Mediation between Design and Use

Revisiting Five Empirical Studies

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This article investigates mediation between design and use, related to which there is an abundant literature in information technology (IT) research. However, the existing literature is fragmented and unconnected. This analysis is motivated by revisiting five empirical studies that address the relationship between design and use. Our collaborative, inductive analysis has revealed mediation as highly influential in these studies, but in a multitude of different forms. Each study is discussed in relation to three themes: design, use, and mediation. The key observations related to each study are highlighted. Thereafter, a categorization of forms of mediation is introduced and discussed. The forms are labeled: 1) people in intermediary positions; 2) representations used in/for mediation; 3) collaborative methods; and 4) long-term integrative forums. In addition, related to each form, interesting aspects characterizing that particular form of mediation are discussed. The article concludes that mediation clearly is a complex phenomenon in need of further study. A number of interesting paths for future work are identified.

Keywords: design, inductive interpretive analysis, mediation, practice, qualitative field study, use

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This article investigates mediation between design and use. Different terms have been used to discuss mediation in information technology (IT) literature. Many traditions, such as information systems (IS), human-computer interaction (HCI), software engineering (SE), participatory design (PD), and computer-supported cooperative work (CSCW), have highlighted the problems and concerns related to the separation of design and use, and the need to bridge the gap between them. As the long list indicates, there is a variety of studies as well as theoretical approaches and disciplines contributing to our understanding of mediation (see e.g. Bansler & Havn 2004; Greenbaum & Kyng 1991; Iivari 2006a; Karasti 2001b; Keil & Carmel 1995; Markus & Mao 2004; Molin-Juustila 2006; Tuovila & Iivari 2007). However, the existing literature on the matter is fragmented and unconnected. Generally, to mediate denotes "to act as intermediary agent in bringing, effecting, or communicating" (Merriam-Webster OnLine). In this article, the concept will be discussed in more detail, focus being on mediation as bridging the gap between design and use.

In this effort, we have been particularly inspired by an article written by Suchman and Trigg (1991), in which they propose that research, design, and use should be seen as three different perspectives in the joint enterprise of developing technological systems and our ways of working together. Actually, they label the perspectives as research, design, and practice. With practice, they mean the situated human everyday practical activity that is social in nature (Suchman & Trigg 1991), but in the article they use 'practice' to refer particularly to the users' current work practices. However, we consider design and research as also being forms of practices. For that reason, the perspective Suchman and Trigg label 'practice', we call 'use', referring to users' (work) practices related to IT use. Design, furthermore, refers to the practice of envisioning future use practices and technologies (Suchman & Trigg 1991). However, the most important inspiration from Suchman and Trigg was that they emphasize that the perspectives of research, design and use do not imply a particular division of labor, but instead they should be seen as "places from which to look" (1991, 85) and, with this in mind, they recommend moving between the perspectives.

We revisited five empirical studies we have carried out, with a particular focus on moving between the perspectives of design and use. The

studies vary in several ways: the IT in question, the organizational setting, and the approaches to IT development. However, they are all based on long-term, qualitative empirical research (for more details, see Iivari 2006a; Karasti 2001b; Karasti, Baker & Halkola 2006; Molin-Juustila 2006; Tuovila & Iivari 2007, Tuovila & Karasti 2003). As in-depth studies in particular IT contexts, they all point to the multitude of complexities and challenges involved in IT development. As the result of our collective, inductive analysis, moving between the perspectives of design and use in our various studies, the theme of mediation emerged as highly influential. From the viewpoint of mediation between design and use, the otherwise divergent studies could be integrated. The studies will be discussed further in the subsequent parts of the article.

The next section outlines existing research on mediation between design and use as a basis for our empirical analysis. We then present our five empirical studies on design, use and mediation. The presentation is followed by a summary and discussion of our findings. A categorization of different forms of mediation is identified and discussed. The forms are labeled 1) people in intermediary positions; 2) representations used in/for mediation; 3) collaborative methods; and 4) long-term integrative forums. In addition, related to each form, interesting aspects characterizing that particular form of mediation are discussed. The final section summarizes the results, discusses their limitations, and outlines a number of interesting paths for future work.

Literature Review

In the field of information systems (IS) development, the gap between IT design and use was acknowledged several decades ago. Friedman and Cornford (1989, 369) argue that the gap emerged already as computer systems were invented and developed in isolation from the concurrent broader social movements and needs of actual use organizations. In the early 1960s, this development gave rise to some schools of thought, such as the Scandinavian tradition of 'informatics' where mediation between design and use was recognized as necessary. Within the Scandinavian tradition, the need for mediation inspired a variety of new approaches, and the theoretical approaches of even the most technology-focused systems advocated that the use organization should be the basis for

systems development (Langefors 1966), while the socio-technical approach emphasized the importance of balancing the technical and the social systems (Bjørn-Andersen & Hedberg 1977; Olerup 1989). The critical (Bansler 1989) and the humanistic (Nurminen 1988) approaches pushed the mediation argument even further. The former envisioned alternative solutions to come about through close collaboration with workers, especially through collaboration and mediation supported by trade unions (Nygård 1979; Bjerknes, Ehn & Kyng 1987). The latter took the human being in the work setting to be the basis for systems development, and stressed the need for understanding work more holistically than merely as use of computer systems (Nurminen 1988).

In IS research more generally, organizational context of use and organizational implications of IT became central topics as computers started to become essential tools for people not involved in their development. In IS research, the development of IT has been considered to be a social, multidisciplinary effort, requiring active user participation (Iivari & Hirschheim 1996). User participation has been a lasting topic, and it is also currently considered an important object of study (Markus & Mao 2004). Traditionally in IS projects, application domain knowledge has been mediated to IT professionals by user representatives. Furthermore, IT professionals have also been positioned as some sort of mediators in IS research. It has been argued that apart from being positioned as neutral, objective experts, IT professionals can also be positioned as sympathetic facilitators stimulating reflection, cooperation, and learning, or even as warriors, partisans, activists, and emancipators of the oppressed ones (Hirschheim & Klein 1989).

Different IT professionals' change-agent roles have also been defined, and some of them clearly imply a particular mediator position. Markus and Benjamin (1996) identify a facilitator role, in which the facilitator promotes change by helping increase clients' capacity for change, and an advocate role, in which the advocate works to influence people's behavior in a particular direction. By avoiding the exertion of power over clients, the facilitator serves as process expert in the clients' interests. An advocate, on the other hand, increases the target groups' awareness of the need for change by using whatever tactics work, including communication, persuasion, shock, manipulation, and even formal use of power to

achieve a desired end (Buchanan & Boddy 1992; Markus & Benjamin 1996). Ethically, however, the advocate role implies quite a questionable position for the mediators. In all, emphasis on organizational context of use, user participation and different kinds of IT professionals' mediator roles are clear contributions from the IS research concerned with mediation between design and use. In addition, within the IS field, mediators within the use context have also been acknowledged; project assistants, IT supporters, administrators etc. have been discussed as mediators adapting and tailoring new technologies to organizational settings (Bansler & Havn 2004; Orlikowski *et al.* 1995).

The field of human computer interaction (HCI) has been positioned on the users' side from the very beginning of the research area in the late 1970s (Cooper & Bowers 1995). This field has traditionally been concerned with the usability of IT and with its evaluation, focusing initially on the human (cognitive) capabilities and limitations that occur in users' interaction with IT (Karat & Karat 2003). User involvement has been accomplished through HCI professionals representing the user in the development process (Cooper & Bowers 1995). It has even been argued that the rhetoric of representing the user has been crucial for the legitimacy and identity of the whole field (Cooper & Bowers 1995). The users do not participate actively, but HCI professionals (particularly usability specialists) act as builders of bridges between designers and users, and deliver user data to the design (Borgholm & Madsen 1999; Clemmensen 2004). Furthermore, the interest in development practices (Carroll 2002) in HCI – and more specifically in usability research in HCI – has begun to overlap with earlier trends in IS. An interest in users, and field studies of the (social) context of use during the early phases of IT development, has become evident also in HCI (Bannon 1991; Holtzblatt & Beyer 1993; Suchman 1987). However, conceptualization and appreciation of the complex relationship between design and use is not very common within the field of (psychology and engineering oriented) HCI. Nevertheless, HCI professionals nowadays have acquired quite an established position as mediators between design and use. In addition, there are a number of HCI methods and associated artifacts (such as user profiles, personas, scenarios) developed for mediation purposes that deliver knowledge of use to design (see e.g. Beyer & Holtzblatt 1998; Cooper 1999).

On the other hand, especially within usability studies, there has also emerged an interest in better integration of the focus on use into industrial development practices (Gould 1988). This usability engineering point of view is closely related to another major field of IT development: software engineering (SE) research. Other recent trends in the SE research – for example iterative development, agile methods (Cockburn 2002), and requirements engineering (RE) – all point towards an interest in the complexities and dynamics of users' actual needs related to the IT design. Especially RE research, which has traditionally concentrated on the modeling of requirements, is nowadays paying more and more attention to the early phases of RE. That is, it pays more attention to the actual needs of the users and to issues associated with the context of use as well as to a more socially oriented view of design. The nature of RE is communicative and collaborative. Requirements emerge as part of ongoing interactions and negotiations between different stakeholders (Coughlan & Macredie 2002; Nuseibeh, Easterbrook & Russo 2001). However, these engineering-oriented fields, although increasingly appreciating the complexities related to use, do not pay much attention to the complexity of mediation between design and use.

Participatory design (PD) strategies, with roots in the Scandinavian tradition, place emphasis on user influence in IS development. The participation of intended users in design is considered one of the fundamental preconditions of PD. Users are trusted to bring the relevant skills, experiences, and expertise of the work settings into the design processes. As design is recognized as a social process that is fundamentally about intervention to create change, workers are given the right to influence decisions that affect their working lives. Design is seen as a collaborative effort to design both technical and work systems. Therefore, mediation between design and use happens through direct collaboration between workers and designer-researchers, which allows for mutual learning, i.e. designers learn about the use context and workers about possible technological options (Kensing & Blomberg 1998). In order to promote productive mediation between design and use, PD researchers have developed a number of valuable methods and techniques for direct worker-designer cooperation, such as mock-up design, cooperative prototyping, organizational games, and future workshops (Bødker, Grønbæk & Kyng

1993). PD methods, however, have been criticized for not sufficiently taking into account users' existing work practices in actual settings, as the foremost focus has been on the future use of technologies to be developed (Karasti 2001b). However, methods that allow for analyzing users' actual work practices have become included in the repertoire of PD methods (Simonsen & Kensing 1994). In addition, PD researchers recognized rather early on that design often continues in use. When end users configure the IS in order to fit it into the use context, it is referred to as 'tailoring'. Thus, 'tailorability' refers to the quality of an IS to provide flexibility so that it can be tailored to fit different or changing use contexts (Henderson & Kyng 1991).

Finally, computer supported cooperative work (CSCW) is an interdisciplinary field that has, since the mid 1980's, focused on studying collaborative work settings and developing technological support for them. The field accommodates various strands with different emphases, but they all agree that it is important to understand how people actually interact and collaborate to get a job done and to find ways to integrate these understandings into design. Thus, mediation is a central issue in CSCW. Ethnography, particularly ethnomethodologically informed ethnography, has proved to be a promising approach for grounding technological development and systems design in an understanding of the specifics of practical, situated collaborative actions in the workplaces (Blomberg *et al.* 1993). Mediation between use and design – or the bridging or aligning of ethnography and design as it is often referred to – has been attempted in several ways. For instance, Karasti identifies three approaches to bridging ethnography and design (Karasti 2001a). First, an 'ethnography informing design' approach (e.g. Hughes *et al.* 1994) relies on a disciplinary division of labor between ethnographers and designers, in which ethnographers mediate between the workplace and the system design. Second, in the approach 'ethnography infused into a repertoire of PD methods' (e.g. Simonsen & Kensing 1994), designer-researchers or ethnographers use fieldwork methods to complement more design oriented methods in order to gain insights into and create shared views of work. Third, 'work oriented collaborative interventions into processes of technology production' have been carried out through intensive interdisciplinary work and mutual exploration (e.g. Blomberg, Suchman & Trigg 1996). The idea of bridg-

ing work practice and system design have expanded from CSCW research projects to other IS research fields, and they have gained ground also in industry settings. Furthermore, aligning with and continuing the point made above about tailoring in relation to participatory design, 'appropriation' has been put forward as a notion to expand from the technologically oriented tailoring to more organizationally oriented, collaborative processses of adopting and adapting information systems and fitting them into working practices (Dourish 2003). Thus, 'appropriation support' covers all measures to support appropriation activities as creative and collaborative processes (Pipek 2005).

All these research fields contribute to our understanding of the complexity of mediation between design and use, thus demanding a multidisciplinary perspective. A few typical characteristics can be outlined. There is an assumption that designers should know the users' needs and their contexts of use; that more attention should be paid to the social implications of IT and to the ensuing social consequences; that one should apply an iterative and multidisciplinary approach to design; and that users should be involved in the design process. There is clearly a huge amount of IS, HCI, SE, RE, PD and CSCW literature arguing for these issues, each having particular limitations. Our empirical studies reveal the need for empirical inquiry into mediation by illustrating some of the varieties and challenges. The theme of mediation will be conceptualized in more detail in the discussion part of the article.

Five Studies on Mediation between Design and Use

To illustrate the complexity of mediation between design and use, we now present five studies that are different when it comes to the IT in question, the approaches to IT development, and the organizational setting. However, they are all based on long-term, qualitative empirical research and they can all be characterized as longitudinal field studies. The empirical material was gathered through interviews (group and individual), (participant) observation in different kinds of meetings, collaboration in workshops and systems design in situ, and document studies. Some of the studies (3 and 4) also include intervention by the researchers. The studies are described in more detail in table 1.

No.	Name	The IT and Approach to Its Development	Organizational Setting	References
1	**Representing Users**	Development of IT products.	A product development unit at a large, global IT development company.	Iivari (2005; 2006a; 2006b)
2	**Involving Silenced Users**	Contract-based IT specification project, participants from a client and a vendor organization, specifying a tailored organizational IS for office work.	The vendor was an IT development company, the client a non-profit organization.	Tuovila & Karasti (2003), Tuovila & Iivari (2007)
3	**Work Practice Oriented Interventions**	Development project of an experimental IS for a new service in telemedicine, based on an existing technology platform for another domain. Participants from two clinics of radiology and two companies. Researchers studied the project and decided to intervene.	Two health care organizations – radiology unit at a primary health care center and a radiology clinic at a university hospital – and two hardware and software companies.	Karasti (1997; 2001a; 2001b)
4	**Cross-functional Interaction**	Development of IT products for specified market segment(s).	An IT product development company	Molin-Juustila (2006)
5	**Collaborative Infrastructure Work**	Collaborative development and maintenance of integrated information systems (information infrastructure) for a long-term research network.	A large-scale science network.	Karasti & Baker (2004), Karasti, Baker & Halkola (2006), Karasti & Baker (2008)

Table 1. Description of the five empirical studies on mediation.

These studies have all been conducted by different researchers with varying perspectives and motives. Therefore, in revisiting each study, we also try to preserve the original tone of the individual studies.

1. Representing Users in an IT Product Development Unit

This is a study about a user interface (UI) software development unit of a large, global corporation developing business-to-business IT solutions for international markets. At the time of the study, there were approximately 30 employees in the unit, most of whom were software designers, whose responsibilities included designing, coding, and testing the UI software they label the 'manager'. The designers worked in large-scale product development projects that involved personnel from several organizational units. In addition, there was a team of usability specialists (4 persons) in the unit.

The joint enterprise of this unit was to produce functionally correct manager software within set schedules. 'Configuring the user', i.e., defining and delineating the user and setting the parameters for his/her work practices (Grint & Woolgar 1997), was not considered an explicit or important task for the designers.

> *Let's say that there is a hierarchy of needs. First there must be quality related to the software; it needs to function. After that one can start to think of these additional things, like customer quality, usability, and things like that. And almost always in projects, it is the functionality that matters; you just desperately try to make the software function somehow.* (Usability specialist 1)[1]

The usability specialists were expected to represent the user in the development process (cf. Cooper & Bowers 1995). They could claim the authority to represent the users because they had conducted empirical field studies and user testing, and because they were assumed to have state-of-the-art HCI knowledge. They had utilized many strategies in making the users and their work visible to the development team (cf. Suchman 1995). Based on their field study data, they had produced a context of use description, a document in a table format that described the users, their tasks, and the use environment. In addition, they had vi-

deo taped the field studies and the tapes were available to the designers. Furthermore, they had created a persona (cf. Cooper 1999) called Eric to make the users more visible to the designers. However, representing the user had proven problematic. The designers had criticized Eric for being "too stupid" (Usability specialist 1) and dismissed him as "a special case, which we don't need to serve" (Usability specialist 2). Furthermore, the documents and the video tapes that the usability specialists had produced tended to be ignored by the designers.

> *You have to read a lot of documents when you design software. […] In this situation you don't suddenly think that I could read more; there could be additional interesting documents that I could read. If it is not totally necessary, you just don't read them.* (Designer 1)

In addition, the usability specialists only had an informative or consultative role in the development. They commented on predefined design solutions and acted as providers of information, but they did not actively participate in the design process or have decision-making power regarding the design solution (cf. Damodaran 1996). It was up to the designers to ask for comments while 'configuring the user': "We all know that we need to ask for comments from the usability specialists in the design phase" (Designer 1); "The usability specialists check whether the design is good" (Designer 2). The usability specialists complained that they could not affect the design much: "If a project is in the early phase, it seems like they actually reject our involvement. They say you don't have to peep in here yet, we are doing nothing yet" (Usability specialist 2). However, the responsibility for the appropriate 'configuration of the user' was assigned to the usability specialists alone: "People think that because we have usability specialists, then they are the ones that do everything" (Manager 1); "And preferably afterwards or at as late a phase as possible" (Usability specialist 3). Therefore, even though the usability specialists were not able to affect the 'configuration of the user' in practice, they were claimed to be responsible for it.

The work in the unit alone could not ensure the usability of the product. Cooperation with other units was needed. The usability specialists had organized cooperation with other units, and established a 'usability

group', in which personnel from different organizational units participated. The usability group aimed at spreading 'usability knowledge': "Mary [a usability specialist] has presented the context of use [material] to the systems department and they had actually had a touchingly positive attitude towards [usability work]" (Manager 1); "Mary has already been there [SW engineering meeting] presenting the results […]. And I have asked Jane and John [usability specialists] to come there and talk about their experiences" (Usability specialist 4). In addition, the usability group formed a community of practice (CoP; Lave & Wenger 1991) for the usability specialists to learn from each other, to teach more junior usability specialists, and to provide peer support in their challenging situation (cf. Iivari 2005). However, it was acknowledged that a problem for the usability group was that it was a "grass root level community, which can't influence much" (Usability specialist 3).

2. Involving Silenced Users in a Collaborative Requirements Specification

This study is about a collaborative requirements specification project, where participants came from the organizations of a client and a vendor, and from different occupations. The client was an office in an organization which developed its information management by changing its old IS to a new one provided by the external software vendor. The vendor was a qualified software company, located 500 kilometers away from the client. One aim of the project was to digitalize paper work in the office. It was also planned that currently filed paper documents would be scanned and included in a digital repository. The participants collaboratively defined the requirements for the new system. Nearly all of the intended users (i.e. the workers from the client) were expected to participate in the project: a secretary, an office manager, one chief inspector, and two inspectors. The client's IS specialists – a system manager and two project managers – also participated in many specification meetings. From the vendor, three software designers participated in the project.

The project plan included no methods or tools for collaborative design or for analyzing users' work. The only time that the secretary's actual work to some degree became visible to the designers was at the beginning of the project, when copies of the users' work documents, forms, and so on, were presented. The secretary tried to make her work

practices visible to the participants. On two occasions she fetched a large stack of work documents that she had placed into folders. She explained to the participants her way of organizing and filing the documents, and how she had used particular colors for coding them. However, it remained unclear to the designers what kind of situated knowledge she needed for performing her tasks, and how her tasks related to her co-workers' tasks. The secretary repeatedly invited others to her workspace to see how she actually worked. Nobody responded to the invitations, and the participants settled for copies of the secretary's document examples.

The designers viewed collaborative specification sessions as occasions for gathering software requirements, not for analyzing users' work. They would have wished to collaborate with the IS specialists and the office manager rather than directly with the users, because they assumed that the users did not understand specifications, and were unable to describe or decide on requirements. Indeed, some of the users were not familiar with new IT solutions and formal software specifications. Because of the distance between the worlds of the users and the designers, it was difficult to figure out design solutions in relation to the users' work both for the intended users and for the designers throughout the project. Related to this, there were many situations when the system manager, the project manager, and the office manager acted as mediators. However, their roles differed in many ways.

Especially the system manager took an active mediator role by organizing a wall chart session yielding representations of the users' current and future work process. She had prepared a tentative representation of the current work process on a meeting room wall. The secretary and the office manager joined her the next day. The system manager's agenda for the session was that the participants should analyze, discuss and refine the representation of the current work and, following that, reconstruct it to represent the future work process. The office manager and the system manager presented the wall chart of the users' current work process. The system manager tried to make the secretary's work visible by supporting her explanations of her tasks with the help of the wall chart. The office manager, in turn, solely advocated the inspectors and himself (cf. Mambrey, Mark, & Pankoke-Babatz 1998). He presented their work and explained why work documents should be available to them in elec-

tronic form. He was informed about the secretary's tasks, and could have described them to the designers. However, he represented mostly the organizational and management point of view of the work processes and the goals of their development. The designers did not participate in the discussion and did not document it. The documentation they made was limited to photographs of the wall charts. However, relying on the photos and their insufficient knowledge of the users' actual work situations, the designers envisioned solutions, for example use cases and UI models, to be evaluated in the subsequent sessions.

Altogether, as mentioned, collaboration between users and designers was difficult. However, in some situations, the IS specialists and, occasionally, the office manager, who had some knowledge of both the user domain and IT design, acted as mediators between the users' existing work and the envisioned work. Their roles as mediators included translating (cf. Williams & Begg 1993) both design solutions to users and user domain knowledge to designers.

3. Work Practice Oriented Intervention in Radiology System Redesign

This study is about an intervention into the development project of an experimental teleradiology system through work practice oriented workshops organized by researchers. The experimental system was used to create a new teleradiology service that allowed clinicians in a remote primary health center to consult radiology specialists in a university hospital. Computer-savvy radiologists and physicists from the university hospital's clinic of radiology engaged with designers from two companies producing hardware and software to identify an initial set of requirements for the system. The designers were interested in applying an existing technology solution into a new application domain through redesign. The research team got involved when the system was ready for trial and carried out an ethnographic study of the system's clinical use phase. The trial period was the first occasion on which the participating radiologists conducted diagnostic interpretation of digital images on computer monitors, as the experimental system presented an initial step in replacing radiology's traditional medium of film with digital images and a computerized infrastructure. After the trial period was over, the research team organized workshops in which the participants' experiences

and fieldwork findings could be taken into account in the evaluation and further design of the system (Karasti 2001b).

The workshops were planned to support the bridging of work practice and systems design in several ways (Karasti 1997). Representatives from several interest groups participated: radiology practitioners from all occupational groups involved with the teleradiology service, professional designers, and researchers. The primary idea for the workshops was to base the collaborative activities of analysis, evaluation and envisioning on actual radiology work. Video collages were prepared to present concrete instances of everyday clinical work in rich natural form. In the workshop, the participants viewed short sequences of the video collage together. The tape was paused and discussion started up. The video collage began with instances of traditional, film-based work (when possible). This allowed the radiology practitioners to elaborate on observable work, to articulate essential aspects of work, to share lived experience and professional expertise, and thus support the analysis and co-construction of shared understandings of their work. The video collage continued with footage of emergent, digitally based work activities with the new system, allowing for analysis and evaluation of the system in concrete use situations. The envisioning of improvements began when problematic system use situations were encountered in the video collage (Karasti 2001a).

A detailed interaction analysis was conducted for one particularly successful workshop where the focus was on radiological image interpretation. Image interpretation refers to radiologists' diagnostic work that is carried out through the reading of images produced by radiological examinations of patients' body parts. It results in answers to clinicians' requests in the form of radiological reports. The analysis identified three recurrent patterns of workshop interaction (Karasti 2001a). Firstly, the video allowed radiology personnel to render the viewed work practice both familiar and strange. This is visible in the reflective statement by one of the radiologists after viewing a video sequence that presented a radiologist moving his body in front of the large alternator light panels in order to create optimal viewing conditions of the prearranged images: "I think it's necessary to reach out to get a view of the right angles of both of the films […] in a way, you look perpendicularly […] when you are

comparing two images. […] I never thought there was so much body work involved in image interpretation." (Radiologist 1)[2] This interplay between, on the one hand, being immersed in the familiar activities displayed on the video and, on the other hand, gaining distance from the activities to reflect on them formed the basis for the interaction pattern called 'analytic distance'.

Secondly, the video collage presented both film-based and digital image-based ways of working, which supported participants in juxtaposing and finding relations between the traditional and emerging ways of conducting image interpretation: "You cannot look at the film, or at the monitor, from the side" (Radiologist 1). By juxtaposing the traditional and emerging ways of working made available by the video collage, the participants were able to continue to envision improved and new features for the future system: "This quick adjustment [a feature available in the experimental system for images' grayscale adjustment] works generally […] But with difficult, complicated cases […] you need a more thorough adjustment of individual images. It's like some second generation tool that we could use in such cases" (Radiologist 2). By juxtaposing the traditional, emergent and envisioned contexts of work and technology use, the workshop participants were able to broaden their 'horizon of work transformations'.

Thirdly, an interaction pattern called 'situated generalization' refers to the interplay through which the particularities of the work displayed on the video gain meaning in relation to the practitioners' experiences and understanding of the underlying rationale of work. The above example of a radiologist moving his body in front of the light panels was continued in the workshop by linking the embodied image comparison activities visible on the video with radiologists' experiential knowledge of the central role of image comparison in diagnostic work: "You search a position in the middle of the images to be able to see them in about the same size. It has to be the reason for moving like this" (Radiologist 1). Thus the meaning of the observable activity for image interpretation work was pinpointed: seeing images about the same size is important for image comparison.

Through the participants' collaborative considerations related to existing, emergent, as well as envisioned work, some of the identified mean-

ings of work emerged as relevant design issues: "Comparison is an important word here. In all the issues that we have talked about here today, we have seen that our original concept was more like solving individual problems. Now, today has proved that comparison is needed even in teleradiology and we just have to make it possible" (Radiologist 2). Workshop participants came to a shared realization that comparison of images, i.e. the possibility to relate and link images from different examinations in order to attain their diagnostic meaning, was such an important design issue that it required a reformulation of the original design concept.

The multiparty workshop setting, with the video collage as a shared object, made possible mediation between use and design via the identified patterns of interaction. It thus provided a prolific way for the co-construction of shared understandings of work practice and design issues.

4. Cross-functional Interaction in an IT Product Company

This study focuses on new product development in a medium-sized international software product company operating in business-to-business product markets. As a product development company (Grudin 1991), their purpose was to produce more or less tailorable packaged software solutions for new emerging markets. Their new product idea was based on Internet technology; it was at the time a radical new innovation with high uncertainties, especially with respect to the needs and requirements of users and of the market.

The development of the company's new product was based on iterative product releases, managed and organized according to a roadmap for the future releases. Traditionally, the word 'design' refers conceptually to all life cycle activities of the new technology development. However, in this company, the developers formed a specialized organizational function, 'the product delivery unit', and were responsible only for part of the release-dependent life cycle activities (e.g., design and implementation). Closely related to the developers was the user-centered design (UCD) group responsible for usability issues (evaluations, visual design, etc.) and more recently for a more systematic UCD approach (see ISO 1999). Furthermore, in the case company, this design work concerned not merely design and implementation, but also multidisciplinary learning and negotiation concerning priorities of market needs and requirements.

This part of the development was a release-independent and cross-functional effort. Other organizational functions also built special links between design and use (see Keil & Carmel 1995). The sales and delivery function was responsible for sales and customer (solution) consulting for some specific market segments, and the operations and implementation function produced the tailored customer applications. In addition, there were the customer support and services and the marketing (market research, focus groups, demos, trade shows, etc.) functions. The requirements for the new product came from these different sources and were stored in a 'requirements database' (an Excel sheet which tabulated requirements from different sources by status, action etc. information) as a basis for iterative release-planning within a cross-functional team effort (Molin-Juustila 2006, 114). The main functionality of the new product release was defined even before the development team was formed.

Although the fundamental aim of any product business is to find the next 'killer application', in practice it is not that simple. Because of high market uncertainties, the company carried out UCD activities (supported by mock-ups and prototypes) with pilot customers in order to learn more about the potentials of their new product idea. This created a continual tension between one unique customer solution and the more generalized product for the market. There was a need to define groups of limited numbers of customers with similar needs as a basis for market segments.[3] Therefore, in addition to the already known confusion between the concepts of the user and the customer (Poltrock & Grudin 1994), there was confusion between the customer and the market. In addition, with high market uncertainty, the future users and customers of the new product were virtually unknown. However, the product was "as good as the accuracy of the contextual assumptions made by its designers" (Potts 1995). Even though the contextual design method (Beyer & Holtzblatt 1998) was used to better understand the customer segments, the requirements of the pilot customers and users only represented the requirements of some potential future market.

5. Collaborative Infrastructure Work in a Science Network

This study is about collaborative information infrastructure work in a large-scale scientific network. In focus is a vastly geographically and insti-

tutionally distributed network of 26 research sites and about 1,800 participants which has the mission of long-term interdisciplinary investigation. The network is one of the longest running efforts at consistent longitudinal data collection and preservation, and a pioneer of an open data sharing policy of primary research data. Information management has been a recognized activity, which has gained increasing importance since the network began in 1980. Information managers work as part of the research sites to support the study of local biomes. They also work on the network level, engaging in collaborative infrastructure work. The two arenas comprise different settings for mediation between design and use.

On the local level, information managers provide support for the differing needs of 1) site science, 2) long-term preservation of data and 3) technology (Karasti & Baker 2004). Firstly, supporting site science is the principal responsibility of the information managers in the network, and therefore "it is absolutely critical to have enough understanding of the science" (Information Manager 1).[4] Typically it involves provision of assistance and knowledge with regard to a great variety of data and technology questions: "helping the investigators with a lot of issues involving data, technology, computers or others, […] helping people to get their thing done, from little to big things" (Information Manager 2). Secondly, information managers provide support for the long-term preservation of data that can have various kinds of (re)uses and (re)users (e.g. scientists, administrators, the general public) during its extended lifespan. Through data stewardship activities (Karasti, Baker & Halkola 2006; Karasti & Baker 2008), information managers attend to the maintenance of the integrity and availability of legacy datasets and to keeping in place a data-safe, functional system, "a protecting cocoon for data" (Information Manager 3). Thirdly, information managers provide support for technology. Since they are responsible for the development of the sites' information management systems and infrastructures, they need to "remain current in technology" (Information Manager 4). However, factors that relate to sustaining the long-term perspective in data-intensive research emphasize judicious technology development: "It's important that information managers continue to come back to assessing whatever projects they want to develop to whether they are really going to support the research at the site" (Information Manager 5). Furthermore,

the features of high reliability and easy maintainability influence decisions about technology development: "The experience we have had with several of our things […] the issue is not how you do it, it's how do you maintain it and how do you make it so that it is easily maintainable" (Information Manager 1).

Local information infrastructure work is a complex balancing between the different needs of site science, data, and technology (Karasti & Baker 2004), thus information managers do not only mediate between use (science) and design (technology development), but also account for the stewardship of legacy data. Their roles and activities in these settings are so complex that the boundaries between use, maintenance, stewardship, and design are blurred (Karasti & Syrjänen 2004). Though the methods for collaborating with scientists vary from site to site, they are typically used both to inform about technology developments and to negotiate possible future directions. The artifacts used are typically mundane and endogenous to the data-intensive science settings, such as lists and tables that allow the representation of often rather complex technological matters, for example databases, in a simplified form. The value of site-based information management is that the understanding, engagement, and forward planning of technology development takes place in conjunction with site research and understandings. Thus, data directly and immediately enriches scientific investigations and site science provides focus for information management and infrastructure development. Therefore, a close relationship of mediation is formed between use (local science) and design (local information management and infrastructure work).

Anchored to the realities and needs of their sites, and working geographically isolated from each other, the information managers have created a long-term network-level forum, called the Information Management Committee (IMC), through which they can come together annually for face-to-face meetings and more often for virtual conferences. The IMC functions as a community of practice (CoP; Lave & Wenger 1991) for information managers. It offers a forum for sharing site-specific experiences on communal topics, learning together, identifying current common matters of interest, and finding solutions for and collaborating on questions of information management and infrastructure work. By coming together, the information managers can reflect together on the

tensions involved in their everyday work, as well as provide and receive peer support: "In IMC meetings I find people that understand my problems. I find the support that I do not find elsewhere" (Information Manager 7). The forum offers an opportunity to develop their identities and roles:

> *I feel really good about these people [information managers], and it just gets stronger as the years go by and the meetings really help me in terms of confidence and knowing what my position is, and that definitely must be reflected when I go back to my site. […] I feel more confident in my mission. It is a little more well defined.*" (Information Manager 8)

Through the IMC, "information managers have taken the time that fosters an integrative, sustainable approach with technology, ensuring that we learn together" (Information Manager 6). Learning about technology matters is an important aspect of the IMC because information managers typically do not have formal education in computer science or information systems design. Furthermore, the network-level community offers an arena for collaborative information infrastructure work in which "a lot of the bottom-up characteristics are important" (Information Manager 1). Through "the recognition that there are legitimate reasons for some differences between site systems" it is possible "to deal with heterogeneity not by limiting it but by dealing with it" (Information Manager 1). The work has resulted in a number of 'home-grown' methods for jointly designing shared infrastructures (for more details see Karasti & Baker 2004; Karasti, Baker & Halkola 2006) that rely on the inherent characteristics of the networked organization, such as long-term continuity and technological heterogeneity at sites. The environment, in which information managers work at different sites and come together to the network level forum, provides them with the grounded perceptiveness required in collaboratively building and maintaining the network's information infrastructure. The IMC gives the information managers a unique opportunity to develop their voice as non-professional technology developers and to act as one group in mediating technology design matters to the other, typically more science-focused, committees or

groups within the network, as well as between the network scientists and the outside professional technology developers.

Summary of the Empirical Findings

Table 2 summarizes the key findings of the five empirical studies presented.

The first study, taking place in the product development unit, reveals problems related to mediation between design and use; there is a strict division of labor here, which seems to be very difficult to overcome (cf. Suchman & Trigg 1991). Design is clearly in a dominant position and use is only 'represented' by the usability specialists, who, furthermore, have gathered snapshot data about use, but do not intimately know the use. Despite this lack of knowledge, however, the usability specialists are the ones responsible for ensuring the appropriate configuration of the user.

The second study, on the collaborative requirements specification project, illustrates a situation in which actual, intended users were expected to participate in producing a collaborative requirements specification. However, ad hoc mediators, in this case IS specialists and an office manager from the client, were needed to try to bridge the gap between the users' actual work and the technology design. Still, on their own, these mediators were not able to make the work of the users, and in particular the secretarial support work, visible to the designers (cf. Suchman 1995).

There are also examples where interventions have been organized to mediate between design and use. For instance, in the third study, about redesigning an experimental teleradiology system, the researchers, who had first carried out an ethnographic study of the radiology work and technology use, intervened into a design project by organizing work practice oriented design workshops. In the workshops, the work practice was made doubly present through the video collage of fieldwork recordings and extensive practitioner participation, which helped make visible the actual radiology work and practitioners' experience. As a result, the collaborative activities of analysis, evaluation, and design were appropriately grounded in actual work practice.

Study	Key Examples Related to Mediation
1 **Representing Users**	Usability specialists produce personas and context of use descriptions. They are expected to know the user, to represent the user in configuring the user and to be responsible for the appropriate configuration of the user. They participate in a usability specialists' grassroot community of practice inside their organization.
2 **Involving Silenced Users**	The customer's IS specialists and an office manager define and redesign the users' work practice in a work process picture on the wall in a collaborative requirements specification project. They try to invite the users to take part in defining and redefining users' work processses. The users also participate, but are not listened to. Therefore, their work remains invisible in the design process.
3 **Work Practice Oriented Interventions**	Researchers intervene in a system development project by organizing work practice oriented workshops in which video collages are used to make the users' actual work visible and accountable for collaborative analysis, evaluation and design.
4 **Cross-functional Interaction**	Usability specialists, customer support, marketing and consultants deliver design knowledge to users and use knowledge to designers through a requirements database, slide shows, demos, prototypes and mock-ups. They organize and carry out focus groups, contextual design and user-centered design with pilot customers, and participate in cross-functional release planning negotiation concerning the user-customer-market requirements.
5 **Collaborative Infrastructure Work**	Information managers take care of the long-term preservation of data, support site science, and engage in design, use, and maintenance of the technological infrastructure, mediating between data, science, and technology at their sites. On the network level, they participate in the Information Management Committee (IMC), which is their long-term forum to develop the roles, tools and methods in information management and infrastructure work by sharing experiences, discussing common interests, learning together, and reflecting. The IMC mediates between the network scientists and the external technology developers.

Table 2. Key examples of mediation from the five empirical studies presented.

As was the case in the first study, the fourth study brings out the complexities related to commercial software product development. It

shows the cross-functional nature of gathering, negotiating, and deciding on requirements. Rather than bringing users and developers closer to each other during the requirements process, the requirements have already been decided before a new development team is appointed for the next product release. The study also highlights the complex relationships between the concepts of user, customer, and market. Mediation, in this case, is cross-functional negotiation concerning the user-customer-market requirements.

The last study highlights non-professional IT development. In the study, which is anchored in the site-level tensions and balancing acts involved in providing support for science, data, and technology, information managers have created, and continue to cultivate, a long-term IM Committee. It is a network level forum where information managers can share, reflect on, learn, and develop various aspects of their work, which come together under the title of collaborative infrastructure work.

Characterizing Mediation between Design and Use

Generally, one can say that mediation aims to bridge the gap between design and use. In our studies, both findings related to making users' work visible to designers and design solutions understandable to users have been encountered. The studies highlight the diversity and complexity of mediation, which emerges in varied forms and is carried out by utilizing different means. Our key findings related to mediation are summarized in table 3, in relation to each empirical study.

Table 3 illustrates that people in various kinds of intermediary positions have acted as mediators between design and use. Different kinds of representations have been employed in bridging the gap, and various kinds of collaborative methods have been used in mediating between design and use. Finally, mediation can also be accomplished through long-term, integrative forums, in which the members negotiate and cooperatively reflect on their understanding of use and its meanings to design and vice versa. Next, each form of mediation is discussed in detail, highlighting the interesting insights and distinctions revealed by the data.

Study	People in Intermediary Positions	Representations Used in/for Mediation	Collaborative Methods	Long-Term Integrative Forums
1 **Representing Users**	Usability specialists	Personas, context of use descriptions, video tapes	–	Usability group
2 **Involving Silenced Users**	IS specialists from user organization	Informal work process picture on the wall, formal software-requirements specifications, UI models	Collaborative requirements specification sessions without explicit collaborative methods or tools	–
3 **Work Practice Oriented Interventions**	Researchers	Video collage	Work practice oriented workshops	–
4 **Cross-functional Interaction**	Usability specialists, customer support, marketing, consultants	Requirements database, slide shows, demos, prototypes, mock-ups	Focus groups, contextual design, user-centered design (UCD) with pilot customers	Cross-functional release planning
5 **Collaborative Infrastructure Work**	Information managers	A number of different kinds of tables and lists	Various means for site-level collaboration with scientists, network-level working groups with scientists	Information Management Committee

Table 3. Different forms of mediation.

People in Intermediary Positions

The different aspects characterizing people in intermediary positions are summarized in table 4. In the studies, people in various formal and informal positions act as mediators trying to bridge the gap between

design and use. In some of the studies, these people were hired to represent the users (studies 1 and 4), and their position was specifically to serve mediation purposes. In other studies, people have acknowledged that without mediation, users' work remains invisible, and for that reason they have adopted a mediator position. In study 2, IS specialists from the user organization took on the mediator position in an ad hoc manner. In study 3, the researchers became conscious of the need for mediation and intervened into the development project as mediators to make users' work practices visible.

Furthermore, mediation may be an inherent part of the activity, as is the case with the information managers. In study 5, the information managers' work is to provide support for long-term preservation of data, for scientists' work and for technology development. As each task area has very different concerns and priorities, an inherent and important part of the information managers' job description is to mediate and balance between the task areas. In addition, the task areas are closely intertwined, causing a blurring of the boundaries between use, stewardship and design, thus positioning the information managers in a complex intermediary position.

In our studies, these mediators have both delivered 'use' knowledge to design practice and communicated design solutions to users in an understandable format. Active participation in local practices is important for people in this position, but for some of these mediators (in particular for the hired ones, i.e. in studies 1 and 4) such active participation may be difficult to achieve. It should be emphasized that practices can be interpreted differently and there is a risk that the expertise acquired by the mediators will not be relevant. In the worst case, their work, which is often short-term, may result in conflicts and views of use that are too general and trivial. Active and longer-term participation, in turn, would make it possible to come closer to the users' point of view and to sustain trustful relationships with the users, but the possibility for this depends on a multitude of factors, including the conditions and circumstances of the field study (cf. Schultze 2000).

Aspect	Empirical Example
Formal mediation position vs. informal mediation position	Formal mediation position Usability specialists (study 1 and 4), customer support, marketing, sales and consultants (study 4) are hired/appointed as mediators. Informal mediation position Customer's office manager and IS specialists (study 2), researchers (study 3) and information managers (study 5) have taken on this position as a response to their circumstances.
Planned vs. ad hoc	Planned Usability specialists (study 1 and 4), researchers (study 3), customer support, marketing, sales, consultants (study 4) and information managers (study 5) plan their mediation work. Ad hoc Customer's office manager and IS specialists (study 2) adopted this position ad hoc, in situ.
Continuous vs. one time only	Continuous Long-term continuance in the position of usability specialists (study 1 and 4), customer support, marketing, sales, consultants (study 4) and information managers (study 5). One time only Customer's office manager, IS specialists (study 2) and researchers (study 3) adopted this position for one specific case only.
Location of people	Located within the use practice Customer's office manager (study 2) located within the use practice; act as 'user of the IT'. Located within the design practice Customer's IS specialists (study 2) located within the design practice; act as 'designer of the IT'. Located within the mediation practice Usability specialists (study 1 and 4), researchers (study 3), customer support, marketing, sales and consultants (study 4) are located solely within the mediation practice, acting as 'mediators between IT design and use'. Located both within use, design, and mediation practices Information managers (study 5) located within all these practices, moving between them.

Table 4. People in intermediary positions.

The mediators in the studies are in situations where they serve many masters, trying to intimately know the users and make the users' work visible, while also trying to stay up to date with technology and ensure an appropriate configuration for the user, in some cases without the formal power to influence the design solution. In some situations, moreover, there might even be difficulties in specifying who 'the user' is and where the users' work takes place, as is the case in study 4 due to the complicated user-customer-market relationships mentioned earlier.

Existing research has discussed this position in relation to IT development in business and research settings (e.g. in HCI, IS and PD literatures). Furthermore, this position has also been identified in the context of use (e.g. Bansler & Havn 2004; Orlikowski *et al.* 1995). However, existing research has not combined analyses of this position in such a variety of settings as is the case in this article. Furthermore, there is a need for further empirical, interpretive studies analyzing the complexities of this position. With respect to our findings, we emphasize the challenges associated with this position and advocate critical analyses of it (see also Iivari 2005; Iivari 2006b).

Representations Used in/for Mediation

The different aspects characterizing representations used in/for mediation are outlined in table 5. Generally, one can say that representations are essential in mediation between design and use. There is an abundant literature on this subject matter. Various kinds of representations were used in our studies, differing by their content and form. Their form ranges from elaborate video collages (study 3) to very mundane, ordinary lists and tables (studies 1 and 5). Some of them came from the designers' world (e.g. in studies 2 and 4), where descriptions rely on some sort of formalized or semi-formalized notation (Anderson 1994), thus remaining distant to users. Some ethnographically informed representations were very close to the users' world (study 3). Representations created specifically for mediation purposes can be established ones, such as personas (study 1), work process pictures on the wall (study 2), or demos, prototypes and mock-ups (study 4), but they can also be designed in situ, as in the case of the video collage (study 3).

However, interestingly, the information managers' tables and lists (study 5) originate from the use practice. These representations have their roots in work activities and have been used for the core purposes of the community, i.e. interdisciplinary research. Thus, they are representations that have been produced under the terms and conditions of the use practice, and have become familiar to all community members through joint activities. These representations have shown a certain degree of flexibility for varying kinds of uses and thus they have become utilized for mediation purposes in the community.

It is interesting how representations of work involve various perspectives (Suchman 1995). Suchman argues that "work has a tendency to disappear at a distance, such that the further removed we are from the work of others the more simplified, often stereotyped, our view of their work becomes" (1995, 59). Clearly, very stereotyped and abstract views of the world were produced in personas and context of use-descriptions (study 1) and wall chart pictures in which users' current and future work processes were constructed (study 2). However, in the video collages in the workshops (study 3) the goal was to make visible several actual, situated use practices of radiology practitioners to be analyzed and interpreted jointly by the workshop participants.

As a solution for bringing users and designers together, the concept of boundary objects (Star & Griesemer 1989) serves as an interesting analytic tool. The creation and management of boundary objects is a key process in developing and managing coherence across intersecting social worlds; the boundary objects inhabit several worlds and satisfy informational requirements of each of them (Star & Griesemer 1989). In our studies, especially the video collage utilized in workshops in radiology system re-design put emphasis on mediating between differing worlds (study 3). In this article, however, many of the representations that were identified deliver knowledge only in one direction. Personas, context of use descriptions, video tapes (study 1), work process pictures on the wall (study 2) and the requirements database (study 4) deliver use knowledge to design. The slide shows, demos, prototypes and mock-ups (study 4), on the other hand, deliver design knowledge to users.

Aspect	Empirical Example
Situated, actual use vs. abstract descriptions	Situated, actual use A video collage (study 3) captures instances of actual, situated use. Abstract descriptions Personas, context of use descriptions (study 1) and work process pictures on the wall (study 2) provide abstract and detached descriptions of users' work practice.
Provenance of the representations	Provenance within the use practice IM tables and lists (study 5) located within the use practice, produced under the terms and conditions of the use practice. Provenance within the design practice Formal software-requirements specifications, UI models (study 2) and the requirements database (study 4) located within the design practice, produced under the terms and conditions of the design practice. Provenance within the mediation practice Personas (study 1), work process pictures on the wall (study 2), demos, prototypes and mock-ups (study 4) located within the mediation practice, produced under the terms and conditions of the mediation practice.
Direction of mediation	From use to design Personas, context of use descriptions, video tapes (study 1), work process pictures on the wall (study 2) and the requirements database (study 4) attempt to deliver use knowledge to design. From design to use Formal software-requirements specifications, UI models (study 2), slide shows, demos, prototypes and mock-ups (study 4) attempt to deliver design knowledge to users. Both directions The video collage (study 3) and IM tables and lists (study 5) attempt to deliver knowledge in both directions.

Table 5. Representations used in/for mediation.

Collaborative Methods

The different aspects characterizing collaborative methods are outlined in table 6. Related to methods developed for mediating between design and use, there clearly exists a wealth of (particularly participatory design, PD) literature. However, a few interesting observations from our studies that

are not apparent in the literature are discussed. In some of our studies a lot of effort has been put into the utilization of these methods in practice, as was the case when researchers made an intervention into radiology system re-design by organizing work practice oriented workshops (study 3). The collaborative activities of radiology practitioners, professsional designers, and researchers were based on an analysis of actual work that was made visible through the video collage and by the practitioners participating in the workshops. Careful ethnographic fieldwork was carried out beforehand, and the researchers took an active role as organizers of the sessions. In contrast to this, however, there was a clear lack of methods and tools to be used in collaboration in the requirements specification project (study 2). In addition, there were no researchers with the goal to mediate between design and use. Mediation was realized only through a few ad hoc attempts to make users' work visible. This study clearly indicates the challenges associated with the implementation of collaborative methods in industrial settings, in which the practitioners might not even be aware of these kinds of methods, and even if they were, there might be difficulties in applying them. Moreover, these methods may be too labor intensive, and thus not cost effective enough in industrial settings, e.g. in the situation described in study 4, where new small-scale product features were considered.

Another interesting issue highlighted by our studies is the collaborative methods that communities have developed on their own to serve their particular purposes, relying upon how the communities and their activities are organized. In the scientific network (study 5), a number of homegrown methods were identified. A similar phenomenon has also been described by Syrjänen (2007), where dog breeders have acted as designers and developed collaborative methods to suit their particular purposes and circumstances. With regard to PD strategies from the viewpoint of ordinary users and non-IT professional user-designers, there are important, unanswered questions related to what actually constitute design, use, and participation (Pipek & Syrjänen 2006). Traditional perspectives on use and participation make it difficult to capture, value, and potentially support activities that people who are not IT-professional users perform in order to make use of IT.

Aspect	Empirical Example
Established methods for mediation vs. homegrown methods	Established methods for mediation Focus groups, contextual design and UCD with pilot customers (study 4) are established methods designed specifically for mediation purposes. Homegrown methods for mediation The IM means for site-level and network-level collaboration with scientists (study 5) are homegrown methods developed for mediation purposes by the community.
Planned vs. ad hoc	Planned Work practice oriented workshops (study 3), focus groups, contextual design and UCD with pilot customers (study 4) were planned in advance. Ad hoc PD attempts in collaborative requirements specification sessions (study 2) emerged ad hoc.
Continuous vs. one time only	Continuous Long-term continuance in the use of methods such as focus groups and UCD with pilot customers (study 4). One time only Work practice oriented workshops (study 3) and PD attempts in collaborative requirements specification sessions (study 2) emerged only in specific cases.
Provenance of the participants	Provenance within the use practice In the IM means for site-level and network-level collaboration with scientists (study 5), all participants were located within the use practice. Provenance within design, use and mediation practices In PD attempts in collaborative requirements specification sessions (study 2), work practice oriented workshops (study 3), focus groups, contextual design and UCD with pilot customers (study 4), some participants were located within the design practice, others within the use practice and some within the mediation practice.

Table 6. Collaborative methods.

This leads us to discuss the divergent backgrounds of the participants in these collaborative methods. As mentioned, in the PD literature the

participants are expected to be users and designer-researchers, who collaboratively design new work practices and technologies. In CSCW, on the other hand, it is suggested that one way to align design and use could be to work with ethnographers as mediators. In the HCI literature, this role is given to the HCI specialists, who are assumed to cooperate with both users and designers. In the methods identified in our studies, people with divergent backgrounds are also expected to collaborate. Some methods emphasize gaining an understanding of use practice, and it is assumed that not all participants are part of that practice (i.e. the designers and mediators). Such methods identified are, for instance, focus groups, contextual design, UCD with pilot customers, and the work practice oriented workshops. However, in study 5, where information managers and scientists collaborate at site level and network level, all participants are located within the use practice. It is interesting in this case that, among other things, emphasis is not on analyzing the users' use practice, which is otherwise typically an important element in these types of collaborative methods (e.g., an integral part of contextual design and UCD with pilot customers in study 4, and of work practice oriented workshops in study 3). This is because all participants are assumed to already have this knowledge because they are immersed in the use practice.

Long-Term Integrative Forums

The different aspects characterizing long-term integrative forums are outlined in table 7. We identify a long-term, integrative forum type of mediation from our studies (studies 1, 4 and 5). This type of mediation necessitates a long-term effort (as contrasted with more short-term collaboration efforts labelled collaborative methods in Table 6) with the goal of producing an integrated understanding of use and its meanings to design and vice versa, as well as aiming for reflection, negotiation and learning among the forum members. Outlined in table 7 are aspects characterizing these long-term integrative forums, focusing on characteristics that the examples share rather than characteristics that differentiate them, as is the case with the other forms of mediation. This is because this form of mediation is clearly novel, and this article is only capable of providing an initial characterization of it.

Aspect	Empirical Example
The shared practice	– Usability specialists' shared 'user representation' practice (study 1). – Cross-functional release planning teams' shared practice of negotiation and decision making for the priorities of the requirements and for the needs to clarify requirements that are too vague (study 4). – Information managers' shared practice of network-level development of information management for long-term interdisciplinary research (study 5).
Long-term orientation	– Usability specialists' grass-root community (study 1) aims at ensuring the usability of the company's products and spreading usability knowledge regardless of individual IT projects. – Cross-functional release planning team (study 4) aims at requirements gathering and negotiation of priorities as a continuous, release-independent activity. – Information managers (study 5) aim to secure the longevity of legacy data and to support long-term interdisciplinary research.
Integrative activities	– Producing an integrated understanding of use and its meanings to design and vice versa (studies 1, 4, 5). – Developing sustainable information infrastructure (study 5). – Learning from each others' experience (studies 1, 5). – Building a shared identity (studies 1, 5). – Providing peer support and comfort (studies 1, 5).

Table 7. Long-term integrative forums.

In the study of cross-functional interaction in a software product company (study 4), release-based development of new software products is a long-term and on-going activity carried out by a cross-functional team in the company rather than a one-time (short-term) development effort. The effort of the team – requirements gathering and negotiation of priorities – becomes a continuous release-independent activity, where new knowledge comes in continually from many different sources and is reflected in decisions concerning the roadmap for forthcoming product releases. These decisions are the result of more or less regular cross-functional (team) negotiations.

In study 1, a long-term orientation and a goal of producing an integrated understanding of use and its meanings to design are also present, as is reflection, negotiation and learning among the forum members. This is evident in the 'usability group'. In this group, usability-oriented members from different organizational units gather to share knowledge, to learn from each other and to provide peer support and comfort, for the ultimate purpose of ensuring the usability of the products of their company.

Moreover, the long-term, integrative forum type of mediation can be found in the study on collaborative infrastructure work in a scientific network (study 5). The role of information management, emerging within the shelter of a long-term science community and subject to ongoing technological and organizational change, forms itself and is being formed between and in relation to the research elements it supports. The information manager serves as a mediator between the elements of science, data and technology as well as between local practices within sites, the network level community of practice, and the larger world of technology development. The fact that there is awareness in the group of the long-term character of their commitment enables them to develop a community with continuity:

> *The long-term [research setting] has the advantage that you know that you are going to come back to things. If a thread slows down or is dropped, down the road you can pick up that thread. You will re-address something the next day, week or year. You are always related, affiliated, associated. [The community] has that continuity.* (Information Manager 7)

The information managers, who are not professional IT developers nor have their background in information systems design, have created their own ways of doing collaborative information infrastructure work that are suitable for the long-term science network. They have turned the heterogeneous local data and technology experiences into a shared resource. Similar types of findings have been outlined in the study of a dog breeding community (Syrjänen 2007), in which the long-term perspective is emphasized and it is argued that the IT use and design cannot be separated from the entire dog breeding activity. Both studies

emphasize the sustainable, long-term orientation of the IT infrastructures that have been co-constructed by local actors.

Concluding Remarks

This article has investigated mediation between design and use. The need for this was illustrated through a literature review as well as through revisiting five empirical studies with a particular focus on mediation. Each study has been discussed from the viewpoint of design, use, and mediation, in order to highlight the key observations related to each particular IT development context and practice. The themes of design, use and mediation were derived from existing research as well as from our inductive, empirical analysis. In particular, the theme of mediation, inductively identified from our studies, emerged as influential. Based on our findings, a categorization of forms of mediation has been introduced and discussed. In addition, related to each form, interesting aspects characterizing that particular form of mediation have been discussed.

As our empirical studies indicate, mediation emerges in many different forms. Our studies describe various types of IT-related practices, but clearly they provide a limited set of studies concerning mediation between design and use. We acknowledge that additional forms of mediation can be identified from other kinds of IT-related practices. For that reason, based on our findings, only an initial categorization is proposed. However, due to the fragmented and unconnected nature of existing literature on mediation between design and use, our categoryzation can be seen as a useful attempt to provide an integrated understanding of this complex matter.

With respect to the limitations of this study, mediation between design and use has been addressed by so many traditions that it is clearly impossible to address them all in depth. For example, one could mention activity, actor-network and structuration theories, and their conceptualizations of mediation that could be analyzed in the future. Empirical research, relying on and contesting our initial categorization, is needed. Other researchers are warmly invited to reflect on and use the findings presented in this article. Furthermore, the different forms of mediation identified in the article need further empirical analysis. As already mentioned, the theme was inductively identified through our empirical analysis. Empirical research on mediation – bridging the gap between de-

sign and use in a multitude of different IT-related practices and contexts (in work environments but also elsewhere) – is recommended. To unravel this phenomenon, long-term interdisciplinary research is needed.

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Notes

1. Citations in this section are from group and individual interviews, translated into English by one of the authors.
2. Citations in this section are excerpts from the workshop dialogue translated into English by one of the authors.
3. Market segment is an identifiable group of actual customers or prospects with some important similarities (defined by the company, e.g., needs) from the point of view of the product market.
4. Citations in this section are excerpts from interviews with information managers and scientists.

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