Improvement of Interactive Products Based on an Algorithm Minimizing Information Gap

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Abstract. This paper feature results of scientific research that is associated with the improvement of interaction conditions of interactive products. Efficiency of use of these products remains in close correlation with efficient performance of decision making processes. Available information resources assist the user in the effective use of electronic devices only when, at the same time, mechanisms of adaptation of information to the real needs and learning capabilities of the individual user in the information environment are being designed. This multi-dimensional space in which cognitive processes are carried out, in regard to processing and transferring information, is nowadays characterized by excessive amounts of information, also called information noise. However, in the use of interactive products, the common phenomenon of the so-called information gap, which is the difference between relevant information and the collection of information became available in the system. The result of designing interactive products targeted at eliminating this discrepancy is that the user achieve goals with satisfaction, in less time and without frustration and anxiety, which would otherwise occur as a result of emotional and cognitive dissonance.

Keywords: Decision making processes · Cognitive processes

1 Introduction

The most important task for the IT product designer is to develop mechanisms to provide set of information, which will be used by the user during interaction, assessing the current situation and making appropriate decisions [1, 2]. The designer solves problems supporting user's limitations, which are described by [3] in his work on human-computer interaction. Moreover he or she designs interface, which reflect in possibly most vivid way the information structure of operating environment. Thanks to the plasticity of mapping the elements of sought reality, the user is able to project the images of operational environment, restore from memory the missing pieces of information and make sound decisions. Basic limitation of humans, related to the existence of information gap include:

– "visual limitations: ability to flawlessly read information from the screen, the screen layout should enable the user to clearly separate work areas and easily access objects in these areas;

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– limitations associated with human's memory capacity and ability to process data: the manner of information coding should allow for flawless decoding;
– limitations of manipulation efficiency," [3].

The scope of knowledge about the information-processing by humans, implemented in the interactive product design is directly proportional to the effectiveness of tasks and user satisfaction and inversely proportional to information gap. A foundation in these proceedings is to maintain the generally accepted guidelines for interaction design, published by the authors dealing with human-computer interaction [4, 5]:

– supporting work tasks;
– taking into account the limitations of humans;
– assuring the enjoyment of use;
– using experience;
– understanding the characteristic of the problem situation.

Fundamental goal of designing is improving the interface through all sorts of measures:

– ensuring normal flow of information processes, which reduce the load on the visual system in regard to seeing objects,
– ensuring correct logic of information appearing,
– ensuring human's ability to keep all necessary information in the so called operating memory,
– ensuring the development of specific action strategies, e.g. possibility to acquire additional information.
– introducing harmony of use (visual and auditory stimuli contained in color schemes and sound settings)

The fundamental criteria of design in the evaluation of the interface reducing the information gap is the set of quality and ergonomic requirements [6–9]. They include, among others, the following requirements: currentness, completeness, detailed character, reliability, availability, comparability, appropriate reaction time and proper fit between the system and the real world, consistency and standards, preventing errors, recognition instead of reminders, flexibility and the ability to use shortcuts at work, aesthetic and creative design [10–12].

A large number of these requirements force the designers of interactive products to find in the course of numerous experiments, the significance of some of the requirements against the others [7, 8]. In the course of these experiments, based on user's subjective assessment, relationships between measures in the information environment of decision-making processes are defined. Results of research regarding the improvement of conditions of perceiving information, understanding information and regarding the assessment of information usefulness during interaction are presented in Table 1.

Table 1. Summary results of research on efficiency of ergonomic design of operator work method interface [5]

Information means	Characteristic of work processes	Assessment criteria of method of using interactive product		
		Perception [relative response time]	Understanding [adequacy of choice - in two categories, in the unit of time]	Assigning appropriate category of importance [aptness on a scale 1 to 5]
Effects of shifting attention by breaking the rules	A. Sewage treatment technology operator	Improved by 30%	Correct	Correct
	B. Executive team operator	Improved by 5%	Correct	Overstated
	C. Executive devices operator	Improved by 2%	Correct	Correct
	D. Safety conditions monitoring system operator	Improved by 21%	Correct	Correct
Eliminating words, which are not emotionally neutral	A. ditto	Improved by 5%	Correct	Overstated
	B. ditto	Improved by 7%	Incorrect	Overstated
	C. ditto	Improved by 3%	Correct	Correct
	D. ditto	Improved by 12%	Correct	Overstated
Reducing the number of sources of information	A. ditto	Improved by 24%	Correct	Correct
	B. ditto	Improved by 2%	Correct	Correct
	C. ditto	Improved by 2%	Incorrect	Correct
	D. ditto	Improved by 3%	Correct	Correct

2 Methodological Bases to Minimize the Information Gap

Properly designed interactive product requires associations and synthesis of data research methods of various origins with a specific situation of human-object interaction. I real situations, the value sought by the designer depends on the state of "n" parameters, which constitute a multi-dimensional sphere of data and moreover a synergy between these parameters is the core of the designed solution. Choice of possible solutions during minimization of information gap requires reduction of a number of variable factors "n" to the most important for a given human-interactive product system, with regard to technical and psychological aspects.

Since the tasks of a user are focused on constant processing of information, therefore general requirements regarding the functioning of IT devices users are treated as an autonomic system, in which searching, receiving, processing and storing of information from the environment along with decision making processes occurs.

In the set of preliminary criteria of product improvement there will be those, which are identified with the following three issues:

1. perceiving information by the user;
2. understanding the content of information;
3. assessment of the level of perceived information;
4. selection of the variant of sought information, when there is abundance of it.

Therefore the criteria of the evaluation of effectiveness of decision making actions are the following:

– minimal time to perceive and process information,
– comprehensibility (clarity) of the content of information,
– correctness of the assessment of the importance of the perceived information,
– ability to use the information in decision-making.

In order to justify the implementation of appropriate information means, it is required to describe the process of usage in the observable categories of cognitive processes (Fig. 1).

Three phases were distinguished during experiments, were suggested:

1. Phase of acquiring information with concurrent analysis of information (searching for alternative variants);
2. Phase of decision making;
3. Phase of executive action of decision making processes.

Acquiring information is based on direct observation of the interface. In this phase the main emphasis is on the perception of various visual, auditory and tactile information and appropriate reaction to them. This causes an absorption of certain intellectual resources, particularly memory and attention. The more complex is the device the more information and knowledge is required to properly handle it and correctly perform the task. Analysis of information includes thought processes leading to establishing a hierarchy of information variants with regard to the expected usefulness in the decision-making process and its practical use (carried out with a use of decision rules). Decision making refers to situations in which the user has to take action with regard to more than one piece of information [13]. In case of repetitive decisions, which are typically taken quickly, even automatically, mental effort involved is small. If however the decision is more complex, it requires the use of large amounts of information, often incomplete and associated with a lot of responsibility.

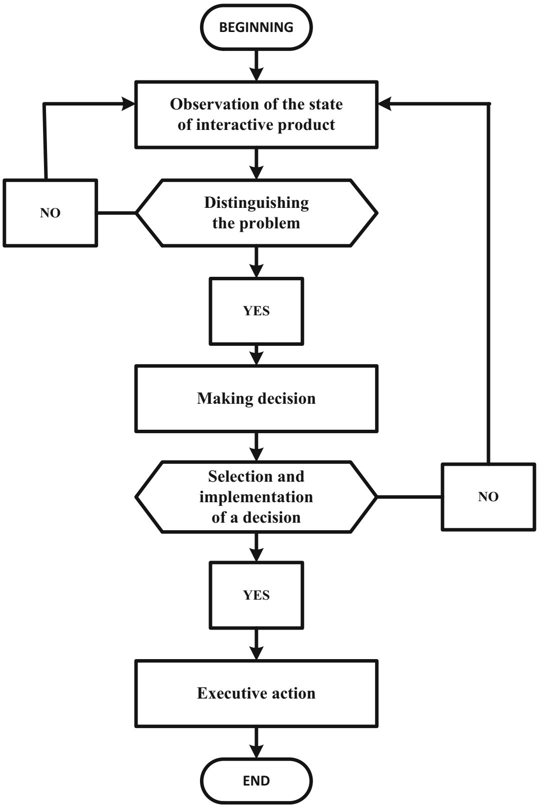

Fig. 1. Conceptual model of a tasks of an interactive product user. Own elaboration

Executive actions primarily depend on the complexity of tasks, the degree of practice, typicality or abnormality of movements, particularly from the consequences of their implementation in a complex decision-making process as shown in Fig. 2.

The occurrence of the information gap is most generally justified by selection process, which determines the information reaching the human, and which cannot be processed by him or her.

Knowing that brain can flexibly change strategies of dealing with information in environment and thanks to appropriate factors in creating a system of ideas, which are achieved through adequate information measures in the designed systems. A strategy of the so called active operator is an example of a complex solution, which is focused on the effect of supporting orientation attention. Thanks to this strategy, rigid boundaries of brain capacity don't exist and information gap can be significantly reduced in decision making processes and executive tasks can be improved.

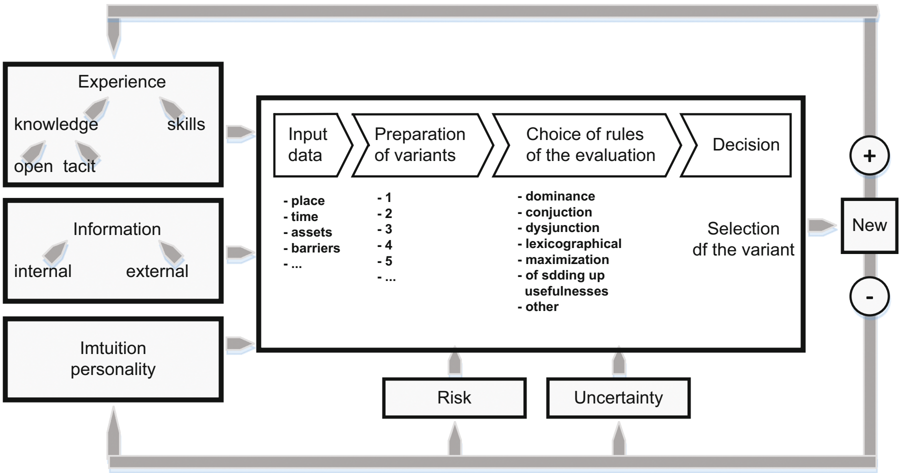

Fig. 2. Structure of elements constituting the relationships in decision making cycle [14].

3 Algorithm of Minimization of Information Gap

Initially starting from the standard approach to the design of interactive products of high usability according to ISO 13407 norm, in many design projects the ability to improve the efficiency of research by restricting their scope to specific cognitive processes has been observed. In this area the activities of users of interactive products associated with decision-making were accepted as representative, in relation to which the validation of interface was prepared and carried out with positive results. A method of improvement of interaction requires 9 stages as shown in Fig. 3.

Stage 1: Preliminary analysis of historical data. Relationships in the user's environment in case of performance failure are recognized. Availability of this type of data enables identifying distractors and initially defining the sources of information gap. It is when the diagram of information flow is designed for the system human - interactive device – information environment.
Stage 2: It is required to document the cases of using a taxonomy characterizing the action for cognitive processes. A description of user's tasks is created and the knowledge about improper behavior of the user is supplemented.
Stage 3: Information means supporting user's decision making tasks are designed. The objective for the design is to include an optional solution for each individual task.
Stage 4: Planning training and exercises, during which the use of interactive product is forced in the situation of stress and lack of time. The assessment of effectiveness of feedback is required.
Stage 5: Documenting the effectiveness evaluation of user's tasks in difficult situations. A simulation of the information means used in executive actions of decision-making tasks under stress and lack of time.
Stage 6: Recording reaction times.
Stage 7: Identification of distractors.

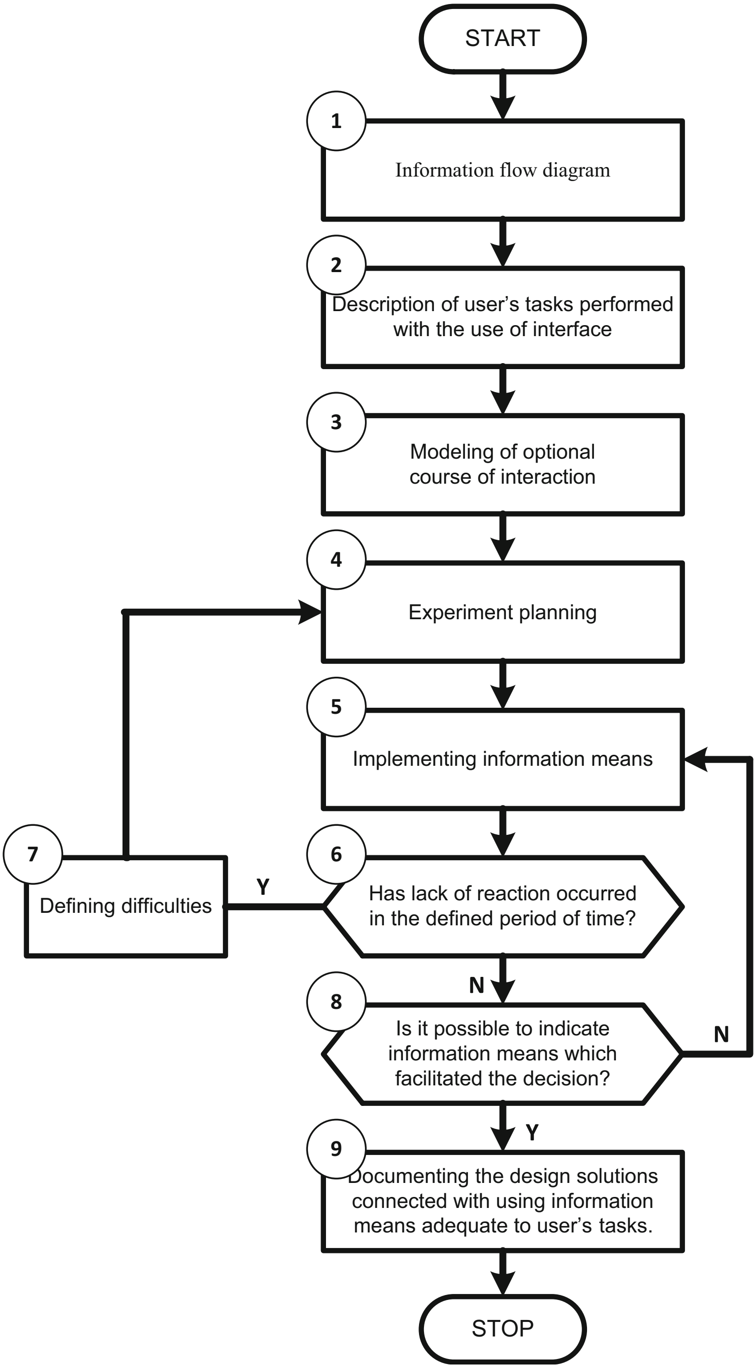

Fig. 3. Algorithm of minimization of information gap. Own elaboration

Stage 8: Selection of information means facilitating the decision making during interaction.
Stage 9: Describing the design solutions supporting user during interaction. The design is being enriched with innovative solution. The implementation of the project module is being implemented, which allows the user to actively participate in the creation of interactive products in the re-validation stage. The effectiveness of user's tasks in situation modeled personally by the user is compared.

Experience in regard to information means optimizing the work of interactive products' users during decision making activities are related to the following four areas of research:

1. Reducing the load on visual system with regard to seeing objects;
2. Guaranteeing maximally accurate reception of information provided by the indicating device;
3. Facilitating the including of information appearing "at the input" of the subjective sphere (a human creating a subjective model of activities);
4. Ensuring human's ability to keep all necessary information in the so called operating memory.

4 Conclusion

Ergonomic approach in minimization algorithm of information gaps in interactive products fulfills the postulate of individual adjustment of technique to user's abilities. Using adequate information means generates the transmission of information in such portions that none of them will exceed the capacity of its reception, and all of them together guarantee necessary fullness to reflect the reality.

Designing interface with knowledge of human's information processing processes, of cognitive processes which characterize executive actions of decision making processes influences directly the scope of information gap.

The suggested algorithm of minimization of information gaps provides knowledge about problem situation and situational context I which the processing of information of interactive product user occurs. Making use of the phenomenon of time deficit during critical test at the stage of design validation additionally provides data about conditions of fallibility of user's activity efficiency and test the device for compliance with human's characteristic. If the human-interface system is to function effectively, it is necessary that information addressed to man is transferred to him or her in the most convenient form to be noticed, remembered and understood. Analyzing the model of information processing we can distinguish components activating the user. Therefore, the base of interactive product design is the conceptual model of user's tasks along with specific activities of the cognitive system.

Interface of every interactive product integrates all elements of the system, between which the information exchange occurs. It constitutes a hub which filters the exponentially growing amount of data which are fed to the system, which provides resources for the user. The smaller the scope of information gap the better protected is the human in the context of information noise and the more favorable and the "mechanisms responsible for planning, decision making, discovering errors, reaction in new situations and refraining from habitual reactions," [8].

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