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Designing human-computer interaction, the psychological aspects

The organization of effective human interaction and information systems is considered to be one of the most promising areas of modern science. Today, the speed of computerization of all the aspects of human activity is most often provided by the efforts of specialists who work in the field of computer science and in the fields that are most focused on information process, such as business, engineering, medicine, etc. The participation of psychologists in this process can not be considered adequate today - high expectations of psychological technology experts in the field of computer science are only slightly justified. It seems that the direction of designing human-computer interaction is the realization of the efforts of specialists of only computer science, and is not interdisciplinary.

The main purpose of my presentation is not to enumerate the achievements that have already been completed by the specialists, but to indicate the contradiction between the great potential of psychology and the lack of influence it has on the development of the computer industry. Psychology has gained a considerable amount of knowledge that can be applied to computer science, but it hasn't received a proper application to computer science yet.

The areas of psychology such as psychology of perception, psychology of thinking, organization of collaborative intellectual activity, human-machine interaction have a high potential to be used in the design of computer systems and in the organization of support for people who use them. In the psychology department of Tomsk State University, we have been developing assessment methods to learn the peculiarities of interaction between humans and computer systems. Techniques that we develop here are focused on identifying strategies that people use to solve problems by means of computer systems.

As an example, I would like to demonstrate the two diagnostic methods that are based on well-known problems in psychology. The idea of the first method is built

on the basis of the mental rotation task and has the purpose to identify how users interact with the interface of information systems.

The experts in the field of usability are constantly focused on resolution of the contradiction between the effectiveness to involve the beginners into information environment, and the ways of organization of professional activity of the advanced users. This problem could look even more difficult as people may use different strategies of problem solving in their professional activity being focused on creative or logical way of thinking. The knowledge about the preferable way of users' interaction with the computer can help to organize their activities more effectively. It can be organized by means of setting the information environment, and specially organized training.

The task of mental rotation was initially developed by the American psychologists in 1971 (Shepard & Metzler). It still attracts the attention of the specialists who work in the field of cognitive psychology because of a striking discrepancy between the simplicity and ambiguity of the stimulus situation and the interpretation of the mechanisms of its solutions. The scientists who follow Shepard's and Metzler's theory think that the stable strategies of problem solving demonstrated by the participants can be considered to be the ways of cognitive activity. It is important to say that the problem of identification and the interpretation of these methods is a separate topic for discussion, and it is defined as "a strategy of mental rotation"

This topic greatly expands the original problem that says the operation with a mental image is initiated with the flat projection of abstract shapes that is located in the 3D or 2D (dimensional) Euclidean space. It was also proved with the statistically significant correlation coefficient, found between the angle of rotation of the two figures and the time spent on solving problem about their identity.

I can say that this idea of "mental rotation" is considered to be methodologically acceptable for Russian psychologists.

In 1982, R. Shepard and L. Cooper showed that there was no correlation found between the angle of rotation of the figures and the time of solutions. It became possible to speak about the fundamentally different mechanisms for decisions. The attempts to define the boundaries in the differentiation of these two strategies have demonstrated that they can be within a single species, as was shown by the example of Macaca mulatta (Köhler et al. 2005).

We also found out an "invariance" of problem solving time of mental rotation relative to the rotation angle of 3D shapes. There could be two explanations about it. The first coincides with its analogue, demonstrated in the case of animals. The second one is a decision that involves the replacement of stimulus objects by their images. It turned out that some participants solve the problems not by the method s of "mental" rotation of figures but schematically. In this case, the scheme of mental arrangement of its elements is built for every task. One way to detect such a strategy is to add instructions to verbalize the solution. The very first difference between the schemes can indicate its match or mismatch. The use of such a strategy indicates the existence of psychological construction that is emanated from the experience of building the schemas that can substitute the complex objects.

Now we can name the three strategies of problem solving, they are - "intuitive", "mental rotation" and "schematization". The title of first one - "intuitive" strategy - is selected by key words taken from the explanations of the subjects that were used. The sequence of enumeration of strategies corresponds to the increase of the degree of organization of new psychological formation, they are based on.It was also found out that none of the strategies occurs alone, mostly they coincide. For example, "intuitive-mental rotation," "mental rotation – schematization," etc.

The second method is based on the studies of the issue of a compromise between speed and accuracy, as well as the amplitude of movement. The purpose of this method is to identify preferences of the users for information systems of human-computer interface (speed and number of mistakes). This method is

methodologically based on the law invented by P. Fitts in 1954. This law was argued so often by the scientists that currently it became the subject of independent studies. Scientists, such as S., Kong J., Ren. X., Zhai described the peculiarities of the violation of this law. As for our studies, we used a modification of the stimulus situations of Fitts as the key one.

In the assessment process, the Personal Digital Assistant (PDA) was used. The peculiarities of the PDA for our research are: it has a touch screen, the interaction between the person and computer is based on the movements that are very typical and familiar for the humans. The specialist presented 120 stimulus objects to the participants do the research. The objects are ellipses that have different characteristics such as position of the center, the eccentricity, diameter, etc. The test participant had to indicate the center of these figures and to touch it with stylus. Stimuli were presented in 2 steps. Each step has its own instruction. The first step is to act as accurate as possible, the second – to act with the highest rate (speed). There were 60 stimuli presented in each step. The accuracy of the solution of the estimated minimum units of resolution touch screen is considered to be the "points".

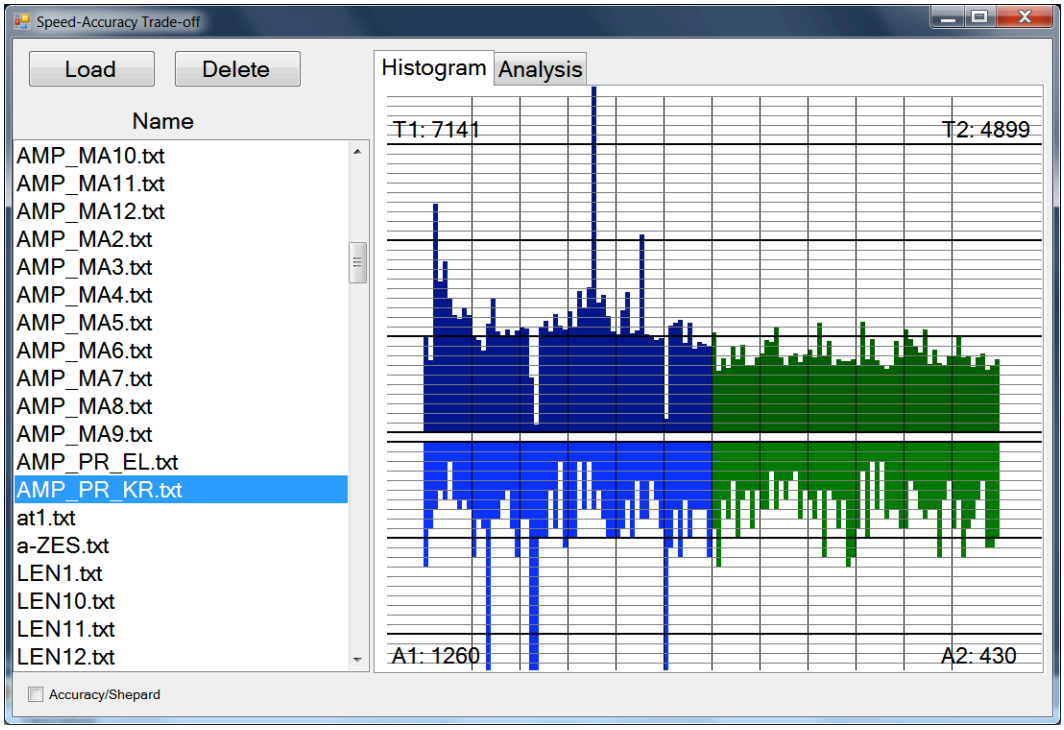

Figure 1.

The effectiveness of the attempts in the situation of the shortage of time.

The special program was developed to analyze the results. A histogram became the primary means of qualitative analysis. It consists of four main segments. Figure 1 shows the window with an active tab "Histogram." The upper part of the histogram is a set of columns that display the corresponding numbers of the tasks. The height of the column represents the time spent to solve this task. The horizontal lines correspond to tenths of seconds, and the bold lines are the seconds.The lower part of the histogram shows the values of variable accuracy. The net of this part of the histogram (each of its divisions) represents one PDA screen pixel and signals about the value of an error in the task.

The left and right sides of the diagram correspond to different instructions. Left-hand side reflects the instructions "for accuracy" task, the right one - "the speed" task. They are colored in a different ways. Each segment represents one of the generalized indicators: the upper-left (T1 time 1) is the time of the accuracy problem solving, lower left (A1 accuracy 1) - the sum of errors in solving problems "for accuracy", upper right (T2 time 2) - time to solve "speed " problems, "bottom right" (A2 accuracy 2) - the sum of errors in the solution of problems" on speed.

There were 300 participants in this research. They represent different regions of the Russian Federation (Tomsk Region, Sakha Republic, Irkutsk Region and Moscow Region).

There were 5 types of problem solving found out:

1. "Smart";
2. "High precision";
3. "Effective in the shortage of time ";
4. "Insensitive to the instruction";
5. "Non - effective."

Each type has the peculiarities of its own that should be considered in the process of organization of interaction between human and the computer system environment, these results are important for the interface development and the choice of the level of education training for the different users.

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