Preparing Students for (Inter-)Action with Activity Theory

Susanne Bødker* and Clemens Nylandsted Klokmose

Department of Computer Science, Aarhus University, Aarhus, Denmark

In this paper we explore recent developments in activity theoretical HCI with the purpose of preparing designers for action. The paper discusses two projects where students engaged in iterative design applying fundamental principles from Activity Theory. They had been introduced to these principles through the Human-Artifact Model and an iterative framework, where analysis of existing practice, design of the future artifact, hands-on prototyping and consolidation of use are important elements. In other words, they were given activity theoretical tools rather than being taught Activity Theory. Through these tools, we suggest, designers are equipped to act skeptically and systematically, supported by theory. Obviously, a design process with students cannot in every respect be compared to a real design process, yet this paper will discuss whether, through the model and framework, designers may become better prepared to act in design with theory, and with Activity Theory in particular.

Keywords **–** Iterative Design, Activity Theory, Design Tools.

Relevance to Design Practice **–** The research presented in this paper demonstrates how principles of Activity Theory can be taught to students through a simple conceptual tool rather than an introduction to the whole framework – yet still equipping them in design to act skeptically and systematically while supported by theory.

Citation: Bødker, S., & Klokmose, C. N. (2012). Preparing students for (inter)-action with activity theory. *International Journal of Design,6*(3), 99-111.

Introduction

Rogers (2004) points towards several discussions of if and how theory may contribute to design of new technologies. Based on her studies of how practitioners have adapted more recent theories, she points out that the practical impact currently lies mainly in singular concepts, such as affordances or personas. The processes and methods of interaction design seem like essential ways of moving beyond such singular concepts, even if this process of transferring theoretical concepts and insight of HCI research into HCI practice and interaction design often fails. In this spirit, cultural probes (Gaver, Boucher, Pennington, & Walker, 2004), participatory design strategies (Bødker, 1991; Ehn & Kyng, 1991), and prototyping approaches (Bødker, 1991; Lim, Stolterman, & Tenenberg, 2008; Mogensen, 1992), are all part of the toolbox proposed by researchers to address interaction design. Such tools may be seen as helping designers explore and characterize the design space (Jones, Floyd, & Twidale, 2008), or they dress up (Bødker & Christiansen, 1997) or prepare designers for action (Stolterman, 2008). Hanington (2010) points out that design needs to be systematic and skeptical. A solid and broad understanding of research helps designers be systematic and able to avoid bias and idiosyncrasy. However, Rogers is critical as to whether designers at large have such a solid understanding of research, and whether it is important for them to have one.

As part of preparing designers for action, Stolterman (2008) discusses the role of theoretical constructs in design. Stolterman's *designerly way* in general addresses how to frame and explore a design space through sketching, iteration and alternatives, while emphasizing how designers need to become prepared for action through a conceptual and methodological basis. In contrast to research, design is specific and intentional, and hence the complexity of design must be dealt with differently from the complexity of research. Accordingly, Stolterman argues that designers are inclined to appreciate the following from theory: Precise and simple tools or techniques; frameworks that support reflection and decision-making; individual concepts that are intriguing and open for interpretation and reflection; and high-level theoretical and/or philosophical ideas and approaches that *expand* design thinking but *do not prescribe* design action. Similarly Bødker and Christiansen (1997) point out how theoretical ideas equip designers for action:

> Designers need guidelines and plans, not for total prediction, but to guide the process and come to grips with the shaping of the future artifact. They need help to assess current use, as well as to anticipate and transcend use in a planned and focused way. (p. 221)

This is an elaboration on what we mean by *systematic* in this paper. Designers need to represent and hypothesize about artifacts and their use, and in this endeavor they need to be supported by thinking tools (Bertelsen, 2000).

Underlying our interest for the application of theory to design is a concern for how Activity Theory may inform design. Rogers (2004) as well as Clemmensen and Leisner (2002) characterize Activity Theory as making contributions to

Received Mar. 3, 2012; **Accepted** Oct. 7, 2012; **Published** Dec. 31, 2012.

***Corresponding Author:** bodker@cs.au.dk

interaction design, mainly through its conceptual scaffolding and an analytical framework. Rogers (2004) also refers to the criticism made of activity theoretical HCI of being overly complex and complicated. In this discussion it seems largely ignored that Activity Theory has strongly influenced how and why we think and undertake prototyping in interaction design. However, even within this framing, this paper aims to provide more systematic ways in which Activity Theory may be made useful in design.

Accordingly, this paper focuses on how Activity Theory can help the *designerly* way of working with complex and open design spaces. In particular, this paper explores the potential ways of understanding the relationships between prototypes with respect to what aspects of human activity get explored or addressed, and what elements of the design space get opened or closed. We emphasize the use of Activity Theory to address human handling of artifacts in addition to the high-level/organizational understanding of human activity most often seen when Activity Theory is applied in design.

In our everyday lives as university teachers, we prepare designers for action when we educate interaction design students. The examples used in this paper come from design in this particular educational setting. As a continuation of a long tradition of teaching such design, we do not just teach methods theoretically. Rather, the students do hands-on projects as a natural part of preparation for action in their future lives as interaction designers.

In what follows, we present the activity theoretical basis and tools before moving on to a presentation and discussion of student design cases. First, we introduce the leveled and dialectical thinking leading to the Human-Artifact Model, and we introduce the principles pertaining to the iterative framework. The paper ends with a discussion of the approach as such: Have we managed to deliver tools to help designers work skeptically, systematically, and informed by theory?

Susanne Bødker is professor of Human-Computer Interaction at the Department of Computer Science, Aarhus University where she leads the Computer-Mediated Activity group. She is known for her theoretical and empirical work on second-wave Human-Computer Interaction, computer mediated activity, and participatory design. Her book, *Through the Interface* helped put the socio-cultural research tradition of Activity Theory on the agenda for Human-Computer Interaction research. She has been teaching participatory design interaction design classes for computer science and IT students since the mid-1980s. Susanne helped initiate the Participatory Design and Computer Supported Cooperative Work conference series and is currently, for the second year running, paper co-chair of ACMs Computer-Human Interaction conference. She co-manages Aarhus University's new interdisciplinary center for Participatory IT research.

Clemens Nylandsted Klokmose is a postdoc in the Computer-Mediated Activity group at Department of Computer Science, Aarhus University and is currently funded by the Carlsberg Foundation. Clemens received his PhD from Aarhus University in 2009 and has since worked as a postdoc at Université Paris-Sud XI followed by a year as a system engineer and user-interface developer in the industry at Cetrea A/S. Clemens has a strong interest in how we conceptualize interaction with computers, and how we push interaction with computers to be more aligned with the way we perceive and interact in and with the physical world.

Activity Theory and the Human-Artifact Model

In this paper we draw on a recent elaboration of activity theoretical HCI, in particular the Human-Artifact Model. This model is intended for analyses of current and future artifacts, and provides an emphasis on understanding interaction with technology as multi-layered and dialectical, and the details can be found in Bødker and Klokmose (2011).

Dialectics is the method of reasoning that aims to understand things concretely in all their movement (change and interconnection), with their opposite and contradictory sides in unity (Bødker & Klokmose, 2011). Dialectical methods offer new opportunities for understanding mutually exclusive pairs such as individual-group, agency-structure, material-ideal and whole-part. Whereas dialectical thinking in general has been known and applied in systems design (Bjerknes, 1992; Bødker 1999; Mathiassen, 1981) and organizational analysis (Engeström, 2005; Kerosuo & Engeström, 2003), this particular activity theoretical framework helps address the specific relationships between the human being and the artifact(s) in design (see also Kaptelinin & Bannon, 2012). Using the Human-Artifact Model helps capture, for example, the tensions between the use situation and its existing artifacts, and the new artifact under design. These tensions are both a matter of the relationship between the whole and the parts, of the material and the ideal (not yet built).

Activity Theory addresses collaborative practice as well as individual skills, knowledge and judgment. Human conduct is anchored in shared practice, and the model focuses on the appropriateness of certain tools for certain practices. Activity theoretical HCI studies how the introduction of new artifacts changes practice, and how practice may change the use of these artifacts. According to Activity Theory, human activity is mediated by artifacts through which the user may act on objects of interest or with other subjects. The mediator stands between users and their object of interest, and in this role it helps users act on the object of interest in ways they could not do without the mediator, as described in Bødker and Klokmose (2011).

Human beings use multiple artifacts in multiple, overlapping use activities, called artifact ecologies (Bødker & Klokmose, 2011; Kaptelinin & Bannon, 2012). There is no one-to-one relationship between human activity and artifacts. Artifacts are crystallizations of activity both as externalizations of operations carried out with earlier artifacts, and as representations of modes of acting in the given activity. In this manner, the design space extends into the past as well as the future, across ecologies of interrelated artifacts.

The analytical scheme combines analyses of action possibilities and mediators (Bødker & Klokmose, 2011) on three levels reflecting the activity hierarchy: activity, action and operation. These levels provide three sets of analytical perspectives, each of which focuses on an important aspect of human activity: Motivation (by asking why?), goal-orientation (by asking what?), and operation (by asking how?).

The Human-Artifact Model (Figure 1) accordingly focuses on the artifacts that human beings use, and the practices that these reflect. The model is intended to highlight tensions between intended action possibilities in the artifacts and the action possibilities expected by the user; the assumptions of use embedded in the artifact on the one hand, and the experiences or the orientation of the user on the other.

Overall, we offer a model for reasoning about the dialectics between the whole of the use of an artifact in relation to activity, and its parts. For specifics of such analysis, see Bødker and Klokmose (2011). This work is an example of the many attempts to transform activity theory into workable models for design. Korpela (1994) has developed a simple model that helps designers structure their analysis of stakeholders, artifacts, division of work, etc., based on Engeström's triangular model of activity systems (1987). The HCI field has previously been introduced to specific concepts such as mediation (Bødker, 1991; Bertelsen & Bødker, 2003), and checklists to be applied in analysis of interaction (Kaptelinin & Nardi, 2006; Mwansa & Bertelsen, 2003). With this current work on the Human-Artifact Model, we are focusing on a simple model that focuses on interactive artifacts on the background of other artifacts, helping designers bridge between current and past use situations and the future.

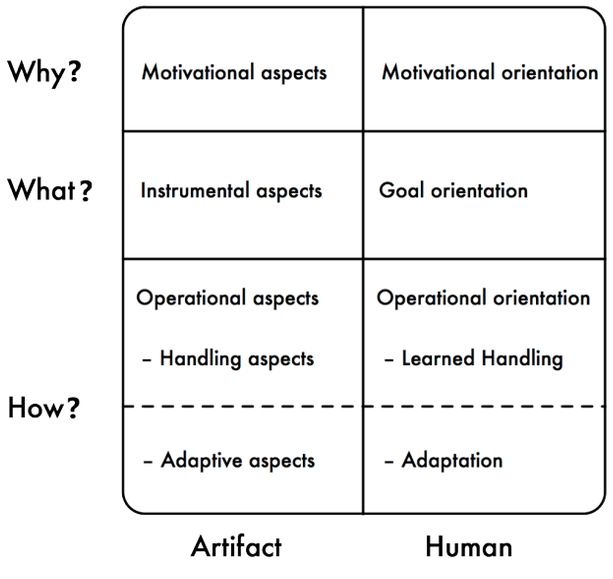

Figure 1. The Human-Artifact Model. The human half comprises the learned routines and action possibilities of the user, the artifact half the assumptions and constraints of use embedded in the artifact. The three levels reflecting the activity hierarchy: Activity, action and operation, with the bottom level reflecting the separation of learned handling and of adaption to physical conditions (classical affordances). The questions of Why? What? and How? help zoom in on each of these analytical levels (see Bødker & Klokmose, 2011).

Conceptualizing the Design Activity — An Iterative Framework

With the introduction of his developmental work research cycle, Engeström (1987) brought out a number of elements of Activity Theory to establish a focus on change in general; change as in contrast to stability, or even a standstill. He pointed out that such change processes are not fully predictable; when a new artifact is designed, its use cannot be predicted. Neither is its use static and unchangeable. Hence, *iteration* is needed to establish new human practices with new artifacts. He further introduced the need to address the relationships between the future design, and past practices and artifacts as part of these change processes. He introduced the idea of a *springboard* to change the conception of the new future artifact and its use. These thoughts fed nicely into ongoing research in HCI and software development of *prototyping* and iteration, and several authors suggested to apply Engeström's ideas (1987) as a basis for design and design research (see e.g., Bertelsen, 2000; Bødker & Christiansen, 1997; Kuutti, 1999). In the following, we address the role of prototyping, iteration, relating artifacts and practice in the future and past, as well as springboarding in design.

Prototyping

Prototyping has been a well-established practice of software design since the 1980s where Floyd (1984) distinguished between exploratory, incremental and versioning prototyping processes. Greenbaum & Kyng (1991) discussed the need for prototyping and hands-on experience in participatory/user centered design, and Bødker (1991) developed a motivation for hands-on experience, hence prototyping with users based on Activity Theory. Accordingly, prototyping is a means for users to experience the future hands-on throughout the process of design.

More recently, Stolterman (2008) and Lim et al. (2008) presented sketching, alternatives, and iteration as important elements of the designerly way, i.e., of the design process as seen from the needs of the designers, in addition to the need of users. We accord with Lim et al. (2008), that prototyping can be seen as "framing and exploring a design space" by traversing the design space, providing prototypes that are "purposefully formed manifestations of design ideas," rather than as something that makes evaluation possible. Prototypes help designers sketch and filter design ideas.

Prototyping may be utilized to question current practice, what Mogensen (1992) calls provotyping. Mock-ups and simple prototypes are useful means of sketching visions and ideas (Ehn & Kyng, 1991). Video prototyping (Mackay, Ratzer, & Janecek, 2000) has been used for both idea generation and systematic exploration of ideas. Prototypes are incomplete portrayals of design ideas (Lim et al., 2008). How they filter and manifest these ideas, however, often seems ad-hoc. Our concern is how to make prototypes and prototyping less ad-hoc, hence providing a more systematic and skeptical approach to prototyping (Hannington, 2010) to frame and explore the design space better. In other words, we aim to help designers explore the design space openly, skeptically and systematically rather than just building the easiest or most immediate prototypes.

To summarize, the role of prototypes are to manifest and hold on to sketches and ideas, as well as to provide hands-on experiences for users. In framing and exploring a design space, the prototypes may be exploratory, emphasizing particular interaction elements and alternatives. Also they may be incremental, adding to the function and interaction of a previous prototype, or they may be versions that are ready to be applied in real use. Our project is to make prototyping less ad-hoc, and provide a more systematic and skeptical frame for exploring the design space.

Iteration

Iterative design goes hand in hand with prototyping, even though there can be prototyping without iteration, and vice versa. In recent years iterative design of IT has been strongly connected to agile methods and the like, which were in turn strongly inspired by the Scandinavian participatory design tradition (Beyer, 2010). Many of these approaches emphasize incremental design, a type of iteration that mainly adds to existing prototypes, and leaves little room for understanding current practices, as discussed by Beyer.

Iterative approaches typically start with a focus on existing work/use practices, and end with a more or less final artifact that is deployed and studied in some kind of trial use. One such model is described by Bødker and Petersen (2000) (Figure 2). Its initial step is analyses of existing activity. The specific focus is to understand the current practices, as well as past experiences, and to address the immediate learning potential that may be utilized in adapting a future artifact. This model is inspired by Engeström's (1987) developmental work research cycle, which also provides the motivation for iteration: Future use can never be fully predicted, and it is the tension between what is actually designed as opposed to what was expected that drives the need for new iterations.

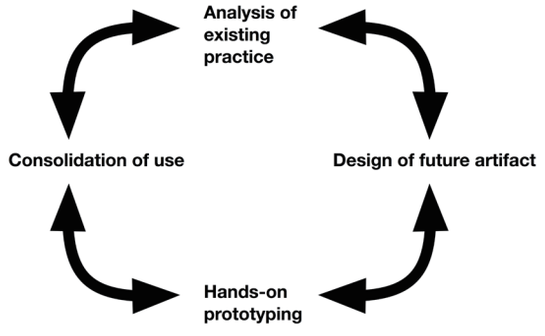

Figure 2. The process framework, as outlined in Bødker and Petersen (2000). The iterative design process consists of four principal activities (each with their purpose) that may be iterated in smaller and larger cycles. The first is concerning the analysis and understanding of the existing use practice, while the second is the design of the future technological artifact. The third activity is concerned with hands-on prototyping in use-like situations, and the fourth is concerned with the larger consolidation of the future artifact in the use activity, including, e.g., education of users.

As the iterative process progresses, the primary focus is moved to conceptualizing future artifacts and setting the stage for exploring such new artifacts. This step addresses the future artifact as a vision, e.g., through use of metaphors. It establishes a reference to the current activities of the users, and focuses on establishing a microcosm where such artifacts may be tried out. This microcosm is a delimited activity and community of practice, where intermediate artifacts can be tried out through prototyping and mock-ups in more or less controlled environments, and where a future set of practices may be consolidated (Bødker & Christiansen, 1997) and the new artifact appropriated, as discussed by Kaptelinin and Bannon (2012).

These steps, the *four principal design activities*, are part of smaller and larger iterative cycles (Bødker & Petersen, 2000). What drives the iteration is the difference between the future artifact as it was imagined and conceptualized, and the actual artifact as it functions in consolidated use (Engeström, 1987). Bødker and Christiansen (1997) and Bødker and Petersen (2000) propose to deploy checklists to support a systematic and skeptic approach to design, yet as discovered in our previous experience of preparing students for design action, such checklists need to be supplemented with a stronger support to carry insights and decisions across analysis and design. Exactly how, will be explored below.

The role of iteration in the design processes is to emphasize the smaller and larger cycles of the four principal design activities. Iteration supports the prototyping process and points to the relationships between exploratory, incremental and versioning prototypes. In order to make the iterative design process more systematic, we use the Human-Artifact Model to summarize each step in a cycle, and point to relationships between iterations, including analyzing the differences between the imagined future artifact and the actual artifact built and consolidated in use.

Relating Artifacts and Practice in the Future

One of the fundamental principles of Activity Theory is that artifacts in general crystallize traces of past routines (Bertelsen & Bødker, 2003; Bødker, 1991; Kaptelinin, 1995). Engeström (1987) activates this understanding of artifacts in his developmental cycle where he introduces analyses of artifact history as an important element. By identifying the origins of past routines it is in some instances possible to identify alternative ways of carrying out actions. Fundamentally, the past, both in terms of the artifacts used and the human practices developed, is part of shaping future possibilities. At the same time, such historical traces may be used actively in design. The relationships between these elements are profoundly dialectical, rather than being chains of causalities.

Bødker and Andersen (2005) analyze how several historical generations of essentially the same technological mediator are used interchangeably. Bødker and Klokmose (2011) propose how the Human-Artifact Model in general may be used to capture the past. However, very little has been done to systematically map out the design space in terms of artifacts and past practices, which we will further elaborate on below.

Springboarding

In Activity Theory, springboards are artifacts that point towards the future, without being direct versions of the future product or use situation (Bødker & Christiansen, 1997; Engeström, 1987). Springboards are design artifacts that get introduced into the design process to help designers think about future possibilities. Many of the instruments used in design may be seen as sketches (Bødker & Christiansen, 1997; Stolterman, 2008) and hence springboards, rather than as direct steps towards the future computer artifact. Scenarios may be used in design as springboards that help bring forward new artifact and use practice (Bødker & Christiansen, 1997). When we talk about springboarding, we focus on the process of designing by using springboards to explore and facilitate conception and instantiation of the new.

Alternative ideas and solutions play important roles in springboarding. To get new ideas, and to make these ideas point ahead as springboards, it is not a matter of identifying one best solution that will eventually serve as a version of the future product. Accordingly, we propose to work with alternatives as springboarding, and scrutinizing the alternatives in a structured way.

Summary

In the four principal activities of design, we have emphasized how we need better artifacts to make prototypes and prototyping less ad-hoc; a stronger support for carrying insights and decisions across analysis and design for mapping out the design space in terms of artifacts and past practices; and a better structured support to explore the design space in terms of design ideas and alternatives. In what follows, we look in greater detail at our experiences of using Activity Theory to address the space between various portrayals of ideas, insights, decisions, traces of the past, future alternatives and springboards, so as to give direction(s) to the exploration of the design space.

In continuation of the general understanding of artifacts fundamental to Activity Theory, the Human-Artifact Model as such can be understood as a vehicle for applying Activity Theory, and as a mediator of design. Hence, it stands between the designers and their materials and objects, mediating their motivation, goals and operations.

This paper explores the potentials for ways of understanding the relationships between prototypes, with respect to what aspects of human activity get explored or addressed, and what elements of the design space are opened or closed. While introducing such artifacts into the design processes of experienced and skilled designers is different from introducing it to novice designers, the design space that we have as academic researchers is naturally that of student design projects. Thus, we will risk the bold claim that if an artifact like the Human-Artifact Model cannot be introduced to students, it will not stand much of a chance with practitioners. Obviously the question is, as discussed by Rogers (2004), how much it takes to dress up designers and design students with theoretical foundation. We return to this issue in the following where we present the student design projects.

The Student Design Projects

The activity theoretical framework and tools have been used in student design projects for four consecutive years with groups of Aarhus University graduate HCI students doing user centered design in a variety of domains. The overview of these projects can be found in Figure 3. The main users in these projects were the general public as part of their everyday lives, even though the last case involved therapists as well as anxiety patients. The project lasted 7-8 weeks and the overall structure was the same: HCI students worked in (sometimes flexible) groups on a specific theme in an iterative design process, where they explored their general knowledge of HCI while applying specific methods such as prototyping, scenarios, personas and the Human-Artifact Model. This model was introduced in two lectures at the beginning of the project, and related to the students' existing understanding of, e.g., prototyping and scenarios.

We have chosen to illustrate the processes and experiences with examples from two of the cases, as each case needs a somewhat extensive introduction. The cases used as examples are 2 and 3. Even though every case is unique, the experiences that we present cut across all cases.

Case	*Theme*	*No. of students*	*Methods*
1	Nature tours	8	Field trips Personas based on field trips Scenarios Video prototyping Mobile prototype
2	Municipal service	12	Prefabricated personas and scenarios from research project Scenarios, mood boards Video prototyping, alternatives
3	Shared nature experience	7	Field trips Personas based on field trips Scenarios Video prototyping, alternatives
4	Anxiety treatment	14	Personas and scenarios Storyboards and sketches

Figure 3. Overview of cases.

Case 2. The Municipal Service

Public authorities often think of eServices as replacements for the ways people would show up in a public office to receive maybe a new passport or a driver's license. These eServices are perceived of as replacing face-to-face service, with people handling everything from home. Many such eServices are not used, however. Some eServices may get replaced or supplemented with machines in municipal offices or shopping malls, such as service- or passport machines. In the city of Aarhus, access to passport and other such citizens' services were provided at several libraries in town, and at a main office at the City Hall, though not (yet) electronically. A major question was if the face-to-face service could be supplemented or replaced by service machines.

The students carried out design in this government setting, focusing on citizens' services. These included many municipal services, like registering when moving, renewing a driver's license or passport, changing taxes, etc. The background of these student cases was the eGov+ project and its studies of the citizen services area carried out (see e.g. Bødker, Christiansen, Nyvang, & Zander, 2012). Based on records of interviews and observations with citizens and municipal workers, the course teachers had developed a set of scenarios and personas that the students were asked to use as starting points when carrying out an iterative design process.

The students used these personas and scenarios together with the Human-Artifact Model to structure their insights regarding the users and use situations in mood boards (Figure 4). The examples that we use in the rest of this paper revolve around some kind of passport or service machine for the municipal office. The next section describes the details of how the activity theoretical tools were applied. The process as such went from further empirical inquiry captured in personas via alternative prototypes analyzed through the levels of activity, to video prototypes that were used to capture these solutions and show them to users (Figure 5). The concept underlying this prototype was that of a *Friend-in-waiting*.

Case 3. Shared Experience of Nature

In Denmark, nature preservation is becoming increasingly popular, and formalized national parks have been established. At the same time, people in general, and young people in particular spend more and more time indoors, and the national park boards and nature guides are interested in new ways to attract more people to their areas. Whereas currently much of the technology being deployed in this type of setting primarily allows nature guides new ways of informing visitors, there has been very limited focus on how visitors may share experiences in networks of friends, families or interest groups.

Such experiences were the focus of case 3. The idea was to provide service for people whether they be seeking inspiration for/planning outings; when on tour, or when sharing memories after a trip. A previous design case (case 1) (see Bohøj & Bødker, 2008) had compiled a first round of insight into the area, and this insight was used as basis for further analysis and design. However, the research was far less systematic and deep than that of Case 2.

The students worked in four groups to explore matters further, and to target alternative approaches to sharing and guiding. One group went on tour into a national park and came back with material that, once analyzed, led to a focus on the tension between being guided and being surprised. Generally visitors liked to be guided in what they do and where they go, and they had different interests and preferences for such tour plans. At the same time, the whole idea of going out into nature is for spontaneity and for surprises to happen, such as when a person out jogging sees a rare bird, a family on picnic gets to witness a group of foxes play, or basically any kind of unexpected natural phenomenon. As we illustrate below, these tensions came out quite clearly (and surprisingly to the design students) when analyzing their data through the perspective of Activity Theory. As such, the particular design idea described here (Figure 6) is that of surprises (Korn, Kawash, & Andersen, 2010).

Figure 4. Mood board structured according to the Human-Artifact Model.

Figure 5. Video prototype of Friend-in-waiting being shown to users.

Figure 6. The surprise token toolbox.

Overview of Processes

Figure 7 presents an overview of two of the design cases with focus on the support of Activity Theory for the four principal design activities. We do not present the two processes in their totality; rather, we work with selected and particularly interesting elements of the process.

Activating Personas in Mood Boards

In Case 2, personas were used to summarize substantial research findings based on observations and interviews from the citizen services office. When drawing up the personas, we used the leveled structure of the Human-Artifact Model to address the motivation, goals and operational orientation of the personas, and their various technological background competencies.

The students were asked to create mood boards to capture these relationships based on five personas. Generally, mood boards are quite unstructured ways of capturing anything from look and feel to emotion in design and HCI (see Benyon, 2010). While the students were asked to use whatever pictures and materials they found useful, they were also asked to structure the mood board around the form of the Human-Artifact Model (see Figure 4). These mood boards helped the students capture background experiences at all levels, both when it came to the activities that the personas were involved in, and when it came to their technological/artifact background (Figure 8). The students being asked to address each level of the activity separately, and to think in terms of related artifacts and activities, helped them think beyond the passport machine towards other everyday activities from which ideas could be borrowed (e.g., net-banking or going to a café to meet friends), and towards other technological solutions of interest to people (net-banking again, smart-phones in general, and tablets to be picked up at the citizen services office).

Exploring Alternatives

In the move from understanding and analyzing current practices to designing the future, students in Case 2 were asked to explore future use scenarios structured according to the levels of Activity Theory. The idea was to juxtapose their design ideas with existing scenarios that had been reiterated based on the activation of the personas mentioned previously. Two of the alternative technologies considered in addition to the above-mentioned pick-up tablets were a cell-phone interface connected to a wall-mounted passport machine, and a large touch screen display with a virtual keyboard. Both are alternatives to the pick-up and use technology, and to the wall-mounted touch screens that the city was considering at the time. Highlights of such a summary can be found in Figure 9, which illustrate some of the potentials and problems of the two alternatives, while also illustrating the differences between findings on each level. This allowed a direct comparison of alternatives, allowing both a systematic assessment of alternatives (such as the cell-phone versus the touch screen), and providing the bases for springboarding in the students' design process.

	Domain	Design idea	Analysis of existing practice	Design of future artifact	Hands-on prototyping	Consolidation of use
Case 2	Citizen services	Passport machine	1. Research findings summarized as scenarios and personas, structured according to the levels of human activity. 2. Systematic analyses of technical possibilities, structured according to levels.	1. Comparison of alternatives, structured by the levels and sides of the Human-Artifact Model. 2. Demonstration to users	1. Video prototypes and prototypes, focusing on the detailed functioning of the artifact. 2. Revised personas and scenarios (structured according to the Human-Artifact Model) 3. Demonstration to users.	1. Questions for implementation, summarized in the Human-Artifact Model.
Case 3	Nature experience	Surprise token	1. Participant observation and in situ interviews.	1. Video prototype to explore the use possibilities according to activity theoretical levels. 2. Comparison of alternatives, structured by the levels and sides of the Human- Artifact Model. 3. Demonstration to users.	1. Prototypes addressing in particular the functioning and handling of the artifact, along with its entire role as surprise token. 2. Workshop with stakeholders.	1. Questions for implementation, summarized in the Human-Artifact Model.

Figure 7. Overview of key components in the four principal design activities of two design cases.

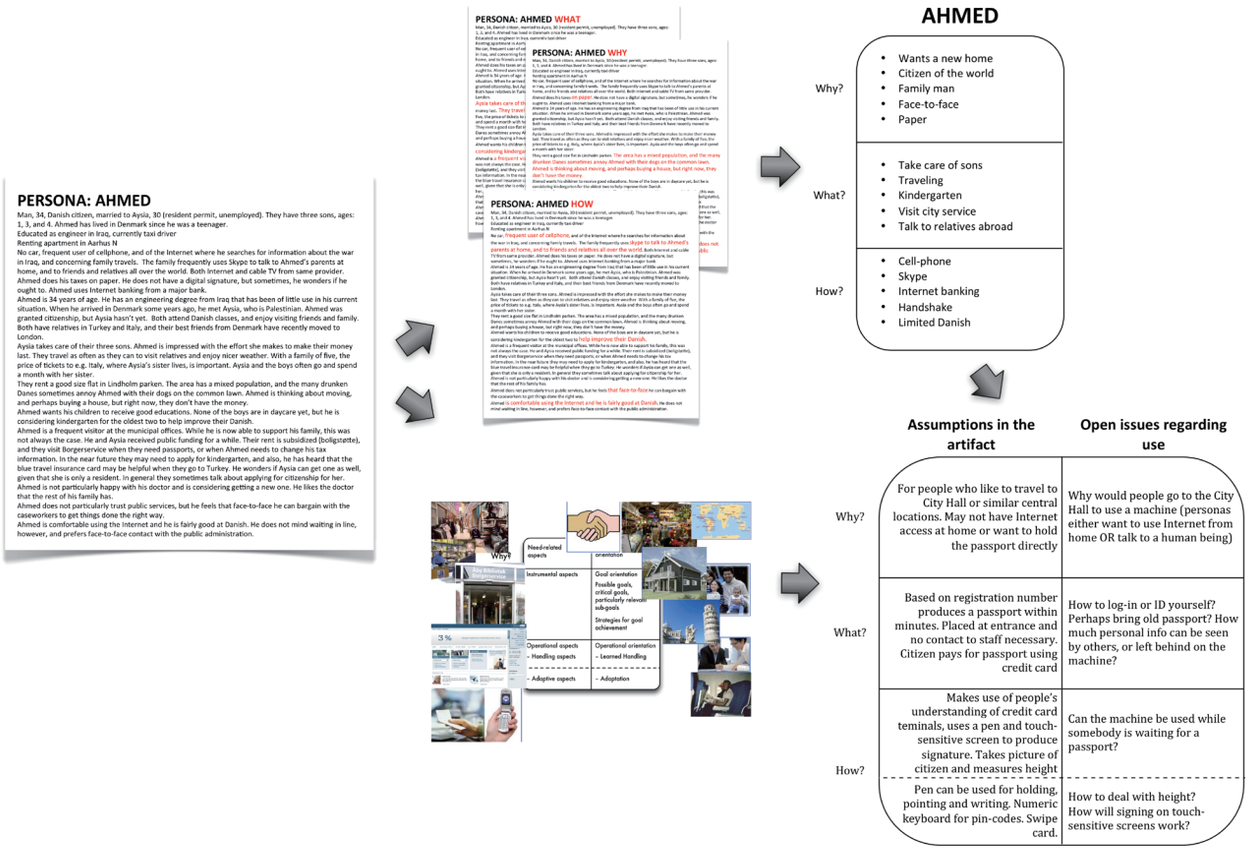

Figure 8. The process of structuring personas and mood boards using the Human-Artifact Model to relate potential artifact design to open issues regarding use.

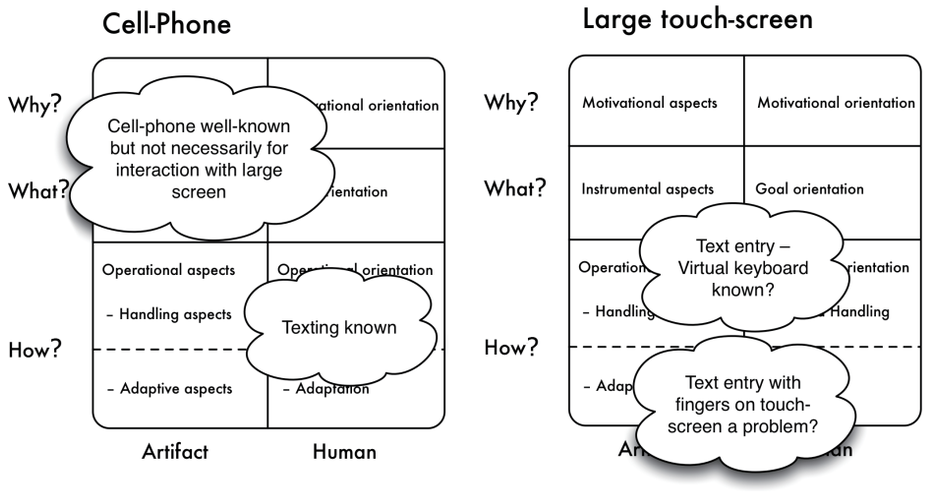

Figure 9. Summarizing issues regarding the cell-phone and touch screen passport machines. The touch screen solution had problems relating to the How? level regarding the use of the virtual keyboard. Despite being a known artifact to many, the cell-phone was seen as problematic because its use with a big screen seemed unclear and unknown to most (Why? and What? levels).

Reviewing Prototypes/Designs

Based on these elaborations, the students of Case 2 worked with prototyping through mock-ups, video, and software prototypes in order to iteratively approach final presentations to the municipality and its citizens. Along the way they were asked to do a review of their design, structured through the use of the Human-Artifact Model. The reviews were done in pairs of groups who went through what the prototype was targeting on the one hand, and the open issues, old as well as new, that were raised in the prototype on the other. Some of these issues were technical, while others were matters to be explored in hands-on workshops with citizens and/or caseworkers, all examples of elements to be explored in further iterative prototyping. This example is part

of a process that eventually led to a video prototype, making use of the above-mentioned tablet PCs that were to be picked up while waiting in the citizen services office. Reviewing this prototype answered some of these issues. There were also issues not addressed, and in addition, new issues opened up, such as the location of pick-up and return of the tablets.

Generalizing slightly, the scheme of Figure 10 provided a structure for documenting and reviewing prototypes as they were developed. Hence, reviews of prototypes and design ideas were supported through the Human-Artifact Model.

Expanding the Scope of the Design

In Case 3, one group of students targeted the intrinsic contradiction of planning for a trip into nature. Being on a trip into nature is about planning according to the interests of the participants, for example whether they like rare flowers or prefer a nice view for a picnic? Are they good walkers, or do they bring small children or elderly persons? At the same time, being on such a trip is about unpredictability, being surprised and getting unexpected inspiration. This tension could not be easily reconciled, and the group toyed with ideas about what kind of items people would normally bring on tours. Through this springboarding, the group came up with the quite simple idea that people could pick up, and even buy, an item such as a doll as a token of their interest, and that this would lead them to surprises related to this interest (see Figure 6).

The students made a systematic analysis of this idea with the token as mediator. They iterated through three steps (Figure 11). In this analysis it soon became clear that there is much more at stake than the simple mediation of a child picking up a doll as a starting point for interesting and surprising stories. Families and groups go together, and whatever tokens they bring, for better and worse, all contribute to their experience. Hence, their motivation is important for understanding this total picture (Figure 12 summarizes the mediated activity), as are the actions before and after the trip, which leads to a regard for the token as memorabilia.

Several of the challenges and problems pertaining to the token as mediator of experience in nature were identified within these fields (Figure 12). However, the group realized that the analysis led to additional challenges that pertained to tensions across the relationship between the artifact and the human sides, and across the four levels of the model (examples can be found in Figure 13). There is a real danger of surprises distracting families and groups from the calm of nature, and in addition it is not necessarily a good idea for a surprise token to give too direct feedback on location, since that would spoil the need for exploration and curiosity.

This analysis helped shed light on how complicated the design of the seemingly simple token is. It is very demanding for one artifact to not spoil a calm experience in nature and distract the user, yet be attractive and provide surprises at particular locations. Additionally, the analyses in this case pointed beyond the activity of a nature experience as such, and towards other activities in the artifact ecology. There is a tension between cheap pick-up and use tokens and attractive tokens that can serve as memorabilia from the trip. The production and economy of selling such items needed to be considered as part of the artifact ecology, as well as the actual outlets where the tokens were to be picked up. Ultimately, the students were left with a design project of new dimensions once they had realized these connections and implications.

In the particular case, the considerations outlined here led the students to realize that building and evaluating prototypes was not as straight-forward as they had thought, and that actually several issues needed to be explored before such prototyping could happen.

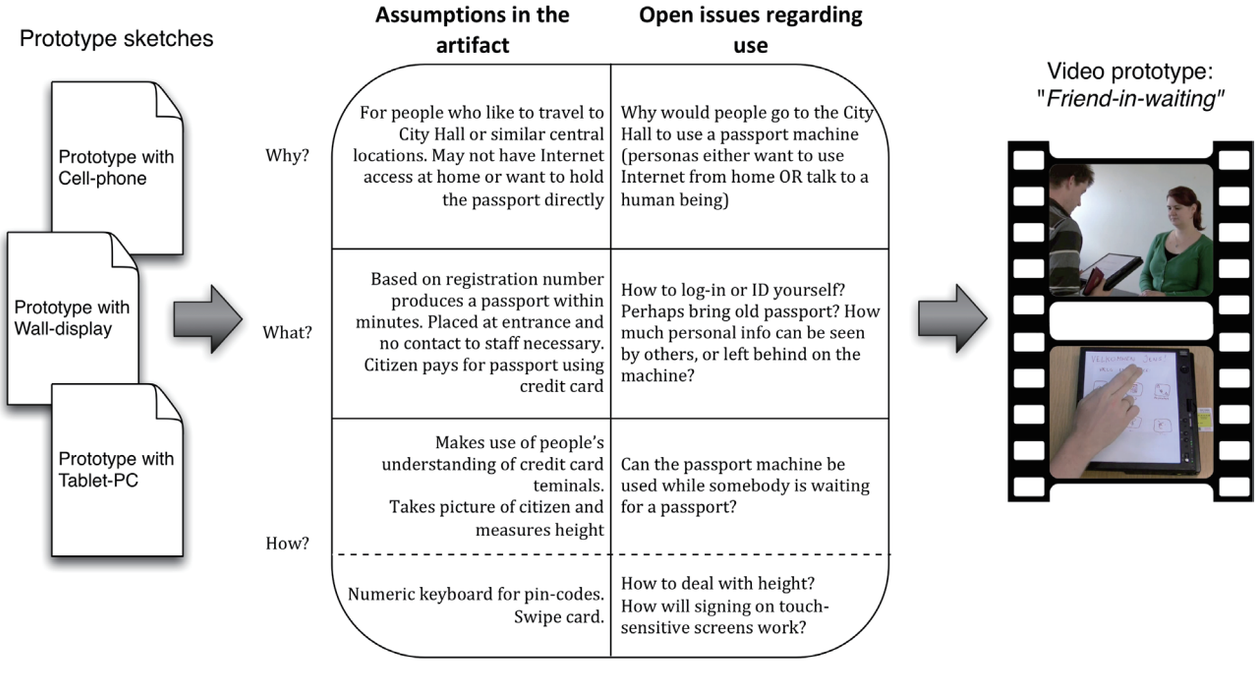

Figure 10. Summary of the review of passport machine between iterations of prototypes.

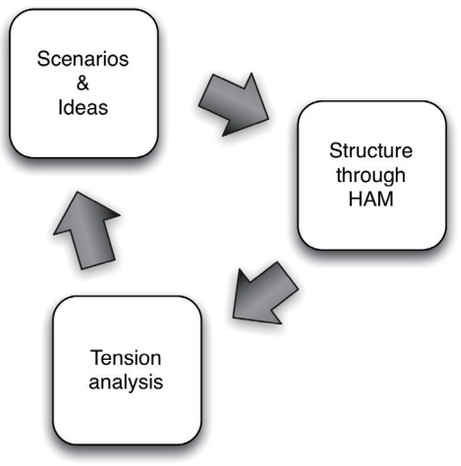

Figure 11. The three steps of iteration carried out by the students.

Key Findings for Preparing Design Students for Action

In the previous sections, we have exemplified the use of activity theoretical tools, in particular the Human-Artifact Model and iterative framework. In the following, we address some main issues of the students' work common to the four cases. These relate to the ways that students can be better equip ped to act systematically and skeptically in their design process. These experiences supplement the specific examples presented previously.

An Eye for Motivation in Analysis

In both of the cases dealt with in detail, it became evident that the level of motivation of users was important, at the same time it was easily ignored in the analyses. In both cases, the level of motivation, once unfolded, actually made the design more complicated, as in Case 3 where the tensions between the individual interests of the users were confronted with the social element of being on a group tour in nature. Nonetheless, the focus on motivation together with the other levels on more standard HCI analysis were quite essential to the design space and how it was kept open in the design process.

The Role of the Past in Deciding the Future

Similarly, the background experience of users with mobile technologies such as Internet banking and smart-phones was important for understanding the new possibilities of a mobile device. The concentration on users' past practices and artifacts helped the students focus, because questions were asked of users explicitly. They did not necessarily get direct answers for which previous competencies to build upon, but by identifying where experiences came from, and which groups of users they were ruling out, they made better informed design choices.

Visions, Springboarding and Tensions

In both Cases 2 and 3, the elaboration of the vision stood strong, though in different ways. In Case 2, an overall idea of a service machine to be placed in the office existed previous to the design process. By systematically working with alternatives at all levels of the Human-Artifact Model, it soon became clear to the students

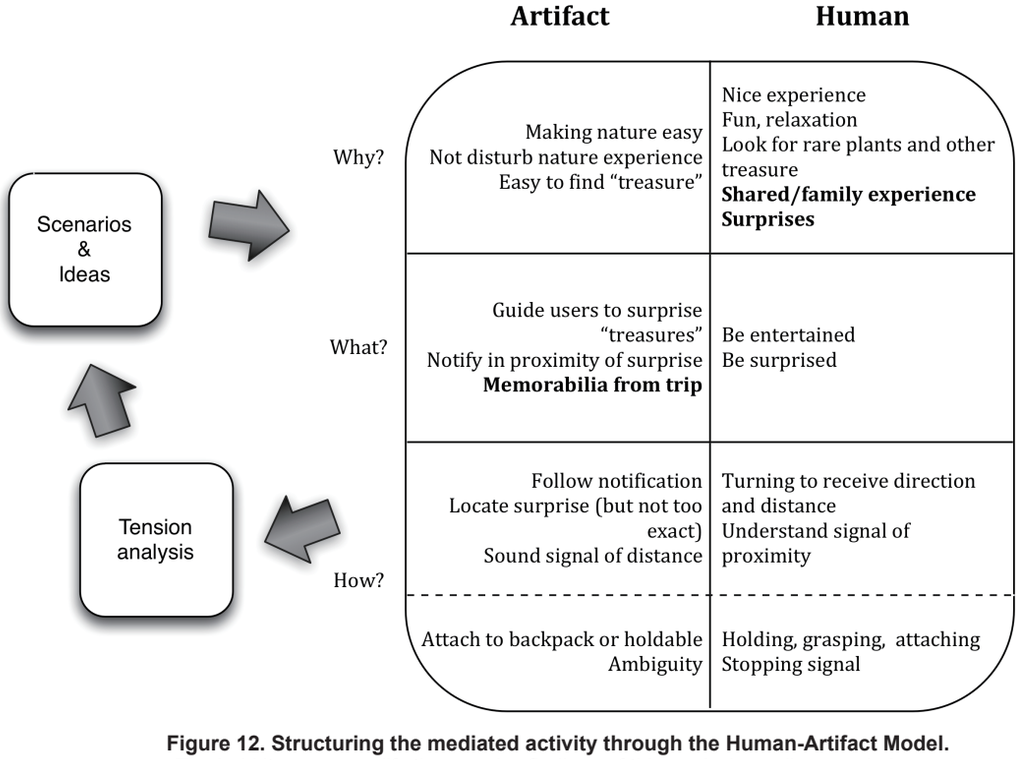

Figure 12. Structuring the mediated activity through the Human-Artifact Model.
The bold items exemplify the surprise findings of this analysis as discussed above.

that there were other options that had to be presented to the users and decision-makers. The mere idea of a passport machine accordingly became a springboard, as did smart-phone solutions (not discussed in details in this paper).

In Case 3, the group came up with the idea of a surprise quite early on, and this simple idea, once unpackaged through the Human-Artifact Model, turned out to be quite complicated due to the tensions between planning and surprise, between the individual and the group, and between the immediate use on the current trip and more long-lasting uses and values. Once the idea of the surprise token had been seeded, children's story books and artificial flowers were used to springboard the process and explore these tensions from different angles.

Systematic Scrutiny

When reviewing prototypes and design ideas upon the basis of the Human-Artifact Model, the groups, which had the patience and the courage to scrutinize their empirical material and design ideas, brought out the most interesting ideas with respect to design. In our experience from these projects, the systematic walkthroughs and reviews applying the model helped in process. Evidently what we mean by courage is very much skepticism, and the will to question ones own design ideas.

Alternatives and Iterations of Prototypes

Often prototyping seems to be carried out in rather ad hoc manners, where one iteration leads to design decisions that lead to a new alternative or iteration. However, the examples illustrate that by structured walk-throughs of elements of the future use, applying the Human-Artifact Model, it was possible to keep the design space open and note which design decisions had been made deliberately or not, backtracking if necessary. Also, alternatives chosen to focus on particular elements of handling, and the resulting reduction of complexity that happens when working with prototypes, was done more systematically and deliberately than what we have seen in the past. Relating to Lim et al. (2008), the students' purposefully formed manifestations of design ideas were better rooted and understood in relation to the entire design process and use situation, and not just in the purpose of the singular prototype.

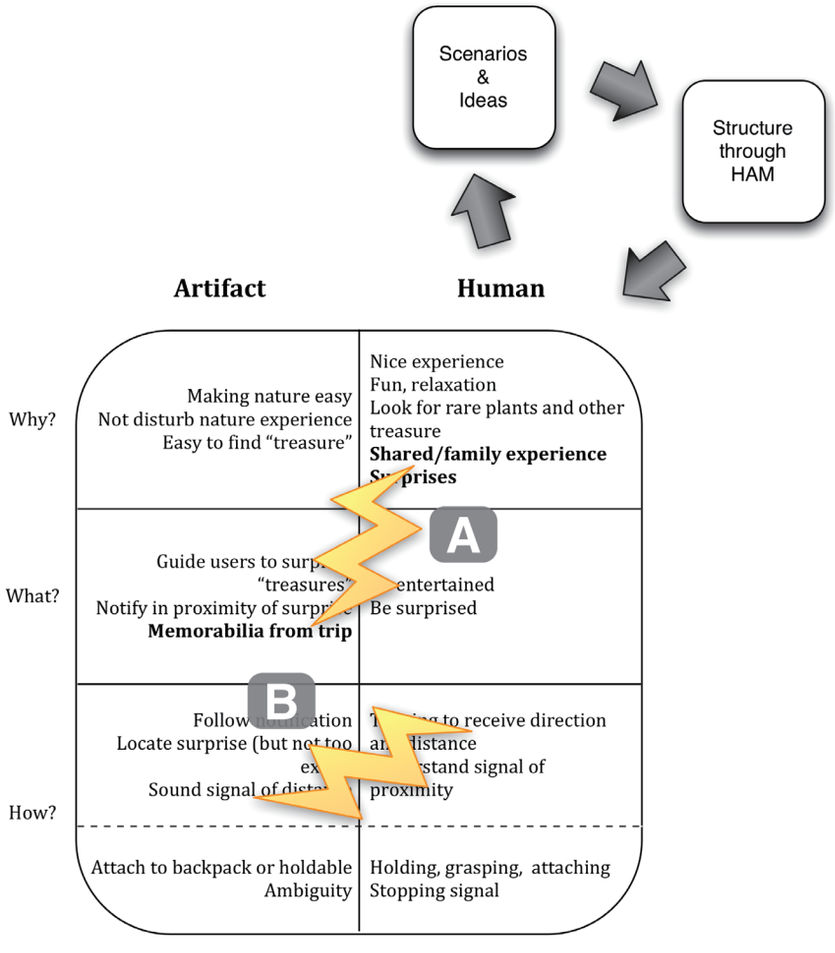

Figure 13. Tension analysis. Tensions are indicated by lightning bolts. A: Notification of proximity of individual surprises may distract from the shared experience. B: Tension between the technology needed to provide positioning and proximity and what level of sound etc. is needed.

Preparing Design Students for Action

It is impossible to address all possible uses of the iterative framework and the Human-Artifact Model in a paper like this because the scope would be too wide, because the examples from the student projects only illustrate some elements, and because we have only selected a subset of examples from the student projects for this paper. In addition, outlining an entire design method as a cookbook for design would conflict with our fundamental ways of thinking and be the exact opposite of what we want to promote. However, the previous examples have illustrated that the activity theoretical tools help prepare designers for action. In many ways, our approach provides instruments for capturing concerns, problems and solutions on the boundaries between analysis and design, between design and exploratory prototyping, and eventually between this and the consolidation in use.

If we return to Rogers' challenge, that activity theory is too complex, and Stolterman's concern that only high-level concepts seem to make impact from theory to design, it is our experience that through only a couple of lectures, the students can be equipped to use the activity theoretical concepts together with prototyping, as it is described in textbooks and already known to them. We hope that the above examples convince the reader that this is sufficient to help designers carry out prototyping more systematically and skeptically by identifying and exploring dialectical tensions in the design process.

Discussion and Perspective

Stolterman's designerly way implies sketching, iteration and alternative, three elements that are somewhat in contradiction to how the use of theory has often been seen in design – to make design "right" from the start. Nonetheless, they are very much in line with the activity theoretical tradition of change-oriented research, where total prediction is impossible, and techniques such as springboards are used for idea generation, and assessed in iterative cycles (Engeström, 1987).

Applying a theoretical approach to design is not science (Stolterman, 2008). The Human-Artifact Model applied in design provides a scheme that helps explore and compare artifacts and the repertoires of actions and operations connected to them, thus providing an understanding of how one mediator may substitute another, and how well the substituting device may be integrated into use. It provides a structured way of asking questions to the current activity, as well as to the past and the future, and a frame for gathering the important findings and for reflecting on them. We have discussed how this structuring helps the students work *systematically*, i.e. structured, and in a planned process where they work with the specifics of the design case, both in terms of use situation and background, and in terms of technological constraints and alternatives. The understanding of the past and the present adds to the design methodological toolbox, and is as such mediating the iterative design. We have presented examples where the model helps the students work *skeptically*, i.e. ask questions and move beyond their own idiosyncrasies and biases.

Stolterman's discussions, however, miss a piece regarding anchoring visions and prototypes in the practice of the (future) users. In our experience, the practice of the users needs to be brought into design, and kept there, to continuously confront design visions and prototypes.

Conclusion

We have developed activity theoretical tools, in particular the Human-Artifact Model, to help designers think and do prototyping by having a stronger focus on systematic and skeptical exploration of particular design elements. Prototypes are meant to anchor future use in current use practice, and they are manifestations of design ideas. The model we present structures this double role. With this, we have illustrated that we can move the use of Activity Theory in design beyond singular concepts towards quite precise and simple tools, frameworks for systematic reflection, and teachable, interconnected high-level ideas. While there is a substantial theoretical framework underlying the development of the model, the model itself is teachable within a couple of lectures and a seven-week project. *It is neither complicated nor complex compared to other approaches*. This is largely a claim, although we have now carried out the process four times. Accordingly, we challenge the readers to pick up the models and use them themselves, based on the examples we have given in this paper.

Acknowledgments

We thank the students whose coursework has provided material for this paper. We thank Marianne Dammand Iversen and Dorthe Haagen Nielsen who have assisted with editing.

References

1. Benyon, D. (2010). *Designing interactive systems: A comprehensive guide to HCI and interaction design* (2nd ed.). Harlow, UK: Pearson Education.
2. Bertelsen, O. (2000). Design artifacts: Towards a design-oriented epistemology. *Scandinavian Journal of Information Systems*, *12*(1-2), 15-27.
3. Bertelsen, O., & Bødker, S. (2003). Activity theory. In J. M. Carroll (Ed.). *HCI models, theories, and frameworks: Toward a multidisciplinary science* (pp. 291-324). San Francisco, CA: Morgan Kaufman.
4. Beyer, H. (2010). User-centered agile methods. *Synthesis Lectures on Human-Centered Informatics, 3*(1), 1-71.
5. Bjerknes, G. (1992). Dialectical reflection in information system development. *Scandinavian Journal of Information Systems, 4*(1), 55-78.
6. Bødker, S. (1991). *Through the interface: A human activity approach to user interface design.* Mahwah, NJ: Lawrence Erlbaum Associates.
7. Bødker, S. (1999). *Computer applications as mediators of design and use-a developmental perspective* (Doctoral dissertation). Aarhus, Denmark: Aarhus University.
8. Bødker, S., & Andersen, P. B. (2005). Complex mediation. *Human-Computer Interaction, 20*(4), 353-402.

9. Bødker, S., & Christiansen, E. (1997). Scenarios as springboards in design. In G. C. Bowker, S. L. Star, L. Gasser, & W. Turner (Eds.), *Social science, technical systems and cooperative work: Beyond the great divide* (pp. 217-234). Mahwah, NJ: Lawrence Erlbaum Associates.
10. Bødker, S., & Klokmose, C. N. (2011). The human-artifact model: An activity theoretical approach to artifact ecologies. *Human-Computer Interaction, 26*(4), 315-371.
11. Bødker, S., & Petersen, M. G. (2000). Design for learning in use. *Scandinavian Journal of Information Systems, 12*(1), 61-80.
12. Bødker, S., Christiansen, E., Nyvang, T., & Zander, P. O. (2012). Personas, people and participation – Challenges from the trenches of local government. In K. Halskov, H. Winschiers-Theophilus, Y. Lee, J. Simonsen, & K. Bødker (Eds.), *Proceedings of the 12th Conference on Participatory Design* (Vol. 1, pp. 91-100). New York, NY: ACM press.
13. Bohøj, M., & Bødker, S. (2008). Meeting (in) the wild. In K. Tollmar, & B. Jönsson (Eds.), *Proceedings of the 5th Nordic Conference on Human-Computer Interaction.* New York, NY: ACM press.
14. Clemmensen, T., & Leisner, P. (2002), Community knowledge in an emerging online professional community: The interest of theory among Danish usability professionals. In K. Bødker, M. K. Pedersen, J. Nørbjerg, J. Simonsen, & M. T. Vendelø (Eds.), *Proceedings of the 25th Information Systems Research Seminar in Scandinavia*. Copenhagen, Denmark: CBS.
15. Ehn, P., & Kyng, M. (1991). Cardboard computers: Mocking-it-up or hands-on the future. In J. Greenbaum, & M. Kyng (Eds.), *Design at work* (pp.169-195). Hillsdale, NJ: Lawrence Erlbaum Associates.
16. Engeström, Y. (1987). *Learning by expansion*. Helsinki, Finland: Orienta Konsultit.
17. Engeström, Y. (2005). Knotworking to create collaborative intentionality capital in fluid organizational fields. *Advances in Interdisciplinary Studies of Work Teams*, *11*, 307-336.
18. Floyd, C. (1984). A systematic look at prototyping. In R. Budde, K. Kuhlenkamp, L. Mathiassen, & H. Züllighoven (Eds.), *Approaches to prototyping* (pp. 1-18). Berlin, Germany: Springer-Verlag.
19. Gaver, W., Boucher, A., Pennington, S., & Walker, B. (2004). Cultural probes and the value of uncertainty. *Interactions, 11*(5), 53-56.
20. Greenbaum, J., & Kyng, M. (Eds.) (1991). *Design at work*. Hillsdale, NJ: Lawrence Erlbaum Associates.
21. Grudin, J., & Pruitt, J. (2002). Personas, participatory design and product development: An infrastructure for engagement. In T. Binder, J. Gregory, & I. Wagner (Eds.), *Proceedings of the 7th Conference on Participatory Design* (pp. 144-161). Palo Alto, CA: CPSR.
22. Hanington, B. H. (2010). Relevant and rigorous: Human-centered research and design education. *Design Issues, 26*(3), 18-26.
23. Jones, M. C., Floyd, I., & Twidale, M. B. (2008). Teaching design with personas, Magazine of *Interaction Design & Architecture(s)* Year II & III N. 3 & 4. pp. 75-82.
24. Kaptelinin, V. (1995). Computer-mediated activity: Functional organs in social and developmental contexts. In B. Nardi (Ed.), *Context and consciousness: Activity theory and human-computer interaction* (pp. 45-68). Cambridge, MA: MIT Press.
25. Kaptelinin, V., & Bannon, L. J. (2012). Interaction design beyond the product: Creating technology-enhanced activity spaces. *Human-Computer Interaction, 27*(3), 277-309.
26. Kaptelinin, V., & Nardi, B. (2006). *Acting with technology: Activity theory and interaction Design*. Cambridge, MA: MIT Press.
27. Kerosuo, H., & Engeström, Y. (2003). Boundary crossing and learning in creation of new work practice. *Journal of Workplace Learning, 15*(7/8), 345-351.
28. Korn, M., Kawash, R., & Andersen, L. (2010). Surprise trips: A system to augment the natural experience of exploration. In *Proceedings of the 12th ACM International Conference on Ubiquitous Computing* (pp. 413-414). New York, NY: ACM press.
29. Korpela, M. (1994). *Nigerian practice in computer systems development: A multidisciplinary theoretical framework, applied to health informatics*. Helsinki, Finland: Helsinki University of Technology.
30. Kuutti, K. (1999). Activity theory, transformation of work, and information systems design. In Y. Engeström, R. Miettinen, & R. -L. Punamäki (Eds.), *Perspectives on activity theory* (pp. 360-376). Cambridge, UK: Cambridge University Press.
31. Lim, Y., Stolterman, E., & Tenenberg, J. (2008). The anatomy of prototypes: Prototypes as filters, prototypes as manifestations of design ideas. *ACM Transactions on Computer-Human Interaction, 15*(2), 1-27.
32. Mackay, W. E., Ratzer, A. V., & Janecek, P. (2000). Video artifacts for design: Bridging the gap between abstraction and detail. In D. Boyarski, & W. A. Kellogg (Eds.), *Proceedings of the 3rd Conference on Designing Interactive Systems* (pp. 72-82). New York, NY: ACM press.
33. Mathiassen, L. (1981). *Systemudvikling og systemudviklingsmetode* [Systems development and systems development method] DAIMI PB-136. Aarhus, Denmark: University of Aarhus.
34. Mogensen P. (1992). Towards a provotyping approach in systems development. *Scandinavian Journal of Information Systems, 4*, 31-53.
35. Mwanza, D., & Bertelsen, O. W. (2003). Methods for applying activity theory to HCI design. In *Proceedings of the* 9th IFIP TC13 *International Conference on Human-Computer Interaction* (pp. 1045-1046). Washington, DC: IOS Press.
36. Rogers, Y. (2004). New theoretical approaches for HCI. *Annual Review of Information Science and Technology, 38*(1), 87-143.
37. Stolterman, E. (2008). The nature of design practice and implications for interaction design research. *International Journal of Design, 2*(1), 55-65.