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The Eradication of Complexities in Human-Computer Interface Design for Increased System Usage Productivity

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ABSTRACT
Computer applications have been developed for virtually all sectors, ranging from medicine, banking to education. The most important factor for the proper use of a computer program is the interface; however in recent times, some computer programs have become highly intricate and uneasy to manipulate. Efforts by programmers to make productive and interactive systems have been successful yet there is the tendency to introduce complexity and sophistication in the interface designs. This paper attempts to review issues surrounding Human-Computer Interaction (HCI) and its relationship to Information Systems. We identify some causes of complexity in user interface design and provide solution paradigms to mitigate these complexities.

Keywords: Interface design, Human-Computer Interaction, Complexities, Systems and Usability

1.0 INTRODUCTION

The use of computers in today's world has become a widespread phenomenon. Computers have basically been developed to aid man in certain endeavors. The application of computers in almost all facets of human existence has helped in development and growth of mankind. As computers are increasingly becoming service oriented, the need to design and implement a friendly user interface is on the rise. Systems ranging from Automated Teller Machines (ATMs), Cell Phones, and Personal Computers (PCs) to Digital blood pressure apparatus are all engineered to be service oriented.

The way humans interact with a particular system is important and as such the major goal of system developers and designers should be to provide a tremendous user interface based on the functionality of the system. Nowadays most companies strive to employ Ubiquitous Information Systems (UIS) to aid their operations. UIS offers a medium for organizations to provide users and workgroups with services of ubiquitous computing technologies in real-time. "UIS come with more complex requirements than the more strongly constrained Information Systems for office settings" (Maass, 2012), and as such introduces some complexity in its structure. Similarly some systems introduce complexity by trying to meet the functionality of the system and often disregard the concerns of the user.

Human-Computer Interaction deals with certain paradigms of how humans relate and respond to computers. Consequently, this project would offer an insight into such paradigms and examine from a contextual view, the importance of interface designs especially in service oriented systems. Considering a scenario where a user stands in front of an ATM machine for several minutes, trying to manipulate the ATM and is unable to perform a smooth operation. This dawdling process can be attributed to so many factors, one of which is intricate interface design.

In the course of this research, similar situations would be pointed out and properly examined to determine how complexities can affect productivity, especially in organizational environments.

2. HUMAN-COMPUTER INTERACTION

Attempts have been made by several authors to define Human-Computer Interaction (HCI). Human-Computer Interaction is an area of research that began in the 1980s as a branch in computer science (Carroll, 2009). Human-Computer Interaction is viewed as a discipline concerned with the design, evaluation and implementation of interactive computing systems for human use (Thomas , et al., 1996). Human-Computer Interaction is a multidisciplinary study that deals with both art and science; it illustrates the interdependence of a software system and its interface. (Nanni, 2004).

According to Tufte (1989) Human-Computer Interaction can be seen as "two powerful information processors, i.e. the human and the computer attempting to communicate with each other via a narrow bandwidth, highly constrained interface" (Tufti, 1989). It is imperative that we have an understanding of what has been said about Human-computer Interaction and how it relates to interface design. Usability in interface design is of importance because it is the degree to which an "interface takes into account the human psychology and physiology of its users" (Wachowiak, Wachowiak--Smolikova, & Friya, 2010).

Therefore we can say that HCI deals with the methodologies of how computers and humans interact and how interdependent they are. HCI, in consanguinity to interface design is vital, and it has been estimated that about 48% of works on system development goes to the design and implementation of the user interface (Myers & Rosson , 1992). When designing user interface for systems, the communication between users and computers must be taken into consideration because the user's attributes do not often match computer features. (Fetaji, Suzana, Bekim, & Mirlinda, 2007).

The significance of interface designs and issues in Human-Computer Interaction has not risen to a high level in information systems; its importance has long gone unrecognized (Peslak, 2005). Zhang, et al. highlights some opinions on the significance of HCI considerations in business applications and how essential it is in the development of a system. They further suggest that some information systems failures can be credited to "faulty design choices resulting from the lack of emphasis on the human/social aspects of system use" (Zhang, Jane, Dov, & Marilyn, 2004).

2.1 Human-Computer Interaction Defined

Early computers were mostly used by scientists for research and by business organizations for several analytical and production functions. Today, the number of computer user's increases due to the availability of Personal Computers (PC).The increase in computer users triggered the need for good interface designs to enhance the interaction between humans and computers which sprung a research stream known as Human-Computer Interaction (HCI). The study of how people make use of various mediums of computer technology tools to perform their daily activities is what we define as Human-Computer Interaction. Consider user-A using an ATM machine to perform a transaction or user-B using a cell phone to make a phone call.

The interaction between the user-A and the ATM's interface or user-B and the cell phone is a basic idea of the concept of Human-Computer Interaction, though it can be viewed with more complex examples. The study of HCI integrates different disciplines like computer science, engineering, graphic design, psychology, philosophy and ergonometric. The interaction between humans and computer systems is made possible through a medium called the User Interface (UI). The user interface acts like a middleman between computer system and humans. The user interface gives the users a first impression of a system therefore if the interface is not properly designed, users may not make optimal use of the system.

To enhance interactivity, the study of HCI is recommended for software developers for the production of user-friendly interfaces. Most software developers focus on the functionality of the system disregarding the fact that the users are also stakeholders of the software. Functionality of a system is the tasks or action that the system can perform. One major key to designing a good interface is by understanding the need of the potential user. To enhance user interactivity with computer systems, there should be a balance between the functionality and the usability of the system. Usability on the other hand is the degree in which the various functions of a system can be used to achieve the goal of the user (Fakhreddine, Milad, Jamil, & Mo, 2008). HCI can also be linked with the integration of Computer Science and Cognitive Science (study of thought, learning and mental organization). To better understand how humans relate with computer systems, it is best to understand how mental activities prompt certain behavior. For this reason, cognitive science plays a vital role in the study of HCI. The study of cognitive science helps designers develop more intuitive systems. It also helps interface designers understand their user which makes it easy for interface designers to know what exactly the users want.

2.3 A Brief History of HCI

As stated earlier, before the 1970s, Information Technology Professionals and software developers carried out both parallel and basic computing. All this changed with the introduction of Personal computers (PC) in the early 1980s. PCs enhanced individual computing greatly by making software such as spreadsheet, gaming applications and computing platforms (Operating Systems) accessible to ordinary people. The existence of Personal Computers basically led to the extinction of machines like typewriters, adding machines and dedicated word processors because PCs had large processing capability and ease of use. Although the PCs made it possible for users to do more, a major setback was the complex and perplexing interface (Carroll, 2009). As PC users increased, there was a need for software developers to understand user requirement and produce intuitive and interactive systems.

2.3.1 Cognitive Science and HCI

Cognitive Science is an area related to HCI that has also been under research since the late 1970s. It is the study of thought, learning and mental organizations. Scientist from different disciplines like Artificial Intelligence, Cognitive Psychology, Philosophy of the mind, Linguistics and Cognitive Anthropology converged to form the field of Cognitive Science. Some cognitive scientist made use of computer systems for their research leading to their understanding of how computers could be used by people to solve problems (Mary & Carroll M., 2002). The merging of Cognitive Science and computer science brought about HCI, which was the first branch of Cognitive Engineering. Most users judge systems based on the interface and not the internal components of the system Also in the late 1970s, the Xerox Park Research Project was in progress though the scientists had no clear idea what HCI was exactly. The major goal of this research was to make computer software and systems more interactive for users to enhance productivity of organizations. This research led to the redesign of the computer mouse technology, which was invented earlier by Douglas Engelbart in 1953 (Vochin, 2009). The use of desktop icons was another important area of the research, a starting point of the more advanced user interface we make use of today (IconLogic, 2006).

2.4 HCI and Software Engineering Models

The study of HCI grew as it influenced most branches of Information Technology. Software engineers in the 1970s developed complex and confusing systems because they emphasized more on developing systems and did not really consider user interactivity. Therefore the need for more interactive and intuitive systems cannot be overemphasized because it plays a vital role for subsequent generations of computing. Another major impact of HCI is the GOMS (goals, operators, methods and selection rules) project which was setup in 1983 by Staurt Card, Thomas P. Moran and Allen Newell. This project provided facts on the usability of a system through the study of the human mental activities. The GOMS model operates by collecting user specifications and description of task that the user can perform with the system and makes predictions based on the data collected. The GOMS model can make predictions of the time it would take a user to perform a task or learn to use a system. This often helps to save resources because data would not need to be empirically collected during design (Mary & Carroll M., 2002).

Branches of Human-Computer Interaction
As previously pointed out, the field of Human-Computer Interaction emerged due to the increasing popularity of personal computers and the need to help designers understand the importance of cognition in designing user-friendly interface and accessible software. Over the years, Human-Computer Interaction has evolved in different fields of study and researchers have come up with substantial works on various aspects of HCI. Due to the extensive streams of HCI topics, some of the major branches of HCI relevant for this research are highlighted below.

- HCI in Usability Engineering; general evaluation of usability in systems
- Group Learning (Computer-Supported Cooperative Work)
- Human-Computer Interaction on the Internet
- Human-Computer Interactions and Help Systems
- HCI in Information Systems

These fields of HCI would serve as a framework to understand Human-Computer Interaction in general and most importantly for this research; we focus on HCI in Information Systems to understand how interface design techniques affects a company's Information System.

3. HCI AND DESIGN COMPLEXITIES

In a world filled with sophisticated computer programs and software, the need to develop highly interactive and easy-to-use software is on the rise. More often than not, computer users are faced with difficulties when navigating a computer, software program, website, or even a handheld device. This problem sometimes affects the users' performance and leads to low productivity especially in organizations that use certain programs for their businesses. Information Systems as a field that deals with the interaction of computers, procedures, and people in an organization clearly plays a part in deciding some of the design principles and techniques to be adopted in programs used by organizations. Most Organizations spend huge sums of money in correcting errors in their processes.

These errors can be attributed to so many factors, some of which are time delays in performing a task, inconsistency, incomplete information and inaccurate data. Sometimes an un-interactive user Interface can be a major cause of these problems. Human-Computer Interaction addresses issues that deal with the design methodologies of user-interface and guidelines for proper interface designs.
HCI in Information Systems is an imperative stream that tends to merge both fields to solve common problems associated in both areas. Further research have sprung up under this topic, but this present work focuses on identifying and proposing solutions to certain identified complexities in systems encountered by users, particularly users in organizations. Several techniques, guidelines, and design solutions are highlighted in this research that can be adopted by developers to further enhance interface design.

4. HCI AND INTERFACE COMPLEXITIES

Complexities are sometimes introduced in interface designs, and as such reduce users' ability to utilize full functionality of the system. Suggestions have been made for developers and students in design areas to develop competency through guided learning in understanding and devising user-friendly systems and solutions (Peslak, 2005). Consequently (Quaye, 1990), further conducted an investigation of HCI and how the quality of an interface affects users both on personal and enterprise levels. Comprehensive works from various researchers have been done on Human-computer interaction and have showcased different topics and raised many concerns as well as contributions.

According to (Danino, 2001) certain questions arise when conferring about Human-Computer Interaction and how it relates to interface design. Questions like; why do some people become so good in navigating new systems effortlessly while others scuffle to learn? Why are some websites easier to navigate than others? Why do some users encounter difficulties in operating electrical devices? The relevance of this work would be to infer ways in which these problems can be alleviated. This project also offers insights into some minor interface problems often neglected by developers which sometimes cause time wastage, reduces performance and usability both on small and large scale basis.

4.1 Usability Engineering
Way back in 1960s, software developers encountered enormous problems in developing flexible software especially because of the increasing sophistication of computer hardware, which supported newer and greater technologies. Apparently in the 1970s, it then became obvious that the most important component of software was the user interface (Mary & Carroll M., 2002). "As more and more software was developed for interactive use, attention to the needs and preference of end users intensified" (Mary & Carroll M., 2002). Usability in computer software began to gain popularity amongst end users because they gradually learnt how to manipulate systems without difficulty. Three perspectives of usability were identified by (Mary & Carroll M., 2002) namely; human performance, learning and cognition, and collaborative activity.

Human performance was measured alongside the software development at both system testing and requirement ends. To understand requirements, clients were interviewed and analyzed to cognize preferences and to determine if systems met the design specification. System testing often involved prototyping, iteration and spiral models in design phase. As computer systems became more usable and goal oriented, end users began to learn quickly through perception and cognition.
Collaborative activity involves integrating functions of the system to conform to the users' perspective. An often-useful method to this approach is the "Wizard of Oz" study. A study developed to experiment how users can use natural language to fully interact with a system. In the Wizard of Oz, (named after the movie), the functionality of the system was simulated by people (Mark & Scott).

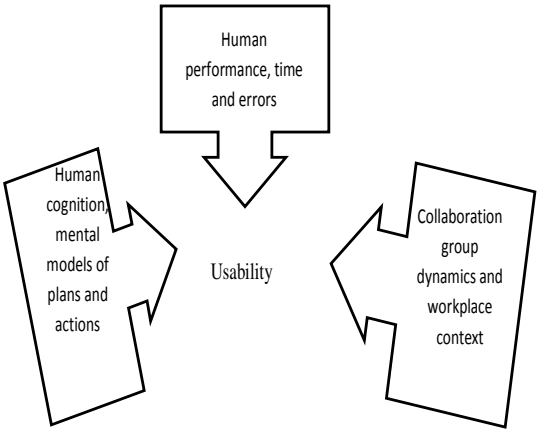

Fig 1. Three Perspectives of Usability Engineering.
Source: Usability Engineering: Scenario Based Development of Human-Computer Interaction

4.2 Group Learning (Computer-Supported Cooperative Work)

Computer-supported Cooperative Work (CSCW) has become the main focus in system usability. CSCW is an important section of HCI, which deals with social interactions. It started in the early 1980s as a "counter-effort to consider collaborative computer use" (Mark & Scott). CSCW rapidly incorporated different forms of social organizations interactions in work, Internet usage and entertainment. "CSCW found its roots and assumptions largely in micro-sociology, as well to a lesser extent in social psychology and cognitive anthropology" (Mark & Scott). CSCW facilitates group work and team learning, it takes into consideration how small and large groups can utilize computer technology in organizational environments to improve performance. Group learning is a medium through which social interactions can be used to promote teamwork. HCI focuses on CSCW as a way to fully involve end users in understanding and communicating with systems in groups and teams. CSCW can be evaluated using various factors from Computer Collaborative Learning (CSCL). These dimensions include; participation, interaction, cognition, metacognition, and socialization (Newman, Brian, & Clive, 2004). Group learning and CSCW further branches different aspects of usability and software engineering

4.3 Human-Computer Interaction on the Internet

As personal computers gradually became popular amongst individuals, the Internet also began to gain widespread recognition. Stakeholders in Human-Computer Interaction recognized the importance of a user- friendly interface on web sites; this lead to the emergence of HCI on the Internet. When users visit a website and they are quickly able to navigate the site without difficulty, then it can be said that there is a high level of collaboration and the HCI is competent. According to (Icon Logic Learning Series, 1994-2006) websites that enable users to "seemingly effortlessly" accomplish a task is a good example of an efficient HCI.

IconLogic (2006) identified "The United States Postal Service's web site (www.usps.com) as one of the single-best models for HCI." Comparisons were also made with other websites that were thought to have "bad examples of HCI" examples of such websites included Xerox real business, Sony and Symantec websites respectively. These websites were analyzed based on completeness of information, ease of use, design, and adaptability and according to (Flanders, 2012) these websites were badly designed and uneasy to navigate.

4.4 HCI and Help Systems

One of the ways to measure if a System Interface is user-friendly is its ability to provide help to users. Help Systems can be defined as a medium through which users can find assistance when they encounter difficulty or get stuck with a program (Icon Logic Learning Series, 1994-2006). Help System as a sub section of HCI emphases on the need for software developers to build a well defined and informative help page for users. Software developers have to incorporate different functions like Table of Contents, Search tabs and Indexes into the Help System to ensure that users are able to easily find answers when using a particular system. There are three common types of Help Systems namely; WebHelp, HTML Help, and FlashHelp. These Help systems are further examined below.

4.5 WebHelp

WebHelp Systems are commonly found on websites that can be used to access a database and online transaction processing websites. This Help System is ideal for cross-platform users ranging from Windows, Macintosh, and UNIX users (Icon Logic Learning Series, 1994-2006).

4.6 HTML Help

This type of Help System is the most common; it is usually embedded on open source programs and software. It provides information on each feature of the software. A typical example of HTML Help system is shown below.

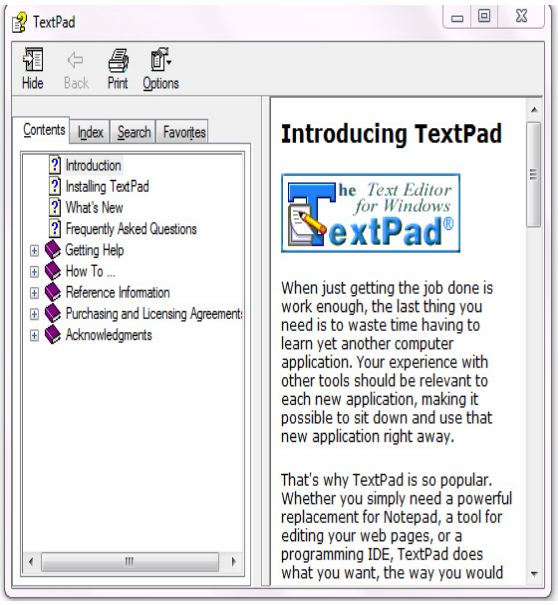

Fig 2. Text Pad Help

FlashHelp
FlashHelp are commonly used on the Internet, they are analogous to WebHelp Systems and "feature more dynamic animation effects" (Icon Logic Learning Series, 1994-2006). This type of help system is usually interactive and provides an option for users to ask questions online. FlashHelp systems can also be found on different Operating Systems. Microsoft Office suit also offers WebHelp and FlashHelp System. An illustration of a FlashHelp System is depicted below

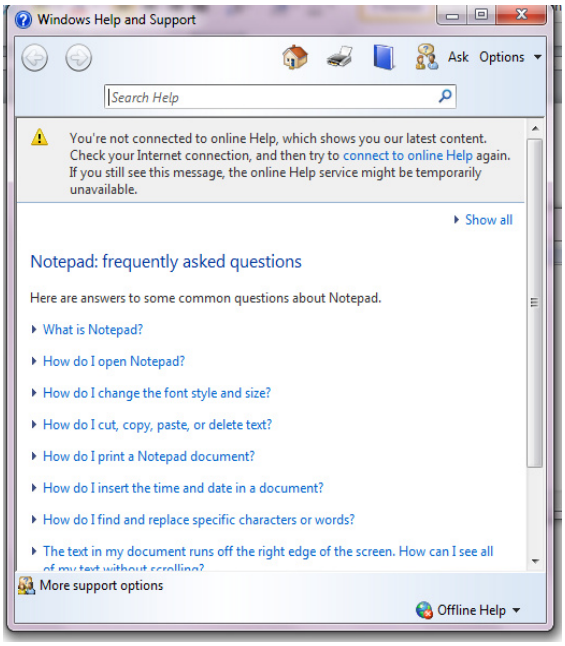

Fig. 3: Notepad FlashHelp System

Help Systems that are composed of various functions like Search bars, Glossary tabs, Table of Content and Indexes are very important in HCI, as they help users with options to easily get help when they are stuck with a particular task. Sometimes users are not able to get help using the Table of Content in such case, the Search bar or Index tab becomes highly useful.

5. HCI IN INFORMATION SYSTEMS

Various researches have been carried out on Human-Computer Interaction and Information Systems. Information Systems is a collection of related components (parts/entities) such as hardware, software, procedures and people put together to make an integral functional whole in order to realize a given objective. These components enable smooth planning, coordination, and decision making in an organization. HCI in Information System is becoming an important topic and stakeholders in both fields are beginning to see the need for both fields to become collaborative.

A major step towards this collaboration is formation of a Special Interest Group on Human-Computer Interaction (SIGHCI) by the Association for Information Systems (AIS) (Zhang, Fiona, & Jenny, 2004) The SIGHCI was established in 2001 and has since then been effective in organizing workshops and conferences on HCI and Information Systems.

5.1 Status of HCI in Information Systems

HCI and Information System are interdisciplinary fields, which complement each other in several ways. Information Systems (IS) draws knowledge from psychology, communication, sociology and management. HCI is also related to these fields of study in different ways. "Interestingly, IS and HCI have more in common than might be expected of two communities that have had relatively little interaction until now" (Zhang, Fiona, & Jenny, 2004). As mentioned earlier, because of the need to collaborate both fields, the SIGHCI was formed.

The Special Interest Group on Human-Computer Interaction offers an opportunity for Information Systems stakeholders to converse and contemplate on an array of topics associated with the "history, reference disciplines, theories, practices, methodologies, techniques, new developments and applications arising from interactions between humans, information, technologies and tasks" (Zhang, Fiona, & Jenny, 2004). The main goal of the SIGHCI is to discuss future trends in business and computing as well as to understand how people interact in these contexts.

The group promotes streams of research topics in HCI and Information systems, with the aim of offering a basic understanding of the relationship between both fields. SIGHCI has been solely responsible for publishing journals and articles that cover different topics and researches from both HCI and IS practitioners. A good example of such journal is the (International Journal of Human-Computer Studies Special Issue on HCI and MIS: Shared Concerns Volume 59, Number 4 October 2003). In 2003, the Americas Conference on Information Systems (AMCIS) organized a conference named (AMCIS'03).

The purpose of this conference was to "encourage future collaboration between AIS SIGHCI and the international HCI community" (Zhang, Fiona, & Jenny, 2004), and also to increase cognizance of HCI in Information Systems as well as offer a medium to discuss the key challenges some Information Systems professors encounter in teaching HCI courses. (Zhang & Fiona, 2003).

The conference attracted a large number of participants and different topics concerning HCI and Information Systems were deliberated on. During the conference, certain panels were set up to discuss strategies to incorporate HCI into existing IS courses. Subsequently a conclusion was drawn by these panels that HCI is an important and integral part of Information Systems, and should be incorporated into the core IS curriculum.

6. CONCLUDING REMARKS AND FUTURE WORK.

In this paper, we have made efforts to define HCI, trace its history, show its relationships with other fields and discipline, its usability and relevance in other fields. We have also reviewed issues surrounding Human-Computer Interaction and its relationship in Information Systems, identify some causes of complexity in user interface design and provide certain solutions to eradicate these complexities. The objective is to situate our research in a proper perspective, so that the gap in the context of increasing complexities in the design of user interface that it sets out to fill is better appreciated. Future work will address how these gaps can be filled

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Inah Usang holds a BSc. in information Systems from the American University of Nigeria. He has a concentration in Information systems security and assurance. He has been involved in several Information Technology projects under the supervision of well-trained faculty of the American University of Nigeria. Asides his interest in Information Technology, he is also interested in multimedia and business management. He plans to go for graduate studies in the United Kingdom where he plans to study Information Systems and Business Management.