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DESIGN FOR LEARNING IN USE

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Abstract

This paper brings information systems design towards a focus on learning in use. Studying learning in use is a matter of focusing on the development of the designed artefact once the design process is over. Accordingly, designing for learnable artefacts is a matter of understanding and developing use, also when a computer-based artefact has been taken over by users. The paper presents a design-oriented model of the learnable artefact, discusses the possible instruments of learning in use and presents empirical studies that support our design-oriented understanding of the learnable artefact.

Keywords:

Learning in use, integration of use and design, design model

INTRODUCTION

Information systems design does not stop when the design process ends. As people start to use the products they learn, i.e. they go on developing the artefact. This paper brings information systems design towards a focus on learning in use: Designing for learnable artefacts is a matter of understanding and developing use, also once a computer-based artefact has been taken over by users.

Traditionally, information systems design and human-computer interaction/usability studies have focused on snapshots of use. They share a linear thinking where evaluation of usability is a concern only after design and some amount of implementation. As it turns out, use is not static and snapshots of use yield little insight about the developmental aspects of use. Hence, there is an increasing concern, theoretically and practically, for designing computer-based artefacts that are useful, for the advanced user as well as for the first-time novice user, and which support the user in this development. And not least, it is a practical concern to include instruments through which the learning of the artefact may be supported in the design. Usability studies, which has tradition-

ally been where the concern for use has been located, is increasingly moving towards integration with design, in iterative processes, where prototypes are developed and tried out by and with users (Buur & Bødker 2000). The theoretical and empirical work presented in this paper takes such a general development as its starting point and presents a design model that supports the design of artefacts supporting learning in use.

Because the interplay between the computer-based artefact in use, their learning and design are tremendously complex, we will work with an example of an artefact that is much simpler than a traditional information system: a modern TV set. Though there are indeed limitations to such an approach, the paper raises many interesting problems that are valid for a much wider class of computer artefacts.

Learning in use and usability design

Consider the following example from a usability evaluation at Bang & Olufsen, a well-known manufacturer of hi-fi equipment. A user is seated in the Bang & Olufsen testlab which is equipped as a living room. She is carrying out an assignment where she is asked to tune in some channels so as to set up the television set. The user has previously successfully tuned the channels of another Bang & Olufsen TV, where she discovered an auto-tuning facility (automatic scan and allocation of all traceable channels in the frequency band). In the current situation she expects that the TV supports this same functionality. Accordingly, the user spends a long time searching through the menus in order to find something about auto-tuning. However, despite her expectations, this functionality is not supported by this particular TV set and she eventually gives up tuning in the channels.

This example demonstrates why it is important to focus on learnability in the design of computer artefacts. It illustrates how a user learns through use, and how, in the encounter with the second television, she is actually prevented from using her experiences since nothing on the second TV makes it clear, that this TV was different from the first TV tried out. We see how her expectations are formed from previous experiences, and how the user tries to transfer experiences between artefacts.

However, the challenge of designing for learning in use is not simple and the example above illustrates some of the design challenges that Bang & Olufsen is facing concerning the learnable artefact. The overall design philosophy of Bang & Olufsen is that each product must have its own identity, in its physical appearance as well as in functionality. Given the need for individual product identity, it is not necessarily a solution to change the second TV so as to allow auto-tuning. However, it is necessary to provide ways for the user to *understand* how the TV set offers itself to be used in a way different from the one known by the user as auto-tuning. And, further to provide means of leading the user in *handling* the TV set in a different yet more appropriate way (see also Bærentsen, this issue).

Design is further complicated by the fact that an artefact always implies more possible uses than the original operations giving birth to it (Engeström 1990, p. 174). Thus, the presence of a designed artefact does not mechanically determine the way it is actually used and conceived by the users. It is hardly surprising that design changes the artefact being designed. However, use changes the artefact as well, as noted by Engeström (ibid.). This emphasizes the need to look at

artefacts-in-use as emerging rather than static. The artefact, at the same time, constrains or disciplines use through the kind of operations it allows the user to form, through the conceptual understanding it offers to the user, through the kind of uses it lends itself to, physically, handling-wise and through the foci that the user is "offered" in or through the artefact (Bødker, 1991, 1999).

Activity theory provides an interesting starting point for designing for learnability by offering a design-oriented framework that accounts for the dynamic nature of artefacts-in-use.

In this paper we first address the issue of design for learning in use through a theoretical exploration of the learnable artefact as seen from the perspective of activity theory. Based on Engeström's work (Engeström 1987, 1990), as well as our earlier work on iterative design (e.g. Bødker & Grønbæk 1991) this exploration lead us to a design-oriented theory consisting of a combined design model and checklist for designing "the learnable artefact". This design model can be seen as a hypothesis for what it implies to design for learning in use. Subsequently, we report on the early findings from a long-term empirical study of television use, analysed in terms of the activity theoretical framework. Studying learnability of IT-based artefacts is often complicated by the complexity of the artefact. In a typical text processing program numerous metaphors are layered over each other, and the actual complexity of menus etc. is fairly big (Beaudouin-Lafon, 2000). In this respect, our Bang & Olufsen TV set seems much simpler. Finally, we discuss the proposed design model in light of the empirical findings.

THE LEARNABLE ARTEFACT: A THEORETICAL INVESTIGATION

Activity theory assumes an asymmetric relation between people and things, in contrast to the proposal of a symmetric relationship offered by cognitive science or various brands of computer science, where computer programs and human behaviours are modelled using the same language and methods. Activity theory places computer applications, along with other artefacts as *mediators* of human activity (See Bødker (1991)). Through a set of dynamic concepts (activity, action and operation) it makes important features of human endeavours stand out, and makes us focus on the context of use instead of seeing computer use in isolation.

Any (use) activity is both social and motivated. Since artefacts most often mediate several activities, they may usefully be seen as situated in a web of activities. Each activity is conducted through *actions* of individuals, directed towards an object or another subject. Activity gives meaning to our actions, though actions have their own goals, and the same actions can appear in different activities.

Each action conducted by a human being is implemented through a series of *operations*. Each operation is connected to the concrete physical or social conditions for conducting the action, and is "triggered" by the specific conditions of the situation. Artefacts, in a human activity framework, have a double character: they are objects in the world around us which we can reflect on, and they mediate our interaction with the world, in which case they are not themselves objects of our activity. In normal use situations our handling of artefacts is done through operations, and is not conscious to us. When we have difficulties with artefacts, the world does not come to a standstill: Breakdowns lead to actions and operations that "work around" the problems, so that we can carry on.

Artefacts are seen as historical devices reflecting the state of practice up until the time that they are developed. This practice in turn is shaped by the artefacts used etc. Artefacts can be characterised as *crystallised knowledge* which means that operations developed in the use of one generation of technology are later incorporated into the artefact itself in the next. Thus to learn something about the present shape and use of an artefact, a *historical analysis of artefacts* as well as of practice is important.

Learning in this perspective is a matter of development of operations, actions and activities (and transitions between them) as these developments take place in use, or in dedicated learning activities. Theoretically and practically this learning is a consequence of the interaction of the human beings with the material conditions, with each other, and of the historical development of practice as well as of the individual repertoire of actions and operations. Accordingly we focus on the learning that takes place

- in use of artefacts,
- between users of artefacts and
- in the transfer of experiences that users make between artefacts.

Grudin (1990) rightly points out how computer artefacts-as-seen-from-use, is constituted not only by the software and hardware, but also by the surrounding manuals, teaching, management and support, i.e. human beings as well as material artefacts. This goes for a wider class of artefacts than traditional computer applications, and as Engeström (1990) points out, artefacts are implicitly or explicitly accompanied by models that reflect, and give guidance for their use. Accordingly we have found it useful to look at the artefact as such as well as its surrounding models as instruments of learning. These instruments will be studied further in the following. *Hence the learnable artefact not only encompasses the artefact "proper". It further encompasses the models, references to other artefacts, etc. that are part of the web of activities of the users and helps the users get started and develops their use.*

In this section we look specifically at the artefact-in-use; how learning takes place in use–in use as situated in a particular context, between users of artefacts, and in the transfer of experiences that users make between artefacts.

Learning in use

Operations are often *transformed actions*, i.e. we conduct them consciously as actions in the beginning. Through learning we transform them into operations, but on encountering changed conditions, we may have to reflect on them consciously again, and thus make former operations into conscious actions once more. Learning in terms of operations that get formed and break down is one aspect of learning seen from the point of view of activity theory. The transparency of handling the artefact thus achieved, is certainly important. Consequently, transparent interaction is a kind of interaction with focus on only the objects of work, and when breakdowns happen, and the user gets "forced" to shift her attention to the artefact, there is support for bringing back the focus to the objects of work.

Designing transparent interaction is consequently a matter of identifying the objects of work to be focussed on, in or through the artefact, and identifying how these are handled through operations on the artefact and which support the artefact needs to give for this. Bødker (1991) distin-

guishes between handling aspects and subject/object-directed aspects in order to identify, on the one hand, the aspects of the artefact that supports the development of a *repertoire of operations* through which the user handles the artefact, and, on the other hand, the support for the development of a *repertoire of purposes* of use of the artefact.

This repertoire of purposes is a matter of the development of the motives of what we do, and as pointed out by Bardram & Pedersen (1994), the formation of actions and the moves happening between the levels of actions and activities are equally important for learning, and our understanding of these is far less well developed.

In our case of Bang & Olufsen television users, it seems that the complex look of the remote control and the invisibility of a range of buttons positioned at the back of the TV get in the way of the formation and operationalisation of actions. In many cases users expected to access functionality via the remote control rather than on the TV itself. This was the case when a user was searching for a button to eject a video tape. In this situation a breakdown occured where the users' focus shifted from the contents of the video to the investigation of the VCR itself, searching for the expected functionality on the remote control. In this situation the user lacked support for the formation of actions, and the TV failed to support the users in developing their expertise in general and their repertoire of operations in particular.

From our studies of television use, we also saw examples of how activities took form. As an example, by the time of the installation of the television in the home of some Bang & Olufsen costumers, the husband and wife explained excitedly about how they were looking forward to obtain the *cinema experience* with their new television. This expectation of a new experience with their new television (which includes wide screen and surround sound facilities) was coined and demonstrated for the family already in the shop. The cinema experience was then later pursued (and transformed) over time as the family came to use the television in their home.

In order to support learning in use, we need to understand how the learnable artefacts support these processes. Bødker (1991) proposes an understanding of how users develop their repertoires of operations as follows: When operationalisation takes place, it is at first very situation specific, but as the human being meets new conditions, the variation of situations that can be handled by operations is growing. The novice carries out the activity at a very detailed level of actions, each action being consciously planned. With experience, the human being moves toward an operationalised totality. This is achieved through generalisation, operationalisation and abbreviation. The use of an artefact is, if the artefact works well, operationalised. Ideally, learning starts out with actions toward the artefact and ends without those actions.

In the case where the cinema experience formed the initial motive for the users, we saw how, over time, the users insisted on pursuing this experience and we saw how the concept as well as the design of the physical television supported the users in setting out to explore the possibilities of the television in this direction.

Thus, in our interpretation of this, the learnable artefact is becoming transparent to the user, by supporting the development of a repertoire of operations, the formation of high-level actions and of a repertoire of purposes related to the web-of-activities in which the artefact is used.

In studying expertise in actual work settings, Laufer & Glick (1996) talk about noviceness and experteness, where noviceness is characterised by single purposes defined by official norms, single-

layered surface relations, and (similar to what Dreyfus & Dreyfus (1986) point out) detailed actions. Expertness, in contrast, is characterised through handling of several conflicting purposes, where official as well as unofficial norms and personal judgement play a role. Complex, multi-layered social relations and high-level actions are other aspects of expertness. To understand expertness, and, hence, learning beyond the immediate introduction we consequently need to understand more about the ways in which learning may be aided through additional instruments and through the social interaction among users.

Learning between users of artefacts

Learning is fundamentally situated, and socially mediated, as discussed by many authors (Engeström 1987, Lave & Wenger 1991). Where Vygotsky (Engeström 1987) looks upon the interaction with the more capable peer, helping the learner through the zone of proximal development, Lave & Wenger (1991) depict learning as legitimate peripheral participation in a community of practice, where novices gradually move from the periphery, through increasing participation, towards the centre of mastering practitioners.

When it comes to learnable TV sets, we see both challenges and potentials in supporting social participation in a community of practice of Bang & Olufsen users. As of today, the practitioners of Bang & Olufsen TV sets are globally distributed individuals using their TV sets in their private homes. Accordingly, the peripheral participation in the community of practice of Bang & Olufsen television users, or easy access to more capable peers is not apparent. Nevertheless, the Bang & Olufsen sales staff often try to create a community feeling, and this is, as described below, well appreciated by the customers. Indeed, what people often get attracted to and stress as a main reason for buying Bang & Olufsen is the sense of community that goes with being a customer in a Bang & Olufsen store, of being invited to certain arrangements etc.

The concern for e.g. Internet connections for TV sets, or combined TV/PC appliances are increasing among television producers including Bang & Olufsen (Madsen & Petersen, 1999). Cable TV suppliers offer Internet connections and in general the band-width of Internet connections in the home are increasing. In our opinion this opens perspectives for creating e.g. web sites and communities for Bang & Olufsen TV users, because these web sites may be integrated with the TV sets in a medium term perspective, rather than an add-on to them. We see this as a way of moving the learning-in-use out of the homes of individuals and as a learning device for Bang & Olufsen R&D, usability and sales staff. As illustrated by our example every Bang & Olufsen TV is delivered to the buyer and installed by Bang & Olufsen sales staff. Hence, the buyers always get, in principle, a fully functional TV set, and this sales staff manages the immediate problems of introduction of the appliance to users. We see a potential for this role to be expanded a great deal more, so that the sales person act as a more capable peer to the new user. A web community with participation of sales staff, is likely to serve as a learning process for users as well as sales staff, and support the kind of community feeling already being created by the sales organisation.

However, this is hardly enough and we need to approach the *means of learning in or close to the artefact*.

Transfer of experiences between artefacts - instruments of learning in, or close to the artefact

The fundamentally situated, and socially mediated nature of learning means that we need to be concerned with the context of use, even in situations where there are no immediate peers. Context comes into the picture through the past experiences of the users, and through the meaning that the artefact represents to the user (Bertelsen 1998). As we have seen developed by Engeström, Bertelsen, Bødker and others (e.g. Engeström 1990, Bødker 1999, Bødker & Christiansen 1997), such experiences may easily be contradictory, and involving, or being derived from contradictory purposes of use.

As an example, working with teletext, a computer-experienced user successfully navigated through the menu structure on the TV set which, with its "computer-look", strongly suggested a hierarchical menu structure that was also perceived by the user. However, as the user got too far down in the menu hierarchy, and relying on previous experiences with computers expected to be able to go one step back in the structure, the user was stuck. After many unsuccessful and inelegant attempts including turning the TV off and on again - a typical work-around - the user finally realised that the "stop" button on the remote control supplied the go-back mechanism she was searching for.

Dwelling a bit further with the computer analogy, we identify the problem that it is unsystematic: Some foci of use stay closely with the computer analogy while others do not. Furthermore, the computer analogy means very different things at the activity- and action level. In terms of activity, it gives connotations of interactivity, or perhaps efficiency. On the action level, on the one hand it may lead us to think about settings for volume, luminance etc. But on the other hand it also seems to us that the computer/menu analogy, which seems fundamentally object/action oriented, contradicts with the fundamental capabilities of a TV set, that of processing a stream of pictures and sounds. At the level of operations, the computer analogy allows us to focus on menus as a way of e.g. creating settings of the TV.

In order to look at the instruments of learning in or close to the artefact, we have found it useful to look at the set of models or artefacts developed by (Engestöm 1990). Engeström discusses how these serve different purposes at different times in human learning of the primary artefact, by Engeström called the *what* artefact.

The first level of learning is close to the forming of operations as described above, through trial use of the *what* artefact as such. In the second level of learning "the object/outcome is given, and the instrument found through trial and error" (Engeström 1987, p 148), and the *how* artefacts applied "may be understood as algorithms and rules directly guiding the use and formation of primary [i.e. *what]* artefacts" (Engeström 1990, p 187). At the next level, the object/outcome is given, and the instrument invented, demanding models that deal with expectations and explanations, models that are constructed based on systematic testing of hypotheses, *why* artefacts. *Where-to* artefacts are the imaginative artefacts that help change and recreate the understanding of the human being of the change of the overall activity. As examples of these, Engeström analyses the instruments of medical doctors giving examples of *what* artefacts: patient's account of the disease, records, examinations; *how* artefacts: examination procedure, algorithms of computer use; *why* artefacts: explanatory models of illness, hypotheses, etc. The *where-to* artefacts in this example is

a matter of dealing with the entire understanding of what it means to be a doctor as part of the, in this case, Finnish health care system.

When working with the learnable artefact we must remind ourselves that this does not only encompass the artefact "proper". We may start from the artefact and work to understand the learnable artefact through the *what, how, why and where-to* artefacts that it encompass. In this way all artefacts can be seen to include (parts of) *what, how, why and where-to* artefacts and we may design the learnable artefact so as to contain all four in appropriate ways. Starting out from a particular use situation, we may choose to study as well the models, other artefacts, etc. that are part of the web of activities of the users that help the users learn about the artefact of interest. This is an alternative perspective by which we can see all of these artefacts as combinations of *what, how, why and where-to* artefacts. And we can design the wrapping or portable context of the artefact (Brown & Duguid, 1994), in terms of manuals, checklists etc.

In the world of purchasing and starting to use Bang & Olufsen TV sets, we have found the following examples of artefacts: *What* artefacts can be the TV set including the remote control. The manual in turn can act as a *how* artefact and so can demonstrations of use given by sales staff, and in some cases, the above mentioned computer analogy. Further we have seen how visits to sales rooms and glossy brochures can serve to introduce the level of purpose to users, and thus take on the role as *why* artefacts. Interestingly, we have found that the *where-to* artefacts that give indications of why people would want to buy a Bang & Olufsen TV set often have little to do with better watching of or listening to TV. Rather it is the enrolment into the world of the Bang & Olufsen family through special arrangements with other Bang & Olufsen customers that matters.

In line with Engeström (1987), we see unexpected uses as a natural extension of use, as resources for learning rather than 'accidents' and we agree with Béguin and Rabardel (this issue) that such instances are valuable resources for design. Béguin and Rabardel (this issue) develop primarily the interplay between *what* artefacts and *how* artefacts, in what they call catacresis. "Catacresis refer to the use of one tool in place of another or to using tools to carry out tasks for which they were not designed. ..(Catacresis are).. an indication of the user's contribution to the development of an instrument and its uses" (Béguin and Rabardel (ibid.)). Part of understanding learnability of artefacts consists of understanding how users' previous experiences can be reused and brought into play when users face new artefacts or problems with handling known artefacts.

Although (Béguin and Rabardel, this issue, Engeström, 1987, 1990) describe the way models of use are constructed for later reuse, neither of these dwell into the details of how these models come into play in concrete situations of use. Furthermore, the notions of *why* artefacts and *where-to* artefacts are little developed in the context of development in use of artefacts, whereas they are developed more in the general design domain, e.g. through the works of Bisgaard et al (1989), Bertelsen (1994), Bødker & Christiansen (1997).

We see these general concepts as good starting points, but barely more, for developing a practical approach to designing learnable artefacts, and we find it necessary to move on to develop more practical means of design for such.

DESIGNING THE LEARNABLE ARTEFACT

In the following section we develop our design-oriented theory of the learnable artefact. This theory focuses on how design may work to uncover instruments of learning and to embed such in the learnable artefact being designed. Coupled with our theoretical investigations we develop a design model for designing the learnable artefact. This model should be seen as a hypothesis, which is further investigated in the next section covering empirical investigations.

Design of learnable artefacts gives a particular focus on design. At the same time our earlier general analyses of the inter-linking of usability matters and design, shows how learnability must be considered in all stages of design. Hence, our concern is to devise a design model that allows (Bødker 1999)

- iteration, as a result of our earlier work on the non-linear nature of design,
- focus on user background and learning in use as the best starting point for design,
- reflecting iterative design and learning-in-use in the product, so that the artefact becomes self-contained to the largest possible extent, i.e. so that it contains, or is "wrapped up" together with models that support learning so as to become a learnable artefact.

We have been seeking inspiration from Engeström's general methodological cycle in providing a methodological cycle that focuses on *design* of the *learnable* artefact, rather than on investigating expansive learning in general. Engeström's work on models is an integral part of his quest for expansive learning, and his methodological cycle of expansive development takes us some way in developing a theoretical hypothesis of learning and designing for learnable artefacts. Earlier our way of thinking about design has showed well in line with Engeström's work (See Bisgaard et al 1989, Bødker 1999). Our particular concern for learnability of artefacts is new here.

However, there are several challenges in the kind of design setting that we look at here:

- Engeström is concerned with expansive learning that changes the fundamental (work) activity of the involved people. When it comes to TV sets, they are a minor part of everyday life, and though TV as such can be said to have revolutionised people's lives, buying a new TV set does not have that character–what we are talking about is more likely to be a change of how people handle a new artefact in what is basically the same activity. At the same time, it is useful to think about how these possible use activities may be extended or changed, e.g. so as to include a different perception of why one wants to use a TV, beyond watching TV. E.g. video-on-demand services or Internet integration, may change our ways of understanding why we want a TV-set, and the producers of TV-sets may need to support such changes actively e.g. through advertisement.
- Given the diverse group of users of TV sets these users do not have one, but many different backgrounds needing to be the starting point for learning to/in use. However, this is the case with most artefacts, the main reason for Engeström's (1990) argument that it is necessary to move beyond the personal view of the artefact to understand it.
- Engeström (1987) bases his cycle on the recognition of individuals that their lives need to change. In connection with e.g. TV sets, this is not the case necessarily, though such a need state may be created through active work of advertisement and TV sales people.

In other words, the primary instruments that we are looking for in our attempt to create learnable artefacts are not primarily instruments intending to transcend the use of the artefact as such. Most

aspects have to do with the shaping and developing of actions and operations, not activities.

In forming the design model, we further draw upon the work of Bardram and Bertelsen's (1995) design oriented understanding of conditions for transparency, i.e. for supporting learning in use. Interpreting Vygotsky's concept of the zone of proximal development onto the situation of learning in use of IT, Bardram & Bertelsen (Bardram & Bertelsen, 1995) insist that the learnable artefact needs to

- support *development in use*, i.e. to embed learning in real, meaningful use situations not as a separate activity,
- establish an image of the future use - *the potential competence* of use
- ensure a certain degree of *initial familiarity* with artefacts and use, with due concern for when the initiation of the learning of something new may usefully be initiated, and to
- set conditions for the *formation and operationalisation of actions* and in this way support *mastering* beyond sheer trial and error.

When these claims and Bødker's (1991) aspects of use/foci are looked upon from the perspective of an iterative design model, they are closely connected to Engeström's methodological cycle of expansive development (1987). This model start with the delineation of the phenomenon of interest, the work practice to be changed and the historical and empirical investigation of this. The next stage is the formation of new instruments to make the move towards the new. This phase consist of identification of models, springboards and microcosmos. In the next stage these instruments are applied to carry through the change and this is evaluated.

This general cycle we have confronted with the findings of Bardram & Bertelsen (1995) as well as our own, leading to a design cycle focussing specifically on the learnable artefact:

1. *Investigate the multiple backgrounds of the users*. The investigation of the practices of users must focus in parts on their general cultural and most likely diverse practices. And since we are primarily concerned with the handling of artefacts, the variety of artefacts owned and used by the users are of great importance along with how they undertake the types of activities and purposeful actions that we design for. These investigations on the one hand need to be dealt with in an open-minded fashion through e.g. field work (Bødker & Madsen 1998, Nielsen 1998), on the other hand we suggest that it is important that certain questions do get asked regarding the actual competencies of the users, their current needs and experiences with present artefacts. According to Engeström (1987) existing artefacts-in-use should all be analysed as both *what, how, why, and where-to* artefacts through historical analyses.

2. *Establish the new instruments* to us consist of three parts;

a. *the establishing of the potential competence of future uses including springboards and images helping use to move ahead*. This, we propose, involves forming hypotheses about future use, e.g. through use of metaphors (Madsen 1994), future workshops (Kensing & Madsen 1991) exploration of the use of artefacts that have somewhat similar use qualities, confrontation of actual users with images of future use through participatory design techniques (e.g. Bødker & Christiansen, 1997, Kyng 1995). Designers need help in forming the hypotheses as well as in examining them and including the vision in the learnable artefact.

b. *the establishing of instruments to emphasise initial familiarity*. Emphasising initial familiarity means establishing reference to the actual competence of the users as well as to the potential

one, the possible future use. This may be done in several ways e.g. through use scenarios (Kyng 1995, Bødker in press) and it means to ask questions linking the past to the future and linking use and learning. The designer needs to be concerned with the particular mechanisms supporting learning in use, how they are established, directs use, and develop through learning in use. Again these mechanisms need to be constructed so as to deal with *what, how, why, and where-to artefacts*. A completed cycle with a microcosm (Engeström 1987) of users to explore the formation and operationalisation of actions is most often necessary, hence 2c.

c. *establishing of a microcosmos* where such instruments may be tried out. This microcosmos is the delimited community of practice where intermediate instruments can be tried out through prototyping, mock-ups, in more or less controlled environments depending on the stage of the design and purpose of the microcosmos. In our experience a microcosmos will in some instances encompass 2-3 users in an artificial, lab-like situation, working with a couple of specific use scenarios in close cooperation with a couple of designers and usability people. In others, real trial use for a limited period of time, in a real use setting constitutes a more useful microcosmos.

3. *Support formation and operationalization* of actions basically needs to be dealt with through hands-on experience by users, as discussed in (Bødker 1991). In Bødker (1996) a detailed way of analysing the forming of operations and breakdowns of operation in actual use situations is outlined, and e.g. Bødker & Madsen (1998) discuss how to establish context for prototype evaluations in usability settings. The overall particular concern of the particular focus of this paper is that the operations formed are, if not initially then at the end, use operations and not operations pertaining in isolation to the learning activity. This means that the users are able to focus their attention on actual objects of the use activity and not objects that pertain to learning in isolation. We see this stage of the learning as supported by the primary artefact, the *what* artefact, as well as the *how* artefact that support the initial development of a repertoire of operations.

4. *Consolidate use*. Mechanisms to consolidate use could, both figuratively and literally be a matter of removing the scaffolding of the learning in use activity. In accordance with (Newman et al. 1989), we see this not as an act performed by the artefact, but through the cooperative effort of the designer and the actual users, i.e. a process where the designer makes the consolidation possible, but where the user makes the decision of moving to "full-blown" use, if at all. This move can be, but is not always, a matter of stepping out of the learning environment, and is heavily supported by why artefacts supporting reflection in action.

In our model, the stages in the design cycle, and the aspects of the learnable artefact in focus, are in some ways orthogonal. We should be concerned with all aspects of the learnable artefact at all stages of design. At the same time, there is a natural progression of concerns: focus in the investigation of use backgrounds is mainly the existing competence of users, and the questions that we may usefully ask reflect that. As design proceeds, the concerns move along, and in the later stages we are moving towards a primary focus in the handling of the *what* artefact, focussing on *what* and *how* artefacts.

Figure 1. The design cycle for designing the learnable artefact

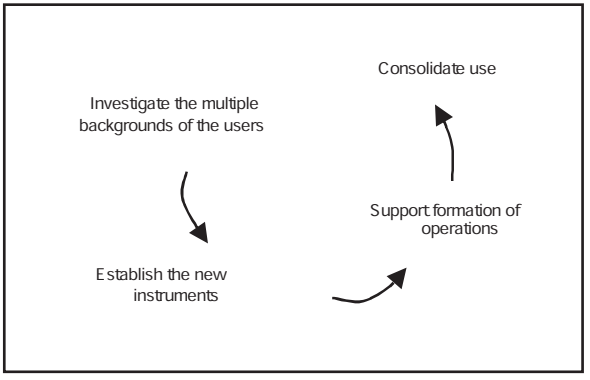

Table 1. A checklist for designing the learnable artefact

CHECKLIST FOR DESIGNING THE LEARNABLE ARTEFACT
Investigate the multiple backgrounds of the users.
Identify artefacts with similar as well as different handling. (How) does the appliance act in the capacity of what artefacts? how artefacts?
Identify artefacts with similar as well as different purposes. (How) does the appliance act in the capacity of what artefacts? why artefacts?
Identify previous generations of artefacts with similar purposes, and investigate how handling, purposes and contexts of use have developed over history.
Identify previous reasons for purchasing similar artefacts.
Identify additional artefacts of possible future use.
Establish the new instruments
Establish potential competence
Looking ahead, the important matter is to identify where-to artefacts. A starting point for this is the above identified present and past artefacts:
Does the artefact propose new possibilities regarding purpose, handling and technological innovation in general?
Where-to artefacts can, however, also be crystallized from other technical and cultural domains (metaphors, science fiction characters, etc.).
Establish initial familiarity
How to propose to the user what to do with/through the artefact and how?
Support for user to recognize what he or she is doing (why artefacts, where-to artefacts)?
Support for user to recognize similarities and differences to other well-known artefacts, regarding both handling and purposes?
Process of acquiring artefact: introduction in shop, commercials, manuals, etc?
Establish a microcosm
What is the appropriate group/community of practice in which to evaluate design thus far?
What is the status of prototypes, models, etc. with which to evaluate the design?
What is the time scale?
Support formation of operations
Artefacts that support access to the real objects of the activity (what artefacts) and operationalized handling of the artefact (what and how artefacts).
Support for experimentation, e.g. through "undo"?
Catacresis (supporting existing repertoire of operations to be used with new artefacts, or in new situations)
Consolidate use
Support for focus on the real objects of the activity, flexible changes between such foci.
No causes of e.g. recurrent breakdowns

The kinds of questions of interest in the various stages are summarized in table 1. This table is seen as a checklist for design (see Bødker et al, 2000). It has been developed in iteration with our theoretical and empirical work. Checklists, in our proposal (inspired by Bødker & Christiansen, 1997), are used to present theory and other sorts of research findings in an operational form, to support the role of theory as mediation of the investigation and design process. The initial version of this particular checklist has been developed in iteration with studies of HCI literature on learning, the activity theoretical framing as presented above and a series of design workshops with usability people in three companies and with a groups of HCI students. And in the following we will discuss how it has been used in empirical studies of introductory use in the homes of Bang & Olufsen customers.

THE LEARNABLE ARTEFACT: AN EMPIRICAL INVESTIGATION

In order to investigate the proposed design cycle as well as take some steps towards a practically applicable approach to design for learning in use, we have moved on to study introductory use of Bang & Olufsen TV sets in people's homes. This study consists of a long term study with recurring visits to the homes of Bang & Olufsen customers. A study which is in its early stages and of which we report our initial findings. Our approach consists of a combination of interviews, incident questionnaires as well as some hands on sessions all informed by our theoretical work and set up to provide insights into some concrete courses of learning in use in practice.

We have interviewed users by the time of installation of the TV sets in their homes, that is, when people have had an introduction and first demonstration of the TV in the shop, but before they have any hands on experience with operating the TV themselves. The following questions form our discussions with users.

Figure 2. Interview guide

Initial interview

Investigation into use backgrounds:

- Have you previously owned a similar appliance? Which?
- Which other technical appliances do you own, e.g. computer, video camera other i-fi equipment?
- Have you previously owned a product by the same producer? Which and when?

Investigation into potential competence:

- Why did you buy this specific TV compared to other TVs?
- What do you expect this TV to offer compared to your earlier TVs and other TVs in general ?
- Can you explain the process that lead to your decision on buying the TV, i.e. what did you learn in the shop, did you hear about the TV or see it demonstrated elsewhere?
- What do you expect the roles of the sales personnel to be during the installation (by the sales personnel) and have you prepared any questions for them in advance?

Further, as a means for providing some points of reference in the ongoing development process we have developed a questionnaire for users to fill in as they try something new, encounter some problems or in situations which are otherwise interesting. We suggested for the users to construct an incident diary using the set of questions, and we intended to use the incidents described as a basis for constructing some use scenarios.

Figure 3. Questionnaire

Questionnaire

Concerning the activity:

- Briefly describe the characteristics of the situation
- What did you do
- How did you do it
- What did you expect to happen
- What actually happened

What did you learn (tick off relevant cases):

o You accidentally discovered new features
o You used a trial and error strategy
o You got an idea about the way of working of the system and you tested your idea
o You got a completely revised view of what is offered by your TV
o Other _____

What served as means of help in this process

o _____ on the appliance indicated what I should do
o I read the manual
o I used my expectations from _____
o I talked to _____
o I had heard about _____ from _____
o Other _____

The questions fall in two parts. The first section consists of an investigation of the activity. In particular we address the two levels of action and operation, and seek to identify possible contradictions between these levels in the way the television offers itself to the user as opposed to how the user is able to operate the television. The second part addresses the levels of learning as well as the levels of artefacts, i.e. *where-to, why* etc. artefacts, which come into play in the concrete learning situation.

We have followed up on both the interviews and the questionnaires in our recurring visits in the homes. Based on the information gathered in these ways, we have set up some hands-on session which have allowed us to investigate how different artefacts come into play in concrete situations of use.

Experiences from studying introductory use in the home

Interestingly, we found that in the case of Bang & Olufsen TV buyers, the *where-to* artefacts are formed by events and activities surrounding the TV appliance, which are only indirectly related to the design of the TV set itself. Through inviting special customers to events where new products are unveiled, Bang & Olufsen uses membership of the Bang & Olufsen society as a *where-to* artefact to provide an overall indication of what it means to be an owner of a Bang & Olufsen TV set. To further concretise this feeling of membership of the "Bang & Olufsen family", Bang & Olufsen presents other members of the family, e.g. lawyers, politicians, artists and designers together with their explanations of why they have decided on Bang & Olufsen products in glossy brochures which are given to customers in the special Bang & Olufsen boutiques. Closer to the

design of the TV set itself, you find the introductions to the overall functionality of the television, which are given by specialised sales personnel in the Bang & Olufsen boutiques. These introductions act as *why* artefacts and in some cases as *where-to* artefacts in that they provide the users with expectations as to what they can accomplish with a Bang & Olufsen TV set and thus justifies why they would want to buy a Bang & Olufsen TV set. It is interesting to observe that the *where-to* artefacts may be formed by events only vaguely associated with the TV set itself i.e the *what* artefact and further that both the *where-to* and *why* artefacts in this case come into play before users get any hands on experience using the TV themselves. The cinema experience which the Bang & Olufsen television owners told about by the time of the installation of their television in their home is an example of a *where-to* artefact which came into play before the customers had used the television themselves. In terms of designing the learning artefact, our empirical experiences implies that we should explore the potential of designing around the artefact or of designing the wrapping. Furthermore, the importance of the events which precedes the hands-on use experience further emphasises the problems of traditional laboratory studies for studying learnability of designs in that they fail to account for some of the expectations formed around the product in the context of a real life setting.

The analysis of our observations in terms of *where-to, why, how* and *what* artefacts further enables us to identify some interesting conflicts in the contextualisation between the different artefacts. As described above, the *where-to* and *why* artefacts provided for Bang & Olufsen TV buyers all serve to indicate the luxury and exclusiveness of Bang & Olufsen TV sets. However, when it comes to the *how* artefact in the form of a computer metaphor represented by the menu hierarchies and mode of operation using the remote control, the sense of luxury breaks down. Instead the computer metaphor signals efficiency and interactivity in operation, which is not well in line with exclusivity nor the nature of watching television. Thus, we need to be concerned with the contextualisation up- and downwards in designing the different artefacts, in order for the tool with its wrapping to stand out as a coherent tool in the experience of encountering and using it. In this way letting the users' expectations guide them in taking the product into use.

Further the Bang & Olufsen example points to potential imbalances in the priority between the artefacts at different levels. When we interviewed users at the time of the installation, they expressed a rich set of expectations as to what they would use their new television for including e.g. teletext programming of video, which enables easy programming of video recordings applying a direct manipulation principle. However, when we talked to them one month later, only few had done any programming in this manner. Some had given up, because they encountered problems they could not solve in going through the steps it takes to do the programming. Some of them had completely forgotten about the existence of the feature even though they had been very enthusiastic about it one month earlier. When analysing the case, we find that the Bang & Olufsen machinery provides a rich set of artefacts on the levels of *where-to* and *why*. However, in terms of *how* artefacts, which serves to support users in moving from expectations to actions, which in this case should have supported them in making use of the teletext programming facility knowing about its existence, the Bang & Olufsen television often fell through. This example points to the need for careful design of artefacts at all four levels. Further, although we may design around the artefact, this example also emphasises the need for the artefact to trigger the expectations formed

elsewhere, i.e. the what artefact must make references to these expectations and remind the user of the presence of the facilities of interest.

Concerning the different methods of inquiry used, our experiences suggest that interviews are useful for providing information on the *where-to* and *why* artefacts. The hands-on sessions which followed up on our interviews regarding users expectations complemented the interviews well. These hands-on session shed light on the transitions or lack of such from *why* artefacts level to *how* and *what* artefacts. However, the questionnaires did not work the way we intended them to. For various reasons, including the characteristics of the setting where a user sits tired in a late evening watching television, which does not lend itself to filling in questionnaires, the questionnaires were not used and thus did not work as an incident diary. However, the questions comprised in the questionnaire still represents a useful focus for studying learnability in concrete use situations and as such has served as our own agenda when discussing and analysing the hands on use sessions.

Thus a range of methodological approaches, necessary in order to investigate and develop learnable designs, need to be developed further, and has been done so in (Petersen et al., in preparation). Moreover as the example with the questionnaires suggests, these methods need to be developed with respect to the characteristics of the use setting, in this case the home sphere. We will look further at these matters below.

Revisiting the design model

The design model presented a hypothesis for a design-oriented theory of the learnable artefact. This model is process-oriented regarding design at the same time as it reflects a developmental understanding of use. Our empirical studies have further provided insights, some of which are discussed here (further details in Graves Petersen et al in preparation). These insights point to further challenges to designing for learnability.

First, our studies suggest a complex interplay between the different stages in the development of use. For instance, in one case a commercial for teletext programming of video, which the user had seen even before when he considered buying the TV, played a role as a part of the user's background in that it formed her expectations to the TV, i.e. formed the potential competence. This case emphasises both the special nature of some potential learning instruments and that the quest for learnable artefacts begins long before the establishment of initial familiarity.

Our studies further illustrate the wide range of artefacts which comes into play in these learning situations. As an example, when one user was struggling with connecting multiple loudspeakers as part of a surround sound set up we saw elements from

- the 'cinema experience' she had been explained about in the Bang & Olufsen boutique, her visit in a real cinema, her visits at her sister's house where they have an equivalent system as *where-to* artefacts,
- an (incomplete) operation principle regarding the remote control which she had intercepted from other members of her household worked as a *how* artefact, and finally
- the loudspeakers and the remote control as *what* artefacts.

However, our material also points to considerable individual differences in terms of preferences regarding learning instruments. Where two of the users we studies strongly relied on the manual

as a *how* artefact when establishing initial familiarity and consolidating their use, two others practically refused to consult the manuals, one by principle and the other one in practice. In terms of designing for learnability we have to consider the spectrum of users and make sure that the self-contained artefact or the *what* artefact at least allows the users to get started and do something, independently of such preferences. Thus although the wrapping, in terms of manuals, checklists etc. can be an important part of the design, we also need to be concerned with the design of the artefact proper, because the wrapping may be neglected by some.

The chosen microcosmos consisted of two families who we intend to follow over a period of at least four months and by the time of writing, we have followed them for a period of three months. Although intensive experimentation happened primarily in the first weeks, and the pace of learning and the interests in the TV set varies significantly among the individuals, we are continuously seeing changes in use and users experimenting with the possibilities of the TV set.

In our studies we have seen examples of how users have consolidated their use through e.g. discovering general principles of operation using the remote control. In the case of the user connecting multiple loudspeakers to obtain surround sound, we see that once she had understood one of the principles of the remote control, namely that it could be set to work in different modes, she was able to connect the loudspeakers repeatedly without problems. In the future, we consider supplementing our studies with visits to families who have owned the same type of television for years to see how their use have consolidated, i.e. which tasks they perform once the hype of the new TV set is truly over.

CONCLUSIONS

Design is a process involving contradictions, choices and trade-offs, rather than one where a predefined one best choice exists and can be found. We have seen how, in the range of concerns over learnability, contradictions need to be reconciled. We have seen how what might be the ideal regarding actions may contradict with the ideal regarding operations. Furthermore, learnability issues are certainly just one side of the issues of concern for design. We see no way of devising a reconciliation of these concerns in general; rather the issues must be dealt with in the particular design situation together with the future users.

We have seen how it is important for design to consider more than the physical wrapping of a technical artefact, by focussing on the *how, why* and *where-to* artefacts that can supplement or be included in the artefact.

Interestingly, the fact that e.g. TV sets constitute a minor and integral part of the everyday lives of people, has made it very evident that experiences from a number of other everyday artefacts play an important role for usability. The diverse group of users with many different backgrounds adds to this, in contrast to artefacts of work, where a systematic effort of introduction can be expected, and where the variety of backgrounds and experiences of users are largely ignored. In general, we have found it interesting how intrinsically complex the learning situation is for such a simple artefact, and we are convinced that this complexity will increase by many orders of magnitude when we study information systems with much more complex use settings.

We have made good use of the framework of Bardram & Bertelsen (1995) as a starting point for our concerns. Our empirical material shows that establishing an initial familiarity of the user

with the artefact is indeed a very complicated matter. The background of the user in terms of previous uses of a variety of artefacts are linked to the proposed new artefact in non-trivial ways, needing to be considered when designing for initial familiarity. Methodologically, the quest for learnable interfaces starts long before the establishment of initial familiarity. In similar ways, we have been more specific regarding how to establish design for learning in use, and for formation and operationalisation of actions, both more well-known points of concern in our tradition.

The design model forms a specialised version of Engeström's general cycle of expansive learning, targeted towards the challenge of designing learnable artefacts. Indeed, not every design-for-learning-in-use process is potentially a matter of a journey through Engeström's methodological cycle, and we are far from always heading for expansive development in and of use. In practical terms it can be worthwhile to focus mainly on the lower levels of learning. At the same time, we have discussed exactly how it is an important concern for usability design to actively consider the conceptual design that will help users understand why they want the new artefact and what place and purpose it will take in the future. Important for our methodological concern here, is that such a reformulation needs to start from the current activity of the users. It cannot be invented from out of "the blue".

Our empirical work has provided examples of what it means to design learnable artefacts. It has illustrated the complexity of this challenge in that we need to design both in and around the product, with respect to–and taking advantage of–the users' background and previous experiences. Our analysis, in terms of *where-to, why, how* and *what* artefacts, has suggested that these artefacts may develop to become important tools in designing for learnability.

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