Chapter 7
Practice-Based Computing: Empirically Grounded Conceptualizations Derived from Design Case Studies

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7.1 Introduction

The introduction of IT has changed the way we live in many ways. Historically, it can even be argued that socially embedded applications of information technology challenge and change practices to an extent rarely seen before with any other type of technological artifacts. If these IT artifacts have strong and recurrent impacts on people's lives, we need to reconsider design practice artifacts which allow for anticipating use practices and bring together inspirational creativity with evaluative methods.

Approaches such as participatory design (Greenbaum and Kyng 1991) and user-driven innovation (von Hippel 2005) have already significantly increased the level of involvement of users and their fields of practice into IT development and have strengthened the role of ethnographic methods as well as the importance of methods providing direct user feedback. But even a strong component of domain analysis or user participation does not warrant an accurate anticipation of the changes in social practices resulting from new technological artifacts or infrastructures. Moreover, the immaterial nature of software contributes to its application beyond the originally

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intended context. The material and social foundations of IT usage have significantly changed over the past two decades. Technologically, the standardization of communication interfaces, the increase of bandwidth and speed of Internet connections, and their ubiquitous availability have connected more and more devices with each other. At a social level, this has also created stronger connections between professional and private domains and practices, offering new room to adapt these practices and renegotiate their relations and compositions. These developments have made us now look at ecosystems (Draxler et al. 2015) or infrastructures (Star and Ruhleder 1996) of technology-based practices.

With regard to methods, EUSSET's research agenda would benefit from a convergence of a broadly defined research program which looks at technology development as well as scenarios of usage and accumulates results in various ways, bridging the gap between a simple "technology-in-practice" perspective and a "technology-based practice change" perspective. We need to consider how to carefully transfer emerging design concepts, IT artifacts, and pattern of appropriation derived in a specific context to other fields of application. We also need to better understand how to transfer findings gained with the design and appropriation of one artifact toward that of another, related one.

In this paper, we will outline a research program, called practice-based computing, which suggests collecting a corpus of highly contextualized design case studies and supports the transferability of insights by comparative concept building on top of these cases.

7.2 State of the Art: Conceptions of Social Practices

In social science, various theories of social practice have been developed as interpretation patterns that serve to provide an explanation for human interaction. Some of the most important contributors to social theories elaborating on practice include Bourdieu (1977, 1990), Giddens (1979, 1984), Garfinkel (1967), and Latour (1993). These approaches turn against rationalistic or structurally deterministic interpretations of human action and interaction as well as interpretations which neglect historical imprint, sociality, and reflexivity of human interaction.

Reckwitz (2002) attempted to elaborate on the various practice theoretical approaches by identifying core assumptions shared by the different theoreticians. According to him, these schools of thinking understand practices as the smallest unit in the analysis of social phenomena. Within the bounds of practice, a pattern is understood as being a considerably routinized, subsiding human action, an action which is not only encompassed by mental and physical forms of activity but that is also greatly imprinted by objects, especially by tools, media, and their usage. A practice generated by human actors is structured by background knowledge that is not entirely explicit but contains emotional and motivational elements. Examples of practices depict a certain manner in which work, research, cooking, or even playing soccer is to be conducted.

With concrete relationships as their contexts, practices represent collective patterns of interaction that are reproduced by human actors. While the interaction patterns may be routinized, the repetitive and tangible acts of execution take place context-specifically. The reproduction of practices goes hand in hand with certain world views, a related normative stance, and use of specific language. Human actors typically belong to different practice systems and mediate among them.

In contrast to other cultural-theoretical positions, practice theoreticians emphasize in particular the social efforts expended in reproducing common routines, the close connection between bodily and mental activities, and the importance of (technical) artifacts for the constitution of practices. In this respect, they offer interesting conceptions for design-oriented research (Wulf 2009; Wulf et al. 2011; Kuutti and Bannon 2014). Regarding the academic discussion in the field of human-centered computing, certain conceptions have already been used by individual authors (cf. Orlikowski 1992; Hanseth et al. 1996; Walsham 2006; Huysman and Wulf 2004, 2006). However, conceptualizations of IT-related social practices have not yet been systematically explored with regard to a methodological grounding for design research.

7.3 State of the Art: The Interplay of Practice and Design

An understanding of social entities that is grounded in an analysis of social practices offers interesting implications. If IT artifacts are not aimed at complete automatization, but rather keep the human actors in the loop by focusing on the support of their collective activities, then these artifacts need to be appropriated within the social practices of their specific fields of application.

The field of human-centered computing has seen different approaches to deal with the interrelation between social practices and IT artifacts. The research can be broadly classified into four lines of thinking: (1) one which grounds the design of innovative IT artifacts in ethnographical studies of one – or a few – specific instance(s) of their domain of application, (2) one in which the appropriation of (innovative) technical artifacts is investigated empirically over a longer period of time, (3) one in which designers engage with practitioners in exploring the design of innovative IT artifacts in situ in a participatory manner, and (4) one that reflects design research on and within design practices.

7.3.1 Grounding Design by Means of Ethnographical Field Studies

At the emergence of the CSCW community, Lancaster University was one of the first places to systematically explore the role of ethnographic field studies for the design of IT artifacts. Ethnographic studies on work practices in air traffic control,

still seminal in the field, informed computer scientists to develop innovative IT artifacts (Bentley et al. 1992). The reference between the work context and IT designers' activities was mainly created by the ethnographers' account. This account became an important element in design activities. Hughes et al. (1992) have classified different roles an ethnographical case description can play in the design process.

Emerging from similar epistemological roots, Dourish (2006) even suggested keeping the linkage between ethnographic (pre-)study and the construction of technical artifacts on a less enforced level. He strongly suggested abandoning the requirement for ethnographers to conclude their studies with a section on implications for design.

On a more fundamental level, Schmidt (2011) sees the role of ethnographers in analyzing complex cooperative work practices. From such empirical analysis, he argues, computer scientists will be able to deduce software architectures and applications which are sufficiently generic or tailorable to be appropriated in different fields of applications.

While the Lancaster school opened the way for the fertilization of design practices by ethnographic accounts, the linkage between designers and users was still a rather mediated one, mediated by ethnographers' documentation of practices. Dourish (2006) contributed to the clarification of this linkage. Overall, in these schools of thinking, there is little interest in rolling the IT artifacts out in the wild; an investigation into their appropriation in practice was not a crucial part in the research endeavor. Schmidt (2011) anticipated context-specific appropriation activities and a need to technically support them. Moreover, he assumed that their range could sufficiently well be anticipated in an ethnographic study. Brödner et al. (2015) proposed an approach of grounded design (GD) as a praxeological research perspective for information systems research, specifying an ethnologically informed set of GD principles and according research process guidelines.

7.3.2 Studies on Supporting the Appropriation of IT Artifacts

There are numerous studies on the adoption of information technology available in the field of information systems, leading up to theories that systematize studies of adoption processes (e.g., the Adaptive Structuration Theory (DeSanctis and Poole 1994) or the diverse versions of the Technology Acceptance Model (TAM) (Davis 1989; Venkatesh and Davis 2000) and epistemologically similar approaches (Venkatesh et al. 2003)). Although TAM has proven useful in understanding behavioral intentions of use, it remained difficult to identify drivers, crucial moments, and activities that lead to a successful technology usage (Turner et al. 2010).

We interpret the appropriation of information technology not as an abstract phenomenon that somehow happens once a software application is in its "application field," but as a network of activities that users perform in order to make a software "work" in the new work environment. Existing practices evolve and result in new practices that may also include software usages that go beyond what was envisioned

by the designers of the software application (Pipek 2005). Appropriation work is a specific part of an IT artifact's usage, but it also remains linked (through the artifact's materiality) with its design process and the designer's work environments. This work has to be studied empirically.

Several early case studies have investigated appropriation work of IT artifacts in a long-term perspective (Karsten and Jones 1998; Ngwenyama 1998; Orlikowski 1996a; Pipek and Wulf 1999, 2003; Törpel et al. 2003; Wulf 1999; Hinrichs et al. 2005; Draxler et al. 2015). They offer empirical insights into appropriation activities and the resulting changes in work practices, and they also show that a significant part of the work being done to make software applications work is collaborative by nature and that it spans from simple sense-making efforts to detailed configuration efforts to make a new technology fit an existing practice.

Pipek (2005) aimed at turning these activities into a seed for new types of functionality to support appropriation work within the technology that is being appropriated: articulation support (support for technology-related articulations – real and online), historicity support (visualizing appropriation as a process of emerging technologies and usages, e.g., by documenting earlier configuration decisions, providing retrievable storage of configuration and usage descriptions), decision support (in a collaborative appropriation activity, providing voting, polling, etc.), demonstration support (providing communication channels to demonstrate usages from one user or group to another user or group), observation support (supporting the visualization of – accumulated, anonymized – information on the use of tools and functions in an organizational context), simulation/exploration support (showing the effects of possible usages in an exemplified or actual organizational setting, maybe allowing configuration manipulations in a sandbox; see also Wulf (2000)), explanation support (explaining the reasons for application behavior, automated vs. communication with experts), delegation support (supporting delegation patterns within configuration activities), and support for (re-)design support (feedback to designers on the appropriation processes). This list focuses on user-user collaboration, and most support ideas still remain as challenges that have to be met with appropriate technological support.

7.3.3 Participatory Design

The Scandinavian tradition of participatory design (PD) was the first to involve practitioners from selected domains of application in the design of IT artifacts (Floyd et al. 1989). As an example of the still seminal work, in the Utopia project, new tools were designed together with employees of the printing industry which was on the verge of digitalization. Over the course of several years, the participatory design community developed and evaluated a variety of techniques of user participation in software development practices (Greenbaum and Kyng 1991). In its traditional mainstream, fieldwork was not considered necessary since its

findings could conflict with the self-expressions of the workers' needs (for notable exceptions, see Blomberg et al. (1996) and Kensing et al. (1998)).

With their empirical analyses, (participatory) designers can however contribute to the reflection processes of practitioners. Some authors discussed the relationship between ethnographic studies and participatory design activities, mainly in using ethnographic data from "rapid" or "quick and dirty" pre-studies to inform PD sessions (Crabtree 1998; Hughes et al. 1995; Millen 2000). As a consequence, Crabtree (1998, p. 93) suggested putting more emphasis on an ethnographic pre-study to gather solid information about the organization in order to avoid "the danger of 'tunnel vision' and thus, of coming up with perfect technological solutions to the wrong set of work problems" in PD workshops. In a long-term analysis on their PD work in office settings, Suchman et al. (1999) summarize the PD activities of critical analyses of technical discourses, ethnographic work at the workplace, and design interventions as a program of reconstructing existing and emerging social practices in the field as well as reconstructing the methodological practices of designers as researchers. The authors do not draw strong methodological consequences but rather demand increased sensitivity toward these two levels of reflection. Suchman (2002) later gave a more detailed account of technology development and its structural problems that result from the existing structures of professional specialization, however focusing more on a lack of continuous interaction between practitioners and technology specialists.

Several more recent reflections try to move away from the product focus (e.g., Ehn 2008; Karasti 2001; Karasti and Syrjänen 2004) and the process focus (e.g., Pipek and Wulf 2009; Di Salvo et al. 2012; Dittrich 2014) that is inherent to technology design efforts (even with "participation"). However, it remains difficult to find clear methodological advice about organizing these efforts in a way that satisfies the needs of all stakeholders involved.

7.3.4 Research Through Design and Design Science

In a more deliberate manner, the "research through design" school of thinking has developed techniques to understand social practices for supporting the design of IT artifacts (Gaver 2012; Forlizzi 2008; Stolterman 2008; Zimmerman et al. 2010). Emerging from a traditional design stance, the output of their works takes the form, primarily, of artifacts and systems, sometimes with associated accounts of how these are used in field tests (Gaver 2012). The main concern of this perspective is on the exploration of new design spaces for IT artifacts. As a consequence, analyses of the existing practice and related empirical (predesign) studies play a lesser role. The immediate reaction to the designed artifact is in the focus, and long-term issues of appropriation work are rarely explored, partly because the artifacts are only at a prototype level. Nevertheless, most projects engage with real practice, not with experimental settings.

Referring back to Herbert Simon's work (1996), Hevner et al. (2004) and Hevner and Chatterjee (2010) have postulated a design science approach to the field of information systems. They argue in favor of a three-step process in which the artifact design needs to be grounded in an important and relevant business problem. Moreover, the utility, quality, and efficacy of the design artifact must be rigorously demonstrated via well-executed evaluation methods. However, Hevner's work suffers from a mechanistic understanding of design and lacks a systematic grounding in social practices (Rohde et al. 2009).

Inspired by the participatory design tradition, Scandinavian researchers in IS have developed design approaches which intervene in real-world organizations (Braa and Vidgen 1999; Mathiassen 2002; Sein et al. 2012). However, they typically pay little attention to the long-term appropriation of IT artifacts (Braa and Vidgen 1999; Mathiassen 2002) or classify their cases in a too schematic manner (Sein et al. 2012).

7.3.5 On the Issue of Transferability

In the field of human-centered computing, there are different understandings with regard to the generality and transferability of research findings. A positivist stance underlying, for instance, the design science approach of Hevner et al. (2004) follows a theory-building paradigm derived from the sciences. It assumes that models and theories can be generated which describe the interaction of humans and IT artifacts in a reproducible, design-oriented manner. In such an understanding, models and theories do not refer specifically to the context of their origin – since they claim general applicability within the limits of their scope of validity (cf. Chi et al. 2011).

Most other schools of practice-oriented design do not follow the positivist stance and raise epistemological concerns whether the generalization of findings is possible in such a context-independent manner. Findings are usually presented together with a description of the context from which they emerged. However, this school of thinking has not yet come up with coherent guidance on how to transfer knowledge beyond individual design cases. Empirical work in the information systems community, e.g., Orlikowski (1996a), thrives on the elaboration of widely applicable concepts and descriptions dealing with appropriation activities. In the participatory design community, the attitude is held traditionally that results should not be transferred from one case to others since the workers should determine their work and codevelop their tools and local knowledge.

When dealing with transferability, the ethnographically grounded design community rather looks upon the transfer of insights as being mediated by the resulting IT artifact that would be designed for the appropriation in different social settings. Such an understanding is close to Gaver's (2012) perspective on a potential epistemological grounding of the "research through design" community. He suggests collecting a set of examples of (well-)designed IT artifacts and annotating such a portfolio with conceptual considerations ("the role of theory should be to annotate

those examples rather than replace them"). This position has been contested by others in the "research through design" community who claim that theory building should be at the core of its academic activities (Zimmerman et al. 2010).

7.3.6 Gap in the State of the Art

The relations between a design process, a design product, and the related fields of practice have been discussed from many angles. The contributions range from philosophical reflections (e.g., Ehn 2008) over case study collections (e.g., Di Salvo et al. 2012) to comprehensive theories (e.g., Hevner et al. 2004). The challenge is – in our eyes – not a lack of attention and discourse, but the lack of a discourse structure that allows a comparison of different practical experiences from different design projects. The quality of IT design can only be determined by looking at the changes in social practices resulting from appropriation activities. We need a conception of how to document design cases in a holistic manner spanning the different phases of a practice-oriented design process: the status of technology and activity systems as well as ongoing sense-making activities that provide orientation for possible further developments of a practice that precede any decision of practitioners to engage in design activities, the (possibly participatory) conceptualization of a new technology aiming at improving a practice as the actual design process, and the appropriation of the new technology that results in a changed social practice. Roughly, this reflects a participatory action research perspective (Whyte 1991), but we need to be more specific with regard to the relations between technology design and practice reflection to allow better comparisons.

The different schools of practice-related design thinking have not yet come up with a convincing understanding as to what extent and how transferability across different contexts could be achieved. Theory building across different examples is mostly dismissed, looked upon with great suspicion, or limited to the generation of concepts to describe only the new phenomena emerging in the case at hand. Claiming the context dependency of the findings, it lacks a convincing model of how to transfer design-relevant findings from one context to the next. The core mechanism of concept building seems to be the comparison of case studies with earlier findings – be they other case studies or theoretical concepts. There is little progress toward establishing what we could call a "corpus" of studies. There is no coherent model of comparative analysis. So it would appear to be the reader of a case study rather than its author who is responsible for transferring findings to a new context.

In the following, we suggest "design case studies" as an action research methodology, and we argue that a repository of design case studies and their comparative analysis can help us in concept building and increasing the level of transferability (cf. Brödner et al. 2015).

7.4 Design Case Studies

In the following, we want to propose design case studies to be an appropriate element in a practice-based research program. To design, we need to better understand the relationship between specific instances of social practices and the design space for IT artifacts in their support. The design of IT artifacts needs to take the given social practices, including the already existing IT infrastructures, into account. However, when these artifacts are rolled out "in the wild," these practices undergo changes during the appropriation process. We need to understand the interaction between the IT design and the appropriation activities over a longer period of time (Pipek and Wulf 1999; Rohde et al. 2009; Wulf et al. 2011).

These changes in practices can occur on different societal levels. The introduction of IT artifacts often connects social practices that were previously unconnected. Because social practices cannot be changed in some random way, due to issues of embodiment and routinization, we need to grapple with the expansive repertoire of practices one encounters in various fields of practice. We also need to gain an understanding concerning the possibilities of change in the context of the introduction of IT artifacts.

Design case studies ideally consist of three phases:

1. Empirical pre-study: This should offer microlevel descriptions of the social practices before any intervention takes place. An analysis should particularly describe already existing tools, media, and their usage. It should also capture the development seen by horizon practitioners from a technological, organizational, and social perspective. Such documentation can be typically formulated in a certain problem or need statement when setting up the research agenda. This documentation may be already available in documents in the fields of practice, or it needs to be collected in an ethnographic endeavor that helps practitioners in reflecting upon their situation.
2. Prototyping/(participatory) IT design: Design case studies should describe the innovative IT artifact from a product as well as from a process perspective. This includes a description of the specific design process, the involved stakeholders, the applied design methods, and the emerging design concepts. A focus should lie on the documentation of what changes in social practices the stakeholders anticipate and aim for and how these considerations have influenced the design of the IT artifact.
3. Evaluation/appropriation study: Design case studies should document the introduction, appropriation, and potential redesign of the IT artifact in its respective domain of practice. Such documentation allows the transformative impact of certain functions and design options realized within the IT artifact to be analyzed. At this point, it is also necessary to document the distribution patterns of the new technology in the field of practice. The work in all phases is always a collaboration between researchers/designers and practitioners. Although there is a natural order of starting points of the phases, we do not understand the phases as being strictly consecutive, but as continuing: once an analysis of

existing practices has started, it does not make sense to stop reflecting upon the momentum of the existing practice; rather, it continues throughout the design and the study of the appropriation. Once the design has started, it may be continued in several iterations, although the technology has already been introduced to potential future users. In the late phase of a design case study, the "phases" should rather be perceived as perspectives.

One other important point to be described is the reflection upon limitations in the researchers' practices. To a certain extent, the funding structures of research define the time and the amount of resources that researchers may be able to invest, particularly in very time-consuming tasks such as participatory observations. Additionally, side agendas (of the researchers as well as practitioners) may influence the dedication of stakeholders. In comparing cases, it is not the exact quantification of these issues that is important, but rather the reflection of the relations between researchers and practitioner's practices.

The whole idea about design case studies aims at informing the aggregation of cases. Typically, a "case" is a "natural" unit to look at: it is one set of connected activities of researchers and practitioners in one field of practice. There may be, however, difficulties of different types that make it impossible to maintain collaboration over the necessary time span of a design case study. There are basically two ways to deal with such a situation:

1. Design case studies may shift over time from one field of practice to a related one. For instance, the pre-study may have been conducted in one field of practice, while the appropriation can only be observed in a similar, but different, field of practice. In this case, we speak about an *aggregated* design case study.
2. Design case studies may need to be disrupted at a certain point of time without covering design or appropriation phases. For instance, we may end up with only a pre-study. However, this empirical study has been conducted in a manner to explore design opportunities. In this case, we speak about a *partial* design case study.

In both cases, it is the research practice that defines the design case study. The necessity to work with aggregated or partial design case studies may result from the practice under observation (e.g., the practice of organizing a conference, Saeed et al. 2011, or the practice of crisis management, Ley et al. 2012). But it may also result from the resource structure of researchers. Again, the point is to comment on the consequences of these restrictions in the design case study itself (Fig. 7.1).

In the following, we discuss the details of our approach against case studies we have conducted. All examples have already been published elsewhere. Starting with a procedural description of our research practice, we continue by referring to those aspects of the individual cases relevant to discuss our approach. We will later also use a fifth example of consecutive case studies to illustrate the concept of partial design case studies.

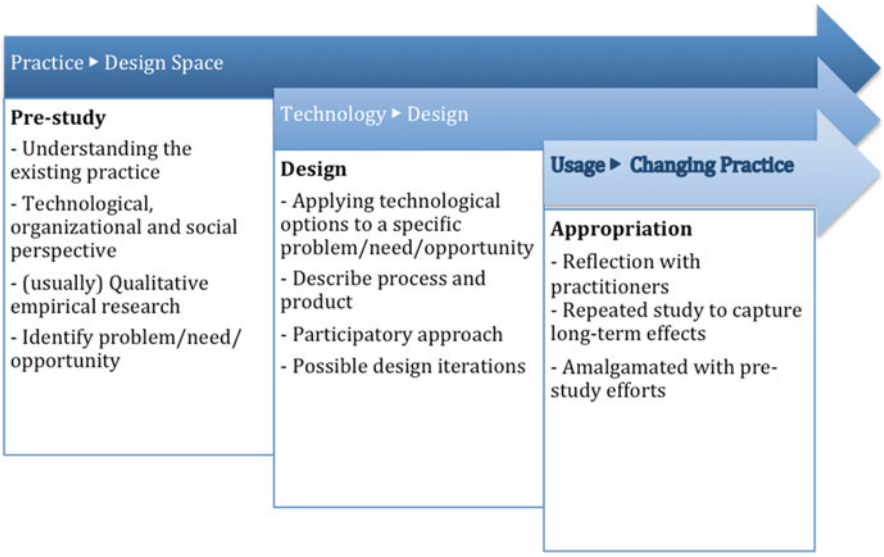

Fig. 7.1 Schematic display of the structure of a design case study

7.4.1 Expert Finder in a Networked Organization

An early example of a design case study is the development of the *Expert Finder*, a recommender system to foster expertise sharing among workers within an industrial association (NIA) and its member companies (Reichling and Veith 2005; Reichling et al. 2007; Reichling and Wulf 2009). The lack of visibility and accessibility of expertise is a recurrent problem in larger organizations and organizational networks. The project was initiated by a fraction of the association's management and was partly funded by the German Federal Ministry of Economic Affairs within a funding scheme on knowledge management. In the first phase, the field of application was investigated empirically by observational studies, an analysis of the IT infrastructure, and 16 semi-structured interviews. The study focused on one operating section of the industrial association, some central units, and their relationship with selected member companies. The study looked at collaborative work with a specific emphasis on knowledge exchange needs and practices. Based on these findings, the design of *Expert Finder* was developed. The development was based on already existing software components, the ExpertFinding framework (Reichling et al. 2005). Specifically, the functionality of selecting documents from the users' ordinary file system, the configuration of the matching according to the specific types of text, and the concepts to protect workers' privacy were stimulated by the findings of the pre-study (Reichling et al. 2007). Finally, the *Expert Finder* was rolled out for a period of 9 months, mainly in those parts of the association which had participated in the pre-study and one member company. The somewhat

restricted field of application impacted the evaluation results concerning expertise sharing practices because many of the actors knew each other rather well. However, the study provided interesting insights with regard to the self-representation of employees within the recommender system and their sensitivity toward privacy-oriented features.

7.4.2 Navigation Support for Firefighters

A second design case study was conducted when developing *Landmarke,* a ubiquitous computing platform to support firefighters in navigating inside burning buildings. The project was funded in two consecutive projects by the European Commission and the German Ministry of Research. The EU-funded project WearIT@work focused on bringing wearable technologies to different types of blue-collar workers. Working with the Paris firefighters, the rather basic design concept of *Landmarke* was developed. At its core, it suggested a navigation support system to leverage the social practices of the firefighters on reconnaissance missions in finding routes by themselves, instead of compiling maps automatically and providing computer-generated guidance. A consecutive project, called *Landmarke* (German term for "landmark"), was funded by the German Ministry of Education and Research (BMBF) to explore and implement the platform for navigation support. In *Landmarke*, we worked closely with the Fire Brigade of Cologne and with the Firefighting Institute of the German State of North Rhine-Westphalia (IdF).

Since it was impossible to observe firefighters and to deploy prototypes in burning buildings, we mainly used training sessions constructed according to realistic firefighting conditions in training centers such as at the Firefighting Institute. The Institute offers buildings in which different architectonical settings are realized, like different apartments, a restaurant, an underground parking lot, and a laboratory. At the beginning of the project, we had little insight into the subtle navigation practices of firefighters. From the very beginning, we therefore followed a participatory design in which intended users have a significant amount of control in design decisions. Video recordings and observations while prototyping, rather than traditional ethnographies, were the driving technique to explore given navigation practices and to bridge between the present and the future in navigation. Prototypes of different levels of sophistication were built and explored in the training center. The Arduino toolset proved to be very helpful in constructing prototypes of medium complexity (Ramirez et al. 2012). Finally, we built our own ubiquitous device which we integrated into doorstoppers: artifacts the firefighters were carrying with them anyway (Ramirez 2012). These devices were used in specifically laid out training scenarios in the Institute's buildings. Due to the danger to life involved when entering burning buildings and the related safety regulations, we were not able to explore the landmarks in real firefighting practice. However, the training sections indicated that the landmarks augmented already existing navigation skills. Specific advantages could be seen when withdrawing from the building and when handing over to a second troop of firefighters.

7.4.3 Location Tracker for Dementia Patients and Their Caregivers

A third design case study is an aggregated one and deals with the development of a GPS service for caregivers of individuals suffering from Alzheimer's disease with a disposition toward wandering behavior. The study was funded by the German Ministry of Economics in a technology transfer funding scheme, supporting a software company in bringing such a product to market. This Alzheimer disposition is very problematic for patients since it fosters anxiety and disorientation and can even lead to life-threatening situations. Caregivers react to these threads by strategies which may reduce the patients' freedom to move. In the first phase of the study, we conducted 21 semi-structured interviews with six family caregivers who live at home with their relatives suffering from dementia and 15 professional caregivers working in retirement homes. We investigated caregivers' practices and uncovered their attitudes toward monitoring systems, which revealed two value-laden dilemmas in the design of location trackers: "awareness vs. privacy" and in particular "safety vs. autonomy" (Müller et al. 2010, 2013). The next step was to implement two location tracker clients, one mobile and the other stationary, which indicated the position of the patient on a map. Certain movements in areas near the patient's home could be excluded from being tracked. Over a period of 4 months, we introduced the system into three fields of application: a family and two different care homes. After the appropriation of the application, we saw a considerable change in the practices of dealing with dementia patients suffering from the wandering symptom (Müller et al. 2013). However, the fields of application where we tested the location tracker were not exactly the same as the ones in which we conducted the pre-study. This was due to two aspects: firstly, there was a deterioration in the health of the patients whose caregivers had first participated in the pre-study to the extent that they could no longer walk on their own anymore; secondly, we had to find evaluation environments in which the system would be embedded in real practices but with a high safety level and risk control as we could not guarantee full 24/7 performance of the prototype (Wan et al. 2014).

7.4.4 Social Display

Social Display is a project located in a residential care home aiming to research the question whether IT can be an appropriate means to support quality of life of persons of advanced age (aged on average between 80 and 90) (Müller et al. 2012). When the project started, the home did not offer public Internet access; few (if any) residents had computers; and only a very small number had any experience at all in using IT. In a similar way, the caregivers only very rarely use new media and the Internet in their work with the residents, and most of them only use the PC for their administrative work (such as documentation, digital records) and had minimal interest in IT, even in their private lives.

The project started in 2009 with an interview pre-study and several participatory workshops to elicit applications for a large-screen display which would be of interest to the elderly residents as well as to the caregivers in their work with the residents. Initially, we undertook 13 interviews with residents and caregivers and 30 h of participant observation in order to study their routines, their wishes, and demands. Based on these findings, we developed design ideas for the display. The pre-study provided insights in the elderly's self-concepts and revealed a high degree of passivity to which an alignment of design ideas looked rather impossible. On the other hand, previous research had consistently shown that the appropriation of specific IT applications may offer significant benefits for the elderly and even for very old people living in residential settings (Piper et al. 2010). We therefore believed we had good grounds for pursuing methods for engaging this potential user population. In recognizing that the residents were familiar with and willing to participate in organized activities, we established "Internet Days." During the Internet Days, we presented different online services at five stations, four with computers on large monitors and one with a Wi-Fi device connected to a large-screen television. It transpired that the Internet Days provided a fruitful setting for mutual learning and common engagement with IT and Internet applications.

Based on these experiences, we built the first version of the social display offering four functionalities: local news, national news, a photo album, and short films presented on a large-screen display. As an input device, we chose a PlayStation buzzer with five colored buttons, each of four buttons representing one functionality. For the more technically affine caregivers, an Internet browser accessed by keyboard and mouse was available to support collaborative Internet sessions, mostly for biographic work. The first stable version, introduced in 2010, has been slightly improved over time according to the results from the ongoing fieldwork. Manifold appropriation processes could be observed; for instance, residents started new forms of interaction in front of the display, while – in the pre-study – we had experienced that the residents found it problematic to get in touch with each other. The staff started to use the display for biography work sessions with both single residents and groups. In the same way, nonresidents, who were regular lunch guests in the home, also started to use the system and came into contact with the residents, something which had hardly ever happened before. In recent years, many additional initiatives associated with the display have been introduced by student groups from our university with the aim of developing additional hard- and software pertinent to the display. Additionally, we developed a training concept for the staff. The work is still ongoing and is nowadays (in January 2015) mainly based on regular meetings with interested residents and staff members to document the appropriation and elicit further design options.

7.5 Characteristics of Design Case Studies

Design case studies represent an idealized model for conducting design research in practice. They provide a clear orientation for the design process. However, as a result of the contingences of a practice-oriented research approach, the concrete

methods to be applied in each of the different phases of a case study will be distinct. Also, the duration and the depth of the activities of each of the three phases may differ. Phases will interleave as well. We want to discuss the variability of design case studies according to the different phases.

7.5.1 Setting Things Up

Design case studies first attain thematic and institutional positioning in the course of their establishment. Developers of innovative technologies need to come together with actors who are willing to explore the potentials of such technology in their daily practices. There may be other stakeholders to be involved in the design process, such as representatives of marketing divisions of the IT companies or higher management and workers' representatives on the side of the user organization. The actors involved in the project establishment define the vision of the research project and should be selected with great care. The experiences and the mind-set of the developers, the selection of the application partners and their individual actors, as well as the mode of cooperation among designers and stakeholders shape the emerging IT artifact. For instance, in the *Location Tracker* project, we decided to involve family caregivers as well as those in residential homes. The resulting IT design reflected the broader variety of different practices rather than just the involvement of one field of application.

These actors contribute their specific interests and perspectives which are not always in line with the issues on the researchers' agendas. For instance, initial access to the home was via the manager. At the outset, his intentions were marketing driven. He asked us to develop a large-screen display for advertising rather than for care purposes. For this reason, it was supposed to be located in the entrance hall. However, we were more interested in large-screen displays in the care context of very old residents, and we finally convinced the manager to open up the project with a stronger care focus while the displays were still visible from the entrance hall. The project setup often requires negotiations to align problem perceptions in practice with an academic positioning of the work.

In the European context, design case studies are often funded by research agencies which either take technological innovation to be a driver in societal innovation and international competition or want to explore the potential of innovative technologies in tackling certain social problems. These governmental agencies fund research institutions and IT industries, and in addition there are often also partners who plan to apply these technologies in their social practices. In most of the design case studies mentioned above, the institutional setting was defined by the project proposal receiving government funding. In the case of the *Location Tracker*, the application partners were not defined by the research proposal, and the *Social Display* project was not funded by any government agency. Institutional divides on the side of the technology developers can impact the course of design case studies considerably (see Dachtera et al. (2014) for the case of the *Landmarke* project).

7.5.2 Pre-study

To ground the design process, the empirical pre-study allows the given social practices in the envisioned field of application to be better understood. The methods are empirical, consisting typically of interviews, observations, video and document analysis, as well as an investigation of already existing IT artifacts and their appropriation, which can include log-file analysis. The configuration of the empirical methods depends on the nature of the given practice, the researchers' already existing knowledge, and how the practices can best be accessed and understood. Certain practices can be better described verbally, while others need to be observed in detail, e.g., the subtle navigation moves of firefighters.

In one extreme, there can be design case studies in which the actual practice, before conducting the design interventions, is so well understood that the researchers may abstain from an explicit pre-study. A good understanding of existing practices and related problems which should possibly be supported by future prototypes is often based on a preexisting problem perception and analysis by the application partners and their ability to articulate and reflect in terms of possible technical solutions.

When working with elderly and non-technology-affine people, there was often no such common ground. This points at other elements the pre-study has to encompass too. For the case at hand, the pre-study target was divided into two parts: gaining insights into current everyday practices and the problem perception of the target groups. However, the pre-study may include measures to help the actors become familiar with ideas of possible IT support.

In *Expert Finder* we mainly worked with semi-structured interviews, while in the *Landmarke* study the firefighters were mainly observed while conducting navigation tasks. The navigation practices we observed were partly made even more challenging by the introduction of specific conditions, such as blindfolding the firefighters' eyes. In the *Location Tracker* project, in addition to semi-structured interviews, we accomplished several days of participant observations in institutions of dementia care. In the *Social Display* project, it was quite a challenge to gain access to the elderly residents in the realm of the pre-study based on a qualitative interview approach. This was due to specific psychological and social issues of the target group. Thus, we enhanced the interview study with interventions such as the Internet Days. Off-the-shelf technology was brought into the residential home for residents and care workers alike to explore Internet content such as Google Earth, which enabled the elderly residents to see their birthplace or where they used to live or work, and YouTube to access music and films, or news sites. In the interview sessions, it had not been possible to find out what the elderly would class as fun since the triggers for chatting about these things had been missing.

The focus of the pre-study is somehow directed by the anticipations – often still blurred – of the design concept to be addressed; it uncovers elements of current social practices and their problematic aspects. For instance, *Expert Finder*'s pre-study indicated severe organizational barriers in knowledge sharing within the

industrial association NIA and its member organizations – related to the fact that people working on similar topics did not know each other.

Based on these findings, the pre-study provides hints at how to design IT artifacts as incentives for the development of the practices investigated. Compared to social science research endeavors which require empirical depth for a profound understanding of the site, the pre-study phase can be a bit fractal since it is the first step of a potentially ongoing engagement. The design case study approach allows the correction of misperceptions during the subsequent participatory design activities and investigations into the appropriation of the IT artifact.

Activities in the realm of the pre-study also aim to build up trustful relationships between users and design team which are essential for further engagement. In addition, measures have to be taken up which help to build a common notional realm of possibilities and also to help the target group to become familiar with ideas of possible IT usages. This may include measures to help the target group reflect and talk about their everyday life and to be able to start thinking about possible IT support for their practices. In the *Social Display* project, the Internet Days created a fruitful environment for prototyping and appropriation. These interventions opened up a common frame of reference and a learning environment which made residents, care staff, and even researchers eager to engage in the next sessions.

The results of the empirical pre-study are, like those of a whole design case study, typically partial in the sense that they only cover a certain, often small, part of the IT artifact's potential field of application. When planning a pre-study, one has to balance depth against breadth under the temporal restrictions resulting from the design process. To envision the appropriate set of stakeholders requires a certain anticipation of the IT artifact. Moreover, a broader variety of different practices and resulting design concepts may contribute to the implementation of a higher level of technical flexibility. It may therefore make sense to involve more potential users and user organizations' perspectives in the pre-study than can be involved in the design process later on. However, the limiting factors are (a) obtaining the required empirical depth in analyzing relevant practices and (b) coming up with relevant results timely enough to influence the design phase. In the case of *Expert Finder* and *Location Tracker*, the empirical pre-studies took between 4 and 6 months and partly interleaved with the following design phase. The selection of the users involved in the early stage of the design case study contributes to the definition of the artifact's scope of validity.

As the *Location Tracker* project focused on both practice areas, familial and residential, we aimed at contacting interview partners in both fields. Obtaining contact to professional caregivers in residential care homes was rather easy because most of them were interested in these new technologies and were eager to learn more about them. In contrast to this, we learned that the "moral universe" in families where a family member suffers from dementia can be very complex and often inhibits them from talking freely about related problems and sorrows. It was often only with the help of a self-help organization that we could gain access to the families. However, some families and institutions read about our project in the newspaper and contacted us to learn more about the project.

The results of the pre-study revealed partly extremely controversial attitudes toward possible GPS-based IT support. We learned that the field of practice is based upon very different and individual approaches to dementia care, depending on the level of care theory knowledge, the familial relationships, and organizational issues such as work load, risk perceptions and risk management, as well as individual IT expertise.

7.5.3 (Participatory) Design

The design phase of the case study builds on the findings and commitments derived from the empirical pre-study. It takes the descriptions of the social practices and their inherent problems and developmental needs as input for the design process. However, the results of the pre-study do not determine the outcome of the design process. Descriptions of given practices do not determine how to support them in the future by means of innovative IT artifacts. Design is a sophisticated activity best conducted by specialists. It requires the anticipation of technological as well as social futures. However, we enrich the design process by input derived from the relevant fields of practice. This includes engaging practitioners, preferably those already involved in the pre-study, in the design process. While empirical findings of the pre-study play an important role in grounding the process, there are other important factors such as the given practices of the design team, its creative potential, its interaction with the stakeholders and potential users, already existing design concepts, and technical infrastructure, such as software repositories at hand, which influence the final outcome considerably.

The four different design case studies deviated quite considerably in their concrete design approach. In *Landmarke*, the firefighters' navigation practices had not yet been perfectly analyzed after the pre-study activities – also the non-design-oriented literature did not offer sufficient insights. Even after a broad design concept emerged, it remained unclear how to support navigation practices in detail. Moreover, there was not yet any technical framework to build the design on. Therefore, the design process was most extensive, including a wide set of participatory design activities (Ramirez et al. 2012).

In *Expert Finder*, the pre-study described problems in knowledge-intense work in quite some detail. The design process was grounded on the assumption that some of the problems which cropped up in the empirical pre-study could be tackled by means of an already existing software framework. In this sense, the pre-study rather hinted at the need to refine an already existing design approach, e.g., by integrating private folder hierarchies and dealing with resulting privacy concerns.

In *Social Display*, the residents' reaction to the Internet Days offered a valuable input. To operationalize the study's results into design features and functionalities, we chose to cooperate with the manager of the home and some of the care staff who showed a degree of technical interest. We chose this design approach because we learned in the pre-study that concrete design aspects would overwhelm the residents.

When including stakeholders in the design phase, we apply a wide spectrum of techniques developed by the participatory design community (Floyd et al. 1991; Greenbaum and Kyng 1991). However, the design phase always has the goal to come up with a running system version whose appropriation will become the subject of investigation. Beyond issues of traditional usability, technical criteria of software quality play an important role in our development process. If an innovative artifact is performing badly algorithmically or does not run stably enough, we cannot seriously investigate its appropriation.

Since our implementation capacities are somewhat restricted, we tend to build our development efforts on top of already existing software frameworks. In the *Expert Finder* project, we implemented on top of our own software framework. In *Location Tracker*, our industrial partner used the open-source framework Liferay in combination with OpenStreetMap to display positioning data. Off-the-shelf GPS trackers were purchased. *Social Display* also drew on existing content on the Internet, e.g., local and national news sites as well as YouTube and standard technologies, such as the photo album and the PlayStation buzzer.

Even in *Landmarke*, a project in which we prototyped in a very substantial manner, we applied the Arduino framework to build some of the prototypes. As a consequence, the availability of given hardware and software frameworks may impact the outcome of the design phase.

7.5.4 Appropriation

The appropriation phase of the design case study takes the IT artifact, rolls it out into one or more fields of application, and observes its usage empirically over a longer period of time. The goal is to understand how the usage of the innovative artifact is changing social practices. The investigation into this phenomenon requires a long-term perspective (Orlikowski 1996a; Pipek and Wulf 1999, 2009).

Ideally, we would like to roll the artifact out into the same fields of application where we conducted the empirical pre-study. This would allow the changes in social practices to be detected in detail. Unfortunately, this is not always possible. We do not always reach the appropriation phase with all our research efforts. Smaller or larger shifts in the project setting or the fields of application may require switching the site to investigate the IT artifact's appropriation. If such a switch takes place, more intense observations to detect differences in practice are needed.

In the case of the *Expert Finder*, the resulting software was basically rolled out in those parts of the organization with which we had conducted the field study. In the second stage of the rollout, we included one of NIA's member companies which had not participated in the pre-study. In *Landmarke*, the pre-study was basically conducted with Paris firefighters, while the participatory design process and the appropriation study were conducted with firefighters of the city of Cologne. However, in *Location Tracker*, we were no longer able to work with the families and care institutions who had participated in the pre-study and, partly, in the design

process. The physical condition of those patients we had worked with in the pre-study had deteriorated so badly that they were no longer able to run away anymore. The care institutions participating in the pre-study did not have appropriate patients at the time of our rollout. To investigate the location tracker's appropriation, we had to find elderly people with wandering syndrome whose institutional or family care setting could compensate for a potential failure of the system.

In the *Social Display* project, pre-study and evaluation took place in the same residential home. However, we could not work with the same people during the whole process. Although many of the elderly and the care workers involved from the beginning used the first prototype, we were confronted with the sudden death of some of the residents working with us in the earlier phase. So there is a variety of practical reasons why the continuity in the field of application is not always given throughout the course of a design case study.

There are other challenges we experienced when trying to investigate into the appropriation of IT artifacts. Some IT artifacts require a critical mass of users to study the appropriation of its whole functionality. For instance, the evaluation of the *Expert Finder* suffered from the problem that most of the initial users knew each other quite well since they were from the same organizational subunit of NIA. For this reason, our empirical study concentrated more on the self-presentation functionality rather than on the one-on-one people search.

A rollout in practice can also be problematic, if the required technological infrastructure is not yet there. For instance, Dörner (2010) developed an interesting toolset allowing end users to find and assemble software services to tailor ERP applications. However, we did not find any ERP ecosystems in organizational practice which would have allowed us to evaluate this application. We were therefore restricted to a lab study for evaluation purposes.

We experienced a different type of problem with the technical infrastructure when evaluating the location tracker. While the system requires a state-of-the-art browser, one of the care institutions provided the nurses only with a set of outdated Internet tools, which meant that our system could not run on the house's infrastructure. For this reason, we had to provide the nurses with an iPad with mobile Internet access via SIM card instead of letting them use the desktop PCs for tracking.

In *Social Display*, the research team built up a fully new technical infrastructure and even acted as counselors to the manager of the residential home in building up a sustainable IT environment. Here, prototyping and investigation into the appropriation directly led to a long-term usage scenario.

When trying to understand how our ubiquitous computing application supported the navigation practices of firefighters, we experienced another problem. Due to the highly risky nature of their work, it was not possible to roll out the IT artifacts in actual firefighting practice. However, even if the firefighters had used the markers inside burning buildings, we would not have been able to observe their practices easily. In this case, therefore, our investigations into IT appropriation remained on the level of training practices.

While the investigation of an IT artifact's appropriation in practice is a real challenge, it is the final proof of the validity of an IT artifact's quality.

7.5.5 Discussion

Design case studies represent an idealized model of our research approach. As a result of the contingences of the practice orientation, one may not be able to conduct all suggested phases – at least not to their full extent. Specifically, the appropriation phase requires the researchers to deliver a high standard of software technical perfection, with regard to performance, stability, and usability. Moreover, the field of application needs to provide an appropriate technological infrastructure to roll out the newly designed artifacts. The practitioners need to be willing to engage with the technological opportunities.

However, the presented instances of design case studies also indicate potential limitations for the ongoing participation of practitioners. For instance, the fact that the elderly participants in the *Location Tracker* and *Social Display* projects were not capable of expressing their perspectives in an ongoing manner poses a serious challenge to our design approach. In these cases, other stakeholders and the designers play a dominant role which poses the danger of paternalizing the elderly. In these cases, the pre-study phase is of specific importance.

In terms of setting up appropriate environments for investigation into the appropriation, both the firefighting domain and the aging domain pose special challenges. With the firefighters, the prototype had to be tested in a training center where researchers were allowed to participate and observe. However, neither the researchers' participation nor the usage of the prototype was possible in a real fire emergency. There are strict standards in that domain in order to avoid endangering the firefighters (and their observers). Thus, the evaluation of a prototype whose stability and functionality are not certified is not possible in a real fire.

The safety aspect was similarly important in the *Location Tracker* project when allowing patients to wander outside the well-protected care settings. We need to find a viable trade-off in an environment which is as close as possible to real practice while avoiding putting users at risk by relying on prototypes which might not operate stably. A proper balance has to be worked out together with the relevant stakeholders.

The projects differ in the degree to which different fields of practice were covered in the individual phases. The breadth of the coverage was typically influenced by the institutional setup and the available (financial) resources. In the European context, the requirements of the funding agency play an important role in shaping the institutional setting. In the *Expert Finder* project, the application partner was a predefined part of the publicly funded project setup. The design case study *Landmarke* involved two different firefighting organizations – in two publicly funded projects following up on each other. The *Location Tracker* project did not predefine application partners because in this scheme there was no funding available for any application partners. In *Social Display*, the project was set up in a single residential home by a PhD student who had a university grant to pursue his thesis. Whether the integration of more application partners would have enhanced the understanding of relevant practices is an interesting question. Given the limited

research resources, one has to typically trade off breadth against depth with regard to the involvement of practitioners (see above).

Public funding schemes considerably influence the domains of practice being addressed and seem to act as an incentive for the participation of (well-known) institutions in domains considered by the funding agencies to be socioeconomically important. This sheds light on the institutional conditions which typically frame research interest and outcome. Without external funding for application partners, the researchers are quite free in their theoretical sampling and can add application partners whenever it seems meaningful. Projects in which the application partner is defined during the project setup can restrict the researcher's opportunities to orient the project and can dictate that a certain practice be employed. However, a lack of funding can limit the practitioners' commitment and level of involvement. Beyond money, the researchers have to typically come up with additional stimuli to motivate the practitioners during long-term cooperation. Such incentives are related to their personal perspectives and ambitions.

Another important issue is sustainability beyond a (funded) design research activity. When we examine the appropriation of IT, we must take the post-research phase into consideration. When people start integrating the technology in their everyday life to leverage specific problems, the technology can become an important part of their social practices (Ogonowski et al. 2013). A sudden withdrawal could disrupt and challenge the newly established practices (cf. Pipek and Wulf 1999, 2009). Therefore, researchers have to carefully consider the sustainability of their interventions in practice.

In the case of *Social Display*, sustainability is given by the strong collaboration with the residential home from the beginning and the manager's motivation to keep the system running. He understands it to be his task to make sure that the application is to be maintained. The other design case studies followed a different path. We had agreed with the application partners to test the prototypes over a defined period of time. However, in the *Location Tracker* case, one family appropriated the IT support to such an extent that they wished to keep it permanently – a service we were not able to provide. In this case, we helped to find an application with less functionality but already available on the market and economically affordable for the family (which is not always the case). Affordability of the resulting artifacts and the accompanying business models thus present another issue which has to be considered in the project setup – beyond traditional plans of transferability of results.

7.6 Concept Building Grounded in a Corpus of Design Case Studies

Our research approach documents design case studies (or parts of them) in different application domains. Based on a growing corpus of design case studies, we try to identify intersecting themes, compare the context-specific findings, build

terminology, and try to develop abstractions. These abstractions should facilitate the transferability of findings while still staying related to their context of emergence. They can be seen as elements of a theory of practice-based computing.

With regard to the role of abstractions, our work follows a similar epistemological stance as that of Herbert Blumer when he speaks about sensitizing concepts: "[A sensitizing concept] gives the user a general sense of reference and guidance in approaching empirical instances. Whereas definite concepts provide prescriptions of what to see, sensitizing concepts merely suggest directions along which to look" (Blumer 1954: 7). Following Blumer (1954), we are able to question taken-for-granted concepts in the given literature and enrich them with empirical phenomena found in our design case studies.

Concepts, in this sense, can deal with:

1. Specific features of social practices: Prominent examples of abstractions dealing with aspects of social practices are the concepts of *awareness*, as suggested by Heath and Luff (1991), or on a more abstract level the concept of *situated action* (cf. Suchman 1986).
2. Principles for the design of IT artifacts: Examples of such principles are the architectural model of an *awareness pipeline* (Fuchs et al. 1996; Fuchs 1998) and *mechanism for handling conflicts* when activating groupware functions (Wulf 1997; Wulf and Rohde 1996; Wulf et al. 2001). On a more general level, the concept of *tailorability* is another example (Henderson and Kyng 1991; Wulf et al. 2008).
3. Specific features characterizing the appropriation of IT artifacts and the resulting changes of social practices: The concept of *over the shoulder learning* (Twidale 2005) is an example of such a category. At a higher level, the concepts of *anticipated, emergent, and opportunistic organizational changes* following the introduction of groupware fall into this category (Orlikowski and Hofman 1997; Stiemerling et al. 1998; Pipek and Wulf 1999). Overall, this category seems to be less developed so far.

Concepts can also deal with methods covering the individual steps of a design case study or research practices providing a perspective for a whole case study. The concepts of *integrated organization and technology development* (Wulf and Rohde 1995; Rohde 2007) or *infrastructuring* (Pipek and Wulf 2009) are examples for the last type of abstractions.

Concept building can also be grounded in partial design case studies, e.g., just containing a design-oriented empirical study of social practices and/or a study on the appropriation of an IT artifact. Indeed, many of the abovementioned conceptualizations were developed based on a partial design case study. However, we argue that full-fledged design case studies offer a more profound insight into the complex interaction of innovative IT artifacts and the supported social practices.

Based on a repository of design case studies, there is a vast variety of different perspectives for classifying, grouping, and comparing. As already stated, resulting abstractions can be built on different levels. In the following, we want to explore

comparative concept building on a more detailed level. In Sect. 7.6.1, we elaborate on two concepts which have emerged from the complete design case studies *Location Tracker* and *Social Display*, conducted in the elderly domain. In Sect. 7.6.2, we look in the domain of office work and elaborate on practice-oriented design of access control mechanism. The concept building in Sect. 7.6.2 is based on partial design case studies.

7.6.1 Concept Building in the AAL Domain

In the following, we first introduce two concepts which we think may help to better understand specific aspects of the design space in the AAL domain. Then we will reflect upon the concepts' emergence from a practically grounded perspective.

We suggested the first concept, (a) Grown and Constructed Autonomies, as an abstract term to sensitize for a better understanding of specific features of social practices in the AAL domain. We coined the second concept (b) Procedural Interaction Design with which we would like to describe a principle for the IT design for elderly people.

7.6.1.1 Grown and Constructed Autonomies

When we started our research, the provision and preservation of elderly peoples' autonomy was considered a major goal, at least in government-funded European research projects following the AAL agenda (Malanowski et al. 2008). In this perspective, autonomy is basically understood as the ability to lead one's everyday life as independently as possible. Technologies developed in this realm should serve this target, and an autonomous appropriation of these technologies is taken for granted. Autonomy then, one would assume, is a well-defined concept in directing AAL research. However, when looking at elderly people with special cognitive or physical needs, our design case studies have argued for differentiation of this understanding.

Our research work in the field of dementia care showed a more nuanced picture of autonomy-related thinking and acting. The handling of the topic in practice has many more facets than seen so far in public discourses. This variety of facets influences IT appropriation which is supposed to foster autonomy and lead to a multitude of emerging practices.

Our initial approach to the field of dementia care was in the context of the *Location Tracker* project. The project proposal had a strong focus on caregivers in familial and institutional contexts rather than on the people with dementia themselves because the caregivers were seen as the ones actually appropriating the application. However, our interviews and participant observations directed our view at a very early stage to the caregivers' value trade-offs between "autonomy and privacy" and "autonomy and safety." These trade-offs found their instantiation

in relationship-based problems at microlevel, but were also interwoven in broader organizational, ethical, and legal problem spheres.

Autonomy was thus reflected and enacted differently in the various application contexts (cf. Wan et al. 2014). The situated enactment of the legal concept of "freedom-depriving measures" is a good example for our argument. In the nursing institutions interviewed, "freedom-depriving measures" were mentioned frequently by both the managers and the ward nurses as measures to be avoided. In Germany, such measures are forbidden by law; their initiation requires the ruling of a judge. However, what would count as such a measure was not always well defined. The participants in our study agreed on some core principles, such as not fixating residents to a chair or their beds without a court ruling or the fact that entrance doors to nursing homes must always be kept open. However, workloads on wards in some cases lead to practices which in effect had freedom-depriving effects but would not be easy to prosecute legally – such as heavy doors which could not be opened by a weak elderly person. Other institutions put, e.g., curtains on the doors to distract the wandering residents from finding the door.

The analysis of the interviews with family caregivers – husbands, wives, sons, and daughters – offers very different perspectives on the concept of autonomy of wandering patients. The differences range from one extreme to the other. In one case, where care took place in the home, the husband reported that he allowed very little freedom of movement to his wife, who is a dementia patient. When in their home, he would not allow her to be alone on another story for fear that she might hurt herself. Being a retired engineer himself, he developed coping mechanisms for their everyday life: he "engineered" her eating, sleeping, and bathroom habits by means of medication. In his understanding, autonomy was not a relevant issue to his wife as she was "no longer here" with her mind.

At the other extreme, the daughter of a woman suffering from the early stages of dementia has built a social network to collaboratively take care of her mother. Her mother was able to live independently in her own home and conduct everyday tasks – even go to the city – on her own. For the daughter, it is vital that her mother feels she is autonomous – and she has adopted many measures to "artificially" achieve this, such as asking shop assistants and bank clerks to give the mother what she wants, but only within reason. Sometimes the daughter "shadows" her mother on her way to town. From the daughter's perspective, her mother's ability to maintain a public and independent "face" is of primary importance.

In another case, a husband with dementia was taken care of by his wife and daughter at home. The women reported that the father had always had a dominant role in the family and a strongly independent attitude. Despite the onset of dementia, he continued to assert this dominance. He still took long walks on his own, leaving his family in a self-confessed position of helplessness. This, we discovered, is not uncommon in situations where female relatives have to cope with male dementia. This treatment of autonomy is quite different from the case of the husband who "engineered" the behavior of his dementia-suffering wife. His preexisting and continuing dominance in the family had actually helped him manage his wife's life with less resistance.

In the home context, we learned, families tailor care strategies to fit local conditions and needs. Each family has its own habitual familial pattern, such as structure, hierarchy, balancing between genders, and children vs. parent roles. Our empirical analysis indicated that preexisting life practices lead to completely different effects on the care concept when dementia occurs.

For many of the relatives, the classic value trade-off between safety and autonomy is of minor relevance in their decision-making, especially when the disease advances. Many relatives report primarily about the overwhelming burden of safety concerns with regard to family members who are dementia patients. So for them, keeping the patient safe is much more important than preserving the patient's autonomy. As Alzheimer's disease progresses, the patient's mental existence is often perceived as "fading away," and autonomy thus becomes less and less important for caregivers who put the symptoms of the disease at forefront.

It is a feature of such relationships that they engender a great deal of reflexive concern, contingently negotiated – which means autonomy is far from being a universal discourse to be used for organizing people's actions and behaviors (O'Connor and Purves 2009). In addition, current approaches in AAL research often neglect the social and interpersonal contexts in which actions and reflections on autonomy-related decisions occur.

What the studies strikingly have shown is that the term "autonomy" – and how this is used to talk about care practices for elderly persons – is manifold in its appearance in the practical context. It has implications on different levels, whether at a political, social, or practical level in the everyday work of caregivers (Müller et al. 2010). To stress interdependencies between increasing physical and cognitive decline of elderly persons and the respective needs for help of caregivers, Fitzpatrick et al. (2010) suggest the concept "dependable autonomies." This, however, seems to imply that autonomy might be conceptualized in stages or steps, which need a related adaptation of care measures when a disease progresses. From a practical perspective, this seems to be a helpful approach at an operational level. Our research, however, wishes to contribute to a better understanding of autonomy-related care situations from a more deconstructing perspective in questioning the rationales being used in care relationships toward concepts of personhood and how they are positioned in the related sociocultural contexts of families, care homes, etc. From this conceptual perspective, the deconstruction of autonomy in decision-making processes may open up new areas for improvement (O'Connor and Purves 2009). The analysis of our case studies makes visible the multiple and sometimes contradictory meanings the different measures and decisions taken by caregivers in dementia care imply. And they are rooted in personal value systems, in historic and habitualized developments of the patient-caregiver relationships, and in micro-political contexts, such as care home politics, or situated aspects, such as the actual health statuses of the patients. In addition, decisions in caregiving for an institutional patient or a relative at home can be consciously reflected, but also stem from habitualized activity and value patterns. This also implies that we need to better understand how situated care experiences are shaped by and embedded in broader societal contexts.

Authors in gerontology or care sciences point at the need to move beyond the focus on the individual to examine collective experiences and interrelational aspects in dementia care and to take up a more critical lens in order to implement new ways of thinking "about the place of autonomy (and arguably cognition) both within our society, but especially in the lives of persons with dementia" (O'Connor and Purves 2009: 206). For them, the task of deconstructing autonomy is a major first step toward envisioning personhood and for providing a useful framework for ethical decision-making. This is far more important for IT development, and our concept aims at challenging taken-for-granted assumptions of design teams and guiding their attention to a more holistic and deconstructive stance.

The *Social Display* design case study revealed yet another reference to how autonomy and self-determination are being negotiated and enacted, both by the elderly care home residents themselves and by the care staff. As reported above, the initial interview and observational studies in the care home showed a huge passivity on the residents' behalf and thus a great reluctance to engage in a common project with us. This was equally mirrored by many of the social workers who often told us that they did not think that many residents would be interested. That is the reason why we initially had to strongly convince the staff that the Internet Days might indeed be interesting for people who were mainly perceived as passive. In the end, all the social workers were extremely surprised that residents formerly perceived as passive started to engage so actively in the workshops. On the residents' side, the pre-study revealed their behavior and the way they thought of themselves as being strongly self-positioned at the margin of society, expressing sentiments such as "people do not care about old people like us, but that is just how it is." Thus, we were confronted with their self-image of being marginalized but also their huge acceptance of this issue.

Here, we furthermore learned that the caregivers' perceptions of what the residents would be able to do or in which topics they would be interested influenced the process at first. However, by dint of the Internet Day interventions, not only did the interests and motivations of the residents open up, but also those of the caregivers.

All in all, we see that the term "Grown and Constructed Autonomies" aids a better understanding of the design space in the analysis phase as well as in guiding actual design research methods.

In the *Location Tracker* case, the issue of stakeholder constructions of autonomy (and by this the evaluation of what a person with dementia should or should not be allowed in daily practice) points to the need of providing a communication area in the system in which collaborative caregiving and negotiation would be allowed to align individual views and to develop a more human viewpoint to the affected persons' everyday practice and needs. Various stakeholders with diverse backgrounds often have to align their approaches of thinking what good management of "wanderers" should be in regard of their conception of autonomy. That is why the IT system should enable mutual learning and negotiation around this issue – at system level, support must be provided for negotiation space on how functionalities should be adapted to manage the wandering of an individual person.

7.6.1.2 Procedural Interaction Design

We coined this term to highlight several issues which come to the foreground when designing with the very target group. The concept is relevant for the design phase as well as for the empirical work in the context of pre-studies and studies on appropriation.

The first aspect of the "procedural" is devoted to the target of building up a common design space with the partners of the very target group. The elderly people themselves with whom we worked as well as their caring social networks at home and in caregiving institutions can be described as not affine to new technologies and the Internet in most cases. There is also a lack of ability in articulating problems of their social practices in which design ideas are usually grounded. We therefore tried to find "anchor points" in the people's social practices which can serve as "tickets to talk" (Svensson and Sokoler 2008) to start a deeper conversation about issues of everyday life.

In the *Social Display* project, we organized workshops which helped the target group to develop a sense of how technology could be meaningful for their lives and for the caregivers' work with the elderly. Bringing in off-the-shelf technology in a very early phase turned out to be very helpful for two reasons: firstly, the collaborative search for interesting media content on the Internet could easily be linked to the elderly person's former or current experiences in a broad sense. For example, showing a music show from the 1960s was met with joy and excitement and could serve as a starting point for a further journey through the Internet to other anchor points bringing enjoyment to the elderly person. Secondly, the technology used at the Internet Days also served immediately as an experience-based example of what the residents might be able to achieve with modern technology, and it also afforded them hands-on experience. The mutual learning processes between the elderly, the staff, and the design team initiated by these interventions revealed anchors to former and current aspects of life practices which could be explored more deeply and from which meaningful design ideas could be derived.

In the *Location Tracker* project, we used a similar early intervention – however this time mainly with the caregivers. We discussed with them examples of off-the-shelf technologies and elaborated on their concerns to find their specific "anchor points."

For the design phase, another "procedural" element became important. We were confronted with problems of reminiscence in the care home. We therefore attempted to install a performing prototype as soon as possible in order to keep the residents on track and interested in our project. We rolled out the display offering only very simple functionality and reduced content to help the elderly become acquainted with the system. The first prototype version included a very simple color-coding system and reduced selection options. By doing this, we could lower the barrier to technology appropriation and were able to increase complexity in successive versions of the application. In addition, the technology and the media content during

the workshop/Internet sessions as well as in the first functional prototype were kept similar in order to support the residents' ability of recognition and reminiscence.

7.6.2 *Computer-Supported Access Control: Building Concepts by Comparing Cases*

We have worked for a longer period of time on access control in cooperative work. When we started our research, the discourse on access control was merely framed by a technical perspective. The given concepts suggested how to design access control in the sense of a technical functionality (Lampson 1974; Shen and Dewan 1992).

We conducted empirical research investigating how access to data was controlled across three different organizational settings: a state representative body, a federal ministry, and an editorial office (Stiemerling and Wulf 2000). In the first two cases, we observed access control practice dealing with a groupware application; in the third case, we observed access control to paper documents. Comparing the three empirical cases, we could identify three factors which were relevant elements of the observed practices of controlling access:

1. The control of access could be delegated to an actor who was not the owner of the data to be accessed (third person).
2. Actors who accessed the protected item could be tracked and made accountable (awareness).
3. The legitimacy of a certain attempt to access the groupware application was negotiated among those who wanted to have access and those who granted access (negotiation).

In the first two cases, the observed elements of practice had to be realized in circumventing the implemented access control functionality. An analysis of the state of the art indicated that these elements of practices were not yet supported by technical functionality. As inspiration to design access control functionality in an innovative manner, we related back to earlier work on conflict management when activating groupware functions (Wulf 1997; Wulf et al. 2001). Considering access to data to be a potentially contested activation of a function, we transferred and adapted design concepts to this particular case. Based on these concepts, we implemented a prototype which supported negotiating over access to data by means of a semi-structured communication protocol (Stiemerling and Wulf 2000). This design case study remained fractal since it fell short of an evaluation in practice.

In a fourth case study, we investigated access to a steel mill's central drawings archive. The steel mill was maintained cooperatively by an internal work unit and external engineering offices. The drawings were stored on paper, on fiches, and, partly digitally, in a central archive and its database. We investigated empirically how the external engineers' access was controlled, considering the existence of different media and a historically grown classification scheme. Controlling access appeared to be a highly situated activity which was not well enough supported technically, specifically for granting permission remotely to the external offices.

Looking more systematically at the temporal structure when access permissions were granted, we were able to differentiate between three cases:

- Ex ante control: if permission has been defined before the access takes place
- Uno tempore control: if permission is defined at the moment of access
- Ex post control: if permission is checked after access has taken place

Based on the empirical findings, we built a prototypical access control system in extending the steel mill's database. To support different access control strategies, the application was built using software components which could be (re-)assembled by users during runtime. We involved the different internal and external engineers in both lining out the set of components and defining suitable access control functionality. However, this design case study fell short of a long-term evaluation in practice.

In a final journal paper, we elaborated more fundamentally on the four fragments of design case studies. The first step was to suggest the conceptual differentiation between the social practice of controlling access to data/resources ("computer-supported access control (CSAC)") and the IT functionality which supports this social practice ("CSAC system"). This distinction enables us to discuss in a more differentiated manner how to complement practices by IT design. In our earlier publications, the design approaches were based on the assumption that given CSAC practices were insufficiently supported because (1) awareness is only possible in physical proximity; a technical substitute would be needed in a more distributed setting; (2) negotiations happened either face to face or by means of external media, such as telephone; and an integration of a (semi-structured) communication channel into the CSAC system would better enable the direct implementation of the negotiation's outcome (Stevens and Wulf 2009).

Comparing the four cases with regard to the different design approaches, we were able to describe the design space for CSAC in a more systematic manner. A two-dimensional matrix classified the different approaches according (a) to the temporal relationship between the legitimation of access and the access attempt taken from Stevens and Wulf (2002) and (b) to the mode of interaction, specifically awareness, protection, and negotiation. The second dimension was an elaboration of the classification scheme emerging from Wulf et al. (2001) and Stiemerling and Wulf (2000). Based on these two dimensions, the given technical mechanisms could be classified. By comparing different implementations of CSAC systems, we were able to extract further design requirements – specifically with regard to modularization of their implementation.

7.6.3 Discussion: Concept Building in an Environment of Competing Claims

We have presented two domains in which we have explicated sensitizing concepts based on a comparison of different design case studies. Following Blumer (1954),

we understand these concepts as suggestions to consider a certain perspective on design in practice. In this sense, they can be seen as condensates of practice-based research.

The sensitizing concepts cover quite different aspects of a design case study. In Sect. 7.6.1, we elaborated on the concept of Grown and Constructed Autonomies to frame a certain perspective on practices in care settings. The concept of Procedural Interaction Design describes the procedural experiences we gathered when working for and with the elderly. For the development of a first working prototype, we also were able to describe specific aspects in actual design. In Sect. 7.6.2, our first conceptualizations dealt with recurrent elements of access practices. While exploring design opportunities for unsupported elements of these practices, we were able to describe the design space for technical implementations of access control in a new and systematic manner. Finally, a practice-based analysis of the fractal design case studies allowed us to reflect upon the relationship between access practices and technical control mechanisms. We labeled such a research perspective "computer-supported access control."

The very nature of the data generated in design case studies positions concept building into a certain epistemological tradition. This tradition is often at odds with prevalent styles of concept building. Our research approach is strongest where it offers empirical data or design-oriented insights which contradict or extend the findings of given research traditions. The conceptual work in the domain of access control is a good example of how our research tradition can help to develop design concepts beyond the mainstream understanding in computer science; see the extension of the Lampson matrix in Stevens and Wulf (2009).

When pursuing design in certain domains, we are occasionally confronted with the fact that the academic discourse has not yet dealt with it at all or, at least, not in a design-relevant manner. For instance, we could not identify any academic work which had described or conceptualized the navigation practices of firefighters in burning buildings in a manner suitable to ground design. In the gerontology domain, we found care and aging theories which were mainly quantitative in method and context unspecific regarding its findings. At this level, we found competing theories which came to contradictory conclusions, e.g., in analyzing the wandering symptom of early Alzheimer patients. While the gerontological discourse postulated that person-centered care would be the standard approach in Germany, detailed descriptions of caring practices were rather scarce. Our design-oriented studies revealed a much more nuanced view on caring practice. In the mainstream of design-oriented research, a profound level of interdisciplinary cooperation was missing.

However, the state of the art still plays a central role in our work in generating sensitizing concepts. The state of the art in epistemologically related fields shapes our thinking and allows us to identify concepts from our design-oriented work. For instance, when postulating the concept of "computer-supported access control," we drew on two decades of work in the CSCW community.

Pursuing academic innovation in a nonmainstream paradigm can also lead to complications in practice. The world view of the practitioners we work with is often framed by a mainstream understanding often shaped by professional and

educational institutions. We observed these phenomena in the aging domain. The prevalent concepts there do not match up with a practice-based perspective on the analysis of the existent and the design for the future. For instance, the gerontological mainstream has not dealt much with computer support in engaging people of an advanced age in residential homes. The few studies which do exist consider IT to be either not necessary or not successful in these contexts. The caregivers were therefore quite skeptical when they began to work with us. Yet our design-oriented explorations revealed a rather considerable potential in improving the residents' quality of life.

We still have little experience regarding how our approach to concept building supports the transfer of design-relevant issues and insights. We believe that the sensitizing concepts need to be understood as linked to the design case studies they are derived from.

7.7 Discussion

The work with sensitizing concepts is an important bottom-up strategy to develop relevant themes from different design case studies (DCS). For each of the studies above, we were able to derive domain theories that helped to analyze the practices observed and informed design. One of the main perspectives for establishing DCS as an empirical tool is to devote more attention to the emergence of new/changed practices in connection with innovative information technology. The appropriation of a new technology is often a very complex process that is not only influenced by the characteristics of the new technology and the landscape of experiences and needs that lead to the initiative of becoming involved with this new technology and to the requirements that informed the development process. That landscape may have changed significantly during the development phase and during/after the technology introduction, and alternative technological or non-technological solutions may have surfaced along the way – with unforeseeable consequences. The art of conducting a DCS is to be able to capture this richness of relevant developments, although one may have had an initial (technological) idea to follow and although much effort may have gone into making this idea a new software artifact. As these developments may take their time, the appropriation phase cannot be considered finished at a certain point; it merely merges into the "normal" emerging practice of the field. For a design case study, it may even make sense to revisit a field a decade after the technology was introduced and to look for the traces that the then new technology and the discourses around it left behind and to reconsider the level of "success" that can be associated with this technology development project.

It is obvious that if we want to consider and acknowledge the various contributions that led to this level of "success," we can not only look at the actors and activities that contributed to the final shape of the technology product at hand; we further want to look at the actors and activities that contributed to the shape of the technology usages that emerged. If we consider the narrower environment

of the technology development process, we are likely to be able to come up with rather well-structured descriptions of actors, their roles, and their activities, as these may already be suggested by the technology development methods that have been used (e.g., the Rational Unified Process, Agile Software Development methods, etc.). This is much more difficult with the wider field of actors and activities. Even participatory design methodologies that are already more sensitive toward contributions from the field of practice often remain focused on the product (as a design result) and the project (the planned process that guided the mutual exchanges between technology developers and existing/future users) and cannot guide good descriptions outside this scope.

7.7.1 Tensions Between Research-/Development-Based and Practice-Based Thinking

Orlikowski (1996b) started a discourse on practice-based research that focused on the events and actions that made a particular practice emerge. She made explicit that a further development of technology-based practices ("organizational change") is far from being the plannable, organized process that development process models usually assume when they talk about "introduction" as a final phase of development. In research-/development-oriented thinking, a defined, structured process is necessary to organize the work around creating an IT artifact, and this is what process models in software engineering and information systems design do. "Organizational change" is often a spontaneous, challenge-based, or opportunity-based phenomenon that does not align well with the structuring perspectives of these technology development methods, with the time frames to consider being the maybe most obvious asynchronicity: development and research projects having a fixed time frame in which the resources of researchers and programmers are allocated, practice as an evolving phenomenon emerges at speed, and a resource investment that strictly follows practice-internal needs and considerations. Although there have been tendencies to overcome the project/product focus (e.g., Dittrich 2014 looks beyond the project as an entity of activity in software engineering, Hanseth and Lundberg 2001 argue in favor of speaking about "infrastructure improvement" rather than of "information systems design"), we would argue the necessity of establishing a level playing field for describing the various actors, roles, and activities with a similar level of detail for those parts of a study that are concerned with the professionalized field of technology development and its related domain models, as well as those parts of the study that are concerned with the emerging/changing practices in the field. Earlier, we (Pipek and Wulf 2009) suggested a theoretical framework of "infrastructuring" for this purpose.

7.7.2 *Infrastructural Breakdowns and the Point of Infrastructure*

The term "infrastructuring" has been used occasionally earlier, but a consistent description of its potential has only been provided by Star and Bowker (2002), and it was first used in that sense by Karasti and Baker (2004).

Project-based thinking usually assumes that the project goal is so important that all stakeholders are involved with a level of attention that matches their project role. With "infrastructural" thinking, practice emerges along discrete events that bring infrastructural issues into the focus of attention of the stakeholders affected. From their perspective, Star labeled these events "breakdowns." We wanted to have a broader and deeper understanding of the attention economy around technological infrastructures and called that event the "point of infrastructure" (POI) (Pipek and Wulf 2009).

On these occasions, the invisibility/transparency that infrastructures usually have during use ends and issues concerning the extension or reconfiguration of an infrastructure come to the fore. These are the occasions when practitioners are "by nature" able and willing to engage in a discourse about the future developments of an infrastructure and about the associated reconfigurations that lead to a changed practice.

Within the context of DCS, these concepts are important to consider on three occasions:

- When relevant practitioners decide to engage in a design case study, the researchers may assume that there have already been several "points of infrastructure" that lead to relevant insights and attitudes. During a pre-study, this element of the practices' historicity should be captured and acknowledged.
- During the pre-study, it makes sense to actively look for potential discrepancies between what the work infrastructure provides and what is perceived as necessary or interesting by the workers. These are potentials for "points of infrastructure" to be explored during the design case study. During the course of the study, more "points of infrastructure" may occur that need to be acknowledged to inspire and inform good design.
- The introduction of a new technology that results from the (participatory) design activities is an additional "point of infrastructure."

On these occasions, empirical work within the framework could take "points of infrastructure" as a sensitizing concept to reflect upon the infrastructure development that practitioners engage in.

7.8 Conclusion

Design case studies can be understood to be empirical investigations into interventions which explore the potentials of an innovatively designed IT artifact. The direction of the empirical pre-study is broadly defined by a technological potential

available but not yet explored in (this) context. Therefore, design case study-based research is driven by new technologies as much as by societal problems and potentials. They are a means to understanding the opportunities in encouraging social innovation by introducing appropriately designed IT applications (cf. Pipek and Wulf 2009). Thus, they allow the understanding of the quality of design by its effects in practice. To reach such an understanding, a long-term engagement with the relevant domains of social practice is important. It is required to gain sufficient commitment from the practitioners in the design process and to allow for the investigation into changing practices during IT appropriation. The findings of such a single design case study are highly specific to the social context they take place in. Their results do not allow for simple generalizations; their transferability into other contexts needs to be considered with care. We, therefore, suggest building a corpus of well-documented design case studies. We hope that the contextualized description of the social practices, the IT design, and its appropriation, together with a link to the authors of the study, may enable other researchers and practitioners to transfer findings to their own contexts. The transferability of findings is supported by the creation of sensitizing concepts which are grounded in individual case studies. Following Blumer's (1954) tradition, these concepts do not claim general validity. We understand sensitizing concepts rather to be an offer to the reader to be aware of condensed insights and a pointer to more contextualized results – documented in the original case studies. We believe that the discourse on "infrastructuring" (Bowker and Star 1999; Pipek and Wulf 2009) provides interesting perspectives to conduct, document, and compare different design case studies. Rather than pruning the research questions and methodology poorly according to technological design opportunities, we would like a case study to be a unit whose coherence in presentation is mainly shaped by the practices undergoing investigation. Our research approach needs to find an often delicate balance between relevance defined from the practitioners' point of view with relevance and rigor emerging from the researchers' academic practice.

We are still at the beginning of the research program outlined in this paper. Its viability still has to be proven empirically.

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