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***Abstract* - The ultimate goal of user interface design is to develop a product which people can use to reach their goals. By action we normally refer to our attempts to reach certain goals, and this is why it is natural to think user interface design as an activity we engage in when designing tools, instruments or technologies for people to realize their action goals. This paper suggests a novel action-oriented user interface development method that aims to develop a user interface interaction model. This interaction model is based on an organized tree structure composed of node states with relevant usability-related attributes and operations between the nodes.**

Index Terms – action-oriented design, usability, usability attributes, user experience, user interface design

I. Introduction

Human-technology interaction (HTI) research intends to connect technology to human life [1]. This problem is vital because the nature of technologies is changing. The connection between human action and the technology employed has been relatively straightforward in traditional single-function technologies, but today this technology is rapidly becoming multifunctional. This means that the hardware is no longer in a direct relation to the actual use: i.e. in multifunctional technologies one single device can have unlimited number of functions.

In traditional technology such as the one used for steam engines, the function, i.e., what people used the technology for, was well defined. An engine was used to move a train from one station to another, and that was all. Today, one single mobile phone can provide thousands of services, and it can be used for very different goals. It can function as a phone, a camera, or a navigator, and have numerous applications for supporting very different human actions.

This means that we must take a new look at the basic problems of human technology interaction design. We have to begin with the function of the technology and ask what kinds of actions the technology is intended to support and define the interaction processes from the perspective of actions [2, 3].

The difference between two different applications in a computer or a mobile phone is not merely technical. The essential difference is functional, that is, they are supporting human actions that differ from each other. Therefore, it is very logical to think that the contents of the relevant human actions can form the basis for interaction design.

However, human actions have many important parameters. The two most important design questions currently are: 1) how can people best use technology (e.g. traditional usability thinking)? and 2) do people like to use a given technology (e.g. emotional usability or user experience research)? In this paper, we consider how we can combine analysis of actions with the traditional usability thinking and the investigations in user experience.

II. Aspect Of Usability

The foundations of design thinking form an important platform in developing our investigation into human-technology interaction. One may begin this work with existing technical solutions and adapt the human user to the schema. However, it is also possible to think of these problems from a human point of view as is done in traditional human-centered design paradigms. In this section we present the definitions of traditional usability (Table I) and user experience (Table II) in terms of related attributes.

A. Early views of usability

Shackel's [4] definition of usability is one of the best-known. According to him, the attributes of usability are effectiveness, learnability, flexibility and attitude. Effectiveness refers to performance in the accomplishment of tasks (e.g. speed and errors). Learnability is the degree of learning to accomplish a task (e.g. time to learn and retention.). Flexibility means adaptation to variations in tasks and/or environments, and attitude refers to user satisfaction with the system.

Nielsen [5] suggests that usability is associated with five usability attributes: learnability, efficiency, memorability, errors, and satisfaction. By learnability, Nielsen refers to how well a novice user can use the system, while efficiency has to do with efficient use by an expert. Memorability stands for an occasional use of the system. As far as errors are concerned, the system should have a low error rate, and this attribute also includes users recovering from possible errors. Satisfaction refers to the requirement that the system should be pleasant to use. According to Nielsen [5], these attributes are not unambiguous and they can be in conflict with each other to a certain degree.

The definition of usability most often referred to is probably the one in ISO 9241-11 [6] which defines usability as consisting of three attributes: effectiveness, efficiency, and satisfaction. Effectiveness refers to accuracy and completeness in achieving specified goals. Efficiency means resources expended in relation to the accuracy and completeness in achieving goals. Satisfaction refers to freedom from discomfort, and positive attitudes towards using the product.

ISO 9126 [7] identifies usability as one of six different software quality categories that are relevant during product development. The other categories are functionality, reliability, efficiency, maintainability, and portability. Furthermore, the usability category is decomposed into five attributes: understandability, learnability, operability, attractiveness, and usability compliance. Understandability refers to capability of a software product to enable the user to understand whether the software product is suitable or not. Learnability is the capability of a software product to enable the user to learn its application. Operability means the capability of a software product to enable the user to operate and control it. Attractiveness refers to capability of a software product to attract the user. Usability compliance refers to compliance with published style guides or conventions for user interfaces.

TABLE I
EARLY VIEWS OF USABILITY

Usability attributes			
Shackel	***Nielsen***	***ISO 9241-11***	***ISO 9126***
Effectiveness Learnability Flexibility Attitude	Learnability Memorability Errors Efficiency Satisfaction	Effectiveness Efficiency Satisfaction	Learnability Operability Understandability Attractiveness

B. *Modern views of usability*

Preece et al. [8] argues that when designing interactive products, both usability and user experience (UX) are needed. The former refers to the following attributes: efficiency (efficient to use), effectiveness (effective to use), safety (safe to use), utility, learnability (easy to learn), and memorability (easy to remember how to use). The latter refers to fun, emotional fulfilment, rewarding experiences, support to creativity, aesthetically pleasing feelings, motivation, helpful aspects, entertainment, enjoyment, and satisfaction.

TABLE II
MODERN VIEWS OF USABILITY

User experience attributes	
Preece	***Quesenbery***
Fun Emotionally fulfilling Rewarding Supportive of creativity Aesthetically pleasing Motivating Helpful Entertaining Enjoyable Satisfying	Effective Efficient Error tolerant Easy to learn Engaging

Quesenbery [9] suggests that the user dimensions of usability are associated with five attributes (five Es) described by the adjectives effective, efficient, engaging, error-tolerant, and easy-to-learn. It can be seen that one of the main motivation behind this classification is that computer systems have moved beyond being just work-based [10]. Although the five Es are mainly built on ISO 9241-11 [6], one different kind of attribute, called engaging, is suggested. Engaging refers to the degree to which the tone and style of the interface make the product pleasant or satisfying to use.

1) Fun: Read, MacFarlane & Casey [11] suggest that the relationship between fun and usability is associated with three dimensions: expectations, engagement, and endurability (Especially in the context of measuring children's fun). Expectations refer to expectation of use and subsequent perception. This means that fun is composed of two components, (a) the fun that is attached to the current event, and (b) the fun that is attached to the prior expectations of the user. As an example, if we have high expectations and an event is then perceived to be dull, we feel disappointed, and vice versa. Engagement refers to the positive and negative instantiations (e.g. smiling, laughing, concentration etc.). Endurability is composed of two facets: remembrance and accessibility. The former is based on the Pollyanna principle: the likelihood to remember things that we have enjoyed. The latter refers to the desire to perform a funny activity again.

2) Enjoyable: Lin and Gregor [12] have reviewed relevant studies of enjoyment (especially as it is experienced by users of the Web), and they suggest that the concept of enjoyment is necessarily characterized by engagement in an activity, the resultant positive affect, and the fulfilment of some need or desire. Engagement in an activity refers to a situation in which attention is deeply focused on some activity. The resultant of positive affect refers to positive emotions (e.g. pleasure, happiness, contentment etc.) which result from use experience. The fulfilment of some need or desire refers to the fulfilment of user needs, including unexpected needs.

III. ACTION-ORIENTED USER INTERFACE DESIGN, USABILITY AND USER EXPERIENCE

The main goal in action-oriented user interface design is to develop a user interface interaction model which would allow users to use technology in the best possible manner. In other words, the users would be able to effectively reach their action goals. The action-oriented user interface development method is composed of four steps: defining the set of organized actions, constructing an organized tree structure, setting usability-related attributes for node states, and constructing user interface interaction model (see Figure 1).

A. *Defining the set of organized actions*

The first step in action-oriented interaction analysis is to define the relevant actions. One can use here the life-based analysis [13], the goal of which is to study the situation of human life and find the separate actions in it. There are also several other suitable methods and techniques for defining the relevant actions (see e.g. [14]).

B. Constructing an organized tree structure

In step 2, user interaction is decomposed into a form of a hierarchical tree composed of node states and operations. Clearly, whether the user interface is a graphical user interface (GUI), a Web user interface (WUI) or a touch user interface, the user controls the states of the interaction with the product by making selections (e.g. pressing buttons). There are always node states and operations which move the system from one node to another. The task of the user is to make the decisions which give meaning or sense to the transitions from one state to another.

As the nodes are contact points in interaction, we have to concentrate our analysis to these points. The given design criteria should thus be investigated in the context of the interaction in the decision nodes. These nodes do not have such a clear role when the actual operation is carried out. As an example, when the user navigates from one Web page (e.g. the main page of an online magazine) to another (e.g. a sports page of an online magazine), the navigation does not cause that many problems. However, if a Web advertisement in a form of a pop-up banner is added between these nodes, the nature of interaction will be quite different.

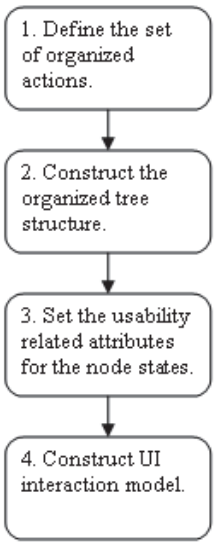

Fig. 1 The steps in action-oriented UI design.

C. Setting the usability-related attributes for the node states

Step 3 means that the nodes of tree structure are equipped with appropriate traditional usability attributes and user experience attributes. The traditional usability attributes (e.g. effectiveness, efficiency, memorability, and learnability) refer to the factors which foster the capability of the user to make a correct decision in the node. They help people pick up relevant information for making the right decision. The UX attributes (e.g. enjoyable, fun) give information about how user interface designers can implement interfaces which the users like to use. Both usability and user experience aspects are important when the user interface interaction model is built in action-oriented user interface design.

As an example, a radio button can be associated with a single action. The designer must understand how to differentiate the critical button from other buttons and how to communicate that this button is important in reaching the defined action state. On the other hand, the designer must also think what the design should be like so that the users would find it cool or prestigious. This means the UX concepts look at the interface from a different point of view. While the usability concepts help in making a device easy to use, the UX concepts tell what looks fine and is enjoyable. In this way, the same node should be analysed from different points of view.

D. Constructing a UI interaction model

Step 4 refers to the organized tree structure description of the relevant interaction tasks. The hierarchical tree structure description is composed of node states with relevant usability and UX attributes and operations between the nodes.

IV. Summary and Conclusions

Usability-related attributes play a major role in the action-oriented user interface development method. In this method it is essential to consider usability and UX attributes not only at the level of a single interaction task but also at the level of single nodes. In this way, it is also possible to define usability-related requirements at the level of single state nodes. Consequently, this method is particularly suitable for UI-intensive systems with high demands to reduce risks.

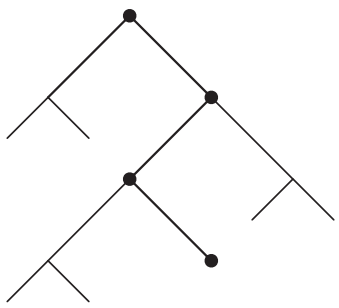

Fig. 2 An organized tree structure with task-specific usability and UX attributes. The relevant usability-related attributes are determined for each state node.

Usability and user experience concepts are interrelated. If the users are not able to reach their goals with technologies in an easy manner, they become irritated. They do not like slow or incomprehensible systems. It is also possible that a beautiful and enjoyable interface design makes it difficult to find and

comprehend crucial information. In this way, the two sets of attributes are often intimately connected to each other. Our action-oriented tree structure analysis gives roles for both types of usability-related attributes.

Our goal was to outline a design approach which is based on the idea of beginning interface design with the analysis of human actions and investigating separately the issues of how users can use interfaces and how they like to use them. The main motivation is that we have to unify "can" and "like" – perspectives in practical interaction design. The action-oriented user interface design and development scheme is composed of four steps: defining a set of organized actions, constructing an organized tree structure while keeping in mind how users can reach their action goals, setting usability-related attributes for node states, and constructing a user interface interaction model. Action-oriented user interface design defines the relations between usability and user experience attributes. It enables us to understand why the users really use the technology, how they could best deploy it and finally, what makes them feel good when they are reaching their action goals through the user interface.

The method of action-oriented user interface design can be integrated into early phases of human technology interaction design methods. For example, within the Life-Based design [13], the action-oriented user interface method can be deployed to build a user interface interaction model based on a set of organized actions. Furthermore, in the later phases of user interface design, early action-oriented UI prototypes can be evaluated by applying action-oriented user interface evaluation methods such as the D-TEO method [15].

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