## HFE in UI Designs

User-Interface or UI is an interface that allows users to interact with a computer. UI must always be "designed with human beings, their abilities and limitations in mind[i]". In order to fulfill this, it is necessary to think in the perspective of the end user. To gain this perspective, a UI design must take into account the following factors: physical abilities, cognitive abilities, social background and the environmental factors of the user.

### Physical Abilities

#### 1) Improving Vision

Of all the human senses, vision is the sense that is almost entirely relied on by the UI. Therefore it is crucial that we analyze how the UI can impact or affect vision. Here are some suggestions to considered when using colors in the UI:

- The color used for alphanumeric character must contrast sharply with its background otherwise user will have difficulty in reading the characters.
- The colors used in the UI should contrast sharply with each other. Using only various shades of blue in the UI will not.
- "Highly saturated reds and blues may appear to be located in different depth planes (i.e., in front of or behind the display plane)[ii]." This phenomenon is known as chromostereopis, which can cause visual fatigue and a feeling of nausea or dizziness in a user.
- "Removing luminance contrast from a color image may produce subjectively fuzzy edges.[iii]" This phenomenon is known as the Liebmann effect.
- Avoid using no more than four colors for inexperience users or if the display is infrequent. Too many colors will increase user's perception of the complexity of the application, especially if users are novices or users are going to view the display infrequently.

#### 2) Improving UI By Using Sense of Hearing

Hearing can play a vital role in UI design; for example the computer making a beeping noise to notify user of a problem that needs attention immediately in the application or what user is currently doing in the UI is incorrect. The use of the hearing sense for specific tasks makes it easier for a user to immediately recognize or understand the situation versus if a message is displayed in the UI.

#### 3) Using Other Human Senses to Improve Human Computer Interaction (HCI)

A new type of user interface, known as Multi-modal Interfaces is being developed. Multi-modal refers to interfaces that support non-GUI interaction such as speech or pen input. When compared to the traditional GUI, the multi-modal interfaces has several distinct advantages for users:

- Who have a physical disability or Repetitive Strain Injuries (RSI) due to strains from using the keyboard or mouse
- Who are illiterate or younger children
- If user makes error in one mode, can switch to another mode and the same mistake isn't repeated
- Speaking often simplifies things (which is easier, writing up a very complicated task for others to do or discussing how to do it with others)
- When median used for input of a written document goes from GUI to multi-modal interface, writing goes from one to several expressive dimensions (for example,

when using speech as input for a written document, user can emphasis words or sentences in document by the tone of their voice)
- In group or collaborative work, the multi-modal interface can communicate a lot more than text would (such as a gesture by a user communicates the feeling of emotion that words solemnly can express)

The main problem associated with multi-modal interface today is that it is difficult to implement given the technology that is currently available.

**4) Physical Disabled Users**

- **RSI or Limit Use of Body** - For users with Repetitive Strain Injuries (RSI) or users who have limited use of their body, the UI should be designed so that it will require as little input from the user as possible or doesn't require the user to sit at the workstation for a very long time such as by limiting or simplifying the features of the UI.
- **Color Blindness -** "About 10 percent of all Western males, but only about 1 percent of females, have hereditary color deficiencies, mostly such that they see colors (especially reds and greens) differently or less vividly.[iv]" This means that a very large proportion of users of computers have color blindness. Some practical solutions are to reduce the use of reds and greens since these are the colors must color blinded people have trouble distinguishing, choose combinations of colors that are highly separable and distinguishable or in an application, create one UI for users who are color blinded and another for users who aren't.

**Cognitive Abilities**

Cognitive abilities relates to how user's mind works in its interaction with the computer.

**1) Fitts' Law**

Fitts' Law, which is based on an understanding of the cognitive mechanism of how the human mind works, states "the time to acquire a target is a function of the distance to and size of the target[v]". Fitts' Law is very influential in UI design, as the following shows:

*Large Target, Close Proximity*

Imagine moving a mouse pointer to a target button on the screen. The farther the mouse pointer is from the target, the more effort it would take the user to move the mouse pointer to the target. Furthermore, the smaller the target (button) is, the harder is it for the user to position the mouse pointer right on the target. This is the application of Fitts' Law in UI design. In order to minimize distance between various targets (buttons, icons, etc.) and increase size of the targets without increasing the display area or size of the pixels, some software developers have advocated using circular menus.

*Positioning of Toolbars*

When you open most software applications you will notice toolbars are almost always located at one of the four edges of the display area. According to Fitts' Law, the toolbars become targets that "are almost infinitely targetable, since they are impossible to go past. You could move your mouse as hard as you wanted to into the upper-left corner, and never get past the first pixel on the screen[vi]" This positioning of the toolbars are used to ensure user can easily get to the menu items and by having thick strips of toolbars at the edges of the UI helps user to easily visualize the boundaries of application from another.

*Links on a Web Page*

On most web pages where there are links to related web pages, most of these links are grouped very closely together and displayed over a small area. According to Fitts' Law

this would result in users often clicking on the wrong link or requires some user effort in acquiring the targeted link. In this situation, it may have been easier to group the related links into one large link that when clicked brings the user to a dedicated web page that shows all the related links with bigger fonts.

**2) Factoring in Other Cognitive Abilities in UI Design**

*Memory*

Memory plays an important role in the cognitive abilities of the user in UI design. Why is this so? Imagine using Microsoft Word for the very first time to create a document. Every time you wanted to do something to the text, such as formatting or spell checking, you probably had to either painstakingly locate the associated menu item or use the help wizard. As you use Microsoft Word more and more often, this became unnecessary. This scenario brings up the following two interesting observations[vii]:

- Frequent customers remember more details
- Infrequent customers may need more help

Although it might require additional work, it would be more helpful to users if the UI were able to distinguish between new and old users. For example, new users will be given introduction to the application, assisted by a help wizard (such as Microsoft Word's paperclip) or where to get tutorials while these features won't be available to old users who would now find these features more annoying than helpful.

*Patience Level/Attention Span*

If user feels they have waited long enough for the UI to respond to their input, user would simply close the running application. Rapid technological advances and achievements made in the last few years have rapidly lowered "our patience level due to rapidity of change and rapidity of response[viii]". This makes it necessary for UI designers to take into account the patience level of the users. If a UI is designed for young children, the UI designer should not have a UI that is slow to the respond nor require too many inputs from user. On the other hand, if the targeted user for the UI was an adult, then the designer can have some flexibility in creating a more complicated UI that requires more user input and processing time to handle requests from users. Depending on what the UI will be used for, there can be scenarios where the patience level and attention span of the user of the UI will be close to none (such as the UI designed for stock traders or 911 dispatchers who can't be required to use UI that requires too many user input or respond very slowly to user requests).

*Reaction Time*

Reaction time is time it takes for the user to react to an event from the UI. From our textbook[ix], "Choice reaction time is a logarithmic function of the number of alternative stimuli and responses. What this means to the UI designer is that time allocated to user should be based on the number of choices presented. Imagine using an application where user has only a second to pick one of many choices. This will quickly lead to user feeling being forced to make rash and quick decisions.

*Mental Ability*

The UI that is designed must identify mental ability user. Most of the difference in mental ability is due to age. Besides age though, there are other ways in which people can have different mental ability. Some people are mentally disabled and if these people are included as the targeted users of the UI, the UI designers must also make the UI simple but yet effective and accommodating enough for these users.

## Social Factors and Background

### 1) Education Level and Work Experience

If targeted user of the UI, such as UI in software development tools, is a user with educational backgrounds in Computer Science or people in the software industry, it won't be difficult for the user to learn to use the UI. But on the other hand, if UI was targeted for user's little computer experience then trying to ease the difficulty of learning a very complex UI with a great tutorial and help features will not help too much.

### 2) Language

The language of a user can be a factor in determining how quickly user is able to learn the UI. Obviously, if the language in which the UI is running differs from the user's native tongue, this will present quite a problem; the user will not only need to learn the UI but also the language the UI is running on at the same time. To illustrate, if user is from an East Asian country (Japan, Korea or China) that uses an English version of Microsoft Word, the user will probably have more difficulty with the UI than a native French speaker would since most of the functionalities in the UI for Microsoft Word is more geared towards Western European rather than East Asian languages.

### 3) Cultural Background

The cultural background of the user can play a prominent role in how quickly user learns the UI. If the users are Finnish, where almost 100% of all Finns have cell phones and e-mail accounts, then the UI designer can safely assume that the user is starting out with at least basic and fundamental knowledge of using UI applications. On the other hand, if the user was from a culture that didn't have exposure or purposely abstained the use of technology, like the Amish, then the starting point for the user in basic and fundamental UI knowledge and experience is practically none.

## Environmental Factors

### 1) Climate

UI design could be changed based on the climate of where user is using the UI. If the application is for use in outdoors with extreme weather (such as application for monitoring sections of the Alaskan pipeline in the dead of winter), the UI should be well designed such that user doesn't have to waste too much time locating or inputting information.

### 2) Work Environment

Sometimes the UI design may need to be tailored drastically to address the work environment. In areas such as stock trading, emergency rooms or on the battlefields, UI must be designed for ease of use, doesn't require too much user interaction and yet is able to present all the essential information to the user in a few screen shots. The work environment can also determine the display of the UI. If the UI was to be used by scuba divers to show measurements of the ocean floor, then clearly it isn't in the best interest of the divers to have UI display colors that can easily attract predators like sharks.

### 3) Situational Factors

UI designers must account for situational factors that can potentially arise among users. An example of a UI user's situational factor can be the time constraint of the user. For designing an UI in this situation, it is necessary to determine what UI functions customers are in hurry for and what functions can wait or the maximum amount of time that a customer has before completing a transaction.

---

## List of Endnotes

[i] http://mar.klaki.net/slides/03.html
[ii] Textbook pg 488
[iii] Textbook pg 488
[iv] Textbook pg 488
[v] http://www.asktog.com/basics/firstPrinciples.html#fitts's%20law
[vi] http://msdn.microsoft.com/library/default.asp?url=/library/en-us/dnhfact/html/hfactor9_3.asp
[vii] http://guir.berkeley.edu/courses/cs160/spring2002/lectures_files/contextual-inquiry.pdf
[viii] http://llc.mtsac.edu/features.php, article titled "Patience in an age of Technology"
[ix] Textbook pg 138

---

## Bibliography

The term paper was written based entirely on using the textbook and the following helpful and insightful websites:

1. http://www.asktog.com/menus/designMenu.html
2. http://msdn.microsoft.com/library/default.asp?url=/nhp/default.asp?contentid=28000443
3. http://www.tau-web.de/hci/space/
4. http://www.cs.sfu.ca/~inkpen/Papers/TR20_DD/tr20.html
5. http://www.site.uottawa.ca/~tcl/seg3120/quadBEvaluation.pdf)
6. http://www.sci.usq.edu.au/courses/CSC3402/
7. http://www.cs.berkeley.edu/~jfc/cs160/SP03/