Ergonomic User Interface: System Logical Analysis and Design Process

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Abstract

The article deals with the ergonomic design of intelligent user interfaces (UI). The present state of the problem area, the criteria of quality and efficiency of software, developed. The author proposed new methods of evaluating the quality, effectiveness and productivity of the UI, and explores the UI design.

Keywords: User Interface (UI), graphical user interface, Ergonomics, Intelligent User Interface (IUI),

1. Introduction

Recent decades marks a rapid increase in the use of information technologies in various fields of human activity. Computers, 20 years ago, used for solving highly specialized tasks, are today an essential attribute of jobs in massive types of professions. Irreversible process of computerization of labor makes more urgent the problem of providing dialogue human-computer mode, suitable for users of different levels.

The development of information systems shows that the competition of products from functional changes in the area of comfort and convenience for the users. The developer there is a problem of UI, allowing for the efficient, ergonomic and economical use of the software.

Has long been a technology to significantly improve the UI. However, by themselves they do not make ergonomic interface. For example, in itself a graphical user interface (GUI) is more ergonomic than the text-based interface, and, as experience shows, may be less suitable for use, if developed without taking into account the requirements of ergonomics. Computer ergonomics and the taxonomy of ergonomics have been explored by the author in [12, 19, 26]. For most systems, the development of the UI consumes significant share of the budget and programming effort. The research [1, 2, 3] indicate that:

- UI from 45% to 60% of the code of the program,
- To develop the UI leaves at least 30 percent of the project budget and an average of 40 percent of the development effort to create a system.

From the users point of view UI is key to understanding the functionality of the program; ergonomic interface severely limits the functionality of the system as a whole. Trends in contemporary interaction of "human-computer" forced vendors to focus on the development of UI. Timely and professional interface development increases the efficiency and performance of the software, reduced the duration of training of users, reducing the cost of processing the system after its implementation.

The rest of the paper is organized as follows: In section one introduction is presented. In section two Criteria for quality and efficiency of software is presented. In Section three the concept used for designing the user interface is discussed. Section four presents a user profiles as a basis for building an ergonomic user interface (EUI) with
elements of intelligence. Benefits of ergonomics and effective user interface are presented in section five. The author finally presents the conclusions and feature directions in section six.

2. Criteria of quality and efficiency of software

The effectiveness of the user interface is directly related to the concept of software quality. Software will perform certain functions, i.e. to do what is intended. Good software must also possess a number of properties, for allowing them to be successful for a long period, i.e., have certain criteria of quality and efficiency. Software quality is combination of features and characteristics that affect its ability to meet the defined needs of the users. [4, 5] Software quality is satisfactory when it has these properties to an extent, to ensure its successful use.

Efficiency of the software: the ratio of the level of services provided by the user at the given conditions, the amount of resources used. The set of properties by which forms a satisfactory quality of the software to the user, depending on the circumstances and the manner of operation of the software, i.e. the position at which to consider the quality of the software. Therefore, when describing the quality of software the criteria required and the properties of software must first be fixed. Basic criteria of quality and efficiency are shown in Table 1 and Figure 1. [6, 7, 8, 9].

<table>
<thead>
<tr>
<th>No.</th>
<th>Criterion</th>
<th>Definition</th>
<th>Weight coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Functionality</td>
<td>Ability to perform a set of functions that satisfy specified needs of users. A set of functions is defined in the external description of software</td>
<td>0.3</td>
</tr>
<tr>
<td>2</td>
<td>Effectiveness of the UI</td>
<td>This set of characteristics of software that minimizes user effort to prepare the source data, application software, and assessment of results and cause positive emotions or implicit user.</td>
<td>0.3</td>
</tr>
<tr>
<td>3</td>
<td>Reliability</td>
<td>Ability to reliably perform certain functions under given conditions for a specified period of time with sufficiently high probability</td>
<td>0.3</td>
</tr>
<tr>
<td>4</td>
<td>Maintainability</td>
<td>This feature allows minimizing the effort for change to eliminate the errors in it and modify it to meet the changing needs of users.</td>
<td>0.05</td>
</tr>
<tr>
<td>5</td>
<td>Mobility</td>
<td>It is the ability of software to be transferred from one environment to another</td>
<td>0.05</td>
</tr>
</tbody>
</table>

As the table shows, the efficiency of the UI, along with the reliability and functionality is one of the essential criteria of quality and efficiency.

In accordance with the criteria of quality and efficiency, the main performance criteria for the UI can be identified by the Table 2, and Figure 2 [10].
Figure 2. The primary efficacy User Interface

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<table>
<thead>
<tr>
<th>S.No.</th>
<th>Criterion</th>
<th>weight coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>the speed of the user</td>
<td>0.1</td>
</tr>
<tr>
<td>2.</td>
<td>Fault-tolerance</td>
<td>0.1</td>
</tr>
<tr>
<td>3.</td>
<td>speed Training / speed Learning</td>
<td>0.2</td>
</tr>
<tr>
<td>4.</td>
<td>Subjective user satisfaction</td>
<td>0.05</td>
</tr>
<tr>
<td>5.</td>
<td>Compliance of problems solved by the user</td>
<td>0.05</td>
</tr>
<tr>
<td>6.</td>
<td>ease of use</td>
<td>0.2</td>
</tr>
<tr>
<td>7.</td>
<td>controllability</td>
<td>0.1</td>
</tr>
<tr>
<td>8.</td>
<td>Adaptability / Individualized</td>
<td>0.2</td>
</tr>
</tbody>
</table>

3. The concept of the user interface

But what is the user interface in the context of the issues of development of modern ergonomic software? Let's try to answer this question. User Interface (UI): a system of rules and resources, which regulates and interacts with the user program [10].

The UI is often understood only as the appearance of the program. But in fact, the user sees through the UI program as a whole and therefore an understanding of the UI is too narrow. In fact, the UI combines all the elements and components, which can influence the user's interaction with the software. This is not just a screen that the user sees. These elements include:

- A set of user tasks, it solves with the system;
- Controls the system;
- The system uses the metaphor;
- Navigation between the blocks of the system;
- A visual (and other) design screens of the program;
- Information display and formats;
- Devices and technologies of data entry;
- Dialogue, interaction and transactions between the user and the computer;
- User feedback;
- Support for decision-making in a particular subject;
- How to use the software and documentation on it.

The concept of UI in its present form was formed throughout the history of computing and software. The history of the interfaces is best characterized by the concept introduced by well-known expert in the field of evolutionary biology Jay Gould “punctuated equilibrium”. One can identify four qualitatively distinct generations that are characterized by four interface styles. Currently, the most commonly used interfaces are third generation and are being developed to improve the interface of the 4th gen.

In the first generation of UI was from 50's to early 60's. Computers worked primarily in batch mode, using punch cards for input and line printer
for output, it can be argued that this fact did not make sense to talk about the user interface - not there was the concept of "interactive user" in the modern sense of the word (sometimes to debug directly from the console, using switches and LEDs as the "user interface").

In the second generation of UI was from the early 60's to early 80's. Dominated time sharing on mainframes and minicomputers using mechanical or "glass" teletype (alphanumeric displays), where users can interact with computer using the keyboard commands with parameters.

The third generation of UI began to develop in the 70's. A time sharing and manual input commands. At the research center of Xerox PARC created graphical user interfaces (GUI), designed to operate on raster network workstations. These interfaces are usually denoted by the acronym WIMP (Windows-Icons-Menus-Pointing device), reflecting the interactive nature involved - windows, icons, menus and pointing device (usually a mouse). It is this type of interface, popularized with the Macintosh in 1984 and subsequently used, in particular, for Windows PCs dominate to this day. Note that today's applications have interfaces of the same type as the earlier application, unless the increased levels of "realism" through the use of advanced interface tools that allow, for example, use a shadow screen buttons. Perhaps the new quality compared to previous generation interfaces was active use of color and available for a wide range of developers of a representative set of software tools for building WIMP-interfaces. The 3rd generation of WIMP GUI dominated for a long time (over two decades).

Essentially, WIMP GUI became the standard for the API, which - compared to the interface "command line" provide a relatively simple study and application, ease the transfer of knowledge gained from the use of a single application to be used in the other due to the high compatibility concept WYSIWYG (What You See Is What You Get).

Currently new forms of interaction between man and computer are development, both conceptually and in terms of software and hardware, is clamoring for a new interface- the 4th generation, known as post-WIMP -interfaces. They do not focus only on the use of menus, forms and toolbars, instead it is focused on specifications of operations and operands, and the emphasis is on training examples, gestures interface (GI), Natural language Interface (NLI) (speech recognition and handwriting recognition), Brain-computer-interface (BCI) and Multi-mode-Interface(MMI), Social Interface (SI). The features of GI, BCI, MMI, SI, NLI and NLP (Natural Language Processing) have been discussed in [12, 13, 14, 15, 16, 19, 18, 27].

4. User profiles as a basis for building an ergonomic user interface (EUI) with elements of intelligence

The term "human-computer" interaction indicates the presence of man as one of the sides of the interaction. However, this is not an "ordinary person" or "average user." In every system, interface is designed for use from time to time every one, and often a few specific categories of users that have certain characteristics. The process of determining these characteristics, the creation of some new "portraits" of users, is a mandatory step of designing any interface and framework for building IUI, ie direct interaction interface for resource information center and user programs, through specific user requests and the elements of the program vary depending on the degree to which the user wants.

There are no interfaces, which would be equally easy to use for absolutely everyone. By setting a goal to create a convenient system, one must ask for how user would be comfortable, and under what conditions. In the design of concrete and
there are no standard rules such as "how to make an adequate, convenient and easy to learn interface." No rules, because for different people, require different interfaces for their quite objective reasons and comfort.

To determine the characteristics of the product and the audience is the user profiles. To collect information about users of different methods: both qualitative (eg, interviews with users of competing products) and quantitative (eg, spend a formalized user surveys). Besides the direct collection of information, developers can describe the audience themselves the product based on their experience.

As a result, work on the definition of user profiles, developers’ description of the main categories of users, often one of these categories can be defined as basic. The exact number is, of course, depends on the product. For a system designed for a wide audience, the number of categories of users will be greater than for a product intended for use by a specialist.

Each one characteristics of the user which contains a detailed description, are essential in the context of its interaction with the system. This includes the user's purpose, its social characteristics (gender, age, education, occupation, etc.), and its characteristic patterns of behavior, the context in which it will be using the system, user skills, and characteristics of his computer. In other words all the things that will have a significant impact on subsequent preferences of the user in the interface design.

A particular problem is the creation of adequate profiles that will be really effective material, which will help better understand the target audience of the system, and will be useful in the development of the interface and its subsequent adaptation. Below is the example of a user profile:

<table>
<thead>
<tr>
<th>Social characteristics</th>
<th>Skills</th>
<th>Motivational target environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Gender</td>
<td>- Work experience with computer</td>
<td>- Goals by general</td>
</tr>
<tr>
<td>- Age</td>
<td>- Medium</td>
<td>- Motivation to learn working with the system.</td>
</tr>
<tr>
<td>- Education</td>
<td>- Screen Size</td>
<td></td>
</tr>
<tr>
<td>- The level of the post</td>
<td>- Screen resolution</td>
<td></td>
</tr>
<tr>
<td>- Does the computer only he and (or) other (family, colleagues) use</td>
<td>- Performance PC</td>
<td></td>
</tr>
</tbody>
</table>

Often together with the definition of user profiles are created for the so-called "person." In this case a description of a particular user. Such a description is created on the basis of one of the profiles. This helps to more clearly imagine a typical representative of any of the user-defined categories. Using such a "person" is much easier to understand the user to see a set of data collected in the profile of a living person.

Another plus fact is that in the future, creating a "person" can be very useful for creating custom scripts to adapt the interface (in semi-automatic mode).

5. Benefits for ergonomics and effective UI

System, designed to meet the requirements of ergonomics, are very effective. They work exactly the way users expect, and allow users to focus on their own tasks, rather than on the interaction with the system. Efficient interface is the result of the fact that the developer pays attention not only to the data users are working with, but also the property of the user's tasks and activities.

With user-oriented design methods UI have some advantages. Obviously, the identification and correction of errors in the early stages of system design leads to its significant reduction in price.
Here are some important advantages of good user interface:

- Improving the competitiveness of the software.
- Reduced development costs.
- Increase in the audience of the product.
- Reducing the cost of training and support.
- Reduced loss of productivity of employees in the implementation of the system and a more rapid recovery of lost productivity.
- The availability of system functionality for the maximum number of users.

Thus, programs with ergonomic UI increase user productivity minimize human error and increase the subjective satisfaction of users.

6. Conclusion

In this article Author have tried to hold system logical analysis and describe the procedure for the design of modern ergonomic user interface. Thus, the creation of ergonomic UI is a promising problem in which there are many outstanding issues, in particular, during the design and testing. Thus it is impossible to overestimate the importance of the intellectual interface, which uses software to significantly enhance its efficiency for the end user.

As shown by the study, the problem of designing intelligent user interface for today is highly relevant and popular and has a lot of unresolved and controversial interpreted tasks and decisions.

Future directions of our research will focus on:
- The development of a mathematical model of the functioning of intelligent interface in the "human computer", based on the use of user profiles;
- Development of general recommendations for building intelligent user interfaces with factors of ergonomics;
- The development of mathematical, algorithmic and software intended for the design of intelligent user interface based on the methods and tools of the theory of pattern recognition;
- The creation of CASE-system to implement a computer-aided design and implementation of intelligent UI for use in web-media and educational systems;
- The author has identified the methods for register the Intellectual property (IP) in [28], the same will be implemented for UI;
- The development of EUI for affective computing [14, 15], remote user authentication systems [30], social computing [16, 18], Internet banking environment [26], and management information system [20];
- The author has worked on software composition models [11], modeling throw roles and ontology [17] and multi-agent system [21]. The same will be used to design an intelligent ergonomic UI.

References


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