Principles of User Interface Design: Important Rules that Every Designer Should Follow

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Abstract

In the process of creating user interfaces, it is necessary to comply with certain rules that should ensure their success among the target audience. One of these factors is their usability, i.e. intuitiveness when working with specific application and satisfaction of the end user after the attainment of the objectives of its use. There are some heuristics (principles / rules), which could be regarded as a universal, independent of devices and operating systems. In this connection, the purpose of this report is to analyse the principles defined by leading experts in the field of usability and on this basis to propose a list of rules, grouped by various signs.

Keywords: usability, user interface design, heuristics, principles, rules

Introduction

Realized the importance to develop technologies for people, more and more companies rely on services such as user experience design, interaction design, usability, information architecture, etc. They make mention of apply user-centred development approaches. Whether these terms are used consciously or under the influence of imposed "modern" trends, the fact is that end users are placed at the centre of technological developments and the ambitions of companies are to affect their emotions and feelings. This is the main objective of the user interface design of the software - focus on attitudes, behaviour, beliefs, perceptions, emotions, preferences, and subsequent psychological and physical reactions of people using the product.

The objectives of the specialists and scientists who work in the field of human-computer interaction are aimed at minimizing the barriers between mental models of users for the fulfilment of their goals and tasks. It is proved that good organization of projects in the first phases of product development reduces errors and costs of subsequent stages. Therefore, **the aim of this study** is to analyse the principles in the design of the user interface defined by leading experts in the field of usability. On this basis, the paper will propose a list of rules that every designer should follow. In this connection, it is necessary to clarify the essence of the term "design" in the sense of software technology and related terminology.

Theoretical background

According to Dictionary of Science and Technology, the word “design” could be discussed in two meanings: as noun and as verb. In the first case, it is interpreted as „the planning or drawing of something before it is constructed or manufactured“[1]. In the latter case, it is defined as „plan or draw something before it is built or manufactured“[2].

Ralph and Wand (2011) have done a thorough analysis of different definitions of the term by addressing the notion of "design" again as noun and verb. In the first situation it is „a specification of an object, manifested by an agent, intended to accomplish goals, in a particular environment, using a set of primitive components, satisfying a set of requirements, subject to constraints“ [3]. On the other hand, regarded as a verb, the term is defined as „to create a design, in an environment (where the designer operates)“ [4].

Therefore, the concept "design" must be interpreted contextually - first as a manifestation of an object’s look, and the other - as a process of building a comprehensive concept for the product. From the point of view of computer technology, the design should be discussed as „the front-end application view to which user interacts in order to use the software. User can manipulate and control the software

[1] „design”. Collin, S., Dictionary of Science and Technology. A & C Black Publishers Ltd, 2007, p. 174
[2] Ibid.
[3] Ralph, P; Wand, Y., A proposal for a formal definition of the design concept. Design Requirements Workshop, Lecture Notes on Business Information Processing. Springer-Verglag, Berlin, 2009. p. 103-136.
[4] Ibid.

as well as hardware by means of user interface. <…> User interface can be graphical, text-based, audio-video based, depending upon the underlying hardware and software combination. User interface can be hardware, software, or a combination of both“[5]. At the same time, the design could be viewed as the process of creating „the front-end application view to which user interacts“[6].

In summary, the design of the user interface could be described as representation of that „how the software communicates within itself, with systems that interoperate with it, and with humans who use it. An interface implies a flow of information (e.g., data and/or control) and a specific type of behaviour“[7].

When talking about software design, in recent years it is increasingly being connected with the philosophy of the so-called “user-centred design” (UCD) or as common “human-centred design” (HCD). According to ISO 13407:1999, the term is "an approach for the development of interactive systems that focuses on creating usable systems"[8]. The standard describes UCD as a multidisciplinary activity that involves ergonomics techniques to increase efficiency and productivity, which improve the working conditions of people with a system and neutralize possible adverse effects of its use on human health, safety and productivity.

Often the term “user-centred design” is used incorrectly as a synonym of some or all of the terms referring to creating designs as User Experience Design (UXD), Interaction Design (IxD), User Interface Design (UID), Visual Design and others related to the process of developing the user interface designs. The reason is that there are practically difficulties in setting the dividing line between the concepts because the specialists can deal simultaneously with the construction of a visual representation, information architecture, user experience, etc. Such a distinction is relevant only by a theoretical point of view, to explain various aspects of the concept of "design" and conform current discoveries and accordingly imposed "modern" trends. The fact is that the world-famous companies in the field of information and communication technologies converge designs not only to the layperson with minimal technical knowledge and to those without any specialized knowledge in this area.

Jesse James Garrett, a co-founder of Adaptive Path[9], created a conceptual model of user-centred design called “The Elements of User Experience”. The Garrett’s model (Fig. 1) divides theoretically different concepts, which are presented in an interesting perspective. The diagram is a process-oriented, i.e. „the user experience design process is all about ensuring that no aspect of the user’s experience with your product happens without your conscious, explicit intent“[10].

The model could be described as a "*multi-layered model of user experience*" and to view at the broader sense - to serve as a basis for explaining the elements of the user experience as part of the overall approach of creating customized designs. In this model, the visual reflection of the concept or the visual design is the final stage of the user experience design.

Garrett’s model presents user experience through the prism of practical experience as a structure whose skeleton is composed of individual panels, which in turn have a defined scope and serve some activity of the overall design. The planes are strategy, scope, structure, skeleton, and surface.

The first layer of the model covers user, organizational and other purposes that have direct relevance to the product creation. Garrett calls them user needs and product objectives. In the development of any product, there is a need to examine the needs of the target audience and how it will be responded to them. The required information is collected by using techniques of observation, task analysis, contextual interviews, focus groups and others.

Once we get feedback from users, the scope of the product should be determined. It is shown

[5] Software User Interface Design: < http://bit.ly/1D0eKjb> (19.10.2015 г.)
[6] Ibid.
[7] Pressman, R., Software Engineering: A Practitioner’s Approach, 5th Edition. McGraw Hill, 2001, p. 337
[8] ISO 13407:1999. Geneva, Switzerland : ISO.
[9] User Experience design and consulting firm: < http://www.adaptivepath.com> (2.11.2015)
[10] Garrett, J., J., The Elements of User Experience: User-Centered Design for the Web and Beyond. New Riders, 2011, p. 19

in Model of Garrett as a second layer. This layer comprises a definition of the requirements for the development - functional and for the content.

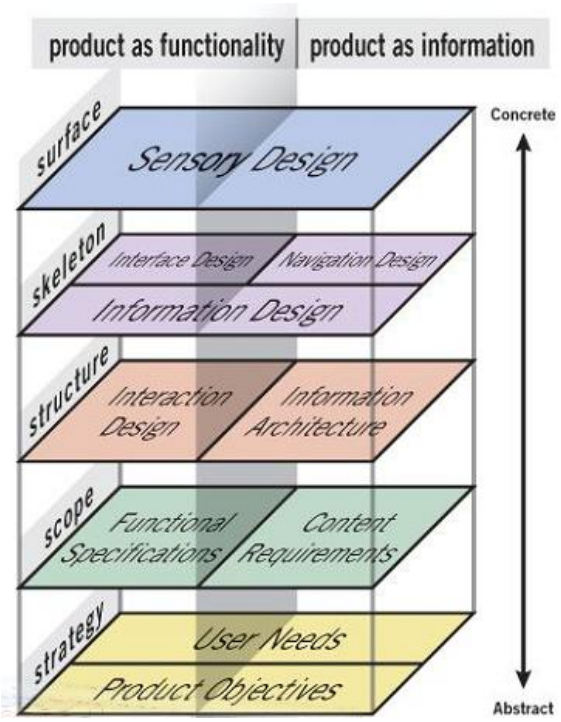

Fig. 1 The Elements of User Experience

The third stage (third layer in the model) from the product design includes interaction design and information architecture. The interaction design as well as talk the term itself is very focused on the interaction between human and computer - what answer will give the system according to requests from the user. There are some similarities between the UXD and the IxD. The similarity lies in the fact that the both of them study the target audience. The difference is that the process of interaction design is part of user experience design and it is not focused on all aspects of the system or software, seen from a user’s perspective, but only on the interaction between human and technology.

Another important term of the third layer of the model is information architecture. It is connected with the organization of information in the software application, including the names of links, buttons, etc. The research in the field of information processing[11] lays the foundations of the information architecture.

The fourth layer placed information design, interface design and navigation. The first of these focuses on the presentation of information in an understandable way to the users of the product. The user interface design focuses on the arrangement of the elements that set up the interface in a convenient and pleasant manner that allows users to reach the functionality of the product. The design of the navigation is connected with the construction of the interface elements, which is used to move between different screens, pages, etc., i.e. it is associated with the development of an effective navigation system.

On the model’s surface (or the last stage of the user experience design) stands sensor design. It binds to the touch experience and experiences that users accumulate with their five senses. In the context of technology, smell and taste are rarely the subject of consideration in the design of user experience.

It should be noted that the Model of Garrett not set specific rules that serve as a starting point

[11] This is an approach in cognitive psychology, examining individuals as processors of information. An analogy between the processing of information from people with that of computers.

for creating usable interfaces and distinguish concepts tied to user-centred design and user experience design. It displays the basic idea that the inventor of the term, Donald Norman, put in. He said: „I wanted to cover all aspects of the person's experience with the system including industrial design graphics, the interface, the physical interaction and the manual. Since then the term has spread widely, so much so that it is starting to lose its meaning“[12].

As has been discussed, models do not offer specific guidance for developing usable interfaces. That is why, in the first place, it is necessary to search such rules, established by leading international standards bodies and secondly, to summarize the experience of leading usability specialists.

Analysis of principles proposed by international standards and leading usability experts

The first of the standards to which the author of this study turns is an ISO 13407: 1999. It provides guidance for UCD lifecycle of the development of computer-based interactive systems. The standard is divided into four parts: rationale for adopting, principles, planning and activities. The parts, which set the principles and activities of user-centred design, are more interesting for the author of the current study.

The principles are four:

- active participation of system users and a clear understanding of the tasks they perform;
- appropriate allocation of function between users and technology;
- reuse of design solutions;
- multidisciplinary design.

The basis of the standard build by the defined activities of consumer-oriented design. They are four and they are reduced to (Fig. 2):

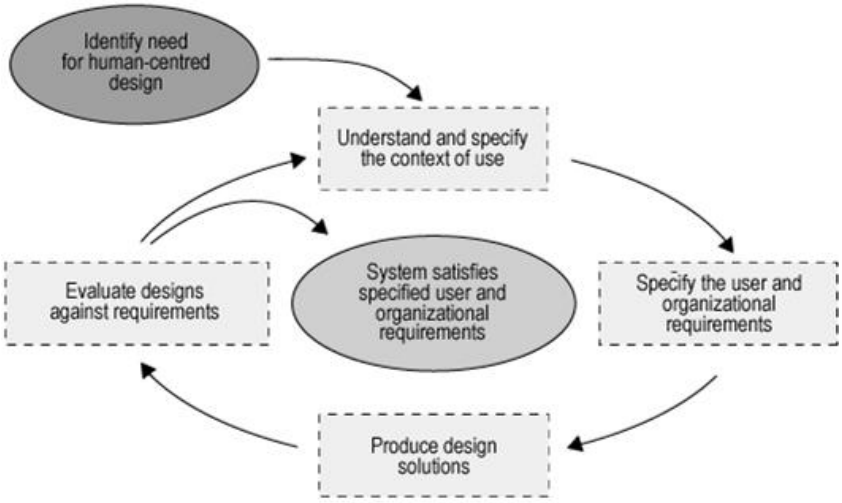

Fig. 2

- *Understand and specify the context of use*: this includes understanding the user environment where he / she work with a specific technology and the tasks for which he / she uses the product;
- *Specify the user and organisational requirements*: to this activity relate determining the criteria for success in the usability of the product in terms of user tasks, such as how quickly a typical user should be able to perform a task with the software. Here goes down guidelines for design and imposition of various restrictions;
- *Produce design solutions*: it should be given the knowledge of human - computer interaction (e.g., a visual design, interactions, usability) to create a variety of design solutions;
- *Evaluate designs against requirements*: usability of the design is assessed according to user tasks.

[12] Peter in Conversation with Don Norman About UX & Innovation: < http://adaptivepath.org/ideas/e000862> (2.11.2015)

It should be noted that neither the principles nor the activities in ISO 13407 set specific rules, which are recommended to be followed for the developing user-centred designs. They are essential in defining the key factors that influence over creating usable interfaces, namely: the audience, the context of use and system requirements defined, both by consumers and by the organization.

For this reason, and because the standard moves to ISO 9241-210, these principles need to be found in other standards. Nigel Bevan (2006) made a detailed study of international standards for HCI and usability. He grouped them by following signs: Use in Context, Software Interface and Interaction, Hardware Interface, Documentation, Development Process, Usability Capability and Other Related Standards. At the same time, standards of each group are divided into two subgroups: Principles and Recommendations and Specifications. This study is interested in the standards assigned to the group "Software Interface and Interaction" and in particular those in the subgroup "Principles and Recommendations". In his analysis Bevan stated that the standard, which „provides detailed guidance on the design of user interfaces“[13] is ISO 9241. It covers many aspects of ergonomics of human-computer interaction. The original title is "Ergonomic requirements for office work with visual display terminals (VDTs)" but it was renamed in "Ergonomics of human-system interaction". As part of this change, ISO standard is renumbered so that it covers many more topics, grouped in series and parts. The part of the standard, which sets universal guidelines for the development of usable user interfaces of software products, is Part 110: Dialogue principles. It can be assumed that the Part 129: Guidance on software individualization can be used as a complementary part. Series and other parts are directed generally to the basics of ergonomics and basics of human-computer interaction, both software and hardware products for; availability of software; user-oriented design of interactive systems, etc. They are not relevant to this study. That is why they are not discussed here.

Due to the limitations imposed by the representation of the study, it is not possible to consider all the rules defined in these two parts of the standard. It can be concluded that Part 110 sets specific criteria for the evaluation of the dialogue, which would serve as guidelines for the searches end result of the process of interface design, namely its usability. The outlined criteria are the acceptability of the dialogue to complete tasks, informative, according to the needs of the target audience, the opportunity for self, controllability, stability fixes, adaptability to individual characteristics of the users.

Compliance with the standard, however, may create unnecessary restriction on the innovativeness of the product, in particular its design, and Nigel Bevan noted in his study of international standards for HCI and usability. However, it is sufficiently detailed standard "describes the principles in the design of the user interface, not working solutions"[14]. It should be borne in mind that the rapid development of information and communication technologies „can quickly become out of date. All international standards are reviewed at least once every five years“[15].

Therefore, it is correct to be addressed and the rules proposed by the leading specialists in the field of usability. Some experts call them “heuristics” [16], and other – “principles”. In this paper, the author accepts the two terms interchangeably, as they can be considered as universal guidelines that must be followed by the interface designers, regardless of devices and operating systems.

Over time, various experts in the field of information and communication technologies defined heuristics, which are crucial for the development of the usability of user interfaces. Leading among them are Donald Norman, Ben Schneiderman, Jacob Nielsen and Bruce Tognazzini whose research and expertise are used as a base in many works. Therefore, the analysis of the principles of design in this study is limited to those defined by mentioned professionals (Table 1).

[13] Bevan, N., International Standards for HCI and Usability. International Journal of Human Computer Studies, 55(4), 2006, p. 541

[14] Bevan, N., International Standards for HCI and Usability. International Journal of Human Computer Studies, 55(4), 2006, p. 549

[15] Ibid.

[16] According to the Dictionary of Bulgarian language from the Institute for Bulgarian Language at the Bulgarian Academy of Sciences (http://ibl.bas.bg/rbe/), heuristics is "teaching method by which the teacher helps the student to reach based on accumulated knowledge to own decision on an assignment.“ From the viewpoint in computer science, it is a technique for solving problems applied to achieve faster results than traditional methods and techniques.

Table 1

Principles of user interface design, defined by
Donald Norman, Ben Shneiderman, Jacob Nielsen and Bruce Tognazzini

Donald Norman	Ben Shneiderman	Jacob Nielsen	Bruce Tognazzini
Visibility	Strive for consistency	Visibility of system status	Visible Interfaces
Consistency	Cater to universal usability	Consistency and standards	Consistency
Feedback	Offer informative feedback	User control and freedom	Aesthetics
Mapping	Design dialog to yield closure	Match between system and the real world	Autonomy
Constraints	Prevent errors	Error prevention	Colour
Affordance	Permit easy reversal of actions	Recognition rather than recall	Defaults
-	Support internal locus of control	Flexibility and efficiency of use	Discoverability
-	Reduce short-term memory load	Aesthetic and minimalist design	Efficiency of the User
-	-	Help users recognize, diagnose, and recover from errors	Explorable Interfaces
-	-	Help and documentation	Fitts's Law
-	-	-	Human-Interface Objects
-	-	-	Latency Reduction
-	-	-	Learnability
-	-	-	Metaphors
-	-	-	Protect Users' Work
-	-	-	Readability
-	-	-	Simplicity
-	-	-	State: Track it
-	-	-	Anticipation

The list of Tognazzini is very detailed, unlike that of others. In this regard, it should be noted that the principles of Norman proposed in his book "The Design of Everyday Things", published in 1988 and revised in 2002. The list of Tognazzini’s principles has expanded over the years (since 1978) and its last change was in March 2014[17]. Nielsen originally developed heuristics in cooperation with Rolf Molich in 1990, but then (in 1994) completed the list and bring it into the kind described in Table 1. Schneiderman introduced its "Eight Golden Rules of Interface Design" in 1985, but he changed it over the years as can be seen in Table 1.

All lists with design principles offer a universal solution for any kind of technology. According to Norman, these principles should be followed not only in the field of information and communication technologies, i.e. in "design of everyday things". Undoubtedly, the authors offer

[17] Full list of principles of design specialist publishes its official website at: http://asktog.com/atc/principles-of-interaction-design/. (3.11.2015)

universal solutions for all kinds of interfaces, but still can not be completely comprehensive, because modern technology is developing dynamically, preferences and users' attitudes are also changing with time. However, these principles can be used as a basis for creating usable interfaces.

Moreover, the four lists are short enough to be easily remembered and implemented by designers. The heuristics of the usability specialists do not limit innovation of design. They remind us that the designs should be user-oriented, and service to the end user.

The authors are of the opinion that there must be compliance with the established and validated standards to ensure uniform terminology for software intended for a specific platform. But this appears inconsistent with the conclusion of Bevan maded in his analysis of international standards, namely that they can be limitation for innovation in design. However, the standards provide a basis for the creation of safe technologies. The definition of "safe" can be seen as a "clear, unambiguous and simple to perceived", as "reliable", as "non-hazardous to health". Standards ensures that the technology is made without risk to the health of its users and that is provided by the minimum requirements in terms of its interface to ensure that it will be used without major difficulties. Therefore, they must be followed unquestioningly, but only partially.

All four usability experts concern the fact that the user interface must be developed in accordance with the real world concepts – it have to speak the user's language using words and phrases. In this sense, it is appropriate interface elements to duplicate real objects. The purpose of the real world is transferred to those in the world of technology, along with the specific terms. For example, some actions with objects in the reality can be made with their software counterparts, such as the writing on the paper, highlighting, using different colours for fonts, and even using fonts that resemble handwriting.

Norman mention a term, which is not a particularly widespread in Bulgaria - affordance. The term describes the properties of objects that tells people what is their purpose. For example, the button (physical or software) should be pressed; the sheet (real or software) is for writing / drawing, etc.

Consistency may have not exists only between real and technological world, and between the conventions imposed a platform. The list of Tognazzini concerns the continuity between the different versions of a product and between products of the same family. This means that developing an interface designer inevitably have to comply with requirements imposed by specific platform. Here it could be made a connection with expectations of users, namely with their mental models for functioning of the product. People constantly draw models in their minds that based on experience to date. The models are actually an idea of the use of an object, the operation of a particular technology or implementation of an action. Attitudes that consumers have built during their life time in terms of work with certain products or expectations they have about the products of a new kind, undoubtedly influenced its success. Therefore, it is strongly recommended to conduct tests with representatives of the target audience to be in line with its mental models. However, it should be noted that it can not cover all expectations, but tests would allow no fewer problems in terms of the usability of the user interface.

Each of specialists discussed emphasizes that essential to the usability of the system have visibility of its main functionalities and progress of its work (system status). Also focus and putting the appropriate user messages. This means that the system must support user feedback, to keep them informed and reassured that work properly with it. As the Tognazzini sometimes prompts, the progress of the system can be unrealistic, resulting in a change in the mood of users and hence affects normal operation.

The two primary rules of Norman in design are build a good conceptual model and doing things visible. Fitt's Law is intervened here, by which it can even determine the size of a button. If the button activates a very important function of the application or product, it should be larger than others should attracts the attention of consumers. In addition, the colour of the button is good to be different, to stand out against the rest. The choice of a specific colour is also important to be able to both attract attention and be consistent with the overall colour solution in the design. For example, the red colour has established itself as a signal, i.e. as denoting something important. Therefore, if there are two

buttons at the same size, the red button will initially draw the user’s attention and not the other. The user will first read the text on the red button and then he / she will pay attention to the other.

Of exclusive importance is the provision of controlled freedom of the system. This means that users expect to be able to enable or disable certain settings, change the colour scheme of the application can set your account to register in several ways the system can edit the data or to delete them, etc. Therefore, users feel satisfied that they could set the system according to their preferences, which in turn leads to comfort their work.

Control of the errors that occur in the operation of a system is important to create a secure environment. This means that consumers must be protected from themselves. Developers and designers must simulate and / or test the developed applications with real users for errors. It is necessary to offer the users appropriately "exit plan".

An important rule, which is included in the list of Schneiderman, is “Reduce short-term memory load”. It can draw an analogy with the first rule of usability that a leading specialist in the field of web usability - Steve Krug, introduced: "Do not make me think!" This rule can be interpreted as follows: technology must be created so that users do not need special training in their use, and to intuitively know how to use them and thus remain satisfied after dealing with them.

Based on the foregoing, it can be noted that heuristics defined by four specialists, are based on results of research in cognitive psychology. This means that the needs of the end user are placed in the centre of the development process. Through these rules are given specific recommendations that guide the designers to create usable interfaces. Rather it should be interpreted as targets rather than as activities. The rules offer universal solutions for all kinds of interfaces without asking any limitations on innovative thinking.

Defining a list of user interface design rules

Based on the analysis of lists of rules in Table 1 it can be concluded that they have a few common points, which mainly focus on the following several attributes: appearance, consistency, feedback, efficiency, security and prevention of errors. The author of this study uses these signs to define a list of rules that will support the creation of usable interfaces.

- **Appearance**
  1. *Sensory comfort* – it is associated with the perception of images, sounds, touches, i.e. human senses of sight, hearing and touch. The touch is more a matter of the development of hardware products. For software, visual and auditory perceptions of people are essential. Some of the actions that can be taken to ensure visual comfort are: selection of the appropriate combination of pulsed sight colours, providing readability of the labels on buttons and texts (messages, settings, etc.), colour distinguish important functions. For people with special needs, such as those who have dyschromatopsia[18], it should be carried out specialized tests that show how the design would look "in their eyes." So check what will be distortions in the perception of the colour scheme and whether it will affect the overall perception of design. To ensure hearing comfort it follows the sounds that are activated when performing a particular action with the product to be changed, reduced, eliminated. This is related to the provision of control over the environment.
  2. *Minimalism* – according to the author of the current study, the beauty of design lies in simplicity. Excess accumulation of ornaments and colours leads to discomfort at work, and from there to the frustration of consumers.

[18] Known as colour blindness or colour vision deficiency. It is the inability of the human eye to distinguish between any or all colours. Colour blindness is a special case (deuteranopia), where there is a breach in the perception of red and green colours. This is the most common case dyschromatopsia that affects 6% of men. This vision disorder affects most men, but also occurs in women.

3. *Intuitiveness* - provided in compliance with the terminology and visual concepts imposed for the platform as well as the affordance. Intuitiveness we can connect with the proposed rule by Tognazzini detection functions of the system. While a product is built in an intuitive way, undoubtedly the problem of discoverability is reduced. It is extremely difficult to achieve in complex systems.
4. *Aesthetics* - minimalist design does not mean austere design. Choosing the right colours, fonts and graphic elements is essential, especially for users who have an affinity with the visual. The aesthetic design is a prerequisite for the creation of satisfaction among users.
5. *Structuring interface objects* - the correct arrangement of the elements of the interface can be determined by Fitt's Law, which is applied by major software companies such as Apple.

- **Consistency**

6. *Standardization* - recommended compliance with the accepted and established standards such as those of ISO, IEC, IEEE, etc., as well as compliance with those imposed for technological environment of implementation (platform, which is designed a software). This will ensure the identity of technological products. This applies to commands, terminology, and icons actions.
7. *Conventions imposed in the real world* - the correlation between real objects and terms used before the emergence of the technology speaks for continuity between knowledge from different fields of human knowledge and facilitates users to take-up.
8. *Mental models of users* - if the design conforms to the preconceptions of users, it would be easier orientation for them.

- **Feedback**

9. *Supporting information* - active windows in the form of advice or pointers to the new features, maintaining documentation.
10. *Messages* - displaying appropriate messages that suggest consumers what to do when making a transaction.
11. *Progress of the work performed by the system* - displaying system status.

- **Efficiency**

12. *Ease of work* - the user must achieve quickly and easy his / her specific goals. Again, Fitt's Law determines the time to reach a certain element of the interface.
13. *Sense of freedom* - it is advisable to enable users to switch off and restart the specified options, i.e. design can be characterized by adaptability to temporary needs.
14. *Implement cognitive resources* - to what extent consumers are obliged to invest surplus cognitive resource in the execution of their tasks. Relevant technology to minimize the utmost thought processes, and hence the involvement of working memory. To determine the cognitive load of users it can be implemented the Model Human Processor of Card, Moran and Newell.
15. *Multivariate approach to achieve the objectives* - implementation of the same tasks in several ways. Thus reaching different user groups - beginner, intermediate, advanced, with special needs, etc.

- **Security and prevention of errors** - to allow users to perform the same task in different ways, so that to find mistakes and to have "a way out" of undesired situation.

Conclusion

In conclusion, it should be noted that no list of rules can be characterized by maximum exhaustive because the cognitive characteristics and capacity of individuals, including affinity to the use of technology, the contexts of use, objectives and tasks of the users are very different. These factors can be added the ever-changing desires of users, which in some cases are subject to “fashion” trends.

However, compliance with the basic principles of design to improve the usability of the user interface of the software product, and hence to provide some degree of confidence o users that work in a correct manner with the application and can fulfil his/ her end goals.

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