ON ONE OF THE EXPERIMENTAL APPROACHES TO RESEARCH OF THE COGNITIVE AND INFORMATIONAL LOAD EFFECT ON USER-TO-PC INTERACTION EFFECTIVENESS

A. BALKANSKII
Senior Lecturer of the ITMO University

A. SMOLIN, PhD
Head of the Department of the ITMO University

Y. SOLONITSYN
Master student of the ITMO University

ITMO University, Saint Petersburg, Russia.
E-mail: abalkanskij@yandex.ru, artikus@inbox.ru, solonitsyn.yury@adesignlab.ru

Abstract. This article is devoted to the one of possible approaches to the experimental research of the cognitive and information load on PC's users – the mental load or amount of efforts, caused by the necessity of recognition of the screen form elements and data to be processed. Authors represent the problem origins, research hypotheses and test materials for the future full-scale research. Project is being run by the groups of teachers and master student of the "Design of Human-Computer Systems" master's program, ITMO University (Saint Petersburg, Russia).

Problem to be investigated. Origins of the problem to be investigated can be found in the modern trends of user interface (UI) graphic design or graphic decoration. More and more designers use so-called "Flat design" or "Flat UI" style, while working on applications UI or web-sites. This style can be characterized by declining of any realistic scent, resembling real-world UI element, like physical buttons. This style is often opposed to "classic", "realistic" of "skeuomorphic" UI design style (compare UI examples, shown at fig. 1 and 2).

"Flat UI" style is widely used in modern operation systems (including world leaders like Microsoft and Apple). Wide masses of designers adopt this style in their projects. However, some experts have opposite opinion. Jacob Nielsen, his colleagues at Nielsen Norman Group and several other specialists point to decreasing of user effectiveness under the pressure of modern UI trends [1, 2, 3]. So, the contradiction can be clearly seen between the common UI trends and expert's opinions. This work is the part of the research project, aimed to the experimental investigation of this phenomenon.

This problem could become more and more actual as long as we consider the effect of UI decoration on user-to-computer interaction in such sensitive fields like industrial production, financial markets, medicine or transportation. UI design can lead to decrease or increase of the load, caused on users, and, therefore, to the probability of mistakes and incidents.

Experts at NASA use term “cognitive load” to describe the amount of mental effort, needed to recognize the UI elements and data presented. They consider this kind of load to be a serious risk for the adequate human-to-computer interaction and, thus, to the overall mission success [4].

Several authors consider the increasing cognitive and informational load to be a serious risk-causing factor, leading to decreasing of labor of user activity safety [5, 6, 7].

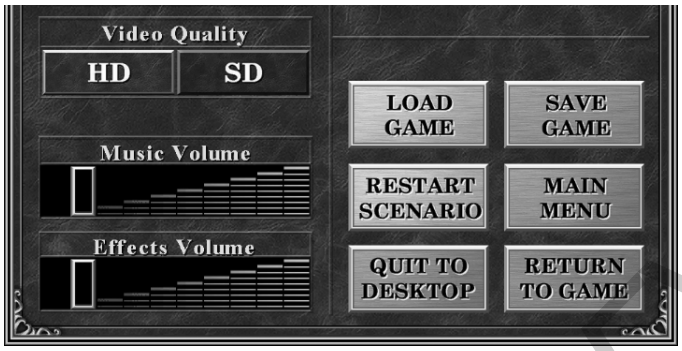

Fig. 1. UI fragment, decorated in “classic” or “realistic” style
(«Heroes of Might and Magic III – HD Edition», the videogame, UbiSoft)

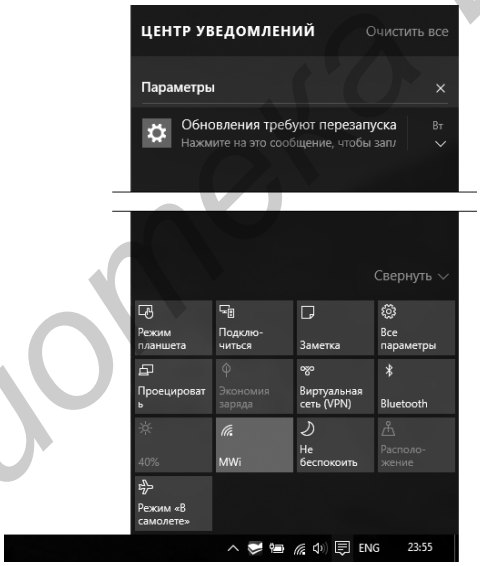

Fig. 2. UI fragment, decorated in “Flat UI” style
(notifications panel, Windows 10, Microsoft corp.)

Analogous research projects. Despite any disputes in the professional society, only a few publications on this subject could be found at open publications. For example, some research projects, related to the given problem, were conducted by Burmistrov et al [8] and Fabio et al [9].

Both of the research groups have provided comprehensive descriptions of their methodologies and the results achieved. But, also there are several weaknesses. E.g., the Burmistrov’s group has applied a king of artificial tests without any connection to the real-world users’ tasks. Fabio et al have provided the detailed description of the

methodology, but their research was pointed mostly to the fundamental nature of the cognitive load, not to the practical UI design projects.

Also we should notice, that both of these groups have involved the limited amount of respondents – about 20 people for each project, all university students.

An approach to the experiment. The conflict between general UI design practice and the opinions of the industry expert gives us the broad field to explore. The results achieved could give us the practical recommendations to be used in real UI design projects, providing users with more comfortable working environment, decreasing the probability of mistakes and overall task completion time.

The remote Internet-based survey was chosen as the main research method. It will not provide us with the ability to directly control the experiment flow (as it could be at usability lab), but we will be able to broaden to respondent's mass, involving people from several countries, while keeping the financial and time expenses as low as possible.

The test materials structure. The test materials are to be presented in a form of web-pages. The test web-site structure could be found at fig. 3:

1. Language selection — test materials are to be presented at Russian and English to ensure the possibility of involving foreign residents;
2. Chose the UI element — respondent is to select one of the UI elements presented, which is more likely to be a "button". UI element will be decorated in various graphic styles (see fig. 4);
3. Chose one of the UI elements of the same style — user will be asked to choose one of the UI elements, decorated in one graphic stile;
4. Find the UI elements — respondent is to find an active UI element (a button) between several distraction stimuli [9] — 3x3, 5x5 and 7x7 matrices of digits, containing 1, 2 or 3 active elements;
5. Find the blocks of data — this task is intended to measure the effect of information load. Respondent should find the given numbers between distraction stimuli (3x3, 5x5 and 7x7 matrices of digits);
6. Demographic data — user is to be asked to fill in some data about his age and the country of residence;
7. Gratitude — we should thank respondents for the time and efforts spent.

Before each task user will be provided with instructions to ensure the smooth experiment flow. Graphic decoration style for the UI elements, used within the test materials, is to be selected randomly to leverage the users experience and individual characteristics.

For all tasks the completion time and the amount of errors (say, incorrectly clicked element) are to be recorded for the future analysis.

Minimizing any unwanted distractions. To avoid any unwanted distractions, the test materials by themselves have no specific graphic decoration or bright elements (see fig. 4 and 5).

Test materials, the approbation of. The preliminary research was conducted to ensure the test materials to be suitable for the main experiment. The research was held

involving the eye-tracking technology at the Multimedia and Design Center of ITMO University. Several early prototypes of the test materials were checked against two respondents, asked to perform the same tasks (see fig. 6 and 7).

Because of the amount of respondents, these results have no statistic quality, but they prove the concept of the test materials and their suitability for the further experiments.

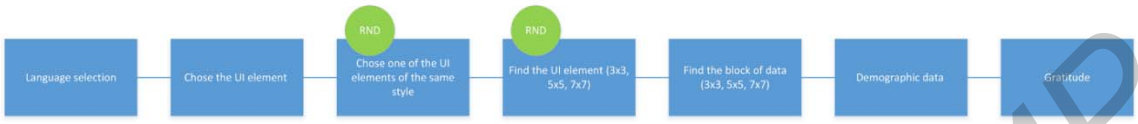

Fig. 3. Test materials structure (RND – 1 of 3 graphic styles is to be set randomly)

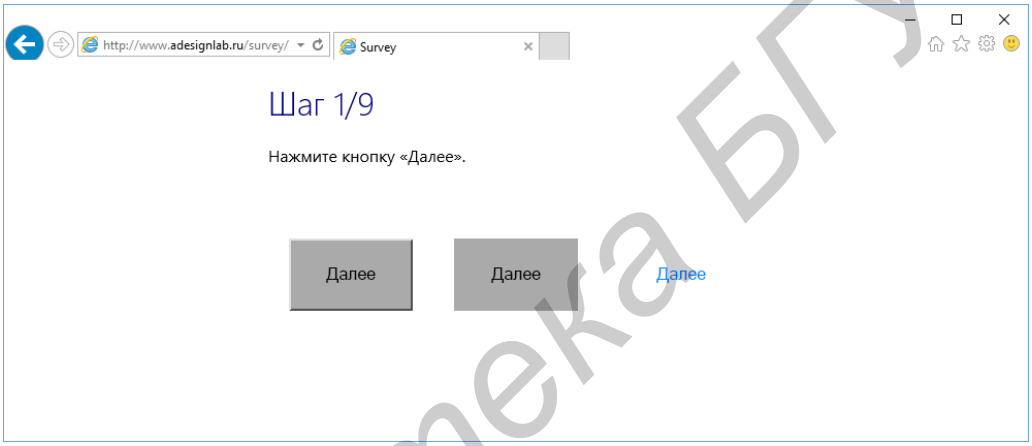

Fig. 4. Respondent is to select one of the elements, which is more likely to be a button(all 3 graphic styles are shown)

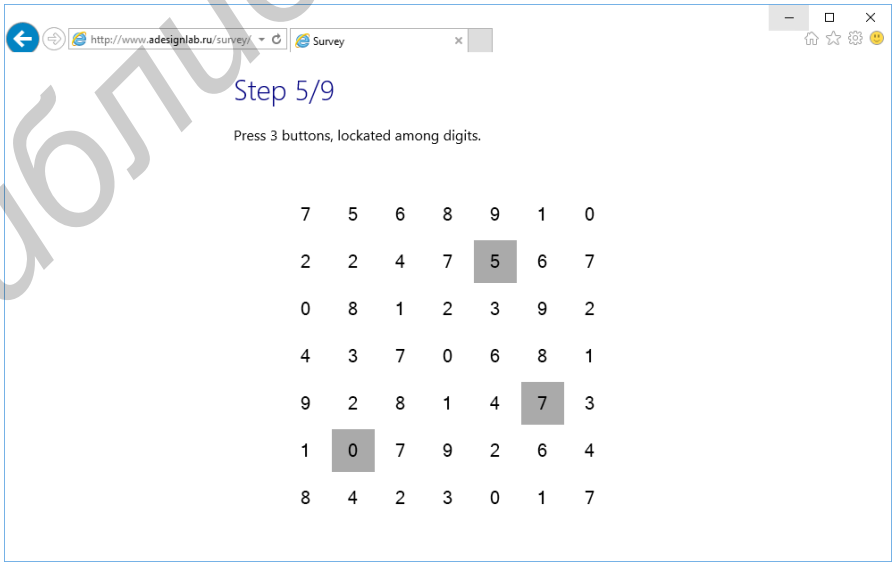

Fig. 5. Respondent is to find the active elements (buttons) between the distraction stimuli (buttons graphic style is selected randomly, flat style in this example)

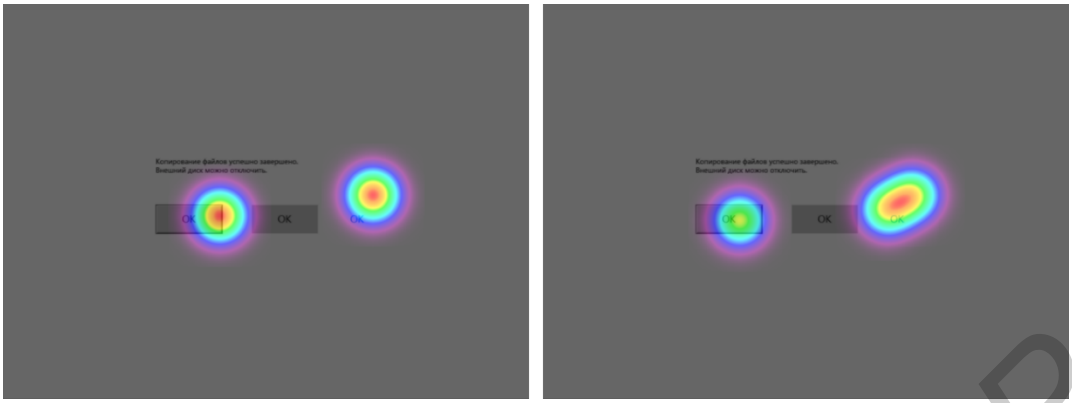

Fig. 6. The test materials, approbation of – chose the UI element (left – respondent 1, right – respondent 2)

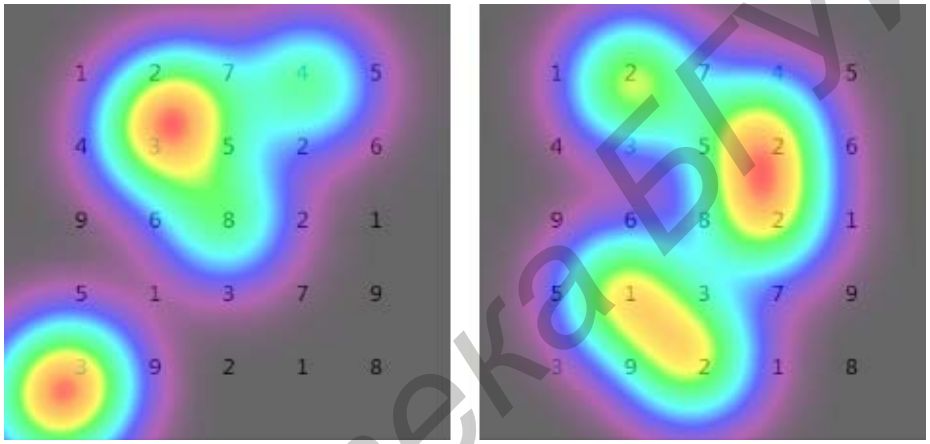

Fig. 7. The test materials, approbation of – find the blocks of data between distraction stimuli, the prototype has 6x6 digit matrix (left – respondent 1, right – respondent 2)

Technologies. The test materials are produced using the general web technologies and languages: PHP 5.2, JavaScript 1.2, HTML 4.2, CSS 2. As long as the given versions are a bit outdated, they ensure the deep cross-browser compatibility.

MySQL database is utilized for storing of collected data.

Compatibility. The test materials are prepared using only stable and cross-browser solutions. No particular optimization for any of modern browsers or operation systems needed. This ensure utilization of the wide range of end-user's (respondent's) devices.

Low bandwidth consumption. The test materials are designed to ensure as low resource consumption as possible and, therefore, provide precise time measurement. Utilizing of client-size code is minimized. The web-page size is 10-20 kilo-bytes against 2 Mega-bytes in average for the general web-pages [10].

Distribution channels. Test material are to be spread by links, posted on social networks like Facebook and VK (Vkontakte), involving users form Russia, ex-USSR, Western Europe and other countries.

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