

Studying the Utility of Metaphors of Human Thinking in HCI

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ABSTRACT

Understanding human thinking is crucial in the design and evaluation of human-computer interaction. Inspired by introspective psychology, we present five metaphors of human thinking. The aim of the metaphors is to help designers to consider important traits of human thinking when designing. The metaphors capture aspects of human thinking virtually absent in recent years of HCI literature. As an example of the utility of the metaphors, we have shown how a selection of good and poor user interfaces can be appreciated in terms of the metaphors. The metaphors can also be used to reinterpret central notions in human-computer interaction, such as consistency and information scent, in terms of human thinking. Finally, we have experimented with using the metaphors of human thinking for usability inspection. The proposed inspection technique makes users' thinking the centre of evaluation and is readily applicable to new devices and non-traditional use contexts. Initial experience with the technique suggests that it in discussing and evaluating user interfaces is quite effective.

1. INTRODUCTION

For some years our research and teaching in human-computer interaction have been inspired by William James's and Peter Naur's descriptions of human thinking [7-11]. Similar descriptions along with many brilliant design discussions have lately been introduced to HCI in Jef Raskin's book 'The Humane Interface' [13]. Naur's and Raskin's work are complementary to most psychology used in HCI, but is supported by extensive evidence from classic introspective psychology [7], and from experimental psychology and neurology [1,2]. Several of the aspects of human thinking described in this work are of critical importance to human-computer interaction: (1) the role of habit in most of our thought activity and behaviour—physical habits, automaticity, all linguistic activity, habits of reasoning; (2) the human experience of a stream of thought—the continuity of our thinking, the richness and wholeness of a person's mental objects, the dynamics of thought; (3) our awareness—shaped through a focus of attention, the fringes of mental objects, association, and reasoning; (4) the incompleteness of utterances in relation to the thinking underlying them and the ephemeral nature of those utterances; and (5) knowing—human knowing is always under construction and incomplete.

2. METAPHORS OF HUMAN THINKING

Below metaphors of human thinking (MOT) is summarized by describing the underlying understanding of human thinking and the five supporting metaphors. We also give examples of how to use the metaphor to conveniently understand good and poor interfaces, and outline key questions to consider in a usability inspection. Note that the metaphors are intended, *not* in any way

as interface metaphors, but to support the evaluator in a focused study of how well certain important aspects of human thinking are taken into account in the user interface under inspection.

Metaphor of Habit Formation. Habits are shaping most of our thought activity and behaviour—e.g. as physical habits, automaticity, all linguistic activity, and habits of reasoning. *The metaphor is:* Habit formation is like a landscape eroded by water. This metaphor should indicate how a person's formation of habits leads to more efficient actions and less conscious effort, like a landscape through erosion adapts for a more efficient and smooth flow of water. Creeks and rivers will, depending on changes in water flow, find new ways or become arid and sand up, in the same way as a person's habits will adjust to new circumstances and, if unpracticed, vanish.

In design, there is an abundance of examples of user interfaces that violate human habits. One example is adaptive menus, used for example in Microsoft Office 2000. Adaptive menus change the layout of the menu according to how often menu items are used, for example by removing or changing the position of items seldom used. However, adaptive menus make it impossible to form habits in the selection of menu items [13], since their position may be different from when they were previously selected. A study by Somberg [15] showed the efficiency of constant position placement of menu items compared to menus that change based on use frequency. Somberg, however, did not explicitly link habit formation to the usefulness of constant placement of menu items. Note that the common practice of adding a fixed number of, say, recently used files or fonts to the bottom or top of a menu does not interfere with habit formation and may decrease time taken to select a menu item [14].

In usability inspection this metaphor calls for considering: Are existing habits supported? Can effective new habits, when necessary or appropriate, be developed? Can the user use common key combinations? Is it possible for the user to predict, a requisite for forming habits, the layout and functioning of the interface?

Metaphor of the Stream of Thought. Human thinking is experienced as a stream of thought—in the continuity of our thinking, the richness and wholeness of a person's mental objects, of consciousness, and subjective life. *The metaphor is:* Thinking as a stream of thought. This metaphor was proposed by William James [7] (vol. I, p. 239) to emphasize how consciousness does not appear to itself chopped up in bits: 'Such words as "chain" or "train" do not describe it fitly. It is nothing jointed; it flows'. Particular issues can be distinguished and retained in a person's stream of thought with a sense of sameness, as anchor points, which function as 'the keel and backbone of human thinking' [7] (vol. I, p. 459).

In design, a simple, yet effective, attempt to recreate part of the richness of the stream of thought when users return to resume interrupted work, is Raskin's design of the Canon Cat [13]. When the Canon Cat is started, the display immediately shows up as it was before work was suspended. Not only does this allow the user to start thinking about the task at hand while the system is booting. It also provides help in remembering and recreating the stream of thought as it was when work was interrupted.

In usability inspection this metaphor calls for considering: Is the flow in users' thought supported in the interface by recognizability, stability and continuity? Does the application make visible and easy accessible such interface elements that relate to the anchor points of users' thinking about their tasks? Does the application help users to resume interrupted tasks?

Metaphor of the Dynamics of Thinking. Here is considered the dynamics of human thinking, the awareness shaped through a focus of attention, the fringes of mental objects, association, and reasoning. *The metaphor is:* Awareness as a jumping octopus in a pile of rags. This metaphor was proposed by Peter Naur [9] (pp. 214-215) to indicate how the state of thought at any moment has a field of central awareness, that part of the rag pile in which the body of the octopus is located; but at the same time has a fringe of vague and shifting connections and feelings, illustrated by the arms of the octopus stretching out into other parts of the rag pile. The jumping about of the octopus indicates how the state of human thinking changes from one moment to the next.

In design, modal dialog boxes prevent the user from switching to potentially relevant information—in Microsoft Word, for example, it is not possible to switch back to the document to look for a good file name once the 'save as ...' dialog has begun.

In usability inspection this metaphor calls for considering: Are users' associations supported through flexible means of focusing within a stable context? Do users associate interface elements with the actions and objects they represent? Can words in the interface be expected to create useful associations for the user? Can the user switch flexibly between different parts of the interface?

Metaphor of the Incompleteness of Utterances. Here is focused on the incompleteness of utterances in relation to the thinking underlying them and the ephemeral character of those utterances. *The metaphor is:* Utterances as splashes over water. This metaphor was proposed by Naur [9] (pp. 214-215) to emphasize how utterances are incomplete expressions of the complexity of a person's current mental object, in the same way as the splashes tell little about the sea below.

For design, one implication of the metaphor of utterances as splashes over the water is that we must expect users to describe the same objects and functions incompletely and in a variety of ways. Furnas et al. [4] investigated the diversity in words used for describing commands and everyday objects. On the average, two participants described the same command or object by the same term with less than 20% probability. The most popular name was chosen only in 15-35% of the cases. Furnas et al.'s suggestion for relieving this problem is called the unlimited alias approach. Instead of using a fixed set of words for commands and functions, the unlimited alias approach lets users enter any term they want. If the term is not in the range of terms initially suggested by the designer of the system—which the data of Furnas et al. and the

metaphor suggest it often will not be—the system may interactively suggest appropriate commands or object names. This approach is coherent with the metaphor and uses interactivity to clarify the intentions of the user. On the other hand, the approach partly goes against the metaphor of habit formation.

In usability inspection this metaphor calls for considering: Are changing and incomplete utterances supported by the interface? Are alternative ways of expressing the same information available? Are the interpretations of users' input in the application made clear? Does the application make a wider interpretation of users' input than users intend or are aware of?

Metaphor of Knowing. Human knowing is always under construction and incomplete. *The metaphor is:* Knowing as a site of building in progress. Also this metaphor was proposed by Naur [9] (p. 214-215) and meant to indicate the mixture of order and inconsistency characterizing any person's insight. These insights group themselves in many ways, the groups being mutually dependent by many degrees, some closely, some slightly. As an incomplete building may be employed as shelter, so the insights had by a person in any particular field may be useful even if restricted in scope.

In design, mental models have been extensively discussed. Consider as an example Norman's [12] description of the use of calculators. He argues that the use of calculators is characterized by users' incomplete understanding of the calculators, by the instability of the understanding, by superstitions about how calculators work, and by the lack of boundaries in the users' understanding of one calculator and another. These empirical observations by Norman are coherent with the ideas expressed by the metaphor of knowing.

In usability inspection this metaphor calls for considering: Are users forced by the application to depend on complete or accurate knowledge? Is it required that users pay special attention to technical or configuration details before beginning to work? Do more complex tasks build on the knowledge users have acquired from simpler tasks? Are users supported in remembering and understanding information in the application?

Further examples. In [3], each of the metaphors and their implications for user interfaces are described in more detail. In [5], we propose the metaphor-based usability inspection technique and discuss how to conduct such a usability inspection. In [6], we present initial empirical results on the effectiveness of the inspection technique.

3. CONCLUSION

General properties of thinking activity known to all of us by introspection were emphasized through five metaphors, which build upon the work of William James and of Peter Naur. The metaphors catch psychological aspects of habit formation, stream of thought, awareness, utterances, and knowing. With the possible exception of awareness, these aspects of human thinking are rare in recent years of HCI literature (cf. [3]). From commonly available user interfaces and from a selection of empirical studies, the utility of the metaphors was illustrated by their ability to clarify designs and notions in HCI. We suggest that the metaphors, by virtue of their psychological recognizability and focus on basic aspects of thinking, can help designers consider important human traits.

When using MOT as a usability inspection technique, inspection is focused on the users' mental activity through the five metaphors of essential aspects of human thinking.

In an experiment [6], MOT compared to Heuristic Evaluation (HE) uncovers more of the usability problems that were assessed severe on users and complex to repair. In addition, the evaluators using MOT show a stronger agreement by finding the same problems more often; and evaluators use less time to perform their evaluation.

It is remarkable how MOT in its first experimental study has given good results compared to HE, the usability inspection technique most widely used in industry. HE usually performs very well in comparison with other inspection techniques, e.g. cognitive walkthrough and GOMS-based techniques.

It must be emphasized that these results are preliminary and have to be challenged by further studies. What happens when MOT is used for evaluating interfaces in non-traditional use contexts, when the evaluators are more proficient, or when MOT is used in design work? In the experiment, however, usability inspection by metaphors of human thinking showed to be viable.

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