

Making Use

Understanding, Studying, and Supporting Appropriation

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Introduction

“In autumn 2001, I bought my first mobile phone. I want to point out that the technology did not change very much in the five years between total denial and actual use of the technology; the technology designers had little influence on the buying decision. It was rather my notion of interesting usages that evolved over the years.” (Pipek 2005, p. 16)

Appropriation – *to set apart for or assign to a particular purpose or use* (Webster) – is, refers to the establishing of new social practices in the light of new technologies. So, roughly speaking, appropriation is closely related with change, while, in everyday life, such transformations may be a slow, unnoticed, quiet, and evolutionary. The world, in other words, continues to look stable and ordered to those undertaking routine activities. Technologies, as is often said, are made ‘at home in the world’. Moreover, in an epoch of rapid change we take innovations for granted, so that is hard to imagine how to life e.g. without Electricity, Washing machines, Road networks or even Smartphones. Because of this power of the present, it is the role of stories and vignettes to bring once familiar situations and practices into explicit consideration.

This is true not just for the past, but also for future and otherwise alien practices. In this respect, reports of historians, ethnographers, visionaries, and design researchers face the same challenge and what appropriation studies are all about – namely helping the reader to familiarize themselves with unknown practices and their (emerging) nature. This brief outline suggests that established orders are quite malleable, which is one of the reasons why emergence and structure are of theoretical interest, even when these issues pose no problems in everyday life.

A survey of the origins of the term shows that appropriation is an ambiguous concept, used in different ways in various disciplines. The aim of this chapter is to provide an orientation to how appropriation might usefully be thought of, and why its use is becoming increasingly important. We will suggest that one important value here is to do with what it offers to the informing of design, but also to reflection about the limits of design. With regard to the latter, a common assumption is that designers are responsible for all outcomes associated with their vision. Concerning this, the concept of appropriation has a critical function in sensitizing us to the limits of design, emphasizing the openness and potentially creative use of artefacts. In addition, the concept sensitizes us to the power relation between designers and users – or more generally between software industry and the consumer class (Stallman 1985). Exploring the concept of appropriation, then, in a long term perspective plays a key role in our Grounded Design framework (see Stevens et al, in this volume).

Get back to work: A brief survey of the origins

The various meanings of ‘appropriation’ are connected by a web of historical and thematic similarities. Hence, we do not seek to introduce a definition, but to give a brief overview of the scholarly traditions that contribute to the concept. With regard to the design discourse on appropriation, two main lines of development are of special interest in the history of the concept. The first line is rooted in German Idealism, its elaboration by Marx and later adoption in Activity Theory. The other line of development is rooted in French poststructuralism with de Certeau’s view on the practices of the ordinary man.

In some way, the CSCW agenda represents a third branch that was influenced by both Activity Theory (e.g. via the Scandinavian participatory design tradition and the German usability tradition) and Post-structuralism (e.g. via Dourish and the British critical design tradition). Nevertheless, by its emphasis on appropriation *work* and appropriation *support* CSCW provides a distinctive focus. With this stance, it allies neatly with in the concept of Tailorability and that of End User Development (EUD), but broadens the perspective taken both into account: the adoption and adaptation of digital artefacts within the local context.

Express yourself: Appropriation and the German Idealism

"[Man] confronts the materials of nature as a force of nature. He sets in motion, his embodied nature forces, his arms and legs, head and hands in order to appropriate materials of nature in a form, which is suitable to his own life. Through his movement, he acts upon external nature and changes it, and in this way simultaneously changes his own nature. By thus acting on the external world and changing it, he at the same time changes his own nature." (Marx 1973 p. 283).

The concept of appropriation originated in the late 18th century, and initially was limited to legal questions of property and the (il-)legal possession of something. Hegel picks up on this discourse about possession to reflect on the general relationship of man with the world (cf. Braun, 2004, Keiler, 1990). Hegel views private property as the vehicle through which one is recognized by others as a free agent. In this way other agents "would be able to see that a person owns something, and therefore this individual can be treated as a realized person" (Hidalgo 2013). Appropriation, in this view, can be understood as incorporating both 'ownership' and expressivity (through the working of materials). Hence:

"[O]ur life is seen as self-expression also in the sense of clarifying what we are. This clarification awaits recognition by a subject, and man as a conscious being achieves his highest point when he recognizes his own life as an adequate, a true expression of what he potentially is - just as an artist or writer reaches his goal in recognizing his work as a fully adequate expression of what he wanted to say. And in one case as in the other, the 'message' could not have been known before it was expressed. [...] The specific property of human life is to culminate in self-awareness through expression" (Taylor, 1977, p. 17)

Moreover, in the moment when man recognizes his work as an expression of selfhood, man is not alienated from nature anymore, but has become part of it. In this view, appropriating external conditions means to gain autonomy by recognizing the necessity of the given.

"At the same time man in acting on external nature to serve his purposes, in working, helps to transform it and himself, and to bring both sides towards the eventual reconciliation" (Taylor, 1977, p. 120).

In a further step, Marx's contribution was to free the concept from its pre-industrial, slightly elitist connotations. He generalizes the concept of man as an expressive being by taking everyday labor instead of artistic works as the paradigmatic case. In this view, man is constituted by labor as the realization of man in nature through appropriation. Under the capitalist mode, and relations, of production, however, people sell their labor power to others. As a result, the worker manufactures products with which he has no relation. This logic alienates man from his work. He owns the products of his work neither legally, cognitively, nor emotionally. Instead the products of his labor remain completely alien to him. As a result, capitalism denies work its status as a resource for human development.

In sum, the concept of appropriation in German Idealism focuses on the interplay of man and his surroundings. It is part of the expressive nature of man and implicates an individual, social, as well as anthropological dimension. This, we will argue, has much to do with the concept of appropriation as learning-in-practice and expansive-learning outlined by the Activity Theory.

Learning by doing: Appropriation and Activity Theory

"Appropriation means very generally the exploration, touching, and grasping, but also changing, re-purposing and converting the physical and social environment. Appropriation implying the active doing of the subject, his interaction with the physical and social environment by making it, owns and by the same token creatively recognises oneself in it. From the appropriation perspective, human development is no adaptation to its environment. On the contrary the environment is the place for personal development, overcoming the boundaries of limited nature. It is a mere adoption of the environment as it prevents him from fully develop the richness of human capabilities and real humanity." (Deinet 2014, translated by the authors)

In the 20th century, the Marxian view of appropriation had a certain renaissance in Activity Theory (AT), where the concept was elaborated from a psychological stance (cf. Keiler 1993; Giest and Lompscher, 2006). In comparison to orthodox cognitive psychology, AT does not view the subject as an isolated entity that is detached from its environment, but views the active engagement of the subject with its environment as essential for individual development. In his engagement with the world, the actor appropriates the existing material and symbolic culture.

This stance also has methodological consequences. AT, like other ‘humanistic’ approaches, has a priori objection to laboratory experiments on the grounds they lack ecological validity. Instead, human activities should be studied in the wild, where *activity systems* are the basic unit of analysis. Moreover, research methods should be historical in order to reconstruct the socio-material genesis of the subject matter: “[to] explain a subject scientifically means to understand him through his becoming” (Holzkamp/Schurig 1973).

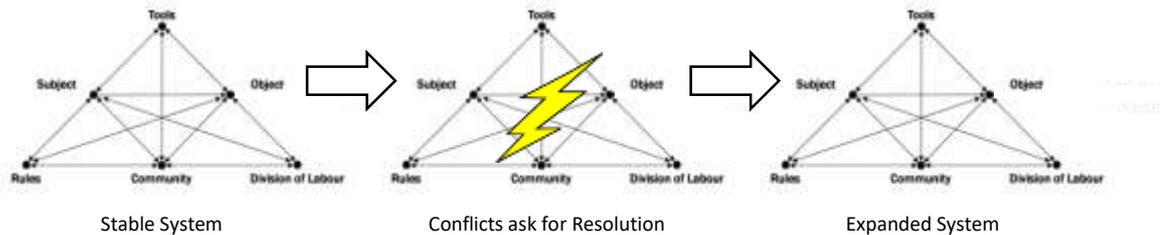


Figure 1 Constitutive elements of an Activity Systems: Modifications of an element or conflicts in a relationship have effect on the whole activity system and are driving forces for the further development (Source: Own diagram)

The core of an activity system consists of the triadic relationship of subject, object, and tools. In particular, the tool-quality of things must be learned through appropriation as active, cooperative engagement in the world:

“The spoon does not meet him [the child] in the socially developed manner of its use, as embodied in the characteristics of its shape, but in its non-specific, ‘natural’, physical properties. [...]. The mother observes this. She helps the child by engaging in what he does. In the resulting joint action the child forms the skill to use the spoon, it uses it from now on as a human subject.” (Leontjew 1967, translated by the authors)

In this triadic relation, the tool has a mediation role, having both a mental and a material relationship. The mental quality is given by the person’s competency and his repertoire of routines when using the tool. In addition, AT emphasizes the social dimension of rules, division of labour, and community as further elements of an activity system into account (see Figure 1). These elements and the mediating relationships are historically formed and open to further development. In particular, activity systems do not exist in isolation; rather, they are must constantly react to the external conditions in which they reside, including other related activity systems. Hereby, internal contradictions, breakdowns, and changes in the environment present driving forces. The system is continually striving for balance while encountering tension and contradiction. Appropriation relates to how such events and contradictions are handled, how changed conditions are incorporated, and as a result which structures arise and are transformed - or might be stabilized and retrofitted under the new conditions.

Stability is arrived at through successful internalization expressed in the formation of routinized actions, habits, attitudes, and emotions towards people, objects and situations. Concerning the hierarchical structure of activity (Hashim and Jones 2007), internalization refers to the process where conscious actions become unconscious operations. These operations serve as a repertoire that defines the competence and tacit knowledge of a person: they are a resource which he or she can fall back on within the particular situation. The decent of formerly conscious actions could be describes as

[A] segmentation of appropriation through (1) anticipation, (2) initial familiarity, (3) development of repertoire of routines and the (4) development of new forms of use” (Bødker and Christiansen 2012)

Fluent mastery requires that new practices have to be practiced over and over again. So, the fully-fledged appropriation (especially concerning advanced technologies) is more a slow, emerging process in which progress is often achieved through trial and error.

Wertsch (1998) has also argued, in a similar vein, that “*the process of taking something that belongs to others*” implies, for better or worse, the re-production of traditions, routines, and ways of judging and distinction making. In daily life they become a second nature that are taken for granted. A prominent example is the appropriation of language:

“The word in language is half someone else’s. It becomes ‘one’s own’ only when the speaker populates it with his own intention, his own accent, when he appropriates the word, adapting it to his own semantic and expressive intention” (Bakhtin 2010).

This shared ownership of our words also pinpoints that individuals are always social beings, where their identities are expressed by the way of how they appropriate the objects of their environment.

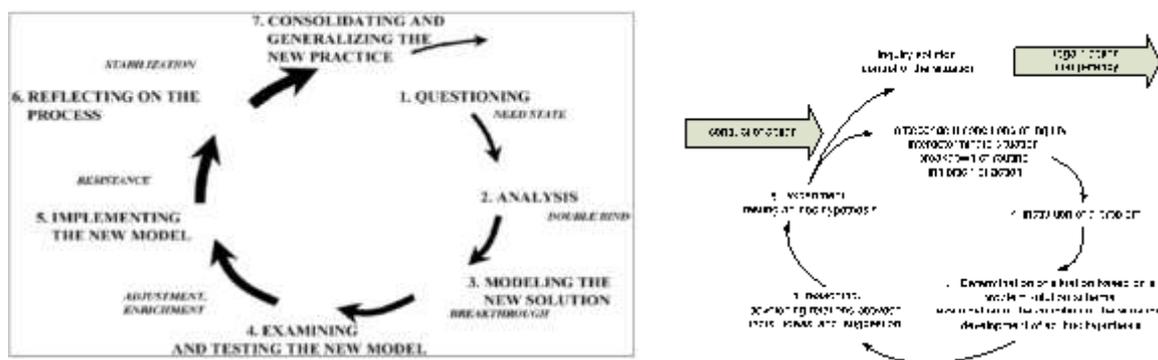


Figure 2 Engeström cycle of expansive learning (left) and Dewey's Pattern of Inquiry (right)

Engeström develops analysis of the process of appropriation as expansive learning, and emphasizes the productive role of unfulfilled requirements, internal contradictions and unresolved new situations. In short, conflicts are the internal and external stumbling blocks that irritate the smooth conduct of action. Because of the possible adverse consequences, such conflicts should be prevented in practice, but by the same token, they are triggers for changing activity systems and as a result present a driving force for innovation and improvement of practices and services. Appropriation as expansive learning, in this context, means a productive confrontation with such conflicts and hence new options. The process is not linear, but involves a tension between physical objects, socio-cultural demands and personal motivations, which often result in resistance. In particular, not all conflicts, situations, or new artefacts submit equally easily to appropriation, some stubbornly resist, and some remain alien (Bødker and Christiansen 2012).

Apart from the individual perspective, the process could be viewed from the activity system as a whole. Such view is more prominent in sociological work, especially with regard to the appropriation of social spaces and the concept of social space analysis. This is rooted in cultural-historical appropriation theory, stressing the historicity of social spaces, regarding them as condition and result of individual and collective human action. In addition, this view emphasises that appropriation takes place in socio-spatial settings in which the relational interaction between individuals and spatial structures are of central importance (Spatscheck 2014). Appropriation, here, is closely related to the intervention in socio-spatial arrangements that resulted in a change of positions of the subject in the social space as well as a change of the spaces themselves. With regard to this facet, video telephony, media spaces, and CCTV and the various ways of their appropriation are good examples of intervention in socio-spatial arrangements.

In particular, the shift to the spatiality of activity systems has also led to a renaissance to the question of ownership and private property, where the legal and political dimension of appropriation have been rediscovered. In particular, the appropriation of spaces is a public issue that goes along with the negotiation of claims, interest, and power structures (Spatscheck 2014). These conflicts are particularly evident when homeless people in the city make public places to their own, when social structures of neighborhoods change through gentrification, or teenagers use playgrounds, schoolyards, shopping malls, or McDonald's outlets as their second home (Deinet 2014). In such cases, appropriation is not just individual learning of how to use these environments, but the everyday use and construction of social spaces becomes a performative demonstration of power and the enforcing of claims. Space in this sense constitutes a political area, where the participating actors in their action must capitalize their resources with regard to their social situation in pursuit of their interests (Spatscheck 2014). With regard to this, the formation of, and access to, resources presents a key aim as well as a key result of the successful appropriation.

In sum, the term *appropriation* in Activity Theory refers to the further development of activity systems, its elements and the relationship among them. Regarding this, appropriation involves two levels: In respect of the individual level, it refers to expansive learning and the formation of new routines, skills and competencies. Secondly, as a collective process it refers to the establishment, reproduction or transformation of action systems where new tools, rules, routines, and division of labor find their place within the activity system. Gärling et al (2002) also refer to this as the dual sociality of appropriation expressing the idea that *persons change by changing their (socio-material) environment*.

Appropriation and De Certeau

Another strand in the history of the concept is de Certeau's post-structural consideration of everyday practices as a place of appropriation and resistance. His interest in studying the margins of the cultural system entails taking a bottom-up view. This stance has quickly become adopted e.g. by Cultural Studies and critical Media Studies.

There are striking parallels between the post-structuralist and the cultural-historical understanding of appropriation, but also considerable differences. In some way, both are heirs to the Marxian concept, but set other priorities. The differences result in the main from different subject matter, methodology, and the role of the concept in theory building. For instance, AT's primary focus is on the psycho- and socio-genesis of man. In contrast, de Certeau's primary interest was how the ordinary man gains autonomy under dominating structural conditions. As a result, he was less concerned with *successful* appropriation, but with 'negative' *tactical* appropriation as resistance against alienation. Another difference is that de Certeau focuses more on everyday culture – or more precisely what people do with commodities of the mass-production. Since Adorno and Horkheimer (2007) widely recognized essay about the cultural industry, mass-production of cultural goods has been viewed as an instrument of power and control. In their essay, Adorno and Horkheimer paint a lamentable picture of alienated mass-consumption that de Certeau's view on appropriation corrects in certain respect. This topic of unequal power relations, suppression, and social discipline was a common topic in the Poststructuralist era, an interest which de Certeau, for instance, shares with Foucault (Frijhoff 1999).

De Certeau's aim is to become an embedded reporter, who follows the situated tactics of actors at ground level. In particular, he believes that the dominating conditions are not alone in muzzling the ordinary man, but that the common, standardized methods of the social scientist play a role as well: The scientist's role is integrative, linking things together into one single theory, and leaving out what does not fit (a critique shared by Harvey Sacks, 1963). This

is an inherent effect, says de Certeau, of standardized methods. Opposed to this logic of subsumption, his aim was to give the particularities of everyday life a voice.

“Cultural history, on the contrary, works with the world as it presents and constructs itself, as a whole. It tries to account for the meaning of everything, which means that it has to start from the whole field of particularities, from the tactics of everyday life. It also means that the relationship between the regularities of history and the particularities, evasive and centrifugal, of the historical reality needs to be continuously kept in mind” (Frijhoff 1999).

As noted, Critical Theory paints a lamentable picture of the culture industry. Mass-consumption was thought as a one-way cultural transfer, where the content was passively consumed and received by the people. Critical Theory and positivist ‘media effects’ theories met each other at this point. Both assumed a homogeneous mass and asked, from this view, what media do to the mass instead of studying what people do with mass-media (Ruggiero 2000). With regard to the latter, de Certeau stress that cultural goods and other symbolic systems are not passively consumed, but are appropriated in such a way that a local, contextualized, meaning is possible. Hence, using goods is not a one-dimensional process of assimilation of externally imposed structures of meaning, but it is an active and artful play of meaning, norms, prescriptions, and power structures (Krönert 2009). Appropriation means inconspicuous *making of consumption* branches into thousands of practices and is fabricated in them. This view is closely related to Levi-Strauss notion of ‘bricolage’ as using the given and recombining them (Ahearne 1995).

“The ‘making’ in question is a production, a poiesis [...] called ‘consumption’. [...] It is devious, it is dispersed, but it insinuates itself everywhere, silently and almost invisibly, because it does not manifest itself through its own products, but rather through its ways of using the products imposed by a dominant economic order.” (De Certeau 1984, p. xiii)

In this view, appropriation resulted from unequal power relations, but it is not determined by this. Where strategic power lies with the proprietor, enterprise, city, or a scientific institution, the tactical is effectively the limited power of the individual to resist and remake space. Moreover, power struggles are open-ended, never ending stories where particular power constellations, cultural forms, artefacts never have a fixed meaning once for all.

Tactics are the art of relatively powerless making use of the situation to ensure what gains are possible. The weak use the gaps in the power structures, the blind spots in the grid of surveillance, in order to open up local conditions. This also includes steganographic tactics, e.g. appropriating the language and culture of those in power ironically in order to disguise and hide oneself by expressing the own using the words of the other.

“For instance, the ambiguity that subverted from within the Spanish colonizers' "success" in imposing their own culture on the indigenous Indians is well known. Submissive, and even consenting to their subjection, the Indians nevertheless often made of the rituals, representations, and laws imposed on them something quite different from what their conquerors had in mind; they subverted them not by rejecting or altering them, but by using them with respect to ends and references foreign to the system they had no choice but to accept. They were other within the very colonization that outwardly assimilated them; their use of the dominant social order deflected its power, which they lacked the means to challenge; they escaped it without leaving it. The strength of their difference lay in procedures of ‘consumption’.” (De Certeau 1984, p. xiii)

The tactics of clandestine usages are hidden from producer’s strategic power and in the same way they are hidden from the standardized methods of the media scientist as well as the positivistic innovation and adoption theories (Rogers 2010). This family of theories in question study artefacts as immutable and monolithic entities that are adopted unquestioningly. The ‘view from above’ of use statistics say nothing about the universe of different practices, needs, rationales, constraints, and emotions. In particular, such statistics neglects the politics

of use and the consequences of power struggles seen as consisting in a struggle between tactics and strategy.¹ The merit of de Certeau is that to make aware of the positivistic shortcomings reinforcing the view to take particularities of context seriously: What is of interest is the local meaning of the used artefacts, how they meld together, and for what reasons they are used seem to be of no concern. Concerning this, appropriation presents a situated, open and open-ended process, where people are not just human factors, but human actors.

Methodologically, bottom-up approaches are arguably needed as different contexts of use are characterized by different modes of appropriation, leading to (in the context of cultural studies) a variety of everyday cultures (Hepp 1998). In particular, individual case studies are needed to do justice to the particularities of the context and the creative ways of situated use. So, instead of asking: “how many cases have you counted”, the question in appropriation studies should be: “what is the logic of this particular case and why specific use practices have emerged”.

Design in Use: Tailoring, End User Development, and Appropriation

In the previous section, the general accounts of appropriation usually describe the phenomenon as a production of individuals and groups, but are less concerned with the qualities that make a tool more or less ‘appropriable’. This applies to material tools (e.g. a hammer) as well as immaterial tools (e.g. language expressions).

For ICT, or more concretely software-based systems, this question deserves more attention. The semi-material nature of these tools allows one to identify, design and implement the aspects a tool is aiming to serve together with, but independently of, interactive aspects of its presentation at the user interface. These interactive aspects may address activities that transcend the intended purpose of software, supporting meta-activities like learning, troubleshooting, or sensemaking with IT tools in relation to a use case (e.g. a help system or an interactive assistant). In addition, they may address the configuration of technologies, even to a point in which the functionality is changed or specialized to support a specific task beyond the original designers’ intentions. This kind of malleability of an information system significantly impacts the space users have for appropriating a technology, and the semi-material nature of software allows much more extensive approaches to design technologies so that they serve appropriation processes of users better. We refer here to two important discourses, namely End-User Development (trying to align concepts from the fields of human computer interaction, software engineering, and artificial intelligence) and Tailorability (derived more from the Participatory Design and CSCW community).

End User Development (EUD) research contributes explicitly to a design oriented view on appropriation. In general, EUD research is interested on how users can be empowered and supported to adapt their computerized environments to their needs:

“End-User Development can be defined as a set of methods, techniques, and tools that allow users of software systems, who are acting as non-professional software developers, at some point to create, modify or extend a software artefact” (*Lieberman et al. 2006 p. 2*)

Application domains for EUD are rather diverse. In the past, the focus was on professional/work contexts, while newer studies also investigate into domestic contexts. Other studies focus on how end users are making use of software ecosystems and existing infrastructures.

¹ At this point, we like to warn against a tendency in the Cultural Studies, too. Here, it seems trendy to subsume appropriation just under the category of power and alienation. Such view, however, could easily lead to the glossing of context and the practices which produce it. As a result, pretty much is said about appropriation in theory, but often say relatively little about appropriation practices ‘in the wild’

EUD research also builds on a long tradition to empower users making use of computers and supporting their computer literacy. This tradition includes the educational research studying computational environments as learning tools (1980), the Open Source movement focusing on the users' right to customize (R. M. Stallman 1981), the research on novice programmer and the cognitive dimension of programming (Pane and Myers 1996) and, last but not least, the Participatory Design movement focusing on tailorable systems as a mean for democratization of work (Henderson and Kyng 1991). Despite their differences all have in common the perception that the ordinary user can and should be the co-creator of the technological environment.

It is also worth to mention that various connecting lines between EUD and the humanistic Marxian appropriation concept exist, in both the case of Papert and the Scandinavian Participatory Design tradition. Papert's constructionist view, for instance, understands learning as the progressive internalization of actions and the externalization of ideas making them tangible and shareable (Ackermann 2001). From this stance, Papert argues that the knowledge building and artefact building go hand in hand. Hence, EUD environments should support (in his case) children to express themselves by enable them to build personal meaningful things and to conduct computational experiments to discover the (computational) world (Stevens, Boden, and von Rekowski 2013). The Scandinavian EUD tradition also shares with Marx the demand that the workplace design should not be reduced to its functional role, but understands work also as a place for self-development and self-expression.

While having a broadly left-wing political agenda, PD's relationship to power seems less ideological than de Certeau and the Cultural Studies, but more pragmatic - one might characterize it as a kind of social partnership between workers, trade unions, researcher, and managers (Ehn 1993). It focuses, it can be argued, quite pragmatically on how such technologies can and must be designed in support of skillful worker. From this stance, the concept of tailoring has been elaborated as a mean for workplace democratization that touches many issues like software construction, learning, organizational change and organizational politics (Trigg and Bødker 1994).

In a narrow sense, tailoring represents an activity taking place during 'use time' after the original design phase, which typically starts right after the first contact of the user with software. Tailoring shares some features, but still is different from both 'use' and programming. With regard to programming, tailoring does not lead to a new system version, but modifies a given one according to local necessities (Wulf 1994). Second, the person doing the tailoring is typically not expert in software engineering, but an expert in the application domain. With regard to normal use, tailoring is distinguished by three aspects: First, tailoring activities modify working tools rather than the working material. Second, tailoring activities have longer lasting effects on the modified functions. Concerning this, Wulf and Golombek (2001) mention the creation of document templates as an example of tailoring. Third, tailoring is a kind of secondary task modifying more stable work structures, making the primary task more efficient. This functional orientation makes tailoring the environment different e.g. from constructive learning environments that are often more playfully designed. Moreover, tailoring "just for fun" – even it is a common practice (Draxler, Stevens, and Boden 2014) – can be dismissed as a waste of time and money. In other words, tailoring as a secondary activity comes with a cost that must be justified. In particular, tailorability initially increases software complexity where the learning how to make use of the tailoring features needs extra time before the user might benefit from it.

This raises the question of why tailorable systems are needed and where the limits of the approach might be.

Contingencies, Heterogeneity, and Dynamics: Reasons to make software flexible

It is an assumption underlying traditional software development methods, that users do not need to tailor software artefacts, because the artefacts are optimally adapted to user and the use context. Equivalently, designers- one assumes- know all about the user and the use contexts. Moreover, users form a homogeneous group, the contexts are well and formally specified, and the application domain does not change over time. In contrast, since we are in reality in a messy, unstable, and often unknown world, it can be argued that tailorable software can be used to cope with the imperfections so frequently identified. Regarding this, overlapping reasons have been outlined why usages are not perfectly anticipated at design time and what design implications we should draw.

Contingencies of use situations

No matter how finely the net of user observation is knitted, no matter how users and use contexts are explored, understood, and measured - regardless of whether standardized surveys, participatory observation, or cultural probes are used - by its very nature the use context is under-determined by data. As a result, there are always blind spots in any given context analysis, where situated use and situated needs are not anticipated. This especially holds true with the Tayloristic workplace design that neglects the difference between the actual work and its formalized work description (Wulf 1997).

“Standardized representations of office work and its products, as captured in forms, diagrams, databases, or narrative text, are thus the result of articulation. [...] Without an understanding of articulation, the gap between requirements and the actual work process in the office will remain inaccessible to analysis. That is, it will be possible to describe tasks in an idealized form but not to describe the actual situation [...] It will always be the case that in any local situation actors ‘fiddle’ or shift requirements in order to get their work done in the face of local contingencies” (Gerson and Star 1986 p. 258)

The under-determined nature of the use situation is closely related to users’ autonomy and their capacity to react to exceptional situations in an ad-hoc manner. By the same token, under-determinacy limits the options for office automation, standardized workflow systems, and ergonomic design that rest only formal task and process description e.g. promoted by methods for business modeling (Scheer, Thomas, and Adam 2005) as well as cognitive modeling (Olson and Olson 1990).

As a reaction, design for unanticipated use results in two, interwoven, interpretations: designing accountable computer systems as a resource and designing tailorable applications (see sections below).

Heterogeneity of application contexts

There are pragmatic-economic reasons, why software does not perfectly fit to the application context. In general, it would be desirable to develop a tailor-made software version for each client that might fit his or her particular needs. However, such individual solutions create extra costs and efforts, so that the development of a non-individualized, standard version may be economically desirable. Customizable software, then, represents something of a tradeoff between standardization and individualization. This also leads to an altered software adoption process: Between the design and the use phase, there will not just be a learning phase, but also a phase of customization.

Depending on the scope and complexity of the application, such customization will be very different. At the one extreme, the user might just enter the mail account data to make an Email client work. At the other extreme, customizing an enterprise system such as SAP and implementing it in a large organization often represents a multi man-years large project, where the project team covers professional IT consultants, managers, and members of the involved departments. The EUD focus is typically in between these extremes, but there is no clear cut-off.

Heterogeneity of users

Users, of course, also vary considerably. They have different knowledges, cultural backgrounds, skills and preferences. Hence, there is, in the traditional ergonomics literature, a large body of work on tailoring with regard to personalization, where tailoring is primarily considered as individual effort. Also, usability norm ISO 9241-10 includes the personalization demand expressed by the individualization criteria:

A dialogue is individualizable when the dialogue system allows adjustments to the task requirements, individual user preferences and user skills (ISO 9241-10)

The norm mentions several justifications for individualization, such as linguistic and cultural differences, individual knowledge and experience in the domain, as well as different perception, sensomotoric and mental abilities. The norm also provides several examples like making font size, color, and key assignments adaptable, or that users should be able to choose between alternative forms of representation and they should be able to enhance input options e.g. by creating one's own commands.

In addition to adaptable systems personalized by the user, there is a large body of research on adaptive systems that are automatically personalized for the user. The essential core is a user model that is constructed from the user input and other personalized data. The aim is to identify the user's background, preferences, and abilities in this model and adapt the system respectively. Such adaptation can relate to the user interface, the content, of the behavior of the system. One well known example is adaptive hypermedia system:

"Adaptive hypermedia systems build a model of the individual user and apply it for adaptation to that user, for example, to adapt the content of a hypermedia page to the user's knowledge and goals, or to suggest the most relevant links to follow." (Brusilovsky 1998 p. 87)

From the perspective of appropriation, we generally have to keep critical eye on adaptive systems for two reasons: the possible decline in user competence and privacy concerns.

Regarding the first, the basic idea is the computer literally reads every intention, so that users make minimal effort themselves. In the long run, adaptive systems may help the user to work more efficiently. However, the danger is that personal competencies degenerate. In addition, for larger adaptive media systems the danger is well-known by now, as news feeds are tailored to the supposed interests and the mindset of the user.

The second issue arises from the fact that adaptive systems need personalized data in order to function properly. Moreover, the approach bases on the principle that the more close-meshed the observation is woven and the more data is collected, the better is the user model. From a user point of view, this poses the threat that the strategic power of the major companies increases while the tactic power of the ordinary man is weakened. Concerning such a shift in power relations, users' readiness to give personalized data away seems tactically (in de Certeau's terms) problematic.

Dynamically evolving contexts

The need to adapt software is also caused by the application context and its surrounding evolves over the time (Wulf 1999). This encompasses the demands of the individual, the team, and the organization as a whole. Indeed, software requirements are a moving target was a painful learning process for software engineering (Böhm 1988, Floyd et al. 1989, Robertson and Robertson 1999, Fowler and Highsmith 2001). In particular, feature requests often arise only in reaction to users having their first experiences of using a new system in everyday life.

With regard to the dynamics of an evolving context, Orlikowski and Hofman (1997) have outlined three types of changes: anticipated, emergent, and opportunity-based changes. Anticipated changes are planned ahead of time and occur as intended. Emergent changes arise spontaneously out of local innovation. Opportunity-based changes are not anticipated ahead of time but are introduced purposefully and intentionally during and in response to the change

process. By definition, emergent and opportunity-based changes could not have been included in a traditional requirements analysis. This reduces the chance that tailoring options exist, where users might fit the system to the new requirements. Hence, a static tailorability approach leads into the following dilemma:

“To make a part tailorable, one has to identify this part in first place and has to know how it should be tailorable [– but this knowledge only evolves in the appropriation process].” (Draxler and Stevens 2006)

A way out of the dilemma is to conceptualize tailorability not only as technical feature, but as continuing effort in an evolutionary, participatory design process. Several related concepts have been elaborated to address this demand:

Wulf (1994), for instance, outlined an iterative-participatory process model that take tailoring activity explicitly into account. The core idea is that tailorable software allows small, anticipated changes within the use context. Larger, emergent demands are discussed in participatory workshops with the developers, so that they might be implemented in the next version. In a similar vein, Fischer et al. (2001) outline with SER (Seeding, Evolutionary Growth, and Reseeding) a EUD oriented, open-ended software development model. The central idea is that the initially deployed system continually evolves in the use context where it alternates between periods of daily use and unplanned evolution, and periods of deliberate re-structuring and enhancement.

Another concept was outlined by Draxler and Stevens (2006), with a stronger focus on mass-products that are developed in an agile manner. They suggest integrating communication channels within the use context with tailoring and online help options. The aim is that users could feedback within the use context e.g. the manufacturer as well as the user community for help and make feature requests that might be realized in the next version. While independently developed, the concept has striking similarities to commercial solutions like *GetSatisfaction* or *UsersVoice* that allows one to integrate channels within web apps, so that customers can ask questions, submit an idea or complaint, or give praise and discuss issues within the online community.

Making it ‘easy to adapt’: Ways of designing flexibility

As outlined, there are several reasons why applications do not always fit to the use context, and thus may require some degree of tailorability. In particular, the *un*-expected, *un*-usual, and *un*-anticipated refers to the inherent contingency and openness of practices that by their very nature cannot captured by formal models, scripts, or regulation. This is not just a complexity issue, but represents a fundamental worldview problem, based on the conflation of real world practices with (formal) descriptions of those practices.

Hence, the flexibility of application context must somehow reflected by equal flexibility in application systems. Facing the apparent contradiction of formalizing the un-formalizable, we could distinguish two different, but supplementing design methodologies in EUD: The first one could be called tailorable design, focusing more on *technical flexibility*. The second has one could be called technomethodological design (Button and Dourish, 1998), focusing more on *interpretative flexibility*. Both, however, have in common the basic philosophy that we need understood software not such much as formalization of labor, but as tools for labour.

Tailorable Artefacts: Increasing the technical flexibility

The first design approach mentioned above primarily focuses on how software could be technically more flexible by making it more tailorable, malleable, adaptable, and customizable. This challenge has led to a series of new design approaches including component based and service oriented architectures, open source software, plugin extensible *software*, and domain specific languages. In addition, EUD environments have been developed in various domains such as web authoring tools, mashup editors, process and workflow editors, business intelli-

gence report editors, etc. One of the most well-known examples is the Excel spreadsheet (Nardi 1993). The off-the-shelf spreadsheet is of little direct value to the end user. However, the empty, application neutral spreadsheet allows the users to create their own, domain- and task-specific one or buy one from a 3rd party provider. Moreover, Excel demonstrates that EUD must not be complicated, but could become a mass-product.

Another important issue relates to the question, to what extent software systems should be open and adaptable – which is also a political issue concerning the power relation between users and software companies (R. Stallman 1985). The one extreme is closed systems like ATMs where users are not able to change anything. The other extreme is open systems like Emacs, where users could, in theory, change everything, increases the power of the end users. However, open source software is also a good example of the fact that only tech-savvy users make use of this power. This demonstrates that providing tailoring options is not sufficient for end user empowerment. In particular, for safety, security and complexity reasons, restricting tailoring options might be useful – and at least should be considered in EUD as having non-technical end users in mind.

Moreover, in the EUD research it was recognized that a gentle slope of increasing tailoring possibilities should be provided. Regarding this, in literature often three levels are distinguished: choosing between alternatives in anticipated behavior, constructing new behavior from existing pieces and altering the artifact (i.e. reprogramming). For instance, the concept of component-based tailorability (Mørch et al. 2004) distinguishes between those three different levels:

“Configuring a component. The configuration of an individual component is the easiest way to tailor a system, since this tailoring level offers the smallest complexity being limited to the so-called component slots only. Due to this restriction, the tailoring action can be supported by providing special tailoring environments. With the help of such special environments, it is much easier for the user to tailor these slots.

Changing the component composition. The changing of the composition allows for a more substantial adaptation. This level includes operations like inserting and deleting components, rewiring the components or building complex components. This level requires the user to understand not only the individual components but also their interactions.

Designing new components. This level increases the opportunities for tailoring since the user is not dependent on already existing components. However, when tailoring on this level the user has to understand the underlying programming language, the component model, and the implementation details.” (Stevens, Quaisser, and Klann 2006 p. 272)

Such advanced tailoring features were implemented e.g. by FreEvolve (Stiemerling 2000; Wulf et al. 2008) of Prospero (Dourish and Edwards 2000 p. 48). Unfortunately, such systems never moved beyond a research prototype, so that tailoring such systems has never been studied in the wild. Yet, these research prototypes serve as visionary concept study to demonstrate technical feasibility and shape analytic lens for studying tailoring concepts in practice.

For instance, in our study about the appropriating component-based systems such as Firefox, World of Warcraft and Eclipse, we study how end-users in everyday life make use of the three levels of configuring components, changing component composition, and designing new components (Draxler and Stevens 2011; Draxler et al. 2011). One of the insights was that most users make use only of the first two tailoring levels (configuring and changing composition). Compared to this, almost nobody, we found, created new components. In addition, the study also showed that the features used for changing compositions looked quite different from those suggested in academia. In practice, built-in plugin managers and plugin repositories were highly popular because they reduced complexity significantly for the user, but at the same time also restricted options for changing the system at this tailoring level. Nevertheless the users’ tailoring activities have lead to a striking diversity of individualized installations.

Accountable Artefacts: Increasing interpretative flexibility

An alternative to increasing technical flexibility is to increase interpretative flexibility. Here, the user does not adapt the artefact, but his way of using it (Wulf 1999). This implies that the system at hand does not prescribe a particular use practice, but allows multiple ones.

A well-documented example such kind of general-purpose tool is Email. As the name indicates, the original idea behind the technology was to provide an electronic version of paper-based mail - which in itself is a general-purpose medium that could be used for many purposes like sending informal love letters, but also formal, official documents. The same variety of usages also holds for the electronic counterpart, even allowing for the fact that legally binding notification was much more difficult to establish than when using email for informal communication. The appropriation also leads to many new practices such as using email as an appointment book sending oneself a reminder, using it in an instant messenger manner, using it for spamming, etc. In addition, various new practices to do with organizing email inboxes emerge (Whittaker and Sidner 1996). Key email protocols like SMTP, MIME and IMAP support this flexibility as they do not prescribe a particular usage, but focus on the interoperability of the underlying infrastructure. In contrast, more prescriptive approaches to structuring email correspondence like the Coordinator (Winograd 1987) have had little success.

The second design approach aims to systematize such interpretive flexibility rooting it at the theoretical level in Suchman's (1987) insight that plans for humans do not fully determine behavior, but present a resource that could be used and adapted in specific situations. As such computer systems should not be designed as a realization of an abstract defined work procedure. Instead computer systems should serve as a resource used in joint activities without a need to anticipate particular contingencies, or the order in which they might arise." (Robinson 1993)

This design view adopts the much-rehearsed ethnomethodological stance to study how members structure and make accountable, through a mutually elaborative process, the situations in which they work. The seminal point for design is that these embodied methods are stable and structured - and that they are observable and analyzable by researchers as much as they are made public by members. Hence, they could be made as the starting point for the design considerations.

With regard to this, system design must uncover and envision which are and will be the relevant members' methods in the application domain, what is the rationale that underpins them, and last but not least, how computational artefacts will affect them and become part of them, respectively. This view is particularly elaborated by the programmatic manifesto of *Technomethodology*:

In contrast with the approaches to ethnomethodologically-informed design [we] consider the relationship between ethnomethodology and system design in a design context to be more than a practical matter. [...] System designers learn from ethnomethodology, not from ethnomethodologists or their observations. [...] Technomethodology attempts to align system design not so much with the details of specific working practices, as with the details of the means by which such working practices arise and are constituted. (Dourish and Button 1998)

From this perspective, Dourish and Button (1998) analyse traditional design methodologies that abstract from the details by hiding the underlying computational mechanisms from the user. While this reduces the complexity of the user interface, it also makes these mechanisms less predictable and as a result makes it more difficult for the user to make use of them.

"The key property of human action is the way in which it is made observable and reportable in the course of its own unfolding. It is organized accountably. As someone speaks, this is how 'he provides the very materials for making out what he says'. Computational abstractions, being static, atomic and unexaminable, provide no such means. Abstract computational behavior is not accountable; and, for this reason, the forms of contingent, improvised (situated) action become problematized" (Dourish and Button 1998 p. 415)

While tailorable and technomethodological system design are different approaches to the problem of flexibility, they have a number of features in common. This especially holds for *Prospero* which served as a kind of reference for technomethodological design (Dourish and Edwards 2000). On a technical level, *Prospero* provide *translucent* user interfaces that ‘open up’ the internal computational mechanisms. These make the mechanisms more adaptable, but also more transparent – and thus make its working more predictable for the end users. The *translucent* interfaces provide cues to what the system is doing, why it doing that way, and what was likely to be done next. In short, such interfaces should make the computational action more accountable, which presents a prerequisite for situated, social action and – if we understood computer systems as an actant with agency – a prerequisite for human computer interaction tout court.

“We will be concerned here with a second approach. This is a more fundamental one, and aims to address the disparity between traditional process-driven models of interface design and the more improvisational model revealed by sociological and anthropological investigations such as Suchman’s. This approach is based on a re-reading of Open Implementations’ reflective self-representations as accounts that systems offer of their own activity.” (Dourish and Button 1998 p. 419)

Of course, one can have reservations about such a view – to what extent, for instance, it makes sense to speak of technical artefacts being accountable. Pragmatically, perhaps the best way of viewing the notion of ‘accountability’ in this context is to argue that it entails the user understanding what the computer is doing, why it is doing it, and what to expect next – in short that the application provides a reliable tool and context for doing things. Concerning this, *Open Implementation* might be one option, but not the only and maybe not the best, to improve transparency and predictability.

In sum, the merits of concepts such as radically tailorable systems and technomethodological design are that they sensitize us to the need for system design to provide resources that help human actors to make of the systems that result. In addition, this thread of research shows that people do not appropriate technology in an unstructured and accidental way, but in virtue of their interpretative and technical competencies, given the demands of the situation at hand.

Making it work: Appropriation as collaborative work

The studies of technology support for cooperative work situations took appropriation work as collaborative by nature (e.g. the negotiation of conventions to establish the non-technological configurations of in work setting, Mark and Sohlenkamp 1997), but initially without distinguishing it systematically from the actual configuration work (‘tailoring’). The term “appropriation” in CSCW is shaped by and further develops the tailoring concept of EUD research in recent decades. In addition to our own work in this field (e.g. Pipek and Wulf 1999, Törpel et al. 2003), important contributions to this topic have been made by Dourish (2003), Balka and Wagner (2006), and Twidale (2005). The common strand of all this work is a praxeological view, one with an affinity to ethnographic methods, a focus on tailorable workplaces, and the activities of the people making use with the situation at hand. From this stance, Dourish, for instance, defines appropriation as follows:

“Appropriation is the process by which people adopt and adapt technologies, fitting them into their working practices. It is similar to customization, but concerns the adoption patterns of technology and the transformation of practice at a deeper level. Understanding appropriation is a key problem for developing interactive systems, since it critical to the success of technology deployment. It is also an important research issue, since appropriation lies at the intersection of workplace studies and design” (Dourish 2003 p. 465)

Tailoring is still central to this research thread. Yet, with the appropriation concept, the aforementioned authors have taken a broader perspective at the constitution-theoretical, methodological, and design-conceptual level, which has a great affinity to the outlined activi-

ty-theoretical concepts discussed above, but with a stronger focus on the role of the digital artefact.

As mentioned, EUD focuses on how to empower users to adapt computer systems with regard to the local context. Related to this, appropriation research asks how people might not just be empowered to tailor, but to make use of technology at hand with regard to the local context. This can also include tactical moves to “mis”-use technologies, the invention of usages, and the informal processes of learning and sense making. In particular, if we examine in minute detail what happens during tailoring, it becomes evident that fitting a technology to the local situation is much more than just customizing it. We have characterized this “more” than tailoring as follows:

“Appropriation can be described as a collaborative effort of end users, who perform ‘appropriation activities’ to make sense of the software in their work context. Besides activities to configure the software to fit into the technological, organizational and individual work context of the users (‘Tailoring’), there is a larger area of technology-related communication, demonstration and negotiation activities aimed at establishing a shared understanding of how a software artefact works and what it can contribute to the shared work context. The mutual shaping of the technology and organizational contexts resemble an ongoing design process that end users perform largely without any involvement of professional developers.” (Pipek 2005)

This “more” can be studied from two sides: from within the situation, studying how the appropriation of a new artefact appears to users, and from the outside, studying how it is embedded in the broader situation.

Dealing with breakdowns: A phenomenology of the appropriation situation

From within, we can ask when and how technologies become present-at-hand (Stevens 2009, Wulf and Golombek 2001). A phenomenological inquiry reveals that manifold of small, insignificant disruptions exist that prompt reflection on the present situation, the technology at hand, and common use practices. With Heidegger we could call them breakdown situations, with Dewey we can call them doubtful situations, or with Engeström we can call them situations of expansive learning (see above). In such cases, the user finds his- or herself in new, unknown situations where common routines are inadequate, so that s/he must ‘invent’ a new one.

In principle, there are various options available, constituting the dialectics of ‘mental’ and ‘material’ appropriation activities. We want illustrate these small steps of appropriation through the following train of thought.

Assume that Jane wants to celebrate her birthday. She would like to send a form letter to all her friends. However, she has never done this before. This forces her to reflect what might be a smart way to solve the problem at hand. In principle, there are a number of options: Such as to explore whether Word has a form letter function, how to use this function, how to bring the data in an appropriate form to bring, etc. She might also search in the Internet, if an according Word extension or Text editor exist that had a form letter feature, trying to install and using it. She might also be competent enough to write a Word macro (or use the situation as a trigger to learn it). Then write a macro that is optimally adapted to her needs, or at least is good enough for her problem at hand. In the situation, it is likely that she starts with a tentative solution, which appears to her as the easiest and the most promising way. If she reached a deadlock, she might change her strategy, e.g. asking someone else for advice. She further experiments until she finds a feasible way or gives up her goal.

Her tinkering leaves “mental”, “social” and “material” traces. The traces are mental, in the sense that she has learned about the software and extended her skills in making use of it. Social in the sense that she may now owe favors to the colleague she asked for help, or she may help others e.g. through a thread in a help forum dealing with how to use the form letter function in Word. The traces are material, in the sense that she modified her Word installation or creates a Word template, she can use in the future. Because of these traces, there is no need to start all over the next time she is faced in a similar situation. The traces are social in the sense that she might trigger a question & answer thread in a community forum, or share the resulted

Word template with others. In sum, the successful mastering of a breakdown or doubtful situation is always related to the expansive growth of the individual person and the activity system as a whole.

The second seminal point is that from phenomenological point of view, it does not matter which choice is the best or most realistic from an external perspective, or that whatever option Jane realizes might be predictable. It is the internal perspective of the situation that matters. And within the actual situation, the various options are real possibilities for action even if they are proven less than optimal afterwards. This demonstrates that learning, and tailoring a tool, have the same genesis: both are the results of mastering doubtful situations. It will eventually become apparent whether the appropriation is more dominated by new ways of sense making or new ways of tool making, or both.

Make it together: Collaboration pattern

Another focus is on the study of collaborative appropriation. This follows up on previous work on collaborative tailoring in organizations (Mackay 1990; Wulf 1997; Trigg and Bødker 1994), which has raised awareness about collaboration patterns such as the existence of sharing networks, sharing habits, different user types with regard to customization (Stevens et al. 2006, Wulf 1999a). Mackay (1990), for instance, suggests a classification scheme where she distinguishes three user types: lead users who play with new software, first creating adaptations and then sharing with others; translators, who are less technical oriented, but customize a bit and in particular adapt the solutions of lead users for others; and ordinary users who use the adaptations of other. With regard to the incentives to share customizations, Mackay concludes:

“Users have a number of incentives to share customizations, including taking advantage of each other’s work, learning new methods of accomplishing useful tasks, avoiding errors, and generally saving time. The net result is that users adopt patterns of use from each other, propagating both useful innovations and errors throughout the organization.” (Mackay 1990 p. 218)

The existence of such collaboration patterns is a quite general phenomenon, not limited to the organizational domain. In the domestic domain, for example, Grinter et al. (2005) found that the party with the biggest technical competence usually configures home IT for others. We found a similar result with regard to the appropriation of domestic eco-feedback systems (Schwartz and Stevens, 2015). Moreover, the collaborative patterns are striking similar to the adoption patterns outlined by diffusion of innovation theory.

[Most individuals do adopt new products] not on the basis of scientific research by experts, but on the basis of the subjective evaluations of near peers who have already adopted the innovation. These peers [typically innovators and early adopters] serve as models whose behavior is imitated by others in the social system.” (Rogers 2002 p. 990)

In addition, a similar pattern can be found the case of informal learning and sharing tool knowledge (Twidale 2005, Wulf 1999a, Törpel et al. 2003). These similarities are not by accident, but more deeply rooted in the fact that customizing, learning, and adopting digital artefacts are just different, intertwined ways of appropriating them.

Infrastructuring: Appropriation and the Emergence of Infrastructure

As outlined above, from an external view, appropriation is closely related to and expressed by the transformation of an activity system in reaction to the adoption of a new technology. In particular, in the social context of the home, the team, the organization, and the community, the adoption of new systems does not just affect the individual, but also the other parts of the activity system including other tools. Local changes also trigger negotiation about the division of labor, what should be the work outcome, what are rules using and customizing the tools,

what are competencies, habits, and expectations of others that might have to take into account, etc.

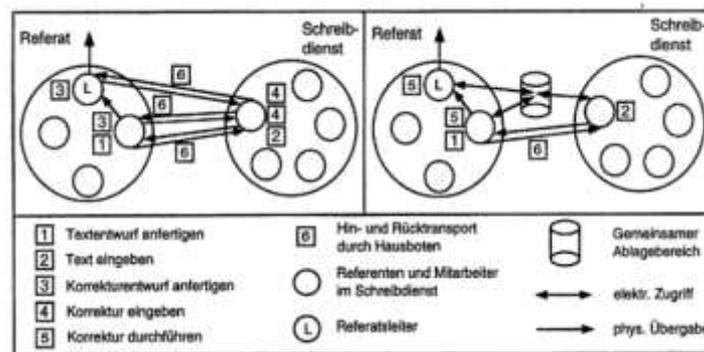


Figure 5 Schematic representation of the procedure for creating text before and after groupware introduction (Wulf 1997)

The POLITEAM study (Wulf 1997), concerning the introduction of a groupware system in a German ministry, presents an illustrative example of the co-evolution of work and working tools as part of an activity system. In the POLITEAM case, Wulf (1997) observes that the adoption of the groupware also affected the division of work. For instance, before the introduction of the groupware, senior civil servants made drafts and corrections by pen and dictaphones, which were then sent to a typing service (cf. Fig. 5). Afterwards, the civil servant, however, used the groupware to make corrections directly in the electronic document. This new division of labor had reciprocal effects on the groupware customization. For instance, the access control rules had to be configured in such a way that civil servants also had write access. In addition, the co-evolution of both technology and work required new skills from the members. For instance, civil servants had to learn how to use text editors and had to develop their typing skills.

The mutual dependencies of adoption and adaptation processes pinpoint the fact that tailoring should not be studied in isolation, but should take the socially embeddedness of tailoring activities into account (Pipek and Wulf 1999 and 2009). However, identifying the technical and organizational ties that bind users together when using different artefacts remain problematic.

Pipek and Kahler (2005) distinguished four scenarios: A “Shared Use” scenario, in which users tailor and appropriate a tool that every user uses independently and individually (individual decisions/appropriations do not influence each other directly – but maybe indirectly); a “Shared Context” scenario, in which a tool is being used individually and independently, but within a shared context (e.g. an organization, virtual team, workflow; here individual decisions/appropriations may influence others e.g. due to changed outcome qualities); a “Shared Tool” scenario, where users tailor and appropriate the same tool (e.g. a shared file repository; here the consequences of individual decisions/appropriations become tangible in a way that it requires collaboration). The final scenario was called “Shared Infrastructure”, and illustrated that if we widen the lens to consider a set of tools, devices and technologies used by users in a (at least partially) shared context, the consequences of individual appropriations of even single-user software like a text processor become difficult to anticipate as ties emerge from the network of conventions, workflow relations, organizational structures and technological dependencies.

Concerning this, the broader view of appropriation helps to get a more complete picture of the interdependencies and the transformation of practices. In particular, it makes us aware of the various feedback loops and mutual influences within the activity system. Moreover, activities surrounding the computer systems in use do not exist in isolation, but are linked by manifold, often implicit dependencies.

“Changes - independently of whether they are implemented by tailoring or by evolving the software - can depend on and affect changes in other applications of the IT-infrastructure and the interaction between applications. This requires coordination between tailoring and development, and cooperation between the persons responsible for tailoring and developing the different applications. And this, in turn, requires a different set of competences from users and developers.” (Eriksson and Dittrich 2008 p. 31)

This interconnectedness constitutes a web of linkages that mediates between the local and global activities of appropriation and development (Wulf 1994). Most of the studies mentioned so far deal with application fields that have one single or dominant software tool. In Törpel et al. (2003) we presented a different case that sheds light on issues of scale within the evolution and appropriation of software infrastructures that involve several tools. During the observation of SIGMA, a network of 200-250 business consultants and trainers, the shared endeavor of building a groupware system for all network members was counteracted by the proliferation of various tool usages of competing products. Robertson (1998) stressed in her discussion of infrastructural decisions of SMEs (Small and Medium Enterprises) that ‘shopping’ for a different product is a perfectly viable alternative for end users instead of tailoring an existing product. As a consequence, appropriation needs to be addressed as a process that involves also alternative tools that could complement the existing infrastructure. Alternative and complementing tools interact with the intended purposes users need. Both of the above papers stress the creative power of users to define their infrastructure in exchanging parts of it or assigning new meanings to it.

In order to describe these changing relations between tools and their associated sense (the purposes they are supposed to serve in a use situation), we distinguished (Törpel et al. 2003) between *proliferation* when different technologies are being appropriated for the same purpose, and *differentiation* when a technology is appropriated for many different purposes. Although a technology itself may be capable to also serve similar or different purposes, it is sometimes specialized for only one or a few purposes. As technological artefacts and/or associated usages change/emerge in a use context, the relations between technological artefacts and use purposes may be redefined. We distinguished here between *integration* (if one new/improved technology provides functionality for multiple existing use modes formerly realized by multiple different technologies), *standardization* (if one or more specific ways of use are objectified in one artifact), and *initiation* (if anticipated but still imaginary new use options are objectified for purposes assumed relevant to the use context). Again, neither of these processes necessarily involves new technologies, they may occur through the pure re-purposing of the existing infrastructure at hand.

The phenomena of disruptions, conflicts, and breakdowns triggered by distributed innovations (and here we refer to temporal, spatial as well as epistemological distributedness) as the main driver for the emergence of technological systems (Hughes 1987). While Activity Theory is well suited to analyse the local context of an activity system, we started to adopt Star’s concept of infrastructure to get a better grip on the interconnectedness of distributed local and global activities. When investigating the phenomena of appropriation, Star’s understanding of ‘infrastructure’ is helpful because it does not refer to an infrastructure as a technical entity, a set of devices (plants, stations, switches, vehicles, etc.) and connectors (cables, pipes, streets, etc.). Instead, infrastructures are described as an ongoing affair that is equally medium and outcome of cooperation practices. From this stance, Star and Ruhleder (1996, later reworked in Star and Bowker 2002) described eight salient characteristics of infrastructure (see Table 1). Star was not so much interested in what infrastructures *are* but what they *mean* to their users, and how they were made in everyday life.

This relational view on infrastructures manifests them as a result of a continuing, everlasting and not necessarily intentional production of connected artefacts and meanings, a process of *Infrastructuring* (Star and Bowker 2002). This view on infrastructuring shares many similarities with other concepts of appropriation we outlined, e.g. with Engeströms newer conceptualization of activity systems. In particular, in Star’s work breakdowns play a similar role as

with Engeströms cycle of expanded learning and Dewey’s pattern of inquiry (cf. Figure 2). As an interruption of the conduct of action, breakdowns are special situations to reflect on and - in reaction - transform established practices, which in turn will have an effect on the infrastructures they rely on.

Table 1 Characteristics of Infrastructure and corresponding activities of Infrastructuring (quoted from Pipek and Wulf 2009 and Di Salvo et al. 2012)

Characteristics of Infrastructure (Star and Bowker 2002)	Activities of Infrastructuring (Pipek and Wulf 2009)
Infrastructures are embedded in other social and technological structures	Activities that connect different technological and social structures, activities that change standards, routines, or traditions involved in mediating between technological and social structure
Infrastructures are transparent in invisibly supporting tasks	Activities that change the visibility of an infrastructure
Infrastructures have a spatial and temporal reach or scope	Activities that increase the longevity of an infrastructure, or that add new members, element, or application area
Infrastructures comprises taken-for-granted artifacts and organizational arrangements learned as part of membership	Activities that change, or reflect changes in, the community or communities supported
Infrastructures shape and are shaped by conventions of practices	Activities that aim at changing conventional practices, or that impose existing practice on new technologies
Infrastructures are plugged into other infrastructures and tools in a standardized fashion, though they are also modified by scope and conflicting (local) conventions	Activities that change standards that mediate between infrastructures (may also include activities that aim at local specializations of standards); activities that change the scope to which standards apply; activities that articulate or mediate conflicts
Infrastructures do not grow de novo, they wrestle with the inertia of the installed based and inherit strengths and limitations from that base.	Activities which interface and align new applications with existing IT infrastructures; activities which challenge and develop existing practices
Infrastructures are invisible but become visible upon breakdown	Activities that help articulating a breakdown; recovery activities after a breakdown

The notion of infrastructure extends the scope of reflection of appropriation phenomena significantly. The discourses on Tailorability and End-User Development still at one point, carried a designer focus with them: Most of them reflected on a single tool or technology, simply because the goal of deriving ‘implications for design’ results in a pragmatically restricted solution space, as the activity range of a designer is defined by the tool she designs. We transcended this in our considerations about *appropriation infrastructures* (see next section), but the terminology that developed in the discourses around ‘infrastructuring’ provides an arena of stakeholder activities around technology development and appropriation that is fresh and unprejudiced in relation to established divisions of labor or structures of professionalization (as they are associated with the contrast between design and use). Infrastructures may stabilize and reproduce through appropriation activities – e.g. when users find out about an infrastructure like Email and learn how to use it for their own purposes. They may also change, through appropriation, old tools by new technologies or through the development of new practices as new technologies afford them. The breakdowns described above may occur as elements of the infrastructure fall ‘out of sync’ with opportunities offered by alternative tools or required by the surrounding technological context (e.g. when the demand to send large pictures and videos via email, combined with network capacities that would allow that, lead to an adaptation of the email protocols and the design of new email servers and clients), a phenomenon described as a ‘reverse salient’ in the discourses around infrastructure.

Concerning the characteristics of infrastructures (cf. Table 1, left), we outlined in a previous work corresponding activities that lead to it emerging/developing (cf. Table 1, right). These activities have been documented in previous appropriation studies where we observed how users adopted and adapted new systems and integrated them in their local contexts, through the articulation of problems and usages as well as the sharing of tailoring artefacts (Pipek 2005; Stevens 2009). This shift of the perspective was also driven by common trends

like Web 2.0, Software Ecosystems, Agile Development, and Open Source Communities, which also provide new opportunities for appropriation support.

Studying and Supporting Appropriation

In the previous section, we have traced the conceptual origins and our actual understanding. While, roughly appropriation could be summarize as it is all about *the work to make things work*, due to the diversity of the contexts, there will be no unified conceptual framework or even a grand theory emerging which would cover all appropriation practices and use cultures. At the same time, what level of generality might be appropriate remains an open question. In this last section, we give a brief, tentative outline about implications for studying and supporting appropriation.

Appropriation and Ethnographic work

Most appropriation studies can be characterized as addressing at least one of the three following questions:

How is appropriation done in practice? This field of research is interested in the situations, people, methods, artefacts, etc. that play a role in the appropriation of artefacts. For instance, empirical studies show that some people make use of new technologies earlier and faster than others. Also, studies reveal that technology breakdowns, looking over the shoulder while working together, or making small talk at the water cooler, etc. seem to be special situations that are important for the emergence and establishing of use practices. In addition, studies have identified common patterns, both temporal and spatial, which entail collaboration between different parties and which result in appropriation.

How can appropriation work be supported? How appropriation could be supported, e.g. by the design of artefacts, processes, or by individual measures, is also of interest. Regarding this, it is mainly EUD and CSCW research which has contributed to this issue (Wulf 1999a, Stevens et al. 2006, Trigg and Bodker 1996). Moreover, appropriation support in CSCW does not merely address tailoring, but also the supporting of articulation work and the negotiation of usages within local social networks (e.g. with peers, friends and colleagues).

The third wave, as yet not fully realized, could be characterized as investigating how to link appropriation with the infrastructuring in a design-oriented manner.

What are the resulting practices and use cultures? A third goal is to document, systematize, and classify the practices resulted from appropriation process and to understand and explain their inner logic. Understanding what practices and contexts are worth studying has to be a pragmatic matter. For instance, in design research the focus is typically on practices resulted from the appropriation of advanced technologies. In contrast, in the early days of CSCW mainly the appropriation of groupware systems like Email, Instant Messenger, Shared Workspace, or Media Spaces was a focus. Later on, the appropriation of community systems like Facebook and Wikipedia has been investigated.

By its very nature, there cannot be one methodology for doing appropriation studies in an appropriate manner. Nevertheless, it would seem to follow that appropriation practices, founded in the kinds of contextual, emerging, use described above require some version of ‘in the wild’ study. However, this also means that appropriation studies could never be representative in any statistical sense. Instead, the goal of appropriation studies is to make the particular case visible, intelligible, relevant and reportable for an external reader. In addition, design-oriented studies into appropriation will owe something to the Grounded Design framework (see Stevens et al. in this volume).

With regard to the manifold options to conduct appropriation studies, a first orientation to classify the various types is to distinguish them with regard to the time horizon of the study as

there are, rather than issues that are specifically to do with the length of elapsed time needed to make sense of the appropriation issue.

It is obviously the case that, if we are to take the notion of appropriation seriously, we need to consider the elapsed time entailed in the conduct of such studies. As outlined, appropriation may take place in of small steps and over variable periods of time.

With regard to the situatedness, the specific disturbances, breakdowns conflicts and tensions, where routines get out of order, may be quickly identifiable. For instance, in one study, we analyse the user activity of a critical incident in minute detail (Stevens, Draxler, and Wienke 2008). In the analysis, we could identify various strategies to cope with the situation that are described by Dewey and Engeström logic of inquiry and expensive learning (cf. Figure 2). In another short-term oriented study, we install smart meters for two weeks and the way data from a new technology was understood and used to understand better how make energy consumption is made accountable with the help of the new technology (Schwartz et al. 2013). A second reason to conduct a short-term study is capture initial, tentative, glimpses about future practices. In this case, however, the actual doing is of less interest than the resulting outcome. These studies may inspire, inform, and improve design and re-design decisions relating to some kind of probe. Overall, such kind of short-term studies serve as a means to better anticipate the future appropriation. Even so, the appropriation of a new technology, the transformation of an activity system, and mastering a practice can take time. Therefore, there are grounds, wherever possible, for a more sustained commitment to understanding the appropriation of new techniques, ideas, rules, practices, etc.

Nevertheless, longer term studies rely on the same bottom-up oriented methodologies as short-term studies, though they are likely to enlist a more complete approach to methodology. They form part of design case study methodology (see Stevens et al. on Grounded Design, in this volume), for instance and may implicate, for instance, Living Lab approaches, where new technology is put in place precisely to investigate its effects over time. An example is the SMEDL living lab study based on a four-year programme of research, where we studied the long-term effects, smater meters have on domestic practices and relationships (Schwartz et al. 2015).

There is also a case for the very long term, such that appropriation studies take on a somewhat 'historical' flavor. There are few such studies in the CSCW or design research context, but they can be found elsewhere. Du Gay et al.'s (2013) study about the rise and evolution of the Sony Walkman and its impact on the media industry as well as media practices is one such.

Appropriation and Design

In conclusion, this chapter has concerned itself with the different ways in which the concept of 'appropriation has been deployed, and asked how best to deploy the concept in pursuit of a design- related agenda. We have argued that appropriation activities are active, creative endeavors to change the technological environment to serve the intended usages of practitioners in a better way.

As a consequence, we can reflect on the functionalities a technology may provide in order to support appropriation activities. Keeping a tool interaction simple, and providing good manuals and help systems is vital, but the appropriation of tools is very often more a social activity than a problem of individual learning and use. Knowledge sharing and delegation structures often develop, although in home and other informal use scenarios these structure are likely to be much more spontaneous and less organized than in professional environments. Appropriation support can address these social aspects of computing by supporting users as a '(virtual) community of tool/technology users', and by providing functional support for different appropriation activities that users can engage in to make use of a technology. Examples of such technological support (Pipek 2005) include:

- Basic Technological Support: Building highly flexible systems
- Articulation Support: Support for technology-related articulations (real and online)
- Historicity Support: Visualise 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: If an agreement is required in a collaborative appropriation activity, providing voting, polling, etc.
- Demonstration Support: Support showing usages from one user (group) to another user (group), provide necessary communication channels.
- Observation Support: Support the visualisation of (accumulated) information on the use of tools and functions in an organisational context.
- Simulation Support: Show effects of possible usage in a exemplified or actual organisational setting (only makes sense if the necessary computational basis can be established).
- Exploration Support: Combination of simulation with extended support for technology configurations and test bed manipulations, individual vs. collaborative exploration modes.
- Explanation Support: Explain reasons for application behaviour, fully automated support vs. user-user- or user-expert-communication.
- Delegation Support: Support delegation patterns within configuration activities; provide remote configuration facilities.
- (Re-) Design support: feedback to designers on the appropriation processes

Most of these suggestions aim to enhance the interactional capacities of a technology to allow end users to exchange and manage the use modes of a technology. They go beyond tailoring interfaces as these use mode changes do not necessarily require reconfigurations of the technological artefact. The user interactions that inspired this set of functionalities currently take place, for instance, in user forums of large software companies, on feedback platforms like GetSatisfaction, on expert platforms like stackoverflow.com, or using videos to explain a technology on Youtube, but its embedment into the very technologies the interactions are about may bring additional benefit.

Where we (Pipek 2005) deliberately took the professional software designer out of the equation before thinking about possible functional support for appropriation work and focused on interactions among users, there are a number of obvious benefits of connecting the spheres of technology design with the spheres of technology usage. Designers may be able to understand the shortcomings of an existing technology when they are able to see and reflect on the appropriation activities of users. The connection may give users an understanding of the difficulties of implementing certain technological options, and allow for a practice-driven prioritization of possible technology revisions.

Subsequently, we went beyond the interface level introducing the idea of Appropriation Infrastructures (Stevens 2009, Stevens et al. 2009 and 2010). The key idea of this approach is to embed tailoring and collaboration means within the context of use, supporting reflective, expansive learning when in a breakdown situation with the artifact present-at-hand. As the breakdown situation typically is not detached from the underlying infrastructure, the key idea is to provide channels in this situation to connect to other stakeholders like peers and colleagues, sys-admins, help desk personal, but also developers and user communities.

In digital artefact itself serving as a boundary object that mediates between the self, the actual situation, and social-material context. In particular, on the one hand the software artefact provides the communication channels, on the other hand, it presents the object the communication is about. This twofold character could be used to support the articulation of the actual situation: The challenge is to make a situation readable by other stakeholders, which implies that have at least a basic understanding of the situation at hand as well as of the other stake-

holders attitudes and interests. Breakdown situations are often characterized by the absence of such understanding; a collaborative solution often requires stakeholders to inquire into the problem itself (e.g. real or perceived breakdown, bug or lack of knowledge) and the involvement of further stakeholders (that may be able to provide a solution or at least have knowledge to inform the repair process, e.g. the local admin or the software developer).

Dealing with this dilemma, a possible support for infrastructuring activities may provide similar functionalities as the ones described for appropriation support, but these must be implemented as intermediary tools that work independently of the single artefact. Devices that are or become part of this infrastructure need to be prepared to interact with these tools. Jiacucci et al. (2003) distinguished between inner tailorability (the classical approaches to keep a tool modifiable at use time) and outer tailorability (approaches that improve the capabilities of a tools to work in an ensemble of tools), something that is echoed by the need for standardization in the infrastructure discourses.

Taken this in mind, we have outline a modular software architecture shown in Fig. 3. The concept distinguishes spaces for personal appropriation, appropriation in self-organized groups and in the public (the users of a technology), each of which aims to provide tools to create as well as to explore adaptations and ideations. The infrastructure should also be context-aware, meaning that the spaces for reflection should be directly accessible from the practice.

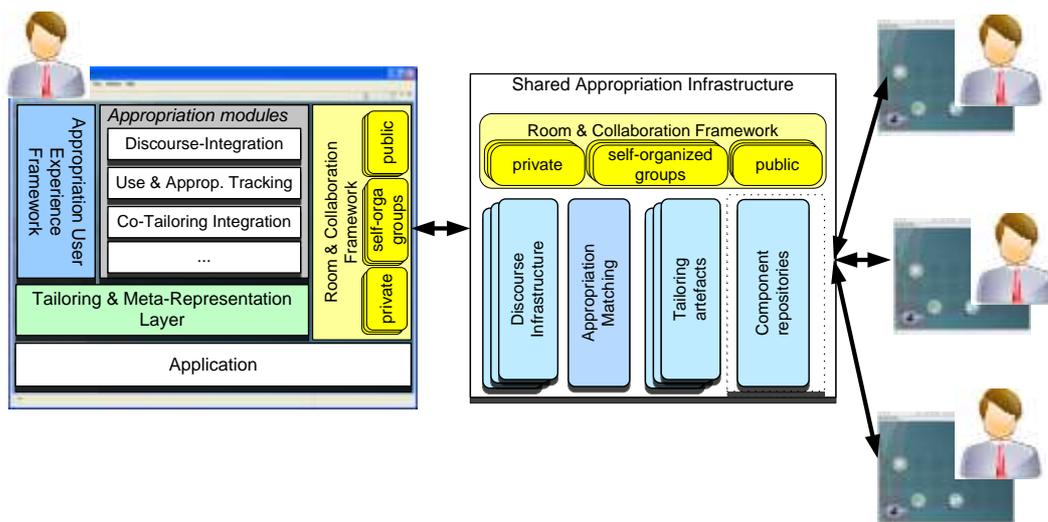


Figure 3 Architecture of a next generation of appropriation infrastructure (taken from Stevens 2009, p. 183)

The architecture is split into a shared or backend part of the infrastructure, and a local or client part that integrates the infrastructure into the context of an application. The right side of the figure represents other agents of the product community (considered experts with various levels of technological expertise, from simple users to professional developers) who are connected to the appropriation infrastructure. Functional modules of this architecture may span backend as well as client implementations. We consider four modules as crucial:

- **Appropriation User Experience Framework:** The framework is a module which is responsible for weaving the shared infrastructure into the skin of the technology, guaranteeing a consistent user experience, regardless of the modular composition. The visual presentation, the responsible computational mechanisms as well as the corresponding discussions are supposed to refer co-referentially to each other to simplify the transition between usage, usage discourse and artifact modification. The Appropriation User Experience Framework should provide an extension point that allows one to plug-in additional and domain-specific connection strategies.

- **Discourse Infrastructure Module:** The function of this module is to foster the social process of sense making and negotiation around the used technology. It may implement many support mechanisms described in the previous section. The module consists of two parts: A shared part is responsible for storing and managing the actors' discourses. A local part is responsible for integrating the discourses into the application in terms of adequate location and visualization at the interface.
- **Cooperative Tailoring Module:** This module is responsible for dealing with the technological aspects of a cooperative solution. The main role of its shared part is to offer management repositories which store and manage ready-made components as well as tailoring artifacts. The local part embeds the shared repository into the application context and should support a cooperative tailoring model.
- **Space and Collaboration Framework:** This module is responsible for providing user management and access control functionalities. Additionally, it maps the logical space concept to the physical layer of distributed computing. In particular, the RCF should offer the different types spaces mentioned above.

Based on the data this infrastructure produces and manages, additional services become possible. User recommendations may be generated automatically, based on the analysis of individual and collective histories of use. The histories need to be tracked and collected locally, and may be matched with similar histories in the shared part the Appropriation Infrastructure. Beside these different appropriation modules, the architecture contains a set of common modules to manage and configure the technologies (e.g. a component management and configuration framework). A modular conceptualization of an Appropriation Infrastructure, and in particular the architectural separation of the appropriation support modules from the running instances of the applications under consideration, helps to increase the extensibility and evolvability of the framework beyond the scope of a single application.

Concluding remarks

As we have shown in the previous sections, appropriation has a long history. In this history, its meaning has often entailed some slippage, and the various school of thoughts have stressed different elements. Even so, a number of family resemblances remain. The various textures of the concept revolved about themes like the productive power of man, the relation between man and nature as well as man and society, and the reproduction, transformation, and growth of culture, practices, and mankind following Goethe's dictum: "What you have inherited from your fathers, acquire it in order to possess it".

The renewed interest in the concept also resulted from the lacunae in the positivistic mainstream of the traditional discourses concerned with technology development (Information Systems and Software Engineering). In simple terms, the positivistic ideology perceives any deviation in practice from the theoretic model as random where the scientific endeavor is to build more accurate models that minimize such "errors". In particular, a technological determinism strand treats the particularities of context, windows of opportunities, and practices and activities of the human subject as irrelevant to the design and development of new artefacts. For this stance, appropriation phenomena still do not exist. However, in 1980/90er, various ethnographic studies reveal that technologies such as the Sony Walkman, the Lotus Notes groupware system, the Worm Community System, etc. are, in practice, used in manifold ways. In itself, it would scarcely be worth mentioning, were it not for the fact that for the various kinds of model typically deployed in service of design, as with the social sciences, this comes as something of a surprise. The phenomenon of *unanticipated use* was a *scandal* as well as *surprising fact*.

In reaction, the observed manifold forms of usages are understood to be the result of an open-ended appropriation process. Depending on the perspective adopted, the assessment of this process, however, has been different: More left wing researchers, for instance, interpreted

the appropriation of, for instance, space as a tactic of the ordinary man expressing resistance to the prevailing order, while others interpret it as a kind of unfaithful, deviant technology use that can lead to reduced productivity. Despite the differences, both interpretations focus on *unanticipated use* as subject matter, which has to be explained. As a matter of course, *anticipated use* is presumed to be the dominant form.

In comparison, we firmly believe that the concept of appropriation should not start from *unanticipated use* as theoretical point of departure, but regards *orderly use* itself as in need of explanation. In other words, appropriation is constituted in the interplay of technology development and situated appropriation *work*, where the outcomes have to be understood as *practical inquiry* or as *infrastructuring*. In contrast to technological determinism *orderly use* is not seen as caused by external factors but is a product of creative actions dealing with the demands and opportunities of the situation at hand.

This view has an impact of the role of abstractions, concepts and theoretic models, too. As has been said elsewhere in this book, the positivistic stance has a tendency to postulate simple cause-effect models and to interpret regularities in technology use as simple causalities without further analysis. This, in turn, produces conceptual apparatuses which gloss over the transformative and emergent quality of appropriation process. At the same time, no generalization is an absurd alternative, since we see, over and over again, that in given settings, work is done in typical ways. The single case, then, is never wholly innocent of pre-existing knowledge, concepts or categories. What is at stake is what kind of use one might make of them. It is the view of the author that, following Herbert Blumer, we should see such examples from previous work as *illuminating*. Existing knowledge, research results, theories, categories, etc. can sensitize researchers to what cases and phenomena are already documented, and within which academic discourses new findings can be positioned. A vital component of this is the business of making the relevance of newly acquired data evident to the reader - e.g. by drawing analogies, making a contrast, etc. There remains a considerable space for empirical appropriation studies, specifically with a design-oriented impetus. They need to be open in their focus and curious in their manner of exploring practices and innovative IT designs. Looking at the phenomenon of appropriation work is an obvious strategy in the framework of Grounded Design (see Stevens et al, chapter 1, in this volume).

There is not any deterministic relationship between the design of IT artefacts and their appropriation, and this is precisely what necessitates a specific focus on appropriation. It is likely as argued above, that certain designs, those with better 'appropriability', have a higher likelihood of impacting practice positively. The focus on 'design', in and of itself, presumes a certain relationship between the functionalities of the artefact and the kinds of use to which it will be put. To assert no such relationship would, of course, be a bizarre argument, but to assert that any given design does not wholly close down the various possibilities of use, and, more strongly, that the objective of designing in such a way that maintaining or opening up this space for flexibility is a desirable objective is a different position.

Last, but not least, supporting the creative, purposeful activities that contribute to the successful establishment of usages, the question is of how to put improved 'appropriability' into the design of technologies. Much of what has been rehearsed above concerns the possible avenues which facilitate the tailoring of, at minimum, interfaces and, more ambitiously, functionality and infrastructure development. Tied to this, but with arguably even greater ambition, is the prospect that 'appropriation support' functionalities will provide a fruitful research arena. With the concept of appropriation infrastructures we have touch this topic, but this needs to be further elaborated, especially with regard to the new technological infrastructures emerging around 'Ubiquitous Computing' and the 'Internet of Things'. In initial approaches to develop 'sociable technologies' (Ludwig et al. 2014, Ludwig et al. 2017) address the complicated relations that make the analysis of and the design for appropriation activities in the 'Internet of Things' era even more difficult. The same, complex, issues, occur when we ad-

dress the area of 3D printing and the 'hacking' and 'making' cultures that have grown up around it. Regarding this, the materiality of appropriation practices becomes a renaissance - thus completing the circle to the Hegel/Marxian beginning of the concept.

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