Chapter 1: Introduction

1.1 What HCI is and why it is important

Human computer interaction (HCI) is a cross disciplinary area (e.g. engineering, psychology, ergonomics, design) that deals with the theory, design, implementation and evaluation of ways humans use and interact with computing devices. Interaction is a concept to be importantly distinguished from another similar term, "interface." Roughly speaking, **interaction** refers to an abstract model by which humans interact with the computing device for a given task, and **interface** is a choice of technical realization (hardware and/or software) of such a given interaction model. Perhaps, the letter "I" in HCI refers to both "interaction" and "interface," encompassing the abstract model and the technological methodology.

[Figure 1.1] The distinguishing concepts of "Interaction (model)" and "Interface."

HCI has become much important in recent years as computers (and embedded devices) have become commonplace in almost all facets of our lives. Aside from merely making the necessary computational functionalities "available," the early focus of HCI has been in how to design interaction and implement interfaces for high "usability." High usability means that the resulting interfaces are easy to use, efficient for the task, ensures safety, and leads to a correct completion of the task. Usable and efficient interaction with the computing device in turn translates to higher productivity.

Simple aesthetic appeal in interfaces (and satisfying the usability at the same time) is now a critical added requirement for commercial success as well. The family of distinctly designed Apple products is a good example. Apple products attract have created faithful followers even though their functionalities may be virtually equal to their competitors. In this context, the concept of "User Experience (UX)" has lately become a buzzword, a notion which not only encompasses the functional completeness, high usability, aesthetic appeal of the interactive artifact, but also its seamless integration into one's lifestyle or even creating a new one around it

[Figure 1.2] Goals of human computer interaction (HCI): (a) functional completeness[1], (b) high usability[2], (c) aesthetic appeal[1] and (d) compelling user experience[3] (UX).

Perhaps a less acknowledged fact is how HCI has had a huge impact in the history of computing and changed our daily lives. It was probably the invention (or rediscovery) of the "mouse" which was the linchpin in the personal computer revolution, making computing intuitive and so easy to

1 Apple iPhone 5s, http://www.apple.com/iphone-5s/

2 Microsoft Pixelsense, http://blogs.msdn.com/b/pixelsense/

3 Microsoft Kinect, http://www.xbox.com/ko-KR/Kinect/

use. The spreadsheet interface made business computing a huge success. Internet phenomenon could not have happened without the web browser interface. Smart phones have almost replaced the feature phones with their touch oriented interfaces. Body based and action oriented interfaces are introducing yet new ways to play and enjoy computer games. HCI still continues to redefine how we view, absorb, exchange, create and manipulate information to our advantage.

[Figure 1.3] The evolution of interfaces in the course of history of computing (e.g. terminal and keyboard[4] → graphic user interface and mouse → hand-held and touch based interface).

1.2 Principles of HCI

Despite its importance, good HCI design is generally difficult, mainly because it is a multi-objective task that involves simultaneous considerations of many things such as the types of users, characteristics of the tasks, capabilities and costs of devices, lack of objective or exact quantitative evaluation measures, and changing technologies, just to name a few. A considerable knowledge in many different fields is required. Over the relatively young history of HCI, researchers and developers in the field have accumulated and established basic principles for good HCI design, in

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[4] Courtesy of Cox, Jamie, https://www.flickr.com/photos/15587432@N02/3281139507/, Melbourn, USA (This photo is allowed to be shared for free under the Creative Commons Attribution 2.0 Generic with the author attribution).

hopes of achieving some of the main objectives (as a whole) as laid out in the previous section. These HCI principles are general, fundamental, and commonsense, applicable to almost any HCI design situation. Here, we give a short review of the main HCI principles.

1.2.1 "Know thy user" [1]

The foremost creed in HCI is to devise interaction and interfaces around the target user(s). This overall concept was well captured by the phrase, "Know Thy User," coined by Hansen [1] in 1971 even though the so called "User Centered Design" approach has become a buzzword only in the recent years. This principle simply states that the interaction and interface should be catered to the needs and capabilities of the target user of the system in design. As easy as it sounds, however, it is more than often the case that the HCI designers and implementers proceed without the full understanding of the user, for example, by just guessing and pretending to know and be able to predict how the representative user might respond to one's design. Ideally, comprehensive information (e.g. age, gender, education level, social status, computing experience, cultural background) about the representative target user must be collected and analyzed for their probable preference, tendency, capabilities (physical and mental), and skill level. Such information can be used to properly model interaction and pick the right interface solution for the target users.

Suppose changing an interface supposedly to achieve higher usability. However, we might need to remember that while young adults are extremely adept at and open to adopting new interfaces, older generations are much less so. Here is another example. Males are generally known to be better than females in terms of spatial ability, and as such one might consider such a fact in employing 3D user interfaces. However, other studies point to females majoring in engineering and science to possess an equivalent level of spatial ability to their male counterparts [2]. So sometimes, even conventional wisdom may not be sufficient to warrant proper interface design. These examples illustrate that there are great many aspects that need to be considered in this regard. An experienced and humble HCI designer will at least try to leverage on the vast knowledge available from cognitive psychology, ergonomics, and anthropomorphic data to assess the capabilities and characteristics of the target user group (if a direct field study is not feasible).

[Figure 1.4] Examples of user centered designs of web pages: for (a) kids[5], and (b) the elderly[6].

A related (or even perhaps opposing) notion to the user centered design is the "Universal Usability" which roughly promotes "humane" interfaces that cater to a wide (if not all, rather than a specific) range of users, e.g. across age groups, skill levels, cultural backgrounds, disability levels. Such a notion has become almost required in our advanced multi-cultural societies. However, as wonderful as it sounds, it is generally very difficult to achieve this with "one" interface. Usually, the universal usability is achieved by justifying and finding the investment to build separate

5 Courtesy of Junior Naver, http://jr.naver.com/ (captured May, 2014)

6 Courtesy of SilverNet News, http://www.silvernews.or.kr/

interfaces for distinct user groups. For example, many government (in advanced countries) web pages are now legally required to provide interfaces in different languages and for color blinds and visually challenged users (see Figure 1.5). Many interactive systems provide both menu-driven commands for novices and keyboard-based hot keys for experts (see Figure 1.6).

[Figure 1.5] Two different interfaces to achieve universal usability (one in Korean[7] and the other in English[8]).

[Figure 1.6] An interface providing both menus (for novice users) and hot keys (for expert users).

1.2.2 Understand the task

Another almost commonsense principle is to base HCI design on the understanding of the task. Task refers to the job to be accomplished by the user through the use of the interactive system. In fact, understanding the task at hand is closely related to the interaction modeling and user analysis. It really boils down to identifying the sequence and structure of subtasks at an

7 Korean Ministry of Health and Welfare, http://www.mw.go.kr/front_new/index.jsp

8 Korean Ministry of Health and Welfare ttp://english.mw.go.kr/front_eng/index.jsp

abstraction level appropriate for the typical user and the larger application context. Take the subtask (for a larger application) for "changing the Wi-Fi connection access point" for a smart phone. For an expert user experienced in computer networks, the task might be modeled with detailed steps, asking the user to select from a pool of available nearby access points based on their characteristics such as the signal strength, bandwidth, security level and so forth. On the other hand, for a casual user, the subtask might only involve entering a password for the automatically selected access point.

[Figure 1.7] Two interaction models at different levels of detail for the task of "connecting to the Internet from a smart phone" depending on the user type.

Note again that the task (or equivalently interaction) model must ideally come from the user. Different users will have different "mental" models of the task which must be reflected to the structure of the interface so that the user will find it easier to use and remember when implemented in such a way. We will study the process of task/interaction modeling in Chapter 2 in more detail. However, it is not always the case that interaction modeled after the user is also the most efficient one. One must remember that humans are very adaptive and as such non-user based task/interaction model may sometimes be used with focus on efficiency and learnability.

1.2.3 Reduce memory load

Designing interaction with the as little memory load as possible is a principle that also has a theoretical basis. Humans are certainly more efficient in carrying out tasks that require less memory burden, long or short term. Keeping the user's short term memory load light is particularly of importance with regards to the interface's role as a quick and easy guidance to the completion of the task. The capacity of the human's short term memory (STM) is about 5~9 "chunks" of information (or items meaningful with respect to the task), famously known as the "Magic Number" [3]. Light memory burden also leads to less erroneous behavior. This fact is well applied to interface design, for instance, in keeping the number menu items or depth to less than this amount to maintain good user awareness of the on-going task, or in providing reminder and status information continuously throughout the interaction.

[Figure 1.8] Interfaces designed for minimal short term memory: (a) a menu system with less than 10 items (left) and (b) categorization by colors, areas, icons, and labels. Badges (circled) are used to display status information such as the temperature and number of unread mails as a constant reminder (Microsoft Metro interface[9]).

[9] Microsoft Metro interface, http://msdn.microsoft.com/ko-kr/windows/apps/

1.2.4 Strive for consistency [4]

In the longer term, one way to unburden the memory load is to keep consistency. This applies to both within an application and across different applications and to both the interaction model and interface implementation as well. For instance, the user is likely to get confused and exhibit erroneous responses if the same subtask involved, at different times, different interaction steps or interface methods. Note that the exact same subtasks may appear across different applications as well. Aside from being able to remember what to do, consistency and familiarity also lead to higher acceptability and preference. One way the Microsoft Windows based applications maintain their competitiveness is by promoting consistent and familiar interfaces (see Figure 1.9).

[Figure 1.9] (a) A consistent look of interface within an application (a game called Subway Surfers[10]), (b) consistent interface between Microsoft Powerpoint and Word[11]).

1.2.5 Remind users and refresh their memory

As any significant task will involve the use of memory, another good strategy is to employ interfaces that give continuous reminders of important information and thereby refresh one's memory. Our memory dissipates information quite quickly, and this is especially more so during

10 https://play.google.com/store/apps/details?id=com.kiloo.subwaysurf

11 http://www.microsoft.com

switching of tasks in multi-tasking situations (which is very prevalent form of interaction these days). In fact, research shows that our brain internally rehearses information encoding during multi-tasking [5]. Even a single task may proceed in different contextual spans. For instance, in an on-line shopping application, one might go through entering of different types of information, e.g. item selection, delivery options, address, credit card number, number of items, etc. To maintain the correct awareness of the situation and further elicit and ensure continued correct response from the users, informative, momentary or continuous feedback will refresh our memory and help the user complete the task easily.

One particular type of informative feedback (aside from the current status) is the reaffirmation of the user action and signaling the closure of a larger process [6]. An example might be not only explicitly confirming the safe receipt of a credit card number, but also signaling that the book order is complete (and "closed"). Such a closure will bring much satisfaction to the user by matching the one's mental picture of the on-going interactive process.

[Figure 1.10] Reaffirming the user about one's action (e.g. credit card number correctly and securely entered) and larger interactive process (e.g. the book purchase is complete).

1.2.6 Prevent Errors / Reversal of Action [6]

While supporting a quick completion of the task is important, error-free operation is also equally so. As such, the interaction and interface should be designed to avoid confusion and mental overload. Naturally, all the aforementioned principles above apply here. In addition, one effective technique is to present or solicit only the relevant information/action as required at a given time. Inactive menu items are good examples of such a technique. Also, having the system to make the user choose from possibilities (e.g. menu system) is generally a safer approach than to rely on recall (e.g. direct text input).

[Figure 1.11] Preventing errors by presenting only the relevant information at a given time (inactive menu items) and making selections rather than enforcing recall or full manual input specification.

Despite employing some of the principles and techniques stated above, there is always a chance the user will make mistakes. Thus, a very commonsense but easy-to-forget feature is to allow an easy reversal of action. This puts the user into a comfortable state and increase user satisfaction as well.

[Figure 1.12] Making the user comfortable by always allowing an easy reversal of action.

1.2.7 Naturalness

The final major HCI principle is to favor "natural" interaction and interfaces. Naturalness refers to a trait that is reflective of various operations in our everyday life. For instance, a perfect HCI may one day be realized when natural language based conversational interface is possible, because such is the most prevalent way humans communicate. However, it can be tricky to directly translate styles and modes of interaction in real life to and for interaction with a computer. Perhaps a better approach is to model interaction "metaphorically" to the real life counterpart, extracting the conceptual and abstract essence of the task. For instance, Figure 1.13 shows an interface called the "ARCBall" [7] for rotating an object in 3D space using a mouse (2D device). In order to rotate, the selected object is overlaid with and enclosed by a transparent sphere, and the user drags on the surface of the sphere to rotate the object inside. One might call this rotation technique to be metaphoric, abstracting the interaction object into the shape of a sphere, the most rotational object we know.

A natural or metaphoric interface (assuming the metaphor is not contrived) will also have "affordance," a property (or additional cues) that appeals to our innate perception and cognition, thus making so intuitive that the interface would require almost no learning [4]. In the example of the ARCBall, the spherical shape of the rotator GUI may be regarded to exhibit a high level of affordance, requiring no explanation as how to rotate the object.

[Figure 1.13] ARCBall [7]: 3D object rotation by using the "sphere" metaphor. It is also very intuitive with a high level of "affordance."

1.3 Summary

In this chapter, I have introduced the field of HCI, namely its objective and importance. We also have reviewed some of the high level and main principles of HCI and such examples. These principles are often based on or just manifestation of deeper theories in cognitive science and ergonomics. Also, they are transformed into more detailed and directly usable "guidelines" when put into actual practice for specific purposes or areas. In the next chapters, we take a look at these guidelines and theories, as the essential knowledge required for the HCI design process.

References

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