Emotional Design for the Blind users: Application of Tactile and Auditory Semiotics in Product Design

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Abstract

As products features and functions and user's conceptions of them could be a part of each product's beauty, aesthetics in product design is not limited to the appearance of a product. Users feel beauty with all of their five senses, so sight is not the only tool for understanding the aesthetics, but a part of each user's emotional ability.

To develop a new product design paradigm for sensitive-disabled users, in the first phase of this research both physical requirements and emotional needs of a blind user (as a certain) group has been studied.

In a product design project as an experimental phase of the study, defining the non-visual signs and symbols for usage scenarios, helped the design team to create an emotional but non-visual design for a product which was designed for blind users, who use their touch sense as the main tool for understanding and interacting with products. A physical model of final design (the laptop for the blind) was evaluated by the user group and achieved attention and successes in various national and international exhibitions.

The results of experimental phase led to a discussion about a holistic and extendable paradigm for bringing emotion into products which are designed for sensitive-disabled users, especially blind users. The study shows that how an emotional dialogue between disabled users and products could exist without depending on visual signs and symbols.

Conference theme: Usage & Interaction
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1. Introduction

Each communication could be based on sight, touch, smell, taste, and hearing senses. In other words, these are signs which connect us to the surrounding world. In recent decades, technology have made many communications machine mediated, so many users feel a lack of emotion in their everyday life. Maybe, that is why designers developed the emotional design concept. One of the main targets of emotionalism in design is to build a deeper emotional communication between products and users, so the designer should use symbols which are known for users or could be found out by them during the usage. This is clear that like other kinds of communication, semiotics play an important role in this process.

Unconsciously, most designers focus on visual signs and symbols in their designs and there is an unwritten rule that a beautiful object should be only visually beautiful. However, each object could be recognized by all five senses. Users with disability in one of their five senses, usually try to strengthen other senses in order to communicate. In this way, they replace the disable sense with other senses. As a specific group of disable users, blind users see objects by touching and sometimes hearing them, so the touch sense is their main source of cognition.

Because of the lack of experience in aesthetics for senses except sight, most products which are specifically designed of blind users, has no emotional and aesthetic value. This situation some times causes blind users to tend to products which are designed for users without disability.

Signs are of most important communicative links in the above process, so in a design project for a certain disable user group, designers should be aware of specific usage of signs according to the understanding and emotional state of users. This research focuses on the area of emotional design and semiotic for blind users, and a design project about a laptop for blind users is the experimental basis of the study. The final result was not only a design sample, but discussion a model for further design activities in similar fields.

2. Background

According to Saussure one of pioneers in the field, semiotics studies the signs and symbols in the social contexts (everyday life) (Nadin, 1990). One of the most recent definitions of semiotics is Eco's definition, which represents the semiotics as the semantics of all kinds of signs and symbols. Signs are the main focus of semiotics (Eco, 1979). The word Semiotic has been driven from a Greece word “seemeiootikee” that means studying sign. Sings are the essential parameters of all communications from early ages until now.

Contemporary to Saussure, an American mathematician Charles Sanders Peirce also worked on semiotics and they both have different models for semiotics, which could be connected to the product design domain (Nadin, 1990). To understand the correspondence between conventional semiotics paradigms and terms, a typical example about a well known product design has been explained.

Figure1.Click wheel of iPod

In the Sussure's model, terms like signifier, signified, sign, denotation and connotation play important roles. The Click Wheel of iPod (Figure1), could be analyzed by these terms as follows:

1- signifier : wheel
2- signified : the sense that user feels via thouching the wheel: nostalgia
3- sign: the wheel and the nostalgia together make up sign as the smallest unit of meaning
4- Denotation : the circular shape of the wheel and the way it turns
5- Connotation : the nostalgia which is result of the circular shape and is the secondary meaning of the wheel which is the nostalgia to one's childhood

Alternatively, in the pierce's model representamen , interpretation and object are the main principals, these terms could be seen in the Click Wheel as:

1- representamnen: the wheel and it's circular shape
2- interpretant: childhood nostalgia
3- object: the circular shape (from both visual and tactile aspects) reminds users their chilhood, as they may have a nostalgia about their toys with similar circular forms.

2-1. Product design and semiotics

As design, on its both macro and micro scopes concerned with communication, the nature of design is semiotic. According to Herbert Simon, a large number of modern human activities connected to design and consequently semiotics. Generally, there are two main implications about the relationships between design and semiotics; one suggests that semiotics is mainly

engaged with the function and usage of a product and the other concentrates on the role of semiotics in the aesthetics and the feelings which are transformed by a product (Westerlund, 2002). Currently, the application of semiotics in computer science and software technology has a great influence on product design, as many products use related technologies and have a kind of smart behavior, so two implications of product design semiotics are going to be mixed in many products (Johansson, 2002).

2-2. Semiotics and blind users- specified products

Although there are significant research studies about the relationship between semiotics and disability, most activities have been done in sociology and psychology areas, not in technology and design related issues. A good example of these studies is the book "Semiotics and Disability, Interrogating Categories of Difference" by Linda J. Rogers and Beth Blue Swadener which includes a set of narratives and summaries of research studies about the problems of existing definitions of disability and difference (Rogers and Swadener, 2001). The applied semiotics has been used an analytical tool to examine the alternative ways that these definitions are socio-culturally constructed (Loisel, 2007).

Alternatively, Braille system as a transmitter has benefited the semiotics in an experimental way, and known as an excellent example of applied semiotics (Saint-Martin, 1990).

2-3. Sensibility Design:

Designers worldwide have adopted various approaches in order to appeal emotionally to users and to infiltrate a competitive marketplace. This tendency is essentially driven by a combination of the rationality of functional design and the sensibility of user-cantered design.
Sensibility often refers to complex feelings such as amenity, pleasantness, comfort, pleasure, and so forth, which are often experienced in the use of objects. Sensibility-Design can be characterized as a specific design approach, which generates products that stimulate the human mind and the senses through visual, audible, and tactile factors (Kim and Boradkar, 2002).
It is obvious that the tendency has evolved from a branch of Pluralism, but derives its essential ideological promise from Modernism.

According to Donald Norman, author of “Emotional Design: Why We Love Everyday Things”, emotional design is base on 3 stages in each product and the users of those products (every product, with or without designer’s intention have these aspects in it) (Norman, 2004):

- *Visceral Design:* It is all about the nature and substance of a product and how a product looks and feels and appears

- *Behavioural Design:* This is about the using process. In Behavioural Design, function plays a more important role than form and appearance.

- *Reflective Design:* It is about the meaning of a product: what this product will tell about you to others? Reflective Design is users' imagination about themselves and also depends on the age and culture of users. In Reflective Design the brand and marketing immerge: selling products not for their functions, but for prestige and being unique. In fact, Reflective Design is creating something that you can "show off" to your friends and attract their attention. This aspect was one of the main focus points of the research study.

3. Methodology

Effective signs are the main essentials of a successful communication between users and a product (and therefore between users and the designer). In order to discover and/or create these signs for a product which is specified for blind users, in the first step the fundamentals of semiotics and emotional design were reviewed; then a study on the behavioral paradigms and physical limitations of a certain (blind) user group was conducted. This study, along with the knowledge of semiotics helped the design team to define a number of useful signs for design. Based on these basic signs, a number of design ideas were generated. Ideas were evaluated by the same user group, and the final design was shaped by their suggestions.

This process which had a quite practical content could be itemized as following:

3-1. Phase 1: study on a blind user group

Because of the practical content of research (in which design practice was the core part of the project) a blind user group was studied by both observation and interviewing methods.

For each user, his/her detailed usage scenario of interacting with a personal computer or laptop has been observed and studied. The ways that they communicated with products, with other users and with the surrounding world were observed to find their needs and related usability problems. For the most parts of the observations, blind users were not aware of observers, so their behaviors were quite natural and intuitive. In other words, the observation was hidden.

Because of the physical disability of blind users, experiencing the feeling of them was impossible for designers and also it was not easy to conceptualize typical users and usage

scenarios. Therefore, interviews were of great importance to this phase. Design team understands some remarkable points by interviews which were difficult to be found out either by observation or self-experience of designers.

3-2. Phase 2: Idea generation

Following sources guided the design team in the idea generation phase:

- Findings of study on signs in related usage scenarios
- Users' behaviour paradigms and users' needs
- Emotional design principals

3-3. Phase 3: Developing the final design

Outcomes of study phases (phases 1 to 3) were the bases of evaluation parameters and also definition of suitable signs for final design. Top rated ideas were turned to limited number of design concepts. These design concepts were described for members of user group and the final design concept was mainly selected based on users' evaluation. Moreover, users' suggestions about design concepts were mentioned in the process of final design. Before a physical design of product, its logical entity was discussed in order to study on its emotional-semiotic content.

4. Study on a blind user group

4-1. Observations:

The observation was conducted in the blind users' computer centre of University of Tehran. The centre was equipped with computers and Braille tools for the blind people.

There were 10 blind people and all of them were experts in using computer. This group included 3 girls and 7 boys with at least bachelor's degree and their age were between 25 to 30 years. The observations were made by the design team for about 2 months (2 times a week) each time for at least 4 hours. Here, we have provided a list of the most frequent behaviours of blind users.

4-2. Specific behaviour of blind users in interacting with computers:

A brief summary of most important points in this step could be presented by following items:

1- Screens are generally off unless they want to show something to a normal people.

2- They use more of auditory feedbacks in their interactions. (TTS soft wares like JAWS are very complete so that they can rely on its services)

3-Braille transmitters (for Braille input and output) are totally useless for them (in this case study) and they avoid using them.

4- They adjust the pace of the voice of the TTS so fast that they skim (hear briefly) each word in a way which is not easy for a normal user to do so.
5- For input, they usually use ordinary keyboard and the starters memorize the locations of the keys on a keyboard like typists but the experts just know where the keys are located by practicing.
6- They use scanner to scan the texts and then via special soft wares (OCRs) they transform the scanned text into plain text and they hear it by JAWS.
7- For showing their abilities, they use normal PCs more and they do not like to interact with special designed machines for the blind. According to Norman's opinion, "they don't like them"
8- They can guess roughly the situation of the mouse on the screen via JAWS, saying the number of the conjunction of the X and Y axis of the mouse pointer on the screen.
9- They can play special voice games that have been designed for the blind expertly. E.g. they can play tennis game by hearing.
10- Except for graphic icons, they can interact fully with computer and internet and their contents.
11- For input, some of them prefer to use Braille transmitters, but most of them prefer to use ordinary keyboards.

4-3. Interviews:

Following interview, stimulate a typical interview, in which a summary of the findings could be observed:

Q: What are the problems of the existing computers?

A: For typing words, a user has to memorize the locations of the keys. We generally use the computers that have been designed for normal people. Braille transmitters are so expensive and we can not afford to buy them. There are few such devices in some public places like libraries, schools and universities that have been bought by the government or the NGOs. Other high tech devices that are now on the market are also so expensive and unavailable in Iran. Because of this unavailability, we prefer to practice on TTS soft wares.

Q: Do the existing devices fulfil all your requirements? Do you enjoy using them?

A: Braille transmitters which have been manufactured in Iran, have so many essential problems that make them hard to use for the users. Because we don't feel like the owner of the devices and feel that they are for public use, we can not like these devices.

Q: Do these devices fulfil all your computer need?

A: If all the converter tools are available, except of feeling the screen and it's content by touching it and understanding graphics and pictures, our needs will be fulfilled, but the problem is that they are not available as whole in a place.

Q: Do you need a portable device that prepares the opportunity for you to take your information with you everywhere and have been specially designed for you and your needs?
A: Yes, this is our essential requirement to reach to our information easily and everywhere and at last but not least, it is so important for us to communicate easily and properly with our surrounding world; a communication that is not based on our disability but based on our special abilities.

4-4. Findings

As mentioned on previous sections, for choosing proper signs for designing a laptop for the blind, various aspects such as semiotics, emotional design, tactile design rules, sensibility design, blind user (in physical, psychological and social aspects) should be considered. The results of each of above categories were classified, and this classification was the start point of finding suitable and/or creating signs and also the design the whole product. In summary, following items could be mentioned as the main findings of this phase:

1-Blind users are usually depressed: signs should help them to come out of their depress mood.
2-Using process should be easy and simple: functional signs such as voices or noises conduct the users to an easier using process
3-Blind's surrounding people should be motivated to communicate with them. (Reflective Design and visual aspects of product): signs should reflect the user's thoughts and abilities to other people (they should start a conversation)
4-Blind people tend to act independently: acting independently can be shown and suggested by special signs such as functional signs like alarms for some functions or auditory feedbacks that lead the user to act undependably in using the computer (e.g. telling screen's situation by special alarms)
5-Users prefer the forms which follow function (considering simplicity, straightforwardness, being standard, showing structure and material)
6 –The tactile sense is the main bridge between user and the product.
7- User's privacy during hearing the TTSs is of great importance to them, as they don't like to share their space during listening to the sounds.

4-5. Design guidelines:

In order to connect the sensibility design, emotional design section and semiotics principals, a correspondence between the main characteristics of design and the main categories of design parameters has been defined as shown in table 1.

Characteristics of design	Design Parameters
• Obvious, plain • Contains an opinion and thinking • Has a meaning of satisfaction, relaxation, etc.	**Function**
• Combination of organic and geometric forms • Represents elevated and higher meanings • Formed on basis of users need and emotions like: nostalgia, richness, happiness, etc.	**Form**
• Represents the form • As a part of the product (dependable) • Transfers emotions from higher qualities	**Colour**
• Fortifies contrasts • A combination of organic and artificial materials • High tech elastic and plastic materials • Inspires fulfilled emotions like: enjoy, satisfaction and etc.	**Material**

Table 1. Correspondence between characteristics of design and design parameters

According to this correspondence, for designing tactile signs and parameters, there should be also a kind of paradigm or a pattern. In this way a research which has been done by a group about design principles for tactile interaction has been studied (Challis and Edwards, 2001).By focusing on blind users, the researchers have organized a list of rules for tactile design, which could be used as design guidelines:

- A consistency of mapping should be maintained such that descriptions of actions remain valid in both the visual and the non-visual representations.
An example in music would be a reference to a location such as “The last bar of line two on page three”. The same would apply to the relative location of on-screen controls including the directions in which they can be moved

- The tactile representation within an interface should focus on data that is static.
This was partially due to the lack of dynamic displays that can function at a tactile level. However, even if a display was dynamic there would still be a problem in notifying the user exactly where within the display a change had taken place. Reliance on visual feedback would be defeating the purpose of integrating tactile interaction in the first place

- Height should be used as a filtering mechanism. The user should be able to home in on certain information types using height as a discriminating feature

- Good design will avoid an excess of ‘empty space’ as this is a significant source of confusion.
The term ‘empty space’ is used in reference to areas on a display that do not communicate anything useful to the user. If a user can place a fingertip into a display without quickly locating a feature that gives them a meaningful cue they are effectively in ‘empty space’. It might not be possible to eradicate this but it should be minimized

- A simple visual-to-tactile mapping is likely to produce many problems and is therefore unlikely to be the most efficient design strategy.
This is not in conflict with the first principle that was described. A consistency of mapping can and should be maintained but the likelihood is that the tactile display will not actually look like its visual counterpart.

- Good design practice should, whenever possible, encourage a specific strategy for the exploration of a particular display.
If the display is to be used in a non-visual way then this principle becomes particularly significant. However, even when used in support to a visual display this principle remains valid. It would be undesirable for the user to have to visually monitor the tactile display to observe their progress within an action.

- Double-clicking is an inappropriate form of interaction within static displays.
Without haptic feedback, double-clicking can quickly become inefficient leading to the user perceiving closure when it has not been achieved. Alternative methods using multiple points of contact and timed single-presses are being explored as part of the Weasel project.

- A display should be sized and orientated such that users are not expected to overreach to discover the full extent of the display.
This may seem obvious but it is surprising how often users will fail to fully explore a display when they are unable to see their progress. A suitable maximum display area is approximately A4 sized in landscape orientation.

- Tactile objects should be simple.
When designing objects for use within a graphic display it is possible to employ a considerable number of dimensions by which differences can be achieved. Tactile interaction can allow

subtle changes within a dimension e.g. changes in height, width or texture. However, the greater the number of dimensions along are (which the user is expected to notice the change); the more complex the object will appear to be to the user. Changes along fewer dimensions will make for a more immediately recognizable object which will in turn provide a basis for faster and more accurate interaction.

5. Idea generation

In a brain storming session, managed by design team and conducted by 5 users (expert in computer), blind users started to generate ideas for the functions of the device, here is a list of most important ones:

1- Light pen: a mouse like pen that can read anything is under the pen: auditory feedback
2- When monitor in needed it can be available and when it is not needed, it can remain closed.
3- Alternative keyboard; i.e. user can choose among the alternative inputs
4- User can draw shapes and have auditory feedbacks of what he/she is drawing.
5- Keyboard be touch sensitive: tactile and auditory feedback
6-Embossed ordinary keyboard with Braille signs on it so that the user can learn where the keys are and then embossed keys transform into ordinary keyboard and again when needed, he/she can press a key to know what is the key that he/she is pressing. (this would help the starters to learn the location of keys and then when they become master, they can ON and OFF the embosser accordingly)
7- A device that can be put on the finger tips and is sensitive so the user can read with his/her finer tips.
8- Auditory feedbacks whilst typing
9- Shortcut keys are available every time.
After idea generation, because there were so many ideas that only some of them were useful, design team had to have a pre-task assessment of ideas and choose the best of them based on the assessment parameters. (The above mentioned ideas are the assessed ideas only).

6. Developing the final design

As mentioned before (the methodology section), final design was developed based on some steps such as evaluation and logical design:

<u>6-1. Evaluation parameters:</u>
A) Product semiotics:

1- Enabling the emotional communication and fulfilled sensual needs function's beauty for a blind user group
2- Considering the people surrounding the blind users and possibility of communication via blind user's product. (Social communication of the product, which is related to the application of signs)
3- Possibility for a blind user to choose how he/she wants to communicate with the product via his/her existing 4 senses. (Optional signs and functions that let the user choose them, not they choose the user)

B) Product usability:
According to the findings of phase 1 and also the study on product's semiotics, following parameters were used in the evaluation process:

1- Simplicity of usage processes.
2- Considering the tactile sense as a priority (after the visual sense, tactile is the priority)

6-2. Principles for defining signs

For choosing proper signs for the final design, design team considered a combination of parameters about semiotics, emotional design, tactile design rules, sensibility design and design for blind users from physical, psychological and social aspects. The main principles in this way were:
1- Blind users (like other disable users) could be often engaged with depression: signs could be used as tools for affecting the users' moods.
2- Signs could be used for more simple usage scenarios. Functional signs such as voices or noises conduct the users to an easier using process
3- Based on reflective aspect of emotional design product's signs would be a way to connect the disable user to other users in the same context.
4- Blind people tend to act independently: acting independently can be shown and suggested by special signs such as functional signs like alarms for some functions or auditory feedbacks that lead the user to act undependably in using the computer
5- By considering tactile sense as a main sense the tactile signs should find their way in the final design.

6-3. Design concepts

In order to use previous research studies in the design project, design team defined a simple process with certain communications between different parts of the study. Figure 2 shows a diagram about how design guidelines are connected to the design concepts.

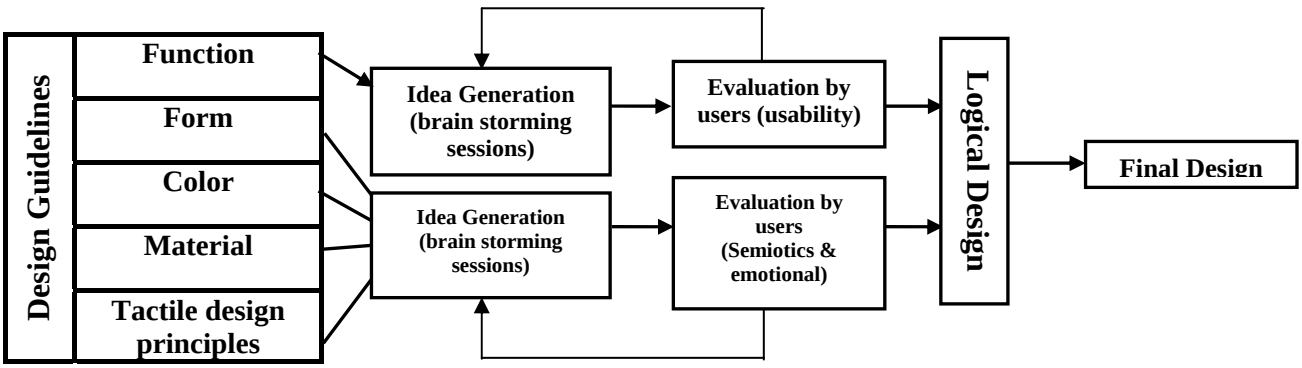

Figure 2. Connections between design gridlines and design concepts.

Assessed Ideas acted the raw inputs for design team to develop them in various design concepts (Such as figure 3). In fact design team used these ideas and mixed them in various products and then assessed the final sketches on the basis of the assessment parameters again, and after that they started to develop the assessed ideas again by logical design that was approved from the sketches:

After the idea generation, the details were explained to users and their evaluation was effective on the development of final design.

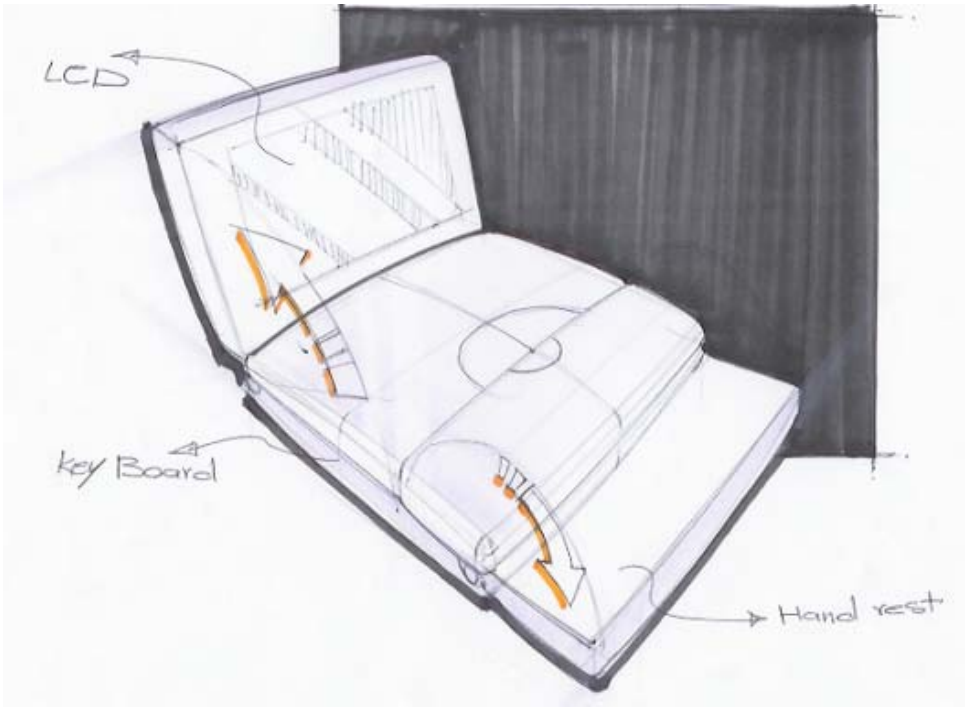

Figure 3: Sample of initial design concepts

6-4. Logical design

As the final product a laptop for blind users would consist of so multiple features, and the lactation of them was very critical especially for a blind user, design team had to determine the priority of importance of the elements and tactile signs like where they should be located according to the availability and easiness of usage process. (Figure 4)

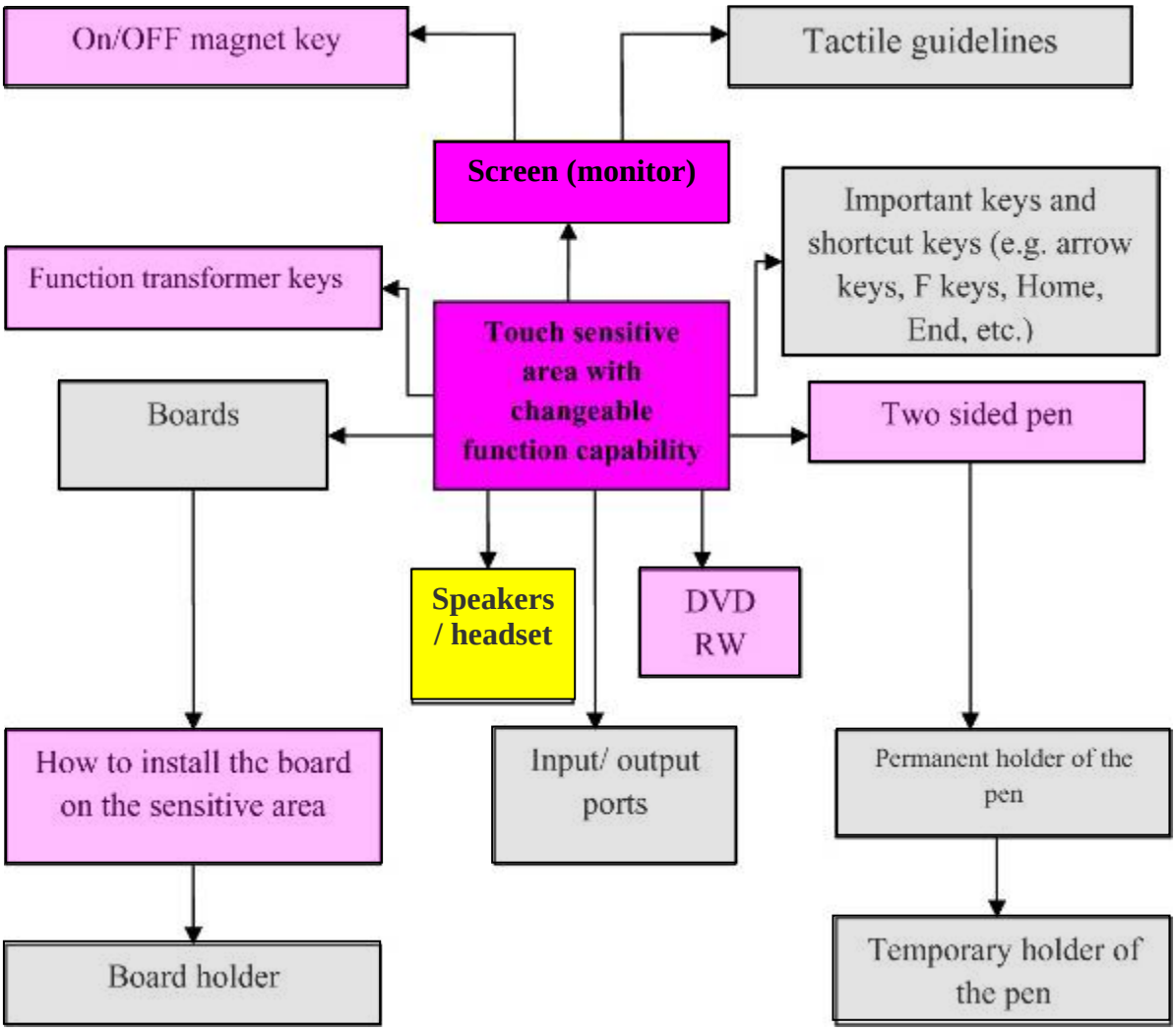

Figure 4: Overview of logical design

*Guide: Represents area for both tactile and auditory feedbacks
Represents area for both tactile and auditory feedbacks
Represents area for only tactile feedbacks
Represents area for only auditory feedbacks

6-5. Final Design

The final design (figures 5,6) , Laptop for The Blind (LTB) has a combination of new user interface and tactile signs, which gives the blind users various options during the usage, such as tactile shortcut keys (figure 7), a magnet grasp system which gaudies them through the touch screen display and a Braille input (Figure 8). All these multiple user interfaces, could be found easily by users as they where classified and recognized by tactile signs. The design won a silver

award of Geneva International Exhibition of Inventions in 2007 and also was a selected design of University of Tehran Industrial Design Exhibition 2007. A real-scale model of the product (figure 8) also has been made, and successfully tested by users.

Figure 5: LTB (3D model)

Figure 6: LTB in closed position with tactile signs

Figure 7: Tactile shortcut keys and keyboard

Figure 8: LTB without keyboard

Figure 9: LTB with Braille stale - for more natural interaction

Figure10: Most important tactile signs on various areas of the LTB

Figure 11: Braille input on the real-scale model is testing by a blind user

7. Discussion

Application of emotional design principles and also semiotics in a product which specifically has been designed for blind users was a new and successful experience. The summary of project shows that in an ordinary design project, semiotics could be used to define evaluation parameters. Maybe, this approach is quite simple and elementary, but considering a space for semiotics in a design process, at least in the idea evaluation steps, could be effective for a better communication between users and final product, as this projects demonstrates. Moreover, emotional design and semiotic have such an integrated relationships, that they could be known as correlated issues. For a better understanding of the whole process and also a generalization of the project, an extendable model has been visualized by the design team (Figure 9).

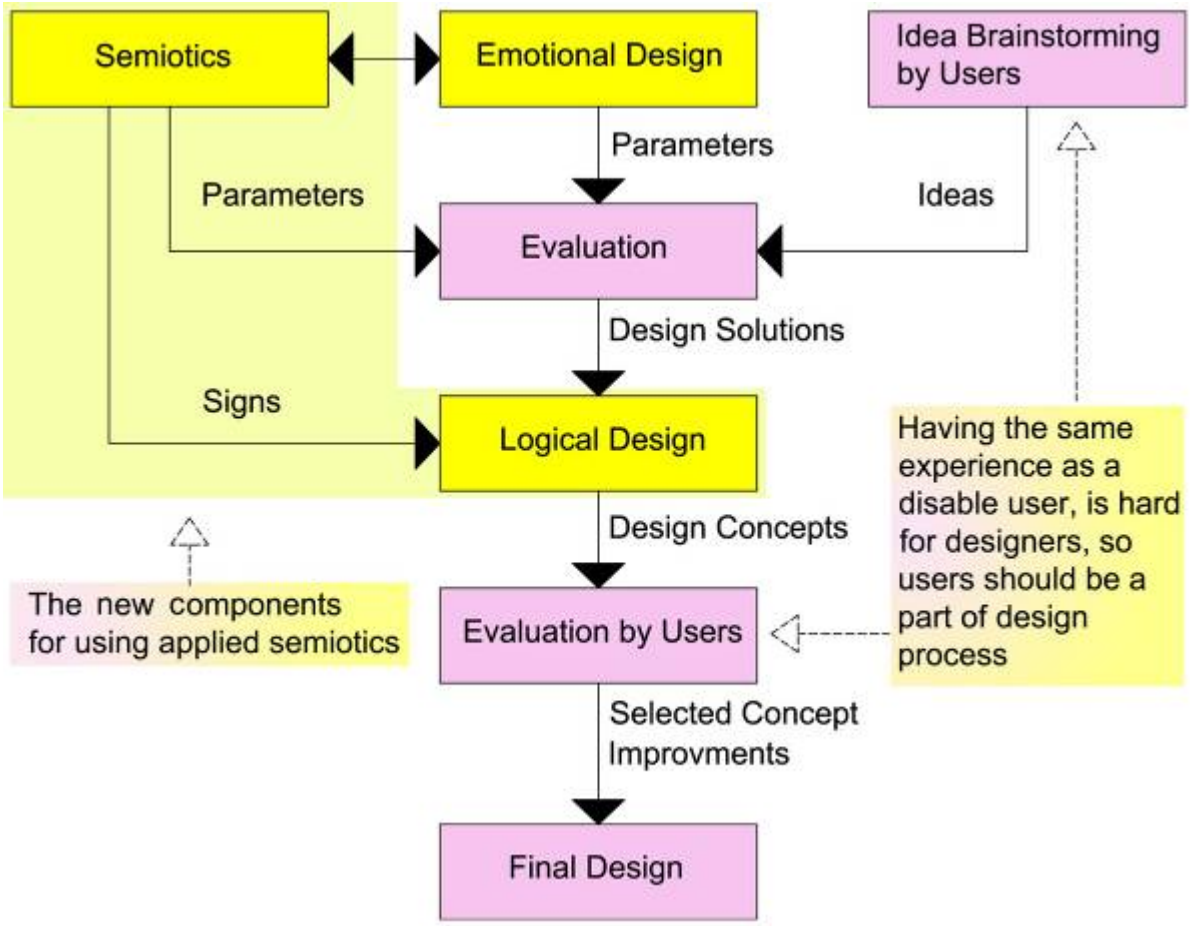

Figure 12: the extendable model

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