signs; communicability; sign production theory.

1. Introduction

The study of human-computer interaction (HCI) is concerned with the processes, dialogues, and actions that users employ in their interactions with computers in a given environment (Preece 1994). Most HCI studies have emphasized the graphic elements of user interfaces, such as fonts, icons, buttons, scroll bar designs, and the arrangement of application elements in displays. It may be true that visual sources can convey more information than sources perceived by any other sense; however, the real world rarely conveys information as solely visual. In everyday life, visual and auditory components of the environment convey information about the world simultaneously, and are often interdependent. We most often use the visual system to provide detailed data about a relatively small focal region, whereas the auditory system provides data from a larger area including regions outside of our peripheral vision. The
combination of data from these two senses provides much of the information we need about our everyday environment (Brewster 1994).

In addition to providing wide-range information, sound from a specific source can indicate what is happening within a system. In particular, we can use sound as a coding method that augments graphic representation. Buxton et al. (1991) have suggested that complex systems might benefit from greater utilization of sound to convey information. There could be a great potential to improve interfaces by exploiting this possibility. At present, interfaces use sound largely to provide alerts and feedback. For example, various beeps and bells indicate incorrect commands or indicate that a process needs attention. Process control plants have also used sound extensively in warning indicators (Preece 1994). Yet, auditory information has the ability to convey information that is much more complex and could greatly enhance the usability of interfaces.

This study compares the three types of auditory interfaces found in personal computing environments: verbal messages (speech sounds), earcons (musical sounds), and auditory icons (natural sounds). Drawing on Peirce’s sign theory, especially the trichotomies of firstness, secondness, and thirdness, we conceptualize verbal messages as “dicent symbol legisigns,” earcons as “dicent indexical legisigns,” and auditory icons as “romantic iconic sinsigns.” The production and use of these auditory interfaces as signs requires a certain amount of mental effort. Based on theories of sign production, especially Kim’s (2000) triple triangle model for sign production, we will argue that the three auditory interfaces require different levels of mental effort for interpretation.

2. Types of auditory interface

There are three types of auditory interface: so-called “earcons,” which use musical sounds; auditory icons, which use natural sounds; and verbal messages, which use speech (Preece 1994). Each can be digitally synthesized or sampled.

Earcons are short, distinctive musical motifs that have well-defined rules of construction (Papp and Blattner 1996) and convey information through “musical vocabularies.” Blattner et al. (1989) have defined earcons as, “Non-verbal audio messages that are used in a computer user interface to provide information to users about computer objects, operations, and interactions.” An earcon uses a musical approach (Brewster 1994), and there is no intuitive or intrinsic link between a sound and what it represents; the link is established by the computer interface designer and must be learned by the computer user. For example, alarms with different meanings may take the form of short, distinctive tunes with different rhythms, melodies, and timbres (Gaver 1993).

According to Blattner et al. (1989), we understand earcons more easily when they have a family-hierarchy; for example, when all earcons representing ex-
Executive orders have common sonic characteristics. Each executive order (such as creating, moving, copying, and deleting files) might share, say, a unique pitch. The common rhythm, timbre, register, and dynamic characteristics create a family that has the same category of function. In this case, pitch identifies a constituent from the family. By combining one family with others, we can extend the meanings of earcons.

Earcons can significantly reduce the workload, duration, or mental effort involved in a task (Brewster 1994; Brewster et al. 1998; Brewster and Clarke 2005; Brewster et al. 1995; McGookin and Brewster 2004). A series of experiments found earcons to be effective means of communicating information, particularly when they used family hierarchies of sound. Sonically enhanced scrollbars, buttons, tool palettes, and windows improved computer usability by increasing performance, reducing time to recover from errors, and reducing workload. There are potentially both advantages and limits to using earcons (Palladino and Walker 2007). Earcons have advantages due to their applicability to any type of menu structure, regardless of menu meaning or domain, and their ability to represent hierarchies by building families of sounds. However, a considerable amount of training can be required to learn the meanings of the auditory elements due to their arbitrariness.

Auditory icons are everyday sounds that represent relevant actions and objects. Similar to earcons, auditory icons can also be organized into families of related sounds. Unlike earcons, however, the arrangement of these families is dependent on relevant dimensions of events (Gaver 1993). For example, selecting a file may produce a tapping sound.

Auditory icons are familiar real-world sounds intuitively mapped onto the interface (Papp and Blattner 1996). Human beings have the ability to identify sources of everyday sounds very accurately, showing error rates as low as five percent in test situations (Brewster 1994). We often immediately understand what is going on only by hearing sounds; for example, the sound of raindrops on the roof is enough to tell us that it is raining. Another important property of everyday sounds is that they can convey multidimensional information. Hearing a door slam provides a listener with multiple layers of information, such as the size and material properties of the door, the force used, the size of the room, etc. (Brewster 1994). Thus, associated sounds can provide information about types of action on a computer. The dragging of a visual icon might be associated with the sound of something scraping a surface, with a similar scraping sound when the icon is moving another folder window. The sound of door shutting might represent the closing of a file, with the size of the file represented by the depth of the sound.

Auditory icons have both advantages and disadvantages (Barreto et al. 2007; Brewster 1991; Dix et al. 1993; Jacko 1996; Palladino and Walker 2007). Provided there are no connections with more abstract mappings of other
systems, auditory icons communicate meanings that users can easily learn and remember. However, applying auditory icon to system design may cause some problems. Not all computer objects and actions have comparable real sounds available to represent them. Moreover, a user may be required to infer meanings for cue sounds and to have extensive knowledge of the sounds because the metaphorical representation of objects or events is completely arbitrary.

The final type of auditory interface, verbal messages, use speech sounds. For example, when a user opens a program, an auditory message might say, “Welcome to this program!” There are two basic ways of generating computerized speech. One is concatenation, the other, synthesis-by-rule. Concatenation uses digital recordings of a real human voice. The voice may be stored as sentences, phrases, or word segments. Relevant computer programs then play these recordings back when required. The rearrangement of words and phrases in the proper order can produce new sentences. Synthesis-by-rule does not use real human voices but instead, synthesizes words and sentences using the rules of phonemics and the contexts of sentences and phrases. Using a database of sounds, this method can produce a wider range of responses than speech constructed by concatenation. Synthesis-by-rule also allows various levels of pitch and tone. However, speech produced in this way can sound synthetic and robotic.

A number of studies have investigated the effects of verbal messages in computer programs. Papp and Blattner (1996) found that when speech and non-speech audio were combined, each presented its own problems of perceptibility in an acoustic environment composed of multiple auditory streams. Grasso et al. (1998) attempted to show that the speed, accuracy, and acceptance of multimodal speech and direct-manipulation interfaces would increase when the modalities matched the perceptual structure of the input attributes. The results showed that the perceptual structure of an input task is an important consideration when designing a multimodal computer interface. Task completion time, the number of speech errors, and user acceptance all improved when the interface was better matched to the perceptual structure of the input attributes.

Other studies have considered the use of human voices in human-computer interfaces from a social psychological perspective. For example, Nass et al. (1994) have argued that users’ interactions with computers are fundamentally social. Through five experiments, they showed that social responses to computers were not the result of conscious beliefs that computers were human or human-like. Moreover, such behaviors did not result from users’ ignorance, from psychological or social dysfunction, or from subjects’ mistaken belief that they were interacting with programmers. Rather, social responses to computers are commonplace and easily generated. Nass and Lee (2000) also showed that people interpret and respond to paralinguistic personality cues in computer-generated speech in the same way as they do in response to human
A semiotic analysis of sounds in personal computers

speech. Moreover, Nam and Kim (2001) found that verbal messages provide a higher level of usability than earcons and auditory icon interfaces since users may use familiar coding schemes (natural languages) to interpret the meanings. It would seem that adding human voices to an interface helps users to treat computers as social actors, which allows them to feel more comfortable, safe, and relaxed.

Any auditory interface used in computer systems acts as a set of signs. Therefore, this study compares the three types of auditory interfaces described based on Peirce’s sign theory. In addition, this study shows how auditory interfaces are conceptualized as sign systems and describes attempts to apply semiotic models to the HCI environment in order to design more usable interactive systems between humans and computers.

3. Application of Peircean semiotics to auditory interfaces

Peirce (1955) pointed out that cognition, thought, and even humans themselves, are all signs. “The entire universe,” he wrote, “is perfused with signs, if it is not composed exclusively of signs” (CP 5.448). Peirce’s semiotics has its philosophical foundation in the idea of universal categories. His semiotic point of view is essentially phenomenological. In his view, there are three modes of being: firstness, secondness, and thirdness (Peirce 1955). This paper analyzes auditory interfaces as signs and attempts to apply Peircean semiotic theory to them by showing how semiotic processes and the characteristics of auditory interfaces affect the usability of HCI. According to Peirce, “A sign is something standing for something to somebody in some respects or capacity” (1955: 99). What a sign stands for is its object. An interpretant is the meaning or the idea to which it gives rise. Auditory interfaces are signs that stand for events to users of an operating system in an HCI. They call attention to events on the monitor or indicate system-operating processes. The most important aspect of a functional HCI is usability; user interfaces need no aesthetic value. Their purpose is to communicate information to users in a precise, efficient, and usable fashion.

A computer program has many signifiers, such as buttons, scroll bars, visual icons, auditory icons, and languages. These enable users interact more easily with the computer. When a program’s usability is high, users understand the intentions of the programmer well. In this sense, when we work on a computer, there is an ongoing exchange of signs between the programmer and us. When we click a mouse or use a keyboard, we are interpreting the signs provided by the programmers. Auditory interfaces (verbal messages, earcons, and auditory icons) are also signs representing certain events in computing. Each kind of auditory interface has its own references and meanings.
Each of the three types of auditory interface has its own characteristic signs, its own processes of perception, interpretation, and signification, and its own modes of being. We next describe the logic and modes of signs.

3.1. Logic of signs in Peirce’s sign system

Peirce’s semiotics has three trichotomies of concepts for a sign, an object, and an interpretant. The first trichotomy is the sign itself and its actual existence. The second is the relationship of a sign and the object. The third is the interpretant representation of the object. These three basic components of sign, object, and interpretant can be better comprehended through the trichotomies.

The first trichotomy divides signs into three concepts: qualisigns, sinsigns, and legisigns. A qualisign is the quality and simple possibility of a sign’s existence. It cannot actually act as a sign until it is embodied; but the embodiment has nothing to do with its character as a sign. A sinsign is the actual existent thing or event that is a sign. A legisign is a law that is a sign. Every conventional sign is a legisign and has a general type. Each single instance of a legisign is a replica. The replica is a sinsign (Peirce 1955).

Peirce’s second trichotomy of concepts is that a sign may be termed an icon, an index, or a symbol. An icon is a sign that refers to the object that it denotes merely by virtue of its own characteristics, which it possesses, whether any such object actually exists, or not (Peirce 1955). Icons can be of three types: images, diagrams or metaphors. An image represents simple qualities as the basis of the sign-object relationship. When an icon represents the relation between sign and object based on similarity, it is a diagram; a map is a typical example. Metaphors are those icons that do not represent a relation between a sign and an object. The second category in this trichotomy is sign as index. An index is its object, not so much because of any similarity or analogy with it, nor because it is associated with general characters, but because it has a dynamic connection both with the individual object, and with the senses or memory of the person for whom it serves as a sign (Peirce 1955). In other words, an index relates to its object through co-occurrence and with the object and by the objects effect upon it. A symbol is a sign that refers to the object that it denotes by virtue of a law and is itself of a general type and a replica. Most linguistic signs are symbols. For example, we speak of writing or pronouncing the word “man”; but what is spoken or written is only a replica. The word itself has no existence although it represents a real entity. The three sounds, or representations of sounds, become a sign only through a habit or acquired law that causes the replica to signify “man” (Peirce 1955).

In the third trichotomy, a sign may be a rheme, a dicent, or an argument. A rheme is a sign of qualitative possibility and represents a possible object.
Any rhyme will afford some information but this is not fundamental to its nature (Peirce 1955). It is neither true nor false but a qualitative possibility. A sound from an unknown source is a rhyme. A dicent is a sign of actual existence. It is both affected by, and indicates, a real object. A weathervane is an example of a dicent. It is affected by wind direction, and indicates wind direction. Body language is another example of a dicent, since it is the direct result of a person’s actual attitude and is therefore affected by that which it represents. Facial expression, body position, and gesture typically create effects at the level of emotional or energetic interpretants (Turino 1999). Finally, an argument is a sign of law. A rhyme represents its object merely in its characters, and a dicent represents its object in respect to the object’s actual existence. An argument represents its object in its character as a sign. Symbolic propositions and linguistic premises are arguments because they can prove its truth by making a judgment.

3.2. Mode of being in Peirce’s sign system

Peirce’s basic premise is that signs are the only means of expression for our thoughts, images, and concepts. Semiosis allows the realization of signification and communication. Peirce divided the semiotic modes of being into his phenomenological categories of firstness, secondness, and thirdness.

Firstness is an object’s mode of being as it is, regardless of anything else or of its relationships. The mode of being of “red” was a positive qualitative possibility, before anything in the universe was yet red (Peirce 1955). It is the category of unreflected feeling, potentiality, freedom, immediacy, undifferentiated quality, and independence (Nöth 1990). Secondness, according to Peirce, is a mode of being in which an object depends on a second object (Peirce 1955). Secondness denotes a relationship between a first object and a second without the mediation of a third. It is the category of comparison, action, reality, and experience in time and space. Thirdness is the determinate general character of future secondness will take on (Peirce 1955). In other words, thirdness is a mode of being mediated between the being of two other objects. It is the category of meditation, habit, memory, continuity, synthesis, communication, representation, and sign.

Every sign has its definition in the three trichotomies. The three trichotomies divide signs into ten classes. Every trichotomy has three types of signs. Each type of sign in a trichotomy can correlate with each type of sign in the other two trichotomies. Systemically, there are twenty-seven theoretical classes of signs, but only ten categories are actually possible. A sign type of firstness cannot include or combine with a sign type of secondness or thirdness. A sign type of secondness cannot include or combine with a sign type of thirdness, but it
Y. Nam and J. Kim

can include or combine with a sign type of firstness or secondness. A sign type of thirdness can include and combine with a sign type from any category. For example, dicent (secondness) cannot be an iconic sign because an icon affords no ground for an interpretation of it as referring to actual existence (figure 1).

4. Applying Peircean semiotics to auditory interfaces

4.1. Categorizing auditory interfaces

A computer program has many signs, such as buttons, visual icons, auditory icons, and language, all of which have some function. Programmers create these signs to allow users to handle the computer easily and competently. To say that some programs have high usability means that users understand the intentions of the programmer well. Programmers convey their intentions to users with signs. Users need to understand the meanings and functions of signs in order to interpret events and complete tasks on the computer.

In an HCI environment, one more semiosis is necessary to use a computer: that of the computer as an interpretant. Users click the mouse button or hit a key to order the computer to do something. The computer converts these user actions into digitized signals or signs by which the CPU accomplishes the task. A user’s performance and the system’s reaction co-occur. For example, if a user hits the letter “G” while using a word processing program, the letter “G”
A semiotic analysis of sounds in personal computers

appears on the monitor at the same time. Hitting that key is a sign that the user gives to the system, and the letter “G” on the monitor is also a sign. In an HCI environment, users and systems share signs and objects (figure 2).

Peirce’s semiotic terms, such as icons, indices and symbols, have been used extensively to describe, predict, and explain HCI phenomena (de Souza 2005). The word “icon” is now in common use among computer users.

Although many current HCI studies refer to semiotic theories, many overlook Peirce’s basic philosophical notion of semiotics. Peirce’s definition and classification of signs helps us to understand the semiotic complexity involved in producing and interpreting signs in HCI (de Souza 2005). Classification of signs according to Peircean semiotics is only useful when based on its intrinsic philosophy. For example, semantic directness is a function of the distance between a user’s conception of their goal and the corresponding structure of functions and procedures in the abstract model of the application. The model can shed light on semantic directness since it can be characterized by firstness, secondness, and thirdness (Hutchins et al. 1986). Category-based semiotic analyses in HCI studies can reveal how different visualization styles and manipulations are interpreted and compared by users, how technology influences problem solving strategies and knowledge discovery, and the different levels of efficiency of types of representation in HCI (Sedig 1998; de Souza and Sedig 2001; de Souza 2005).

Even though category-based semiotic analysis has various uses for HCI study, most studies have focused on the classification of visual components of interfaces using Peirce’s sign system. We can use auditory interfaces, such as verbal messages, earcons, and auditory icons, to improve usability of user interfaces. They represent events in computer operation just as visual interfaces do, and directly influence the level of users’ interpretations, problem-solving strategies, system efficiency. Therefore, this study applies Peirce’s sign classification system to auditory interfaces. We will employ Peirce’s ten classes of signs extensively, rather than just simple categorization into icon, index, and symbol in order to provide more descriptive, predictive, and explanatory powers to our understanding of auditory interfaces in HCI.

Figure 2. A semiotic model for HCI
A verbal message can be the dicent symbol legisign. Suppose a computer mailbox receives an e-mail and the computer system informs the user that, “Mail has been received.” This linguistic message is a symbol. The words, “Mail has been received” replicates the meaning of receiving an e-mail on the computer. Only the situation of receiving an e-mail can cause that event to occur. As this message is of a general type and is a conventional language sign, we can call it a legisign. It indicates an objective fact — that an e-mail has arrived at the computer system — so it is a dicent sign. Thus, a verbal message is a dicent symbol legisign. It produces the thirdness of its referent using conventional language related with an established meaning to represent an actual occurrence within the interface system.

An earcon is a dicent indexical legisign. The dynamic connection between the auditory sense of a person and the task on their computer causes the musical sounds to serve as a sign and brings out the secondness of its referent. We use musical signs in our everyday lives. For example, on a TV quiz show, when a game player answers correctly, a musical sound is played. If a player answers incorrectly, another sound is played. We know whether the answer is correct or not based only on the musical sounds. Another example is the gong sounds used in boxing and wrestling matches. These sounds are indicators of meaning. The musical sound on a TV quiz show indicates whether an answer is correct or not. The gong indicates the beginning or end of a match. The function of musical sounds in an auditory interface work the same way. When a computer program opens and a musical sound plays, the sound indicates the opening of that program. However, this sound has no direct similarity or analogy with the operations of users or events on a PC monitor.

Yet not all musical sounds can be index signs. People can judge certain situations based only on a corresponding musical sound. Usually, error messages use high tones and single sounds. People experience musical sounds as positive or negative, processing or suspending, relaxing or stressful, because musical feelings are conventional. Musical sounds abide by certain laws: harmonics, counterpoint, rhythm, and pitch. They indicate actual events that occur during computer use, which makes earcons dicent indexical legisigns.

An auditory icon is a remantic iconic sinsign. For example, the real sound of a closing window might signify the closing of a program. Although there is no relationship between closing a program and closing a window the event of closing a program is inferred from the sound of a window closing. The sound of a closing window has its own characteristic. Although it does not mean closing a program, people accept it as a sign of this so that it becomes an iconic sign, essentially a metaphor that occurs only when a program is closed. Closing a window or its sound does not represent closing a computer program itself but something interpreted as the closing of a program. Any auditory icon will afford some information but does not automatically indicate an actual
occurrence in the system. In addition, we cannot judge the sound of a window closing as true or false, but we interpret it as a sign of some event actually happening, so the auditory icon is a romantic iconic sinsign.

Based on Peirce’s theory of signs, we argue that verbal messages are dicent symbol legisigns, earcons are dicent indexical legisigns, and auditory icons are romantic iconic sinsigns. However, this categorization does not mean that they are mutually exclusive as the ten classes of signs are not so. In some case, earcons may be closer to firstness than secondness when they reflect feeling and emotion first rather than conventional relations by laws. For example, fast, repeated clanging bell sounds without well-organized music rules can represent something happening in the system that the user interpret as dangerous or urgent. In this case, we could call it as dicent indexical sinsign.

4.2. Usability and communicability as interpretation

Computer systems are symbolic tools (Andersen 1997: 1). Semiotics has provided current HCI studies with insight into the nature and use of computer-based signs. According to Anderson (1997), there are three reasons why semiotics is important to HCI studies. First, the demand for interpretability has risen because computers are now in such widespread use. A good system requires a good interface that all users can understand easily. Second, computers with online networks provide the functions of media such as textbooks, personal letters, newspapers, broadcasts, telephones, films, and games, in which the importance of semiotics is well established. Third, users often have to rely solely on the computer-based signs in complex system when making decisions. Thus, demands to the interface have become much greater.

As computer systems and their interfaces become more complex, usability has become a key concept in HCI (Preece 1994). It is a comprehensive concept that includes safety, utility, effectiveness, and efficiency. It is concerned with making systems easy to learn and easy to use. Usability is measurable in terms of accuracy, time, and satisfaction with the subjective workload. Even if computer system has a powerful capacity, users will avoid using it if it annoys or confuses them. It is important that system designers adequately evaluate the usability of system designs.

de Souza (2005) introduced the concept of communicability by adding semiotic notions to usability. They defined it as “the distinctive quality of interactive computer-based systems that communicate efficiently and effectively to users their underlying design intent and interactive principles” (2005: 113). It also can be evaluated as the designer’s deputy capacity whether the interface achieves full metacommunication, conveying to users the gist of the original designer’s message. Therefore, from a semiotic perspective, the ultimate
purpose of HCI is to increase the communicability that the interface provides between the system and the user.

4.3. Sounds in personal computers in the semiotic model of human-computer interaction

According to the sign production theories of Eco (1976) and Rossi-Landi (1975), and the triple triangle model of Kim (2000), the production of a sign is a three-stage process. The first stage is the production of a percept through perception of the material sensory data of an external object. The second stage is the production of a sign by the percept’s action of signifying. Last is the production of a meaning from the sign through the act of interpreting. Drawing on theories of sign production, this study attempts to model this process, as shown in figure 3. Sign production theories imply that degrees of interpretability determine the usability or communicability of an auditory interface.

Any auditory interface used in a computer system is a set of signs. Every sign needs a material foundation. Sounds need a source, a physical action. Humans understand objects to relate to two different things by perceiving them. We base our percepts on bodily experience that we cannot share with others. The auditory experience of a sound is also a bodily experience. We hear and perceive a sound but cannot share what we heard or compare it with the inner experience of that sound by others.

Reproduction of the percept should produce something exchangeable: it must be a “perception for others” or a “social percept.” Therefore, we need another human action that produces a sign from a percept: signifying. To use the sound sources in a computer system, an auditory percept must be a sign that is exchangeable with others. The design of computer interfaces should improve communicability for all users, rather than one specific user. All auditory interfaces, that is, verbal messages, earcons, and auditory icons, should fulfill this aim.

Finally, signs are both human productions and objectifications of human subjectivity. They should produce meaning for others since any sign exists only in the action of interpreting. Interpreting is the sharing of another’s percepts as my own through meditation. This implies that the referent of a sign is not the material object but the percept. Signs, in the form of auditory interfaces, must be suitable for easing purposeful operation of a computer in a HCI environment. A well-designed auditory interface sign is only interpretable as something close to its actual operation. However, there may be differences in the degree of interpretation. Some auditory interfaces provide better signs for computer operation. They convey the intention of the programmer precisely and allow users to operate the system usefully, effectively, and easily. Other auditory interfaces are, unintentionally, rather disturbing things. The difference is a result of the degree of interpretation required.
A semiotic analysis of sounds in personal computers

5. Conclusion and further thoughts

We argue that every verbal message, earcon, and auditory icon could be included in one of the ten semiotic categories. Every auditory interface has its own sign characteristics. A verbal message is a conventional sign that requires users to know the laws of a linguistic system to interpret it because it is close to a sign of thirdness. On the other hand, earcons and auditory icons belong to firstness or secondness. A sign of firstness or secondness is a more dynamic and emotional interpretant than one of thirdness. In particular, an auditory icon is a metaphor of an iconic sign, and must therefore be accepted as a percept by the programmer, the user, and the computer at the stage of signifying. These minute differences of semiosis can create differences of interpretation. Verbal messages are dicent symbol legisigns of thirdness by law and rule. They need no learning and no instruction. Language is a universal form of communication among humans. It admits no separate interpreting of the output of the computer as signs and removes the possibility of confusing or misunderstanding events during computer operation (figure 4).

We hypothesize that the more users correctly interpret the signs of a computer, the more usable or communicable the system is. Computer users may
anticipate the computer creating an everyday environment that is common among humans. Verbal messages bring the computer closer to the human state. Now the computer is a thing beyond a machine. It is no longer an alien object used only by experts. The ages of automation and cybernation have passed, and we are now in an age of interaction (Huhtamo 1999). According to Manovich (2000), the general-purpose HCI of traditional cultural interfaces relies on already existing metaphors and action grammars. There is a pragmatic orientation to computer design. This orientation begins with an understanding of technology in the human context based on how it fits into the day-to-day practices and experiences of its users (Coyne 1995). Therefore, the classification of auditory interfaces through the application of semiotics to HCI study could contribute to our ability to design interactive systems with greater computer-human communicability.

References

A semiotic analysis of sounds in personal computers


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