What Cognitive Science Has to Offer for Research on Appropriation and End-User Development

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ABSTRACT
To know how to design requires that we know how designs are used in practice. This paper investigates how this requirement can be addressed to account for cases in which users may also adapt, customize and modify its functionalities, and invent new uses for existing features, in other words, *appropriate* the system. Of particular interest is the question what cognitive science can contribute to understanding appropriation, this way complementing the existing research that has approached it as a social phenomenon. To this end, the paper identifies ways to study appropriation as a cycle of perception and action, as construction of new mental models, as learning of new material and digital properties, and as a creative process in which a user invents novel uses for technology.

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Appropriation, cognitive science.

ACM Classification Keywords
H5.m. Information interfaces and presentation (e.g., HCI): User interfaces – Theory and methods; D.2.2 Design tools and techniques: User interfaces.

INTRODUCTION
Development of design towards a scientific practice requires studies on how its principles are put to use, that is, how different designs are actually used by their users. This is because such studies allow validation of design theories and therefore a comparison between different approaches. An approach that poses special requirements for such validation is the idea of turning users into designers by enabling them to customize, modify and develop their tools. The particularity of this approach is visible in the different propositions of how users can be turned into designers. Two examples of such propositions are Participatory Design (PD) and End-User Development (EUD). PD advocates the idea of activating users into design activities together with designers, so as to give users more voice in the design process and to achieve a more appropriate design [6].

In research on EUD and tailorable systems, the attempt is to develop tools that empower every user on her own to adapt the system to be suitable for her particular user needs. In this case, users can – if they wish – be designers who are able to configure the software without the presence of designers. Different approaches are programming by example [9] and tailoring through customization, integration with scripts, and extensions with new functionalities [10,13,21]. Based on these efforts, Fischer et al. are developing a meta-design framework to bring together different tools to integrate different ways to promote "designing of a design process" [4].

However, adapting software through involvement in design and through e.g. tailoring are not the only ways how users find ways to make computer programs more usable and suitable for the task at hand. They are forms of *adaptation through modification*, but they do not cover the adaptations that take place when tools are used for new purposes without being changed. As an example, it is common that people use their email inboxes to store data and not only to store communication. File attachments are kept in the inbox without saving them to the computer's file system, and are and retrieved from there when needed. This adaptation does not change the email program as such but it nevertheless changes the way how it is used.

Adaptation in this broad is sense is called *appropriation* and it can be defined as follows:

> Appropriation is the way in which technologies are adopted, adapted and incorporated into working practice. This might involve customisation in the traditional sense (that is, the explicit reconfiguration of the technology in order to suit local needs), but it might also simply involve making use of the technology for purposes beyond those for which it was originally designed, or to serve new ends. [2]

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Appropriation is therefore a concept that covers all the adaptation activities that user carry out in use time. It is an important concept both for EUD and the development of science of design, because appropriation is the activity that EUD should foster, and in turn, because EUD is an essential part in the attempt to develop a science of design.

Therefore, this paper investigates how appropriation can be studied and what is the value that the studies could bring to EUD and science of design. To achieve a science of design, it is required that its theories of design are validated in real practice, i.e., in user studies. To do this, we need to know the methods and be aware of the theories in other disciplines that also may study how systems are appropriated (and therefore also tailored and customized).

In particular, this paper investigates the value of research in cognitive science for understanding appropriation.

THE OPPORTUNITY OF COGNITIVE SCIENCE

Appropriation has already been a subject of study in many studies with an interpretive approach. These include sociological research on media technologies at home [19], ethnomethodologically oriented mobile messaging research [8,18] and studies in organizational settings [1,15], to name a few.

Some of these studies have proposed different qualifiers to appropriable technologies, using adjectives like equivocality [7], configurationality [20] and user-configurability [10]. Other studies have identified social factors that facilitate appropriation, related e.g. to manager-worker interaction [15] and roles of certain workers in supporting the appropriation in the whole work community [10].

Research this far has thus reached a qualitative consensus on the importance of e.g. flexibility (to recap the idea expressed in the many adjectives listed). There is also some information about the relationships between appropriation and the social organization and interaction in the workplace.

While more research is definitively needed also on these fronts, there is an even bigger gap in studying the same processes on the level of an individual. For instance, there are no studies on how users *perceive* opportunities for action in technology, how the experiences from using technology structure users' *interpretations* that are the starting point for further interpretations, are there differences in individual appropriation styles as there are differences in cognitive styles [3], and so forth.

By recognizing the missing information, it can be acknowledged that understanding appropriation needs also other than social explanations. Naturally, this does not mean that studying social organization and appropriation should be de-emphasized. A cognitive approach is rather just another way to look at a phenomenon in which individual and social forces are reciprocally closely intertwined.

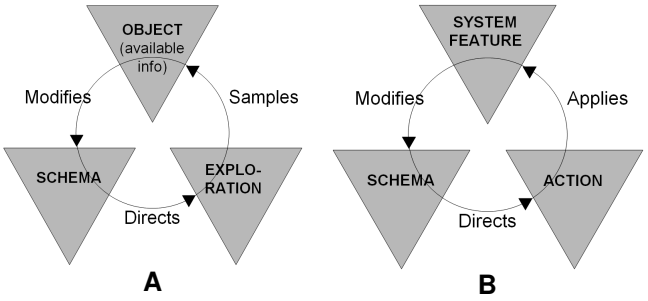

Figure 1. The perceptual cycle by Neisser (A), and an adaptation for the purposes of describing appropriation (B).

TOPICS FOR COGNITIVE APPROPRIATION RESEARCH

This chapter contains a brief review of cognitive phenomena that are worth of systematic research but which so far have not been much addressed. For the programme to build a science of design, understanding these phenomena are important when building understanding of how users will put the features for improved customization into use.

Perception and Action

The cycle of perception and action was already mentioned above, but can be rephrased here. The task is to understand the perceptual process that makes the user aware that a certain technology at hand is suitable for carrying out some action. In turn, when a user puts the perception into action and does something with the technology, she receives feedback from the success of her action, which restructures her interpretation of appropriateness of using the technology in such situations. The perception and action thus form a cycle that is close to Neisser's schema theory (see Figure 1) [14].

Understanding the perceptual process helps to understand how users attend to system features when carrying out their activities.

Mental Models

Since early 1990's, mental models have been influential in the studies how users understand how technology works and how the user interface reflects the inner workings of the system [17,16]. The studies have charted the differences between users' own interpretive models of how the system works and he way how the system actually works. The purpose for which the system is used has been understood as an unambiguous factor. However, the concept of mental models can also be applied to the analysis of users' conceptions of the system's purpose of use.

Learning

Appropriation is a form of learning, because it changes how a user conceptualizes the material and digital properties of a system. Although most of the learning research has been related to educational settings and younger population, there are approaches for studying non-instructed learning among adults: informal and incidental learning [11], transformative learning [12] and self-directed learning [5].

Appropriation as an active constructive process can share similarities with other phenomena of learning. What the science of design can learn from this is how customizing and tailoring change the user's interpretation of the software she is working with.

Creativity and Insight

Psychological research of creativity, creative processes and insight can tell us what factors contribute to inventing the new uses for the system, e.g. by tailoring the system's functionalities for new tasks. Some designs provide more opportunities for such creative adaptations than others, and it would be useful to know what designable factors contribute to it.

DISCUSSION

This paper has charted some of the promising fields of research that cognitive science can contribute to the study of appropriation, which in turn increases understanding of customization and tailoring practices of users. As has been noticed, there are not many existing studies in cognitive science that would be directly applicable for appropriation, but there are many opportunities for such a research. Therefore, this research would not only help in advancing tailoring and EUD research but also cognitive science itself. For tailoring and EUD research, the main contribution would be the complementation of existing socially-oriented findings with cognitive and individual factors. This would provide a more holistic picture of appropriation as a phenomenon, because both individual and social factors are playing a role in the process.

There is also a distinctive role for this research within EUD. Developing technological solutions for users to re-design their tools on their own demands complementary studies on how users actually carry out this design – what are the ways and situations in which the tools are modified, and under what constraints. Understanding use is therefore an important counterpart to understanding how to "design the design-in-use". Appropriation is an important concept in understanding the kind of use that is of interest to EUD research, because it addresses the adaptations holistically: both as modifications that user makes to the software and changes in the software's use that do not require modifications to its structure. This paper has proposed new lines of research to advance studies of this important phenomenon.

PERSONAL RESEARCH BACKGROUND

I am a human-computer interaction (HCI) researcher at the Helsinki Institute for Information Technology and a PhD student of cognitive science at the University of Helsinki. Appropriation is the topic of my doctoral studies, and to learn more about it, I have organized field studies on mobile group communication prototypes in real-life settings, mixing different observation, interviewing and data analysis methods to understand how communication patterns emerge when users engage in social interaction by using the prototypes. My approach on understanding appropriation is multifaceted, and I feel equally attracted to approach it from social sciences and cognitive science points of view.

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