

A Survey on Literature Review of the Usability of HCI

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ABSTRACT: The historical transition from Command Line Interface to Graphical User Interface raised usability problems, and as a consequence, various researchers developed new evaluation methodologies in order to develop friendly systems that were able to support performance and the spread of information on the World Wide Web. The term usability plays an important role in human life. Human Computer Interface & Security has identified the need to improve usability. Most of the recent research in this area focuses on the issue by improving user interfaces to security tools. In this paper, a comprehensive overview of the historical developments leading to the need for usability and security of human computer interaction (HCI) is presented.

KEYWORDS: Computer; HCI; Interaction; User; Usability;

I. INTRODUCTION

Basically HCI is an area which is reinventing itself. It has been around for decades and has impacted nearly every area of our daily lives. As computers are increasingly becoming part of our environments, in public spaces such as airports, garages, and shopping malls as well as in the private spaces of our homes and offices. In the earlier days of computers, HCI was not a topic of interest, because very few people interacted with computers, and those who did, generally were technical specialists. HCI has its origin in the falling prices of computers in the 1980s, for the first time, it was feasible for many users to have their own personal computer. From some years HCI has now been a major area of research in computer science, human factors, engineering psychology and closely related disciplines. One of the reasons for

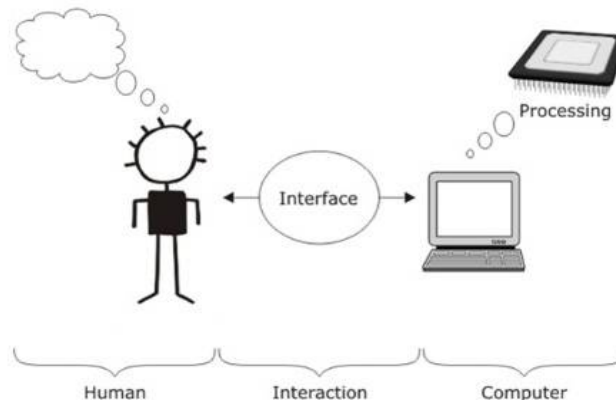


Fig. 1 Interaction between Human and Computer

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studying HCI is to influence the design of future systems and to increase our understanding of technology and its effects, to discover what impact computers are having on people's productivity, job satisfaction, and communication with other people, and the general quality of their lives. Some of the definitions used in this paper are as follows:

Human Computer Interaction: "*Human-computer interaction is a discipline concerned with the design, evaluation and implementation of interactive computing systems for human use and with the study of major phenomena surrounding them.*" Human-Computer Interaction (HCI), just as the name implies, refers to the interaction between humans and computer technologies. Human computer interaction is made up of three components:

A. Human:

Humans are the one who interact with the system. This may include groups of people or specific individuals. Human is the most important part of this research area. They play a vital role while interacting with system and hence when we consider about the other concepts like usability and security, humans are the only weakest link in system.

B. Computer:

In human computer interaction (HCI), computer is an intermediate between human and interaction. All tasks performed by the human on computer are either checks or actions are carried on the process, and at this terminal a system provides the vital link between human and process and results in an interaction. The computer or hardware device that is being interacted with which includes devices beyond the standard desktop computer. For example: PDA, cell phone, car, door lock and ATM.

C. Interaction:

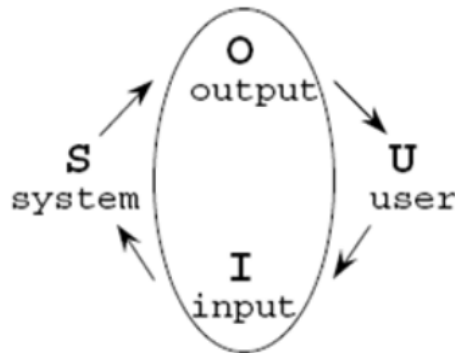


Fig. 2. Interaction component

The sharing of data between human and computer results in an interaction. Mainly interaction has four components: User, Input, System, Output. Interaction component help us to understand what is going on in the interaction between user and system. They address the translations between what the user wants and what the system does. The interaction takes place within a social and organizational context that affects both user and system. The user acquires a central role and the design and development of any technological product is made according to their needs and specifications. As many problem solving solutions involve removing the factor that is causing the problem. In our case, that would require "User less" computer systems.

D. Usability of Human Computer Interaction (HCI):

With the rapid growth of networked systems and applications such as ecommerce and internet, the demand for effective usable computer system is increasing. Usability aims at making desirable action easier for the user. A usable system will minimize unintentional errors. The usability has been decomposed into several sub attributes which are hypothetical constructs to define the success of a system. User involvement plays key role in determining the software usability after it has been developed. Among all these, a generalized definition of usability is:

"The ease with which a user can learn to operate, prepare inputs, and interpret outputs of a system or component".



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E. Usability and security of Human Computer Interaction (HCI):

Security and Usability are quite opposite terms. Security is aimed at making undesirable actions more difficult while usability aims at making desirable ones easier for the user. A usable system will minimize unintentional errors, while a secure system will aim at ensuring that undesirable actions in a system are prevented. Usability necessarily has different meanings in different contexts. For some, efficiency may be a priority, for some, learnability, for others, flexibility. But in a security context, it is like whatever needed in order for the security to be used effectively. Currently the only effective means of ensuring that a secure system is usable is to periodically conduct evaluations and test user responses. Usability evaluations of secure software systems require procedures that deviate from standard HCI techniques.

II. LITERATURE REVIEW

A Lot of research has been carried out to study the usability and security of Human Computer Interaction (HCI) concept; related to that many models are also taken in to birth in making a system usable and secured.

In 1982, Foley and Van Dam described usability with respect to user interface guidelines as a property of the syntactic and semantic analysis of a user interface. In usability evaluation of HCI, user interface plays an important role. Foley and Van Dam focuses on user interface as they says that, at designing phase if interface has good quality then that system is usable. In 1983, Shneiderman, professor in Computer Science at the Human-Computer Interaction Laboratory at the University of Maryland, defined the main features of direct interface manipulation in graphic interface. Like Foley and Dam, Shneiderman also focuses on user interface. But with user interface he gave the main features of interface only for graphical system. Then up to the end of 1984, there was no change for the users or programmers; this period was characterized by an evolution of systems and models of interaction. But after this period the view of researcher get a little bit change and in the year 1984, Smith and Moiser made the next attempt by describing usability as a product attribute, which defines the concept by naming product or system attributes or qualities that influence the usability. In the same year Eason supported the view that usability is the question of how well users can use that functionality. During the year 1985, usability issues became more central, due to the spread of the personal computer and the Internet, with the consequent distinction between users and programmers. At this period, Gould (1985) defined usability differently by considering not only interface but also user. He defined usability as any system designed for people to use; should be built by keeping in mind that it should be easy to learn and remember, it should be useful, it should contain functions that people really in their work and be easy and enjoyable to use. After Shackel, Doll and Torkzadeh in 1988 presented a model for satisfaction measurement called End User Computing Satisfaction Instrument (EUCSI). This model is get succeeds to fulfil user satisfaction level at a certain level. This was used for specific application. Satisfaction in EUCSI is defined as "an affective attitude towards a specific computer application by someone who interacts with the application directly". EUCSI includes: content, accuracy, format, timeliness and ease of use. According to EUCSI, user satisfaction is influenced by the usefulness of the system, characterized by accuracy, task match, and the topicality of presented information, and the users' beliefs concerning the qualities of presentation.

Ravden and Johnson in the year 1989 presented a usability evaluation mechanism, software inspection and gave a detailed checklist of 122 items divided into 9 dimensions. In the same year Igbaria and Parasuraman considered fun to be very influential in acceptance of any software system. Whereas Booth thought that it is difficult to specify and measure flexibility of a system and believed that being useful should be fundamental to usability, thus he modified Shackel's criteria into usefulness, effectiveness, learnability (or ease of use), and attitude (or likeability). After this Polson and Lewis in the year 1990 suggested for the solutions of user interface design. They contributed by giving problem solving strategies for novice users when they interact with the complex interface. It was not until the 1990s that the "I" in HCI switched from "interface" to "interaction" reflecting the vastly expanding range of digital technologies. It was also during the 1990s that the term "Usability" has come to be synonymous with virtually all activities in HCI. Prior to this HCI encompassed five goals to develop or improve: Safety, Utility, Effectiveness, Efficiency, Usability. Originally usability was the least but has since been promoted to cover everything. "The study of HCI became the study of Usability".

In the year 1991 Holcomb and Tharp presented a model of usability for the system designers to decide which usability sub attributes should be included. It provides a consistent metric for usability. At the same time ISO 9126 defined usability as "a set of attributes that bear on the effort needed for use, and on the individual assessment of such use, by a stated or implied set of user". In the same year, the concept of usability elaborated by Brian Shackeld, "usability of a



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system or equipment is the capability in human functional terms to be used easily and effectively by the specified range of users, given specified training and user support, to fulfill the specified range of tasks, within the specified range of environmental scenarios". Mayhew in the year 1992 reviewed the guidelines and instruction for user interface development. It also includes the general usability principles which describe the desirable properties of the interface. Whereas Grudin proceeded towards practical acceptability of the system within the various categories like cost, support, system usefulness. After 1992 the study was characterized into usability which referred how successfully a user can use system's functionality. In 1993, According to Hix and Hartson, On the basis of efficiency of the interface, the reaction of user can be related to its usability. The classification of usability depends upon learnability, retainability, performance, advanced feature usage, first impression and user satisfaction.

From the year 1993, safety of a system is considered with the usability and the various researchers again focuses on various attributes of usability. Means somewhere security of a system is considered with usability of a system. There can be a variation in usability as it depends on user's prior experience with the similar software systems. Again Preece et al., in 1994 proposed a new classification composed of learnability, throughput, flexibility and attitude. Bevan and Macleod, who discusses the ISO 9241 approach regarded usability as "a property of the overall system: it is the quality of use in a context". Nielsen's and Levy's, both worked on user satisfaction assessment of product with the aim of usability evaluation. In the same year the most different concept of usability was given by Logan, he divided usability into social and emotional dimension. The emotional dimension explained that, a usable product will attract user's attention, enable learning and relive computer anxiety. Another expert Caplan cited a new approach of usability; he defined apparent usability as an important consideration in the design of a software system.

In the year 1995, Lamb claimed usability issues are not limited to interface usability; but it also includes content usability, organizational usability and inters organizational usability. According to Guillemette usability is "the degree to which an information system can be effectively used by target users in the performance of tasks."

Lecerof and Paterno (1998) provided a definition addressing importance of a system to users, efficiency of software system, user's subjective feelings, learnability, and a system's safety feature. Thomas categorized usability sub attributes into three categories: outcome, process and task. Outcome includes effectiveness, efficiency and satisfaction; process, defines ease of use, interface, learnability, memorability and error recovery; and task defines functionality and compatibility. In 1999, Microsoft also regarded usability as strategies to attract user's reactions for a system and utilizing them into the various development stages by Veldof, Prasse, and Mills. However, Head pointed a main value point for usability: he stated that the core value of "usability is rooted in cognitive science which is the study of how people perceive and process information through learning, the use of memory, and attention". To build an effective user friendly interface, design guidelines contain instructions and various design principles. In 1999, Vanderdonck provide usability methods described into five categories: design rules, ergonomic algorithms, style guide, standards and collection of guidelines. According to Squires and Preece, in 1999, Usability concept was started for providing an educational value as an important for e-learning systems. Hence, improvement in this, results the systems more usable, still such a system may not have any educational sense. Arms in 2000 stated that usability comprised of aspects including interface design, functional design, data, metadata, computer systems and networking.

In the year 2001, 2003, and 2004 Whitney Quesenbery define "the five E's of usability" which include effectiveness, efficiency, engagement, error tolerance, and ease of learning which are known as attributes of usability. These five 'E's explained the requirement of an interface design that must be easy to learn, remember, and use, with few errors for its implied users and the tasks that it is assigned to use support. Turner in 2002 illustrated a checklist for the evaluation of usability. For this usability could be characterized into navigation, design of the page, its consistency, and content, context of use, accessibility and interactivity. In the same year, Blandford and Buchanan cited the usability concept as technical, cognitive, and social design based. In the context of web usability, Palmer defined usability, which explains ease of navigation for task performance and clarity of interaction. The combination of analytical and empirical evaluation method called "systematic usability evaluation" was devised for usability measurement. Oulanov and Pajarillo stated that effectiveness is one of the most important aspects for successful communication interface because it is the medium of interaction. In 2003, Guenther marked out the difficulties related with usability. According to him "defining usability is complicated". Campbell and Aucoin explicitly stated that "usability refers to the relationships between tools and their user and it is the quality of a system that makes it easy to learn, easy to use, easy to remember, error tolerant and subjectively pleasing. Abran et al. (2003) referred usability as a set of multiple concepts, performance of the system, execution time of a specified task, user satisfaction and ease of learning. Villers in 2004, Dringus and Cohen in 2005 all gave a common expression, according to them the usability evaluation methods should consider for



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educational factors also. Krug in 2006 studied usability from the user's perspective based on their experience. 10 usability factors namely efficiency, effectiveness, productivity, satisfaction, learnability, safety, trustfulness, accessibility, universality, and usefulness are associated with twenty-six usability measurement criteria classified by Seffah, Donyae, Kline and Padda. In 2008, Tom Tullis and Bill Albert presented various Guidelines for Measuring the User Experience which includes certain points: Know your data; Show your confidence (intervals); Show frequency distributions; Combine different metrics; Use appropriate tools; Present data appropriately. Thomas S. Tullis, in 2009 explained some of the myths regarding usability, regarded them as 'Top Ten Myths about Usability'. Gardner-Bonneau D. 2010, he talked about the software system's capability to sustain the changes in the technical prospects without hampering the usability effectiveness. Jennifer C. Romano Bergstrom et al. in 2011 carried out a demonstration and explained the benefits and challenges faced by the designers while usability testing of website design.

Table: Quick review at the development of usability concept from 1982-2011

Researchers	Usability Concepts
Foley and Van Dam (1982)	User interface guidelines.
Smith and Moiser (1984)	Described usability as product's attribute.
Eason (1984)	Interrelated usability and functionality.
Gould(1985)	Defined usability in terms of learnability, usefulness and ease of use.
Shneiderman (1986)	Guidelines for error prevention, discussed the system's response time, data entry within HCI.
Shackel(1986)	Defined usability with the factors effectiveness, learnability, flexibility and attitude.
Tyldesley (1988)	Mentioned 22 factors that could be used to build the metrics and specifications.
Doll & Torkzadeh (1988)	End User Computing Satisfaction Instrument (EUCSI).
Ravden& Johnson (1989)	Presented software inspection as usability evaluation mechanism.
Igbaria & Parasuraman (1989)	Enjoyability is directly proportional to acceptance of a system.
Booth (1989)	He modified Shackel's criteria into usefulness, effectiveness, learnability, and attitude.
Polson & Lewis (1990)	He gave problem solving strategies for novice users to interact with the complex interface.
Holcomb & Tharp (1990)	Presented a software usability model for the system designers to decide which usability sub attributes should be included.
Brian Shackel (1991)	Elaborated the usability concept.
Grudin (1992)	Practical acceptability of the system within the various categories like cost, support, system usefulness.
Nielsen (1993)	Presented usability heuristics for the inspection method of usability evaluation. He classified usability to, learnability, efficiency, memorability, errors, and satisfaction.
Dumas & Redish (1993)	explained their definition of usability on the basis of focus on users, usability means, use of product by users for productivity, users are busy people trying to accomplish tasks, decision of user about when the product is easy to use.
Preece et al. (1993)	Categorized usability into sub attributes namely: safety, effectiveness, efficiency and enjoyableness.
Beimal et al. (1994)	Principles of acceptance for usability.
Nielsen & Levy (1994)	Worked on user satisfaction assessment of product.
Logan (1994)	Divided usability into social and emotional dimension.
Preece et al. (1995)	Related usability to overall performance of the system and user satisfaction.



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Lamb (1995)	Claimed usability as a wider concept which includes content usability, organizational usability and inter organizational usability.
Guillemette (1995)	Reviewed and defined usability with respect to effective use of information system.
Kurosu & Kashimura (1995)	Divided usability into Inherent usability and Apparent usability.
Nielsen (1995)	Presented "Discount usability engineering".
Botman (1996)	Presented "Do it yourself usability evaluation".
Butler (1996)	Dealt with usability engineering.
Harrison & Rainer (1996)	Reviewed a model used for computing satisfaction –EUCSI.
Kanis & Hollnagel (1997)	High degree of usability can be determined when the error rate of usability is minimum.
Gluck (1997)	Correlated Usability to usefulness and usability.
Lecerof & Paterno (1998)	Declared functionality being essential to usability.
Thomas (1998)	Categorized usability sub attributes into three categories: outcome, process, and task.
ISO 9241-11(1998)	"Guidance on usability" which discusses usability for the purposes of system requirement specifications and its evaluation.
Veldof, Prasse, & Mills (1999)	Related usability, user's reaction and system development
Vanderdonck (1999)	Design guidelines and principles to build an effective user friendly interface.
Kengeri et al. (1999)	Explained usability using effectiveness, likability, learnability and usefulness.
Squires & Preece (1999)	Usability concept was regarded for pedagogical value for e-learning systems.
Alred et al. (2000)	Related usability to technical/system and human factors.
Battleson et al.(2001)	Explained interface design that is easy to learn, remember, and use, with few errors.
Hudson (2001)	The concept of web usability was described.
Turner(2002)	Illustrated a checklist for the evaluation of usability.
Blandford& Buchanan (2002)	Explained usability in terms of technical, cognitive, and social design. Also, looked into the future work on methods for analyzing usability.
Palmer (2002)	Explained usability in context of web usability.
Oulanov & Pajarillo (2002)	Interface effectiveness as one of the most important aspects of interaction".
Matera et al. (2002)	Gave "Systematic usability evaluation".
Guenther & Pack (2003)	Illustrated the difficulties in defining usability.
Campbell & Aucoin (2003)	Explained usability as a relationship between tools and its users.
Abran et al. (2003)	Referred usability as a set of multiple concepts, performance of the system, execution time of a specified task, user satisfaction and ease of learning.
Whitney Quesenbery (2001,2002, 2003)	Presented "the five E's of usability" which include effectiveness, efficiency, engagement, error tolerance, and ease of learning.
Villers (2004), Drigus Cohen (2005), Miller (2005)	Expressed usability evaluation methods should consider pedagogical factors.
Seffah, Donyanee, Kline & Padda (2006)	Gave 10 usability factors namely, efficiency, effectiveness, productivity, satisfaction, learnability, safety, trustfulness, accessibility, universality, and usefulness are associated with twenty-six usability measurement criteria.
Brophy & Craven (2007)	Explained web usability.



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Tom Tullis & Bill Albert (2008)	Presented 'Tips and Tricks for Measuring the User Experience'.
Thomas S. Tullis (2009)	Explained 'Top Ten Myths about Usability'.
Gardner-Bonneau (2010)	Explained the effectiveness sustained by the software system when technical changes are made to it.
Jennifer C. Romano Bergstrom et al. (2011)	Conducted iterative usability testing.

Table 1. Comprehensive overview of the usability

The above table gives the total overview of the usability studies done in the past. Up to the end of the 1950s, technological and computer tools were created with specific functions determined by the different ideal interaction models given by programmers. Till up to the 1963, there was no need for usability in the human-computer interface because programmers (the creators of the interface) were at that time, also the users of the software. In 1963, at the Massachusetts Institute of Technology (MIT), Sutherland (1964), then Vice President and Fellow at Sun Microsystems, developed the first interactive graphic user interface, Sketchpad which changed the relation between users and technology. In 1980s, the first kind of usability test, known as "laboratory usability testing", quickly became the primary usability evaluation method for examining a new or modified interface.

III. CONCLUSION

Usability concept has been under focus over the years and has evolved with different definitions by researchers. Different attributes have been built for a clear view of usability and its aspects. The usability has been decomposed into several sub attributes which are hypothetical constructs to define the success of a system. User involvement plays key role in determining the software usability after it has been developed. Usability correlates with the functionality of the system and helps in its evaluation. The lack of usability causes failure of the software system that leads to a substantial monetary loss, user dissatisfaction, staff unproductivity and time wastage. Therefore, usability evaluation is very important for the process of designing usable software system. Most of the recent research in this area focuses on the issue by improving user interfaces to security tools.

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