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From the Editor in Chief

QUESTIONS AND ANSWERS

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Innovative thinking has become a significant need nowadays. Businesses, governments, and large organizations such as the European Union investigate how innovations could best be fostered. Indeed, policy makers speak often about the importance of innovative thinking. An important social goal of governments involves growing innovative thinking as much as possible in support of their economies. Consequently, one can find abundant literature regarding innovation processes on policy and management level. Yet, we do not have much knowledge or research on innovation as human thinking (Saariluoma, Hautamäki, Väyrynen, Pärttö, & Kannisto, 2011).

It is intuitively evident that thinking creates innovations. Money, information systems, and organizations can create the positive or negative circumstances for innovation processes, but they cannot create innovations. Innovations arise from one single source: human thinking. Animals seldom have innovative processes that create cultural evolution because their neural systems do not allow sufficient capacity to store symbolic and cultural information. Thinking is thus a human property like language, and it is the necessary precondition for innovative thinking. This means that it is necessary to add one additional dimension to innovation research, that is, innovating as human thinking. This kind of research has been termed *microinnovation research* (Saariluoma & Kannisto, 2008).

Innovative thinking is important also in human–technology interaction research. New ideas frequently spread around the world. New services, such as games or business or government information systems, migrate quickly from their place of origin, and have been changing modern daily life significantly from what it used to be as recently as a decade ago. Ideas become innovations for many reasons, such as addressing some human need or achieving some outcome in an efficient manner. However, these changes and progressions would not exist unless someone invested time and creativity in the necessary thought work. Thus it is essential to understand how thinking operates within innovation processes. Importance is placed on uncovering the theoretical concepts that could clarify the role of human thinking in innovation processes.

Among researchers dedicated to understanding thought and thinking, the process of thinking is viewed as a mental process that emerges when people have a goal but do not have immediate means to reach this goal (Duncker, 1945; Newell & Simon, 1972). Following this

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definition, Nobel Prize laureate Herbert Simon developed his first artificial intelligence programs to solve problems using heuristics such as means ends, in which a computer compares its current "mental state" with the properties of the goal and chooses a transformation operator, which decreases the difference between the current mental state and the goal (Newell & Simon, 1972). Thus, solving a problem can be seen as transforming one mental state into another, while innovative thinking is viewed as a large process of solving small problems and integrating the results (Saariluoma et al., 2011).

So what role can technology play in innovative thinking? Computers can store helpful information, solve mathematical problems, inductively generate laws of natural science from data, or play chess. Although helpful in many ways, technology is still far from generating innovative thinking—or providing anything practical in analyzing innovative thinking. But technology can still benefit research in to the challenge of innovation: Models of human thinking benefit from the exploration into why, for example, computers cannot solve innovation problems in the area of human technology.

The core problem with attempts to model human thinking with technology is the formal nature of the knowledge computers use. Turing (1936, 1950) created an abstracted version of human thinking. Turing machines manipulate meaningless symbols by following the laws of logic. With a high processing speed, it is possible to search all logically possible solutions and thus succeed in well-defined areas, such as the game of chess. However, Turing machines (1950) cannot provide meanings to their symbols, and therefore they lack some essential human capacities. This was first noticed by Ludwig Wittgenstein (1958, 1969) in his late philosophy. Since then, other critics, such as Searle (1980) and Dreyfus (1972), have illustrated the differences between computational models of the mind and human thinking. To me, the core discussion about intentionality and other related issues is that computers do not "know" what the information content is, and therefore they cannot "know" about the relevance of the things they process. The main reason for this is the poverty of mathematical theory languages in expressing relevance. There is no mathematical way to express what is relevant and what is not. Therefore, to be able to articulate the relevant elements and functions in a Turing machine, extra-formal theory languages are needed (Saariluoma, 1997). Relevance itself is necessary because, without understanding what is relevant and what is irrelevant, how can one know what makes sense?

The goals of thinking, and their contents and relevance, are the very essence of innovative thinking. Indeed, the primary and related questions about the matter form the core substance. If the machines do not comprehend the contents of the bits of data they amply classify and select, they cannot analyze the important questions. In the case of chess, information can be dressed in a symbolic and logical form, making computational problem solving very effective. However, the questions are still presented and defined by people.

Edison was an innovator in that he was able to find good material for his version of the light bulb. Yet he also was innovator in that he understood the significance of the relevant infrastructures and publicity (Millard, 1990). Thus his innovation made an impact because he understood the right questions and, consequently, could find solutions, although sometimes with substantial effort. Had he not formulated the right questions, he certainly could not know how to answer them.

The process of setting, asking, and answering questions forms the core of innovative thinking. However, this process, in the case of human thinking, cannot be random: The contents of the questions are determined by and make sense in the context of the design process. Thus the target of design sets the parameters for what the relevant questions are. On highest level, various design processes share many abstract similarities. Or, products may belong to same product type, or the product line may share similar questions. For example, when considering most vehicles, it makes sense to ask about the anthropometry of drivers so that these specified parameters can be used in various design processes.

Innovative thinking is often based on inherited systems of questions. However, the most important property of the question series is its organization, or ontological structure (Chandrasekaran, Josephson, & Benjamins, 1999). All questions are relevant when considering the final outcome of the design process: They must make sense with the design context, and they are unified together into a whole. Therefore, the connectedness of the design-relevant questions is vital: Developing ontologies of questions and answers allows us thus to consider the organization of design processes around an ontology of product-relevant questions.

When considering any human technology interaction plan, a number of task-necessary questions must be posed and resolved. The design of a house requires a roof—and a floor—otherwise it would be unusable for its inhabitants. Yet, these kinds of questions are mostly irrelevant when designing a banking system. This means that all products have their own system- and domain-specific interaction design problems. In developing human–technology interaction (HTI) innovation management as thinking, a system of the right questions must be considered so that an ontology is created to support the HTI-design thinking.

The logic of questions and answers is a core difference between people as innovators as compared to computing machines. People can ask relevant questions. To assure that the questions remain relevant to the design process, it is essential that the tacit ontological structures of this important field of innovating are explicated clearly.

In this final issue of our Volume 7, we have four papers contributing to their respective areas of HCI. The first paper, by **Harr, Wiberg and Whittaker**, explores the nature of interaction in professional social networks. Specifically, this paper takes foraging theory as a framework to identify how social factors impact decision making and collaboration by professionals in distributed work environments. They conclude that "survival of the social" underscores how the social component is foundational in executing an efficient and long-term professional network.

Next, **Clemmensen** uses grounded theory to extend thinking on human work interaction design (HWID) theory. By analyzing a diversity of data sources gathered from a working group designing an on-line folder structure, Clemmenson finds asymmetrical relations between work analysis and the design artifacts, as well as between the design artifacts an interaction design. As a result, he suggests modifications to the general HWID framework and approaches to artifact design.

The third contribution to our issue is from **Leung**, who investigated the effects of ICT connectedness, flexibility and permeability in the borders between work and home, and negative spillovers between those two domains on the potential for workers' burnout and their job and family satisfaction. His data from workers in Hong Kong suggest that the supposition that ICT connectedness negatively impacts workers' perceptions on their jobs and family lives is not as reliable a predictor of burnout and dissatisfaction as is the workers' personal control over what crosses the boundaries between their work and home environments.

The final paper comes from **Marchitto and Cañas**, who apply a methodology to assist in innovative thinking for improved user experience in product design. They focus on the continuity of technologies (multiple devices can be used to conduct a single activity). These researchers envision how such methodologies can assist in new product conceptualization or current product extension for investigating the phenomenon of continuity.

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