Intuitive Use of User Interfaces: Defining a Vague Concept

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Abstract. In this paper we present a general definition of the concept 'intuitive use of user interfaces' on the basis of our current interdisciplinary work. 'Intuitive use' is regarded as a characteristic of human-machine systems. It refers to a special kind of interaction process between users and technical systems that use the users' intuition. The main part of the paper deals with central aspects of this definition in detail and discusses pre-conditions and restrictions of the use of the concept. The main aspects that we discuss are the design of technical systems, application and non-conscious use of previous knowledge, intuition as a non-conscious process, interaction, and effectiveness. We complement this discussion by addressing the relationship between aesthetics and intuitive use.

Keywords: aesthetics, effectiveness, human-machine interaction, intuition, knowledge, non-conscious, usability, user interfaces.

1 Introduction

With the increasing number of functions and uses of different technical systems in daily life, the concepts of 'intuitive' and 'intuitive use' are used more and more often as an assessment criterion for these technical systems and for User Interface (UI) requirements. Frequently, these concepts are attributed to an interface itself, e.g. 'Firefox 1.5 has an intuitive interface' (www.mozilla-europe.org, 2006), without specifying precise aspects of use or user groups. If one asks users of interactive systems or usability experts what they think about 'intuitive use', one most likely gets answers like: 'acting by intuition', 'acting on instinct', 'using without guidance/explanation', 'acting as a matter of routine', or 'using automatically' [1]. All of these statements suggest that 'intuitive use' should not demand high cognitive resources (anymore), but rather work on a skill based or maybe rule based level [2].

In the scientific literature however the concepts of 'intuitive' and 'intuitive use' are commonly avoided by researchers because they are regarded as vague, ill defined or non-scientific. Facing this situation the IUUI research group (Intuitive Use of User Interfaces) has made it its business to explore the usefulness of the term 'intuitive use' as a well defined scientific concept.

We started our interdisciplinary endeavor as a group of psychologists, computer scientists, engineers, and designers without knowing whether we ultimately would be able to come up with a common concept of the term 'intuitive use' which was shared by the whole group, or whether we would convince ourselves to avoid this term in the future, or (even worse than that) whether we would neither be able to agree on the usefulness of the concept nor be able to avoid it completely. After almost one year of work, we are now not only presenting the second refinement of our definition of 'intuitive use', but we are also confident that it is possible to further develop this concept to create guidelines for the design of intuitively usable systems and devices.

In the following, we start by presenting our current definition of the intuitive use of user interfaces. In the main part, we explain and discuss central aspects of this definition in detail. These main aspects are: the design of technical systems, the application of previous knowledge, intuition as a non-conscious process, interaction and effectiveness. Though we do not regard aesthetics as an aspect of intuitive use, it is obvious that, from a design perspective, the relationship between aesthetics and intuitive use has to be clarified. We address this issue in a separate section. The paper is rounded off with a summary and an outlook of what has to be done.

2 Intuitive Use of User Interfaces: Definition Version 1.1

‘A technical system is, in the context of a certain task, intuitively usable while the particular user is able to interact effectively, not-consciously using previous knowledge.’

The basis of our definition is the conclusion that only human information processes can be labeled as intuitive. The term 'intuitivity', that has been used more frequently in recent years as a product feature, should thus be avoided. 'Intuitive use' can only be used in the context of task, user, environment or technical system. More precisely, intuitive use can only be attributed to the human-machine interaction in a certain context, for the achievement of objectives, but not to a technical system per se.

2.1 Design of Technical Systems

Intuitive usability can only be attributed to the human-machine interaction in a certain context. Nevertheless, there are some aspects which should be considered when designing a technical system.

The design space for technical systems can be described in terms of the layers given by Foley and van Dam [3] and modified by Buxton [4] in their human-computer-interaction model: *conceptual*, *semantic*, *syntactic*, *lexical*, and *pragmatic (physical)* layers. Each layer has its own characteristics in respect of intuitive interaction. The *conceptual* layer describes the main concepts (mental model of the users) of the interactive system, e.g. spreadsheet applications, text editors, graphical tools. The *semantic* layer defines the functionality of the system, sequences of user actions and system responses. The *syntactic* level defines interaction tokens (words) and how to use them to create semantics. The *lexical* layer describes the structure of these tokens and the *pragmatic* layer [4] describes how to generate them physically by means of user actions and I/O elements, e.g. displays and input devices.

Designers of technical systems should carefully go through these layers, starting from the conceptual layer, and carefully provide solutions for each layer and the mappings between them [5]. This process helps to prevent 'apples and oranges' types of solutions and to come up with applicable catalogues of interface solutions. Also the type of mapping between the layers is crucial for intuitive interaction. Modifications made at one level often have strong effects on other layers, e.g. changing the input device may strongly affect the interaction syntax [4].

There are hardly any guidelines for the development of intuitively usable interfaces. Blackler, Popovic and Mahar [6] developed three principles for applying intuitive interaction to interface design: 1. Use familiar symbols (lexical), 2. Make obvious what less well-known functions will do (semantic), and 3. Increase consistency between different parts of the design (lexical, syntactic). They found that the appearance (shape, size and labeling) of features most affects intuitive use (pragmatic, lexical layer). Based on a survey among HCI experts, Mohs et al. [1] list seven criteria which influence intuitive interaction. Five of them are (sub-) criteria of the ISO 9241-110 [7] usability criteria: suitability for the task, conformity with user expectations, and self-descriptiveness; others are related to affordances and Gestalt laws. Hornecker and Buur [8] refer to the vertical design mapping, the *perceived coupling* between the physical (here: tangible) and the semantic layer. Hurtienne and Israel [9] suggest the application of image schemas (pragmatic, lexical, syntactic) and their metaphorical extensions (semantic) for the design of intuitively usable interfaces. We still see a high demand for comprehensive catalogues and guidelines in this field.

Our definition of the intuitive use of technical systems covers primarily the *interaction problem* [10] defined by the pragmatic, lexical, syntactic and semantic layer. We assume that intuitively usable interfaces free more cognitive resources for the solution of the *overall problem* [10] in the conceptual layer.

2.2 Continuum of Knowledge

Users can interact with a technical system effectively and intuitively when applying their *previous knowledge* to a certain situation. This previous knowledge may stem from different sources. These knowledge sources can be classified along a continuum from *innate* knowledge, knowledge from embodied interaction with the physical world (*sensorimotor*), and *culture* to professional areas of *expertise*. On each of the last three levels there might be specialist knowledge about using the corresponding *tools* and technologies (see Figure 1).

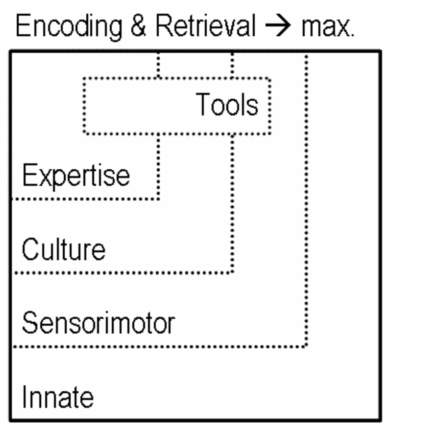

Fig. 1. Continuum of knowledge in intuitive interaction

The first and lowest level of the continuum consists of *innate* knowledge - ‘acquired’ through the activation of genes or during the prenatal stage of development. Generally, this is what reflexes or instinctive behaviour draw upon. Purists will see this as the only valid level of knowledge when talking about intuitive interaction, because it assures universal applicability and non-conscious processing. The next level is *sensorimotor*. It consists of general knowledge, which is acquired very early in childhood, and is from then on used continuously through interaction with the world. Children learn for example to differentiate faces; they learn about gravitation; they build up concepts for speed and animation. Scientific notions like affordances [11] and image schemata [12] reside at this level of knowledge. The next level is about knowledge specific to the *culture* an individual lives in. What is known within the western group of cultures is not necessarily equivalent to the knowledge of people in eastern cultures (e.g. the appropriate colour at funerals). The most specific level of knowledge is *expertise*, that is specialist knowledge acquired in ones profession, for example as a doctor, mechanic, or accounting clerk; and in hobbies (e.g. riding, surfing, online-gaming). Across the sensorimotor, culture and expertise levels of knowledge, we also distinguish knowledge about *tools.* Tool knowledge seems to be an important reference when designing user interfaces. At the sensorimotor level there are primitive tools like sticks to extend one’s reach and stones to be used as weights. At the culture level, we find tools commonly used by people, like ball point pens for writing, pocket lamps for lighting, or cell phones for communication. At the last stage, there is the knowledge acquired from using *tools* in one's area of expertise, for example image editing tools, enterprise resource planning (ERP) systems, or CNC machines. Even within the same domain of expertise (e.g. graphic design) there may be differing knowledge on the tool level of the continuum, depending on the kind of tools used (e.g. Corel Paint Shop vs. Adobe Photoshop).

The continuum of knowledge has an inherent dimensionality. The frequency of encoding and retrieval of knowledge increases from the top to the bottom of the continuum. Then, the further we rise towards the top level of the continuum, the higher the degree of specialization of knowledge and the smaller the potential number of users possessing this knowledge. But still, on each level of the knowledge continuum we may assign 'intuitive use' according to the above definition – as long as it is *non-consciously* applied by users.

2.3 Using Previous Knowledge Non-consciously

The application of knowledge by the user within the interaction with the technical system may be non-conscious from the beginning (as with reflexes) or may have become non-conscious due to frequent exposure and reaction to stimuli in the environment: the more frequent the encoding and retrieval was in the past, the more likely it is that memorised knowledge is applied without awareness by the user. Knowledge at the expertise level is acquired relatively late in life and is (over the life span) not as frequently used as knowledge from the cultural or sensorimotor level. As learning theory suggests, knowledge from the lower levels of the continuum is therefore more likely to be applied non-consciously than knowledge from the upper levels. If the non-unconscious application of knowledge is a precondition for intuitive use, it will be more common to see intuitive interaction involving knowledge at the lower levels of the continuum.

Limiting 'intuitive interaction' to the lower levels of the knowledge continuum which are still consciously aware does have further advantages:

- The further down we move on the continuum, the larger and more heterogeneous the user groups we can reach. While almost everyone will have an understanding of 'verticality' (sensorimotor level), not everyone understands the Corel Paint Shop software package (tool/expertise level).
- Instead of being required to analyse the previous knowledge and experience of the specific target user group, designers might simply refer to rules generated from findings about the general structure of human knowledge (i.e. general human knowledge on the sensorimotor level).
- Extremely frequent encoding and retrieval events lead to a higher robustness of information processing and automatic processes. In situations of high mental workload and stress, a fall-back on lower stages of the knowledge continuum will occur. This will be especially important to the design of systems with a high requirement for security (control of aircraft or of nuclear power plant).
- Non-conscious processing of user interface elements in general means less workload on the cognitive processing capacity. Thus, more cognitive resources

will be available for solving the working task at hand, instead of wasting time and mental effort on figuring out how a piece of technology works.

2.4 Interaction

In the context of intuitive use of a technical system, we understand interaction as a two-way exchange of energy and information between human and product. From the human perspective, this exchange is target-oriented.

Looking at the human aspect, the following can be stated: Tasks or activities have a hierarchical structure [13]. This is shown in Figure 2. Tasks consist of an entirety of actions which are subordinated to sub-goals. These sub-goals can be derived from a superordinate conjoint goal. The role of this conjoint goal can be taken up by the motive of the task. Actions, in turn, are self-contained entities of the task, consisting of sub-actions or operations. These operations are dependent on the task, because their results are not consciously anticipated as a goal. Also, they are inherently regulated by triggering mechanisms (e.g., ‘Traffic light red – brake’). Thereby, a participation of transient sub-goals is possible. Operations include several motions or single mental processes, for example conclusions, at a time [13].

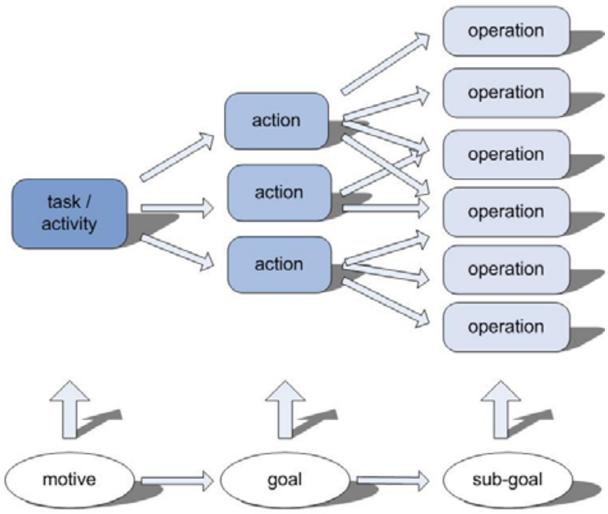

Fig. 2. Hierarchical structure of the task in the Action Regulation Theory [14] adopted from Walliser [15]

In our understanding, intuitive usability of a technical system, in the first instance, refers only to the level of operations as a part of more complex actions. On the level of operations, we think, intuitive use can be made measurable in the simplest way.

2.5 Effectiveness

The rating or assessment of the procedure of intuitive interaction can be done by its effectiveness. According to the ISO standard series 9241 the term *effectiveness* is mentioned as “the accuracy and completeness of users’ tasks while using a system” (DIN EN ISO 9241-11 [16]). In this sense, it is only possible to call an interaction *intuitive* if it leads the user to adequate, exact and complete interaction results. However this understanding doesn’t necessarily mean that an intuitive procedure corresponds to something that system developers would call ‘the optimal way’.

Furthermore, we assume that users experience intuitive interactions as *efficient.* Whereas it is important to point out the multi-dimensional character of the concept of *efficiency* and especially the orthogonality of dimensions like time, cognitive resources, material resources, energetic resources and financial resources. Under that premise, it is possible to vary each dimension extensively, independently from the other. Therefore an operation in human machine systems is meant to be intuitive if the demands of cognitive resources are minimal even if it causes a higher investment of other dimensions like e.g. time.

3 Viewpoint: Aesthetics and Intuitive Use

Though we do not regard aesthetics as an aspect of intuitive use and therefore do not include it in our definition, we also want to look at the relation between aesthetics and intuitive use from the design perspective. Do the aesthetic design characteristics of interactive products have an effect on the intuitive use of products?

Aesthetics is defined as the branch of philosophy “that in its broadest sense, deals with the general questions of art […], and that in its narrow sense, with how things are known via sensory perception […].” [17]

Aesthetic parameters include form, audio, smell, color, proportion, size, material and surface qualities. The appearance, composition and characteristics of an application or product are influenced by many combinations of these design principles and developed, together with the information architecture and the technical solutions, in an iterative product development process. Or put more simply, aesthetics concerns all parameters of interaction and appearance.

The design of intuitively usable interactive information systems and devices takes into consideration all the human senses involved, as with, for example, the visual representation of a communication process. In each sensory system an aesthetic judgment is made. Aesthetic design directly addresses human sensory perception and triggers sensations and immediate evaluations of the user experience. The higher the compatibility of the offered interaction with the user’s personal and cultural habits, experiences and emotional state, the more intuitive will be the usage.

It thus follows that the aesthetics of an interactive offering is an essential influencing parameter on the degree of intuitive use. If the user does not perceive objects and signs as attractive and usable, or at least familiar, then the application or product has almost no chance of being used intuitively by the user or indeed of triggering a positive user-experience. But just what role does aesthetics play in the discussion on intuitive use? If one assumes – as we do - that the degree of intuitive use is dependent on how much previous knowledge can be implicitly recalled in the interaction process, then aesthetics should be considered to be even more important.

Aesthetic qualities trigger previous knowledge as aesthetic judgments are at the start of individual perception processes: When a user begins an unknown process or encounters an unknown device, he or she looks at it, maybe touches it, listens to it, or even smells it. Without these sensory steps, that ask questions of the device and which are answered by its aesthetic qualities, the user cannot get close to the technical system. If none of the impressions of the device are compatible with the user's previous experience, he or she will not be able to intuitively get close to the device and its significance - as a result the user will have to refer to the online help or manual. The user feels subjectively represented by an aesthetically designed product that triggers positive memories and associations. Aesthetics is the key to the technology that lies behind.

4 Summary and Outlook

In our definition of 'intuitive use' we state that this term can only be attributed to the human-machine interaction in a certain context, for the achievement of objectives, but not to a technical system per se.

In the present paper, we explained central aspects of the definition in detail. So, we assume that intuitively usable interfaces free more cognitive resources for the overall problem, as part of the interaction problem in human-computer interaction [10]. Also, we identified several relevant levels of origin of previous knowledge used in intuitive interaction, whereas knowledge from the lower levels of the continuum is more likely to be applied non-consciously. Regarding the interaction itself, intuitive usability, in the first instance, refers only to the level of operations as a part of more complex actions in the Action Regulation Theory [13]. Furthermore, we refer to interaction as intuitive if it leads to sufficiently accurate and complete interactions for the user. Concerning efficiency, an interaction option is intuitive when users' cognitive load is reduced.

We also think there is a relation between aesthetics and intuitive use. Thus, we took a first step towards the clarification of this relation from the design perspective.

The definition and its explanation display the current state of work of our IUUI research group. The content discussion within the research group and with external researchers interested in the topic is continuing and will result in a modified version of the definition (version 2.0).

Based on the development of a concrete definition of 'intuitive use', it will be possible to formulate design principles for intuitive human-machine interaction. Accordingly, in a next step we will analyze which existing usability concepts support intuitive use in terms of our definition. Therefore, we will focus more on the central usability specifications in the ISO standard (DIN EN ISO 9241-11 [16]): effectiveness, efficiency and user satisfaction. In addition, we will look more closely at the relationship between aesthetics and intuitive use.

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