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USABILITY OF INTERFACES

The main principles and heuristics of usability, as well as the importance and necessity of user-centered design are considered.

Introduction

In recent years human society evolved from the "industrial society age" and transitioned into the "knowledge society age". This means that knowledge media support migrated from "pen and paper" to computer-based Information Systems.

This evolution introduced some technological, organizational, and methodological changes affecting the demand, workload and stress over the workers, many times in a negative way.

Due to this fact Ergonomics assumed an increasing importance, as a science/technology that deals with the problem of adapting the work to the man, namely in terms of usability.

Usability is a quality or characteristic of a product that denotes how easy this product is to learn and to use [1]; but it is also an ergonomic approach, and a group of principles and techniques aimed at designing usable and accessible products, based on user-centered design.

User-centered design is a structured development methodology that focuses on the needs and characteristics of users, and should be applied from the beginning of the development process in order to make software applications more useful and easy to use [2; 3].

Usability and interfaces – Basic principles and heuristics

In some countries usability is a legal obligation. For instance, in European Union according to the Council Directive, 90/270/EEC, of 29 May, on the minimum safety and health requirements for work with display screen equipment, when designing, selecting, commissioning and modifying software the employer shall take into account the following principles:

- The software must be suitable for the task;
- The software must be easy to use and adaptable to the operator's level of knowledge or experience;
- Systems should provide users with information on its operation;
- Systems must display information in a format and at a pace adapted to users;
- The principles of software ergonomics must be applied, in particular to human data processing.

Therefore to meet these requirements the software development should be accompanied by an evaluation of its usability.

In simple terms, the usability of a system can be seen as the ease with which the system is used by its users, i.e., with the characteristic of being easy to use, or as is often said, to be "user friendly".

Therefore, usability is a feature of interaction between the user and the system. Usability evaluation can be based on a set of attributes, such as, operator performance (completing a task with reduced turnaround times and low error rates), satisfaction or ease of learning.

Usability can also be seen as synonymous of product quality, namely of software quality.

Usability is a critical aspect to consider in the development cycle of applications which requires a user-centered design and carrying out usability testing. Such tests cannot ignore the context of use of the software, which is essential to conduct usability studies. When human-machine interfaces are built taking into account usability criteria, interfaces are capable of allowing an intuitive, efficient, memorable, effective and enjoyable interaction. As Nielsen refers these characteristics influence systems' acceptability by users [4]. Figure 1 schematically represents the relationship of these particular characteristics with others that influence system usability.

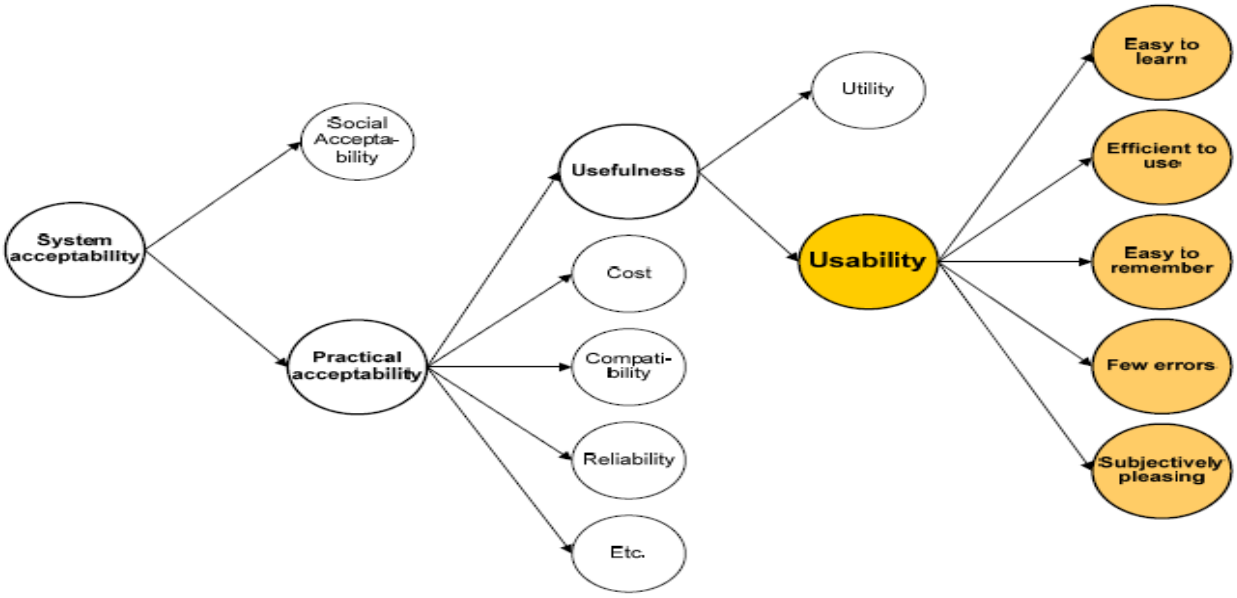

Fig. 1. A Model of the Attributes of System Acceptability (Nielsen, 1993).

Therefore, because of their influence in the usability of a system, it is important to define the concepts inherent to this set of characteristics [4]:

 Ease to learn - the system must be intuitive, i.e. easy to use, allowing even an inexperienced user to be able to work with it satisfactorily;

 Efficiency of use - the system must have an efficient performance, allowing high productivity, i.e., the resources spent to achieve the goals with accuracy and completeness should be minimal;

 Memorability - the use of the system must be easy to remember, even after a period of interregnum;

 Errors frequency - the accuracy and completeness with which users achieve specific objectives. It is a measure of usage, i.e. how well a user can perform his task (e.g. set of actions, physical or cognitive skills necessary to achieve an objective);

 Satisfaction - the attitude of the user towards the system (i.e., desirably a positive attitude and lack of discomfort). Ultimately measures the degree to which each user enjoys interacting with the system.

According to [5], when designing a product to achieve an appropriate usability developers should adopted the following 10 principles:

1. Consistency - similar tasks are performed in the same way;
2. Compatibility - the method of operation is compatible with the expectations of users, based on their knowledge of other types of products and the "outside world";
3. Consideration of user resources - the operation method takes into account the demands imposed to the resources of users during the interaction;
4. Feedback - actions taken by the user are recognized and a meaningful indication of the results of such activities is given;
5. Error Prevention and Recovery - designing a product so that the user likely to err is minimized and that, if errors occur, there may be a quick and easy recovery;
6. User Control - user control over the actions performed by the product and the state in which the product is are maximized;
7. Visual Clarity - the information displayed can be read quickly and easily without causing confusion;
8. Prioritization of Functionality and Information - the most important functionality and information are easily accessible by users;

9. Appropriate Transfer of Technology - appropriate use of technology developed elsewhere in order to improve the usability of the product;

10. Explicitness - offer tips on product functionality and operation method.

The design has also to consider the finite capability of humans to process information, to take decisions, and to act accordingly. These human characteristics have been thoroughly studied in the last decades, considering the Human Computer Interaction. Researchers that became a reference are, for instance, Hick (1952), Fitts (1954), or Miller (1956).

William Hick was a pioneer of experimental psychology and ergonomics. One of his most notorious researches was focused on the time a person takes to make a decision as a result of the possible alternatives, considering the cognitive information capacity, which was expressed as formula known as the Hick's Law [6].

Paul Fitts was a psychologist and a pioneer in human factors, which developed a mathematical model of human motion, known as Fitt's Law, based on rapid aimed movements [7]. This model is used, in the realm of ergonomics and human-computer interaction, to predict the time required to rapidly move to a target area, for instance to point with a hand or a finger, or with a pointing device in a computer interface.

George Miller was a cognitive psychologist that studied the average capacity of the human working memory to hold information. His studies concluded the number of objects an average person can hold is 7 ± 2 [8]. This is known as the Miller's Law or the "magical number 7". One relevant consequence of this finding relates with the ability of humans to evaluate and judge alternatives, which is limited to 4 to 8 alternatives.

Accommodating all these research contributions in a set simple of design principles is problematic; therefore a different approach is the definition of heuristics for the assessment of the interfaces usability. An example of such approach is the work of [9] that developed a set of heuristics to improve performance in the use of computers, which includes the following rules:

 Automate unwanted load:
  - Free cognitive resources for high-level tasks;
  - Eliminate mental calculations, estimations, comparisons, and unnecessary thinking.
 Reduce uncertainty:
  - Display data in a clear and obvious format.
 Condense the data:
  - Reduce the cognitive load, low-level aggregated data turning them into high-level information.
 Present new information with meaningful ways to support their interpretation:
  - Use a familiar framework, making it easier to absorb;
  - Use day-to-day terms, metaphors, etc..
 Use names that are conceptually related to functions:
  - Context-dependent;
  - Trying to improve recall and recognition;
  - Grouping data consistently significantly reduces the search time.
 Limit data-oriented tasks:
  - Reduce time spent in acquiring raw data.
  - Make the appropriate use of colour and graphics.
 Include only information on the screens that the user needs at any given time.
 Provide multiple coding of data, where appropriate.
 Practice a judicious redundancy.

A software program developed taking into account usability principles offers advantages, as decreased time to perform a task; reduced number of errors; reduced learning time, and improved satisfaction of system's users.

User-centered design

One approach to the use of the concept of software usability is the user-centered design. The user-centered design is a structured development methodology that focuses on the needs and

characteristics of users, should be applied from the beginning of the development process in order to produce applications software more useful and easier to use [2; 3].

According to ISO 13407 (ISO 13407, 1999), there are four key activities related to user-centered design, which should be planned and implemented in order to incorporate the requirements of usability in the process of software development (see Figure 2). The activities aim to:

- Understand and specify context of use;
- Specify the user and organizational requirements;
- Produce design solutions;
- Evaluate design against requirements.

These activities are performed iteratively, with the cycle being repeated until the usability goals have been achieved.

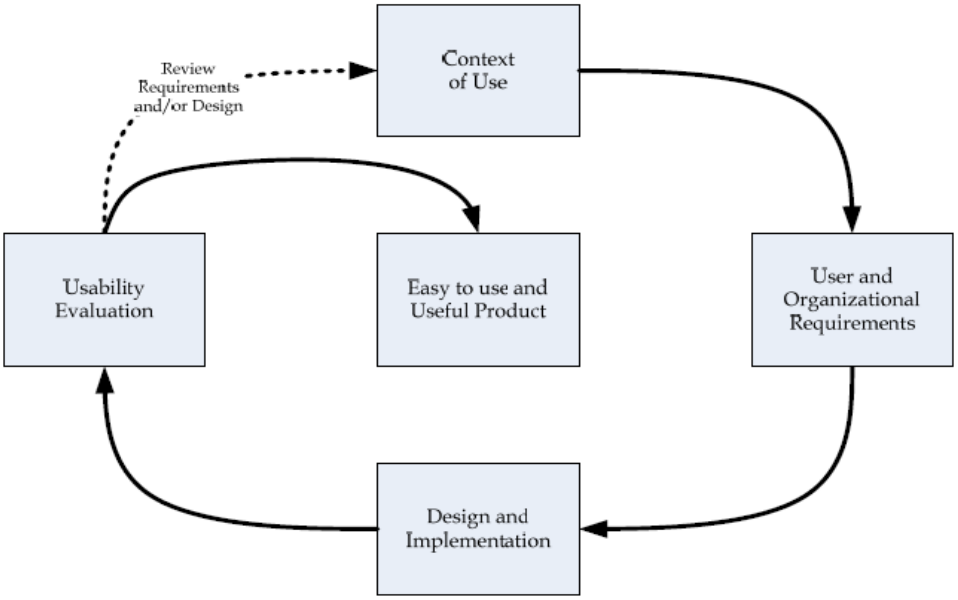

Fig 2. Activities of user-centered design, adapted from ISO 13407 (ISO 13407, 1999).

According to [11], the Usability Engineering process, which aims to implement the activities mentioned above regarding usability evaluation, includes (Figure 3):

- Identify and record critical usability data;
- Data analysis;
- Preparing the report of the evaluation results.

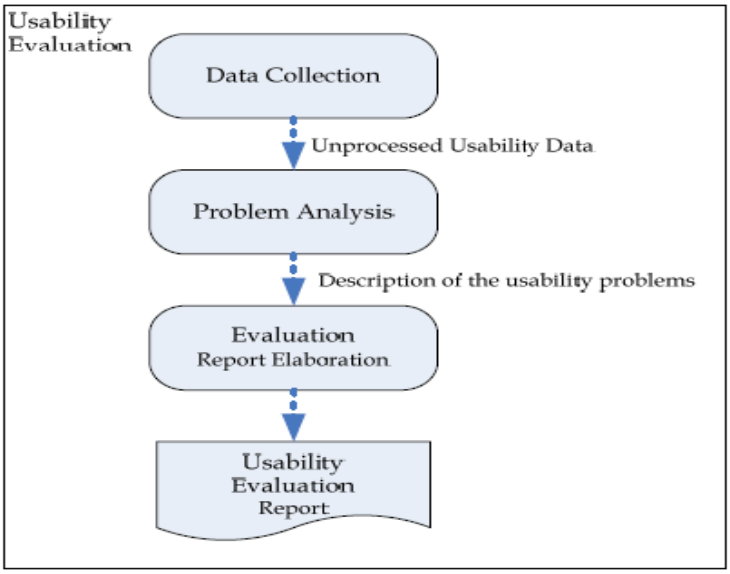

Fig. 3. Usability Evaluation, adapted from [11].

Conclusions

Usability is a critical aspect to consider in the development cycle of software applications, and for this purpose, user-centered design and usability testing must be conducted. The design and testing cannot ignore the context of use of software, whose knowledge is essential.

Usability of a system is characterized by its intuitiveness, efficiency, effectiveness, memorization and satisfaction. Good usability allows decreasing the time to perform tasks, reducing errors, reducing learning time and improving system users' satisfaction.

Usability, process design and development of software have necessarily to be framed by the characteristics of users, tasks to perform and environmental context (social, organizational and physical) for which the product is intended to.

The development of a product must consider the 10 basic usability principles: consistency, compatibility, consideration by the resources of the user, feedback, error prevention and error recovery, user control, clarity of vision, prioritization of functionality and information, appropriate technology transfer, and clarity.

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