SIMPLICITY

How to use a Human-Computer Interface without thinking?

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Abstract. The goal to reach *Simplicity* has been the key point of Human-Computer Interface since 1980s. In this research, we would like to know what *Simplicity* is and how to reach it. We used case studies to get two factors of *Simplicity*, which are the information modeling and the experience of perception through senses. Based on the factors, we implemented a prototype to refine the concepts of simplicity. The prototype was a new attempt to consider only the simplicity of HCI. Further research efforts on emotion, creativity, and aesthetics related to simplicity are important.

Keywords. Human-computer interface; easy to use; ambient display.

1. Introduction

1.1. BACKGROUND

Oxford Dictionary defines: “Simplicity is the quality of being simple.” It meant that achievement of maximum effect with minimum means. In contrast to complex things, simple ones are easier to be understood and explained. Simplicity meant streamlining, pruning clutter, cleaning up presentation, and improving the initial experience with a product (Jenson, 2002).

Since the advent of modern computing in 1946, the uses of computing technology have expanded far beyond their initial role of performing complex calculations (Denning and Metcalfe, 1997). Computers were not just for scientists any more; they were an integral part of workplaces and homes. It has been a part of our daily living. How to design a good computer interface has been more and more important for user interface designers.

1.2. PROBLEM AND OBJECTIVE

The digital revolution was supposed to have made our lives easier, but Philips Electronics' studies had shown that's not the case. Around 30% of home-networking products, for example, were returned because people can't get them to work. And 48% of people had put off buying a digital camera because they see them as too complicated (www.philips.co.uk/about/brand/ whysimplicity/ : Mar 2009). The need to simplify the way we experience technology was something we recognized and wanted to address.

People around the world, regardless of where they lived, wanted the benefits of technology without the hassles. "Ease of use" in the field of Human-Computer Interface (HCI) has been regarded as an important principle in 1980s (Jacko and Sears, 2003). The goal to reach simplicity has been the key point of HCI for a long time. "*What is Simplicity?*" Many of previous works tried to let User Interface (UI) be simpler and easier to use, but HCI research related to the general definition of simplicity was absent. Furthermore, there was still not a clear and definite rule of how to create a "Simplicity of Human-Computer Interface" for designers to follow. In this research, we would like to discuss *what* is and *how* to reach Simplicity of HCI for designers and later provide a reference prototype.

2. Previous Works

2.1 THE PROGRESS OF HCI IN SIMPLICITY

Simplicity has been the core goal of HCI by reviewing its progress in these thirty years. For example, in 1981 Xerox Star Workstation first presented the concept of Graphical User Interface (GUI), working by visualizing information on the screen as pixels or "painted bits," also called "desktop metaphor" (Smith, 1982). The Star set several important HCI design principles, such as "seeing and pointing vs. remembering and typing," and "what you see is what you get." (Ishii and Ullmer, 1997) These principles were all for the user-centred design. GUI let the users feel easier to directly perceive and operate.

And then, Apple Macintosh brought this style of HCI into the public's attention in 1984, creating a new stream in the personal computer industry (Apple, 1987). In the 1980s, the design concepts of HCI paid much attention to the ease of use (Jacko and Sears, 2003). To-date, GUI has become the basic element of computers. Moreover, the information visualization was found to be intuitive and easy to navigate (Dillon et al., 2005). Therefore, it means that GUI was simple for most people and the process of information visualization was useful to simplify the operation of interface.

In 1991, Mark Weiser illustrated a new method of HCI, Ubiquitous Computing (UbiComp), which made computers effectively *invisible* to the user, by having them distributed throughout the physical environment (Weiser, 1991). UbiComp treated computers as a set of small, invisible computing units that were integrated in an environment. From the very first formulation of UbiComp, the idea of a calmer and more environmentally integrated way of displaying information has held intuitive appeal. Weiser called this "calm computing" and described the area through an elegant example: a small, tangible representation of information in the world, a dangling string that would wiggle based on network traffic. When information can be conveyed via calm changes in the environment, users were more able to focus on their primary work tasks while staying aware of non-critical information that affects them (Weiser and Brown, 1995).

Based on Weiser's concepts, Ishii brought the concept of "Tangible Bits" to blur the boundary between physical and digital world, giving physical form to digital information, allowing us to directly manipulate it with our hands, and to enable environmental recognition of digital information at the periphery of perception (Ishii and Ullmer, 1997). Furthermore, Philips Research brought up a term of ambient intelligence (AmI), referring to future digital environments that are sensitive and responsive to people (Aarts and Marzano, 2003). The concept of AmI also built upon the work of Mark Weiser on UbiComp.

From these reviews, we found the progress of HCI placed more and more emphases on human's experience and perception and tried to wipe the demarcation between human and computer. Researchers expected the ultimate goal of HCI was that HCI in the future would be seamlessly integrated as a part of people's daily routines.

2.2 THE CHARACTERISTICS OF SIMPLICITY IN HCI

The progress of HCI was the corresponding process of integration and output from computer data. While a wave of computer technology reached end, it would lead a new beginning of another wave for interface. Therefore, the author defined that simplicity of human-computer interface was a condition of "*dealing with a lot of multifarious and complex information*" by "*a well developed technology*." Jenson (2002) said simplicity drove understanding. By having the simple tasks clean and obvious, designers improved not only the learning of the interface, but also the ease of use. So, how to present efficient and to understand results of information without the technical limitation is the meaning of *simplicity*.

3. Methodology

The research consists of two parts. First, the author uses case study to obtain the factors of simplicity and to explain "*What is Simplicity of HCI*." Second, the research provides a prototype and realise the concepts of simplicity.

3.1. CASE STUDY

The case selection follows two trends: 2D digital interface and 3D physical interface, in condition of "dealing with large data" by "a well developed technology." These cases would be discussed with two aspects, Human and Computer. The aspect of "Human" aims at the analysis of User Experience; the aspect of "Computer" aims at the analysis of Information Processing.

3.1.1. 2D digital interface

2D digital interface is the presentation of digital information with images so that they are immediately understandable and easy to use (Dillon et al., 2005). Moreover, metaphors in visualization are used to help users understand systems in conceptual terms they already know, by appealing to initial familiarity and experience (Vande Moere, 2005). There are several data presentations that use a city structure to spatially organize data, such as Cybernet's file system representation or MvRdV's Data Town (Figure 1).

Figure 1. The city as a data mapping metaphor.
(Left: Russo Dos Santos et al., 2000; Right: MvRdV, 1999)

Besides, data can be presented by very abstract modes, which appeal to eye, are user engaging and provoke novel ways of exploration (Figure 2). Users may learn complex insights by playing, they retain the information longer by using the application repeatedly (Vande Moere, 2005).

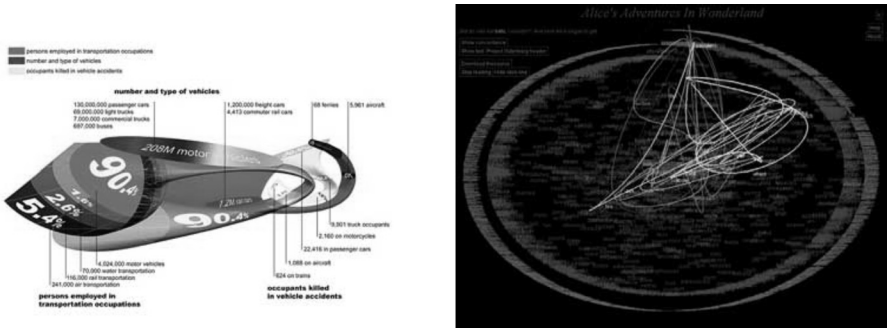

Figure 2. Creative information visualization.
(Left: Rashid and Couture, 2000; Right: www.textarc.org: Nov 2004)

The image compared with text is easier to understand for human visual perception. To present the digital graphical interface, it has to deal properly with complicated information based on user experience with visual metaphor and reduce the gap between human conception and computer information.

3.1.2. 3D physical interface

GUI presents information as "painted bits" on flat screens. The interactions between people and digital information are confined to the conventional GUI comprised of a keyboard, monitor, and a mouse. However, it is utterly divorced from the way interaction takes place in the physical world we inhabit. GUI is designed on the assumption that we will sit directly in front of it; as a result it monopolises our vision and our foreground attention (Ishii and Ullmer, 1997).

Therefore, researches turn to the concept of outputting digital data to physical object. Users can be aware of digital information from the entire physical environment and can directly perceive through senses and use experience. Ishii's research of "Tangible Bits" (Ishii and Ullmer, 1997) is a good example, blurring the boundary between the physical and digital worlds to create an interface between humans and digital information in cyberspace. The key concepts are graspable media and ambient media. Users grasp and manipulate digital data with their hands at the centre of attention, and are aware of background bits at the periphery of perception using ambient media (Figure 3).

Ambient Display makes use of the entire physical environment as an interface to digital information. It suits highly specialized environments where many streams of information need to be constantly monitored. The mapping of data from information source to an ambient display is a key consideration and challenge for ambient media. Designers must transform the data into a display that successfully maps the information into a new form. The designer must decide how the source gets mapped and the location of where it gets mapped

(Wisneski et al., 1998). It is important for the interface designers to output the right information. What users need from an interface is the key resolution of mapping of data presentation.

Figure 3. Tangible Bits. (Left: Pinweels by Ishii et al., 2001; Right: Brave et al., 1998)

3.2. CASE DISCUSSION

Based on the information processing of computer and user experience, the author concludes two of the factors from the above case studies in HCI design. One is "Information Modulisation;" the other is "The Experience of direct Perception through Senses." Information Modulisation includes both 2D "Information Visualization" (virtual) and 3D "Object Movement" (physical). The detail descriptions are in the following sections.

3.2.1. Information Modulisation

Maeda (2006) published ten laws of simplicity, in which Low 1 and low 2 are "Reduction" and "Organization." They are the basis of information processing to reduce the amount of data and organize them. Complexity can be traced to a single design approach: offering too much flexibility. Too much flexibility is the root cause of most design problems. Simplicity is about lowering the priority of the high-end functionality to make sure the core tasks work exceedingly well (Jenson, 2002).

Information process theory hypothesizes humans as information processors (Fitts, 1964; Marteniuk, 1976; Stelmach, 1982). There are three basic components of human information processing: translation, coding and mapping (Romeo et al., 2003). Therefore, when people comprehend the information from the interface, they are based on this model of information processing. If

the interface design appropriately modularize into different parts, it will be easy to map and use. 2D digital and 3D physical interfaces should all deal with modularizing the information, and then showing precise results.

3.2.2. The Experience of direct Perception through Senses

Treisman (1960) shows that information can be processed, even if it is not in the foreground of a person's attention. However, conventional HCI focuses primarily on the foreground activity and neglecting the background (Buxton, 1995). People are constantly receiving various kinds of information from the periphery without attending to it explicitly. If anything unusual is noticed, it immediately comes to the centre of their attention (Ishii and Ullmer, 1997).

In the cases of 2D digital interface, they organize complex digital data with visual images. It is easy to get noticed and to combine with users' living experience, and therefore reduce the difficulty of use. 2D digital interface provides an understanding and familiar UI design for users. In the cases of 3D physical interface, the use of UI becomes more directly perceived through the senses and closer to the human living habits. Simplicity of interface has much to do with the awareness of human behaviours. An UI fitted for human experience is easy to use.

3.3. PROTOTYPE

Based on the above factors, "information modulization" and "experience of direct perception through the senses", the research implements a prototype to realise the concepts of simplicity.

3.3.1. Scenario

"Peter is a video editor. He has to manage a lot of video data for his work. However, he had a big problem of being aware of the remainder for hard space before. He always had to calculate if the capacity was enough. Now he uses a unique physical display beside his computer screen, The Climber, to show the capacity of hard discs. He can be aware how many the rest of capacity in the hard discs instantly and easily. Because every hard disc saves the different type of content, he is easy to know the condition of the database from every Climber."

3.3.2. Early experiment

The early experiment is to set the system framework and test the data translation. The framework is to get the needed information of interface from operating

system, reduce and organize them, and output to physical devices. The hardware devices include a piece of Arduino Diecimila (Fugure 4, left) and a series of LEDs (Figure 4, right).

After testing, the author find that the way of data output with LDEs is too direct to attract the user's interest. The translation of information has to use creative ideas to do. That will be an important cause of improvement in the next implementation.

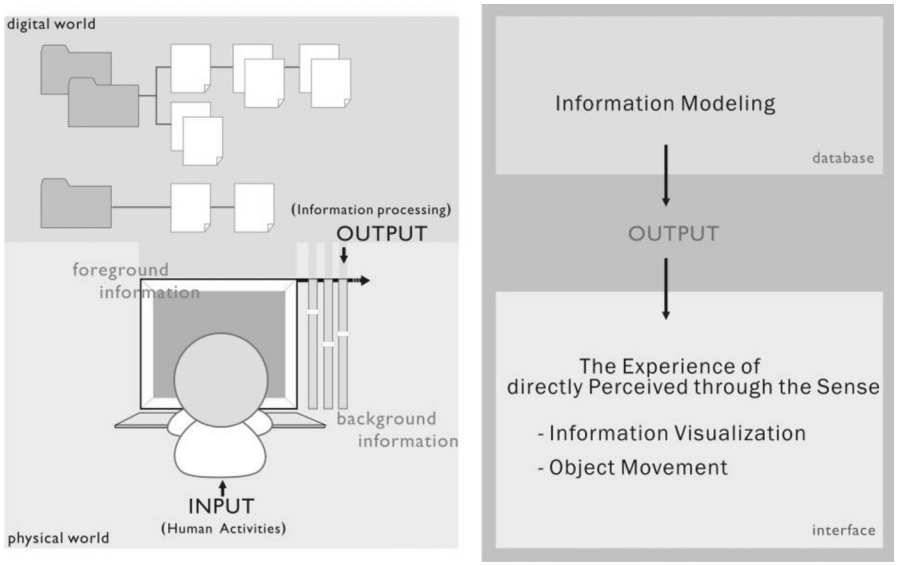

Figure 4. The system framework of prototype.

3.3.3. Implementation: the climber

Base on the early experiment, this prototype mainly improves the display of data translation. The author selects the "Climber" to show the metaphor of the climbing capacity of data. A servomotor is used for the motion of climbing up and down. In addition, it is also fabricated with a roller, steel wire, and line. The finished prototype is shown in Figure 5.

4. Conclusion and Future Study

The prototype is an attempt to reach only the simplicity of HCI, having two factors of "information modulisation" and "the experience of direct perception through the senses." However, it is not easy to completely realise the theoretical concepts. How to do "information modulisation" effectively? How to reach

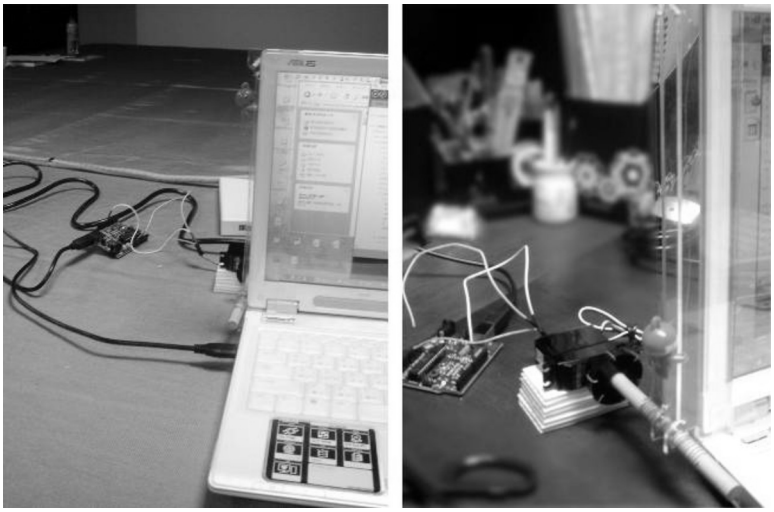

Figure 5. The Climber of output display.

"experience of direct perception through the senses" explicitly? Further investigations are needed.

The users' reactions toward the prototype indicate that they are interested in and show emotions to the device. The relation between emotion and simplicity is an important future issue. Additionally, the relationship between mapping of data and emotion with a creative idea is also worthy of discussion. Of course, how to look after both simplicity and aesthetics is a continuing research topic. Weiser (1991) stated: "the most profound technologies are those that disappear. They weave themselves into the fabric of everyone life until they are indistinguishable from it." This is the ultimate objective of simplicity in HCI.

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