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Towards an Appropriation Infrastructure: Supporting User Creativity in IT Adoption

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Abstract

Research on the adoption of information systems (IS) often stated technology as a fixed entity. Following the 'practical turn' in IS we argue that information technology artefacts are mainly 'cultural artefacts', which are shaped in a social process of appropriation where software usage is accompanied by processes of interpretation, negotiation or change in organizations. We elaborate on a (neo-)Marxian interpretation of appropriation from a design-oriented perspective in order to investigate the possibilities of technological support of activities of appropriation work. To capture the different facets of appropriation, we combine theoretical concepts of social capital and activity-based learning. With the help of this theoretical orientation, we systemize empirical evidence from several research projects in order to detect recurring patterns. We use these patterns to develop a generic architecture for actively supporting the social activity of appropriating the cultural artefact in context of its usage.

Keywords: IT adoption, appropriation of technology, socio-cultural factors, social capital, appropriation support

1 INTRODUCTION

„Although diffusion research has made numerous important contributions to our understanding of human behaviour change, its potential would be even greater were it not for shortcoming and biases happened [since the diffusion paradigm was original formulated in the 1940s]" (Rogers 1995, p. 99)

This paper presents a theoretical reflection of our research on practices of technology adaption. In various ethnographically oriented action research projects we often observed phenomena of creative sensemaking (Weick 1995), of situated (re-)invention and the emerging and diffusion of new practices. Technology does not come "as it is" (Wulf and Rohde 1995; Pipek and Wulf 1999, Pipek 2005), but it is an 'cultural artefact' (du Gay et al. 1997) which will be shaped and further developed in a social process of appropriation in its appearance as well as in its interaction with the context of use.

In particular, we observed that for the diffusion and adoption of new practices, social networks and individual attitudes play an important role. Studying the diffusion, transfer, and implementation of information technology, a considerable number of research in IS (Kautz and Pries-Heje 1996), often refer to the elaborated diffusion of innovation theory (DOI) (Rogers 1995). The DOI is a positivist approach based on mathematical modulation of an innovation diffusion process and a set of hypothesis about the relationship of causal dependencies. The hypothesis presents the empirical part of the DOI, validated by an enormous number of quantitative studies.

At the first glance DOI is an attractive candidate grounding our empirical work, as it is an elaborated and validated theory, addressing some aspects of the observed phenomena. But we should care about the fact, that DOI based on simplifying assumptions, leading to specific shortcoming and biases in the theory (cf. Rogers 1995, p. 99). To state that DOI has limitations is no crucial point, but we have to figure out 'what's wrong' (Lyytinen and Damsgaard 2001) in respect to a particular research interest.

In order to uncover the biases of DOI, it is helpful to consider that the chosen modulation of DOI has been worked out from a change agent perspective, where the change agent, as an outsider, wants to introduce a fixed and isolated entity (e.g. a new technology or any other kind of innovation) into a foreign social system. In our own studies about the adoption and diffusion of groupware technologies (Wulf and Rohde 1995; Pipek and Wulf 1999, Toerpel et al. 2003, Pipek 2005)) we observed a number of phenomena like creative sensemaking, situated (re-)invention of usages and the emergence and diffusion of new practices within an organization, all of which can only be marginally expressed in the vocabulary of the DOI (see also Rogers 1995 pp. 100, pp. 174 and pp. 364 where he discusses the shortcomings of DOI in terms of sense-making, re-invention and de-centralized innovation systems). Our experiences call for an alternative theoretical position, which allows to complement the 'implementation' perspective of IT designers with an 'appropriation' perspective that accounts for the creative activities in the application fields that help establishing a technology usage, and which we believe to have found in the dialectical thinking of Marx and his use of 'appropriation' (Toerpel et al. 2003). In contrast to the notion of the term 'adoption', the term 'appropriation' (cf.: Poole and DeSanctis 1989; du Gay et al. 1997; Dourish 2003; Pipek 2005) or 'enactment' (cf.: Orlikowski 2000 ; Boudreau and Robey 2005) describes processes of bringing technologies into use, where meaning is constructed in and through practice. In particular, in their first work on the Adaptive Structuration Theory (AST), Poole and DeSanctis (1989) discuss the relationship between AST and the Marxian idea of appropriation. We tie our work in this interpretation of Marx, but going back to the Marxian origin of appropriation, practice and culture and also studying the reception of Marx in Psychology (e.g. Engestrom 1987), Sociology (e.g. Bourdieu 1972) and Cultural Studies (e.g. du Gay et al. 1997), we become aware of the different facets of Marxian philosophy. To develop a research perspective on the growth and diffusion of practices related to the use of information system, the term of 'appropriation' can play the role of a generative metaphor (Agre 1997), as it includes these different facets of the Marxian work as connotations.

In section 2, we elaborate this appropriation perspective based on a phenomenological approach where not the formulation of predictive causal relationships is in our focus, but the development of a terminological framework structuring the phenomena. The developed framework is integrating the different facets in a coherent manner. For a bird's eye view, we are applying Bourdieu's (1972) concept of *Social Capital* as framework to characterize different scenarios of actor networks, which where analytically constituted by the appropriation of the 'cultural artefact'. With an actors view, we tackle the question of appropriation support and examine how the activity of appropriation works from the Marxian learning perspective of the Cultural Historical Activity Theory (Engestrom 1987).

In section 3 we discuss the practical consequences: On the first level, we demonstrate the viability on an analytical level, illustrating on four examples of our research work that our theoretical understanding can be used as a framework to classify the appropriation context as well as means used for appropriation support. Here the framework helps to see patterns in activity of appropriation work. Towards an Appropriation Infrastructure, at the end we interpret our work from a Design Science perspective (Hevner et al. 2004), presenting a set of fundamental requirements for software-technical infrastructure supporting appropriation work.

2 APPROPRIATION WORK AS A SOCIAL ACTIVITY

Earlier research resulted in different characterizations of appropriation. E.g. in (DeSanctis and Poole 1994) as well as in (Orlikowski and Robey 1991) appropriation is a construct used to explain the diverse, but also restricted ways to use information technology. In their model users appropriate the 'structures' inscribed in technologies. (Dourish 2003) sees appropriation as similar to customisation, but as "concerning the adoption patterns of technology and the transformation of practice at a deeper level". (Pipek 2005) focussed on appropriation activities that constitute the sensemaking processes around information technologies, seeing appropriation as a collaborative effort of users to make sense of technology in the context of their personal and work affairs.

We think that a Marxian understanding of appropriation work as a social activity provides an elaborated theoretical foundation to capture the different facets of phenomena of appropriation. DeSanctis and Poole (1989)[1] relate their consideration of 'appropriation' to Marxian dialectical materialism: „The concept of appropriation goes back to the 19th century philosophers Hegel and Marx. […] For Marx, who emphasized the productive and self-constructing nature of humanity, the concept of appropriation was the key that unlocked the nature of subject-object relationship" (Poole and DeSanctis 1989, p. 150).

By Marx, self-constructing nature of humanity has a synchronic dimension – where practice is shaped by the existing material and social conditions and a diachronic dimension – where practice is grounded in history and history is made by practices.

In this constitution of practice, 'appropriation' appears in the work of Marx in the discussion of the alienation of work and is related to the dialectical relationship of 'power' (Kraft) and 'needs' (Bedürfnis) and its objectified counterpart of production and consumption. Marx distinguishes between 'natural' needs representing a kind of deficit and 'species' needs representing a kind of passion. In particular, the 'species' needs can be progressively growing – not only in quantity, but in quality - in the dialectical process of objectification and appropriation: „Production not only provides the material to satisfy a need but it also provides the need for the material […] Hence production produces consumption […] Similarly, consumption produces the *predisposition* of the producer by positing him as a purposive requirement" (Marx 1972, p. 624). Appropriation is then related to the growth of needs (Bedürfnisentwicklung) and linked to the historical distribution of work, wealth and power.

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[1] The original formulation of the Adaptive Structuration Theory borrows the term 'appropriation' from Marx (cf.: Poole and DeSanctis 1989).

Sensemaking of a cultural artefact (du Gay et al. 1997) is an ongoing process where the social-technical condition plays a critical role. In addition, the subject and its life-world ("Lebenswelt") plays a critical role in the process of appropriation, but appropriation cannot be reduced to a mental operation of an individual because (in the Marxian conception) the subject and its needs are socially mediated by the community. Similarly, learning is primary not a mental operation, but connected to a social dynamic of internalisation and externalisation (Leont'ev 1978).

We see that sociality and learning are important facets on appropriation. Both, sociality and learning are also an integral part of the DOI. These can be interpreted as fundamentals of the phenomena of practice evolution. A closer examination of DOI reveals that its understanding of sociality and learning is related to 'information' as an paradigmatic term (Kuhn 1970) which structured the studied phenomena around the information network and process metaphor. E.g. it perceives the social level of diffusion as "the process by which an innovation is communication through certain channels over time among members of a social system"(Rogers 1995, p. 5). On an individual level the adoption of technology is perceived as learning process which refers to "an information-seeking and information-processing activity in which an individual obtains information in order to decrease uncertainty about the innovation" (Rogers 1995, p. 20). But as mentioned above through the conception, it is difficult to express in DOI the phenomena of creative sense-making and (re-)invention in and through practice. In the next sections we want to develop a different understanding of sociality and learning is grounded in 'practice' as the paradigmatic term.[2] This means, that not information flow and processing constitute the center of the theorectical reflection, but practice as an embodied, materially interwoven social activity, centrally organized around shared practical understanding (Schatzki et al. 2001). In order to reflect on the structural aspect of appropriation as a practice, we adapt the neo-Marxian concept of Social Capital as the analytical lens studying the social-technical facet of appropriation. Additionally, we adapt neo-Marxian learning theoretical concepts to study the evolutionary facets of appropriation.

2.1 Socio-technically induced user ties

To understand the social aspect of appropriation we refer to the concept to Bourdieu's conception of *Social capital*. Bourdieu (1972) used the term *Social capital* as an theoretical category to understand reproduction processes in social systems. The concept of *Social capital* can be used as framework for understanding these informal structures of social networks. (Huysman and Wulf 2005, p. 85) understand social capital as *"networked ties of goodwill, mutual support, shared language, shared norms, social trust, and a sense of mutual obligation that people can derive value from."*

The social capital research approach provides a focus on the quality of social relationships, including mutual trust, mistrust, reciprocity and acknowledgement as well as on existing interaction patterns, offers an important concept to understand appropriation as a collective process. In addition, taking the materialistic position seriously, we should not understand social ties in isolated terms, but as an element of the dialectics of practice, which is also shaped by the material possibilities and the logic of the work.

Applying the concept of the social capital studying social ties in context of the appropriation of products, we should start to examine the division of labor in software production in the current society. In particular, mass production produces also two different types of social ties in respect to the quality of social capital. In a second step, we should examine practices in more detail. Taken the structure of work and the role of the technical infrastructure into account, it is possible to differentiate the user ties on a more fine grained level. Based on this examination, we achieve a framework that differentiates between four different forms of of adoption ties in practice (Pipek 2005).

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[2] Primary, the 'practice turn' (Schatzki et al. 2001) presents a theoretical shift in the constitutional perception of the phenomena. But the 'practice turn' often goes along with a methodological shift from a quantitative to a qualitative stance. The main motivation for the methodological shift is that practice theories perceive practice as dynamically evolving.

Shared-Use-Scenario (Ties of adaptation based upon a shared interest in using tools): In modern societies users and producers do not share a common practice or belongs to the same culture. The communications between both groups are normally asymmetric, mediated by mass media (e.g. commercials) or by supplied materials (documents and tutorials) from the producer. The social ties between both groups are typical low. In the case of complex and advanced technology, users do not necessarily perceive the supplied materials as very helpful (cf. Stevens and Wiedenhöfer 2006). In the two-way communication model, DOI stressed out the importance of local social network for the adoption of technology as it posits a higher social capital (cf. Rogers, 1995).

But besides the local social network, another important social group is constituted through the mass production, which we can be understood as a "Community of Interest" regarding tool-usage. In this case, the mutual interest in a tool and its usage serves as basis for the tie. With the help of discussion forums and news groups dealing with a certain tool and its usage, a manifestation as well as a means to support this "Community of Interest" can emerge, in which also other types of appropriation work (beyond technological adaptation, e.g. more directed to sensemaking) can become the subject of discussion.

Shared-Context-Scenario (Ties of adaptation based upon a shared working context): When working on tasks in the same organizational environment, a tie emerges that is not only shaped by mutual tool usage, but also by coordinated work flows and usage conventions established in that environment. In this scenario the evolution of technology usage is often embedded in the reproduction process of the shared practice shaped by the implicit requirements which may occur regarding tool usage (e.g. accordance with program versions, same formatting instructions) that have to be respected by all actors. The formation of the cultural artefact happens often in a silent manner, only becoming visible in the case of a breakdown situation where a different appropriation of an application of one actor can influence the work of the other users.

To counteract this effect, technological support regarding cooperative adaptation and collaborative appropriation is necessary (e.g. by supporting shared tool configuration and maintenance, or by providing explicitly negotiated use patterns). In practice, we observed that individuals also carry out adaptations and distribute them to be used by the entire group.

Shared-Tool-Scenario (Ties of adaptation based upon a shared tool): The ties get more obvious and to a certain extent tighter when different users actually share the same software tool (e.g. a Groupware system). In contrast to the shared-context scenario, this scenario holds strong dependencies between configuration activities of the shared tool and shows direct effects of the adaptation of one user's software configuration on other users. For example, when using groupware tools, situations emerge in which, because of technical reasons, only one form of configuration applies to the user group. Because of a strong interdependency on the technical level, new requirements on the adaptation of the artifact's develop, e.g. with regard to explicit support of negotiation of configurations.

Shared-Infrastructure-Scenario (Ties of adaptation based upon shared tool infrastructure): At modern workplaces it usually is not only one tool or software system that is being used, instead an infrastructure of diverse and partially alternative/competing technologies is at hand. In some situations the usages of two users may indirectly be connected by a mixture of shared configurations (as in the Shared-Tool-Scenario) and common usage contexts (as in the Shared-Context-Scenario). The various influences and dependencies of a *shared infrastructure* usually remain concealed to the user.

Amongst others, this may be due to a low standard of knowledge concerning the infrastructure in use, but the constituent cause for this phenomenon is the division of labor: A designer only considers and acts upon the tools he is offering, while a user may consider to use complementing as well as competing IT products, just as he believes it to be appropriate for task and context. As a result, hidden dependencies and the consequences of modifications of a part of the infrastructure (e.g. release change) can not be anticipated sufficiently. On top of that, from a user's point of view, the positive effects of the new technology could cross-fade with the problematic dependencies on other technologies, so that satisfaction not necessarily comes along with an increase of efficiency.

2.2 Supporting appropriation work

After characterizing the socio-technical condition of appropriation in practice, we now turn to the appropriation as an activity which shapes practice as well as it was shaped by practice.

In the realm of historical materialistic approach of the Activity Theory, we have introduced the metaphor of appropriation work addressing the aspect of appropriation as an activity. Leontjew (1978) applies the historical materialistic philosophy of Marx to the field of learning, explaining the learning is primary no mental operation (as suggested by the metaphor of the information-processing activity), but an practical activity. Based on Leontjew, Engeström (1987) develops his model of learning emphasizing the material object-directed activities as socially embedded learning and argues that knowledge is embedded in practices.

In a closer examination of Engeströms model, Paavola et al. elaborate their concept of Communities of Networked Expertise, which is mainly built on the philosophy of Charles Sanders Pierce and American pragmatism (Paavola et al. 2002; Hakkarainen et al. 2004). In this work, Paavola et al. - with reference to (Sfard 1998) - have identified two different ideal types of learning in the scientific discourse: the "acquisition metaphor" of learning and the "participation metaphor" of learning. But Paavola et al. argue that a third conceptionalisation is necessary, which is described as the "knowledge metaphor" of learning, and which has similarities to Engeströms concept of expanding learning (cf.: Paavola et al. 2002).

We would like to consider the multiple forms in the context of the appropriation of software systems. Furthermore we will discuss the support of appropriation work as presented by the various concepts.

2.2.1 Appropriation by acquisition and training

(Paavola et al. 2002) explain the "acquisition metaphor" of learning as basing on a *"traditional view according to which learning is mainly a process of acquiring desired pieces of knowledge. The acquisition metaphor appears to rely on a 'folk theory' of mind according to which the mind is a container of knowledge, and learning is a process that fills the container, implanting knowledge there. Or in other terms, learning is a matter of individual construction, acquisition, and such outcomes, which are realized in the process of transfer; it consists in a person's capability to use and apply knowledge in new situations. Knowledge is a property and possession of an individual mind."*

This form of learning corresponds with the conception that the appropriation of a software system is manifested primarily in the individual learning of the right usage of a tool and through learning by doing. For this purpose the knowledge has to be presented in an appropriate form, making it easier to be "transferred" into the head of the user. One acts on the assumption that exercises and functions of software stand together in a close purpose-device-relation and that the operation is carried out in a standardized way of doing. Especially the adaptation and the acquisition of contact with the software are seen as a primarily optimizing problem. For example, typical devices that support the appropriation usually consist of ergonomic tests of the software system, the supply of user's manuals and they offer training courses with drill & practice exercises. To optimize the appropriation of software systems often software ergonomic and usability engineering methods are used.

This perception about appropriation has its strengths in the area of software systems designed for an execution of experienced, simple exercises in a stable environment. However, on the theoretical level this perception of appropriation has to face difficulties in capturing the phenomena of the not-anticipated usage and to deal with it adequately. On the practical level, limits within the support of appropriation work in dynamic and complex environments arise. Furthermore, this perception loses sight of the social and cultural dimensions of appropriation processes, as observed in long-term studies (e.g. Mackay 1990; Pipek and Wulf 1999). This dimension can also be described with regard to the socio-technical user ties as natural components of modern working environments.

2.2.2   Appropriation by participation and enculturation

(Paavola et al. 2002) describe the "participation metaphor" of learning as follows: *"(This metaphor) examines learning as a process of participating in various cultural practices and shared learning activities. According to it, the focus is on activities, i.e., on "knowing", and not so much on outcomes or products, i.e., on "knowledge" in the traditional sense. Knowledge does not exist either in a world of its own or in individual minds but is an aspect of participation in cultural practices."*

This metaphor corresponds with the conception of the appropriation research, focusing on the socio-cultural dimension of appropriation (e.g. Mackay 1990; Pipek 2005; Pipek and Kahler 2006). In this process, appropriation happens in social networks within organizations (e.g.: Mackay 1990) or within user communities (e.g.: Pipek 2005).

In a not-distributed Shared-Context-Scenario, appropriation activities can be observed which have been named as "over the shoulder learning" by Twidale (2005). Because modern working forms often consist of shared work, methods of the software-technical support of appropriation via enculturation exist to allow forms of "over the shoulder learning" in special and temporal distributed settings. Classical cooperation tools, such as newsgroups and discussion forums can, in this process, be diverted from its intended use. The usage of a specifically designed artefact-integrated discussion forum ("Use Discourse Environment") is for example discussed in (Pipek 2005).

Comparable to the corresponding learning theory attempts, those papers discussing appropriation support, focus on the aspect of participation and enculturation and are heavily influenced by the concept of Situated Learning (cf.: Lave 1989) and Community of Practice (cf.: Wenger 2000). This concept has its strengths in the declaration of learning processes in a relative stable culture of knowledge with stable (working) practices. However, the concept of Community of Practice is limited when it comes to innovation driven working practices, since on a theoretical level learning qua enculturation can only explain the learning processes of the "new" and not the "old" members of a Community of Practice in the learning scenario of an external innovation. The "old" members are seen as actors from whom the others learn, but not as learners themselves. In the area of appropriation, this approach only allows a limited acquisition of the phenomena of the not-anticipated usage. On a practical level the question arises, how appropriation work in a dynamic surrounding, influenced by basic changes and cultural transformation, can be supported. Generally speaking the strengths of this perspective, which regards appropriation as participation of a Community of Practice, are within the possibility to explain and support the diffusion of new things. On the other hand the process of cognition development is depicted in a limited way.

2.2.3   Appropriation as cognitive development

(Hakkarainen et al. 2004) describe the new aspect of the "knowledge-creation metaphor" as follows: *"(The) knowledge-creation metaphor of learning means that learning is seen as analogous to innovative processes of inquiry where new ideas created tools and practices, and initial knowledge is either substantially enriched or transformed."*

The concept of appropriation as cognition development is relatively new. It is also based on the assumption of appropriation being a social phenomenon, but focuses more on the development of innovative user forms, which cannot be traced back to adoption of traditional user forms. Based on the question about "logic of discovery", the point is that the collective creativity of the user has to be supported. One example is in the context of constructionism. (Papert 1993) developed Lego Mindstorms, which suggests explorative approaches for constructing by an appropriate design of the artifacts, but makes little allowance for the social processes in the context of technology exploration. Another example in this context is the "PaDU"-tool for user innovation support presented in this paper.

3   SUPPORTING APPROPRIATION WORK

So far, we have theoretically explained and positioned the social aspect of the establishment of software usage. Appropriation work and its support were introduced as an important aspect in the crosslinking of users and in the establishment of technology-oriented social capital. We now want to clarify, with the help of examples, how appropriation work and its support can look like.

3.1   Applying the framework of 'appropriation in practice' as an analytical lens

We differentiate our examples according to the scenarios of socio-technical user ties and according to the three forms of the appropriation support. With this, it is possible to classify and present projects with various backgrounds in a unitary way. *Table 1* lists different examples of projects, developed within our research on appropriation support. In the following we will explain important aspects concerning the interdependency with social networks.

Project	Scenario	Forms of appropriation support
BSCWeasel	Shared-Tool, Shared-Use	- negotiation of local usage conventions via discussion forums - collective sense making processes via wiki-based aid systems (CHiC) - support of creativity via an integrated design tool (PaDU)
come_IN	Shared-Tool, Shared-Context	- support of appropriation with a project-based initiation of CoPs
Digital construction kits	Shared-Tool, Shared-Context	- support of appropriation with the help of cognition development qua navigated exploration
Olvio	Shared-Infrastructure	- support with the help of usage discourse in an online-future-workshop

Table 1. Examples of appropriation support

3.1.1   The BSCWeasel project

BSCWeasel is a component-based desktop application, permitting an alternative access to the popular web-based groupware system BSCW. It offers a large number of functions, which are supposed to support collaborative work, developed as an open-source project by the University of Siegen[3].

In the BSCW-usage context, self-developed forms of support of appropriation work via enculturation have been observed. For example, some workgroups used the possibility to compile discussion forums in order to administer local contextualized FAQ-lists and to negotiate usage conventions. This form of mutual help was included in the BSCWeasel project and was advanced by the concept of Community Help in Context (CHiC) (cf.: Stevens and Wiedenhöfer 2006). CHiC is based on the idea of combining the context aid with a Wiki. Through this, it is possible to modify and concretize help texts and to exchange opinions with other users. It encourages appropriation via enculturation by simplifying the access for the user on the one hand and the active participation with mutual designed usage documentation and recommendation on the other hand.

The PaDU-project is based on the concept of collective cognition development. PaDU (Participatory Design in Use) supports the exchange of usage ideas and (re)design requests by providing tools for editing screenshots (cf.: Stevens and Draxler 2006). The annotation and discussion of such contributions take place on a shared (by developer and user) design-discourse system. The PaDU-system is an example for supporting collective innovation processes in the Shared-Use-Scenario. After the adoption of PaDU into BSCWeasel, a higher attendance and cross-linking of users or rather designers and users

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[3] Cf: http://www.bscweasel.de

had been established. Thematically, the contributions of users range from the description of simple mistakes in the application development to usability problems and to the description of new functions. These functions do not only make alternative usage possibilities transparent for the user, but also show further development potentials.

3.1.2 Appropriation in the intercultural computer club come_IN

The research project come_IN runs since March 2004. Its main goal is to encourage common learning of various cultures and generations. For this purpose the appropriation of modern information and communication technologies (IKT) and their effects on the development of collective identities is investigated in two elementary schools. Already in March 2004 an internet-and-computer-meeting place ("come_IN") for students and parents was founded, being more than a classic model of a computer club. In this field of application user ties from the shared-tool scenario and the shared-context are complementary.

The appropriation of software applications takes place with the help of collective project work based on modern media. On the one hand those projects are supposed to support a reduction of the linguistical and cultural differences in multi-ethnic districts. On the other hand it is supposed to attain the effect of identity formation among the participants. The come_IN project is an example of the realization of appropriation via participation and enculturation.

Out of the project oriented teamwork of children and parents, new forms of cooperation have emerged, which not only cross the boundaries between generations and cultures, but also reverse or even abolish the traditional roles of teacher and students. Through the shared usage of information technology available in the club (computers with several standard programs und creative programs for drawing and music making, cameras etc), the formation of a Shared-Infrastructure-Scenario can also be observed within the project groups. For example, attempts are made, which base on a bricolage (Levi-Strauss 1966). Bricolage denotes a new composition of tools in order to enlarge the usage contexts. One example from the project are new forms of using mind maps: although mind maps were at first only used for the organization of project goals, they are now also used for the presentation of results (e.g. in connection with a video-projector). This trend of developing a shared-used technological infrastructure will probably continue with the advised networking of both locations. A detailed description of the context can be found in (Stevens et al. 2005; Schubert 2007).

3.1.3 Appropriation of digital construction building sets

This project which is part of a German nationally funded research programme examines the question of appropriation of computers as universal machines through children. With the examples of Lego Mindstorms, designed according to the constructional learning theories of Seymour Papert (cf.:Papert 1993) and Squeak/Smalltalk, an object-oriented programming language created by Alan Kay, a virtual development platform for elementary students is developed at the moment.

It is tested within the above named computer club. According to children the computers are seen as complex systems, which often have to be programmed along a specification, although not in an engineering sense. In a playful way children intervene with the graphical representation of the programming code, in order to irritate the computer system and to appropriate the medium in an explorative way via observation of effects. The aim of the project is to pick up the ethnic/primitive form of cognition development, but to direct it through briefed contextualization. In the last step this is supposed to lead to the metaphors of appropriation of programming techniques. These metaphors are based on the narrative display field of children and gives insights into the constructional process of experience-based everyday life reflection of children. Finally, on the basis of gained metaphors and insights, a software development environment will be developed, which is suitable for children.

As a software- technical support we will build on Scratch (Maloney et al. 2004), which was also developed on the basis of Squeak and Smalltalk, but restricts the users much more in their learn-

biographical development of programming techniques and aims more at the multimedia-based presentation of already existing horizons of experience. (Self-) portrayal (i.e. narration) is put in front of (self-) development. Key to the appropriation support is not only the support of communication, but also the presentation of technical configurability through appropriate, user-friendly metaphors and comprehensible patterns of reaction.

The primarily addressed form of appropriation is the appropriation via cognition development. However it is shown here that this form is to be understood not in contrast but as a completion to appropriation via knowledge acquisition and training. For a final assessment of (software-technical) support measures it is still too early. However, the combination of Lego Mindstorm Robotic, with its relatively strict focus on technical development (already given through the form of its robots), with Scratch (and its narrative construction attempt) could be a fruitful way to programming-supported display software suitable for children.

3.1.4   *Appropriation support in software infrastructures*

Within the scope of the Olvio project a concept of appropriation support was developed, which has helped four research groups with the establishment of a shared development infrastructure (Pipek 2005). Based on the idea of the accomplishment of a modern online future workshop (guided moderation with the steps "critique phase", "fantasy phase" and "planning of implementation") a web-based discussion forum and a tailored screenshot and an annotation tool was offered to mediate the appropriation of a shared infrastructure. In contrast to e.g. the BSCW the appropriation support had to take place, due to its allotted character of the technologies (development areas, code-databases, compiler, graphic-frameworks etc. all in different places), outside the used technologies, which is rather typical for the Shared-Infrastructure-Scenarios.

In the course of the project it was shown that appropriation of a shared development infrastructure did not work, but numerous local improvements of the infrastructure were able to be accredited to the failed appropriation process. Also the cross-linking between the employees of various organizations was improved. However it became clear that appropriation support aims at activities which are subordinated to the productive work of organizations. That is why, in case of its usability, high demands are put on the appropriation support concepts.

3.2   Towards an Infrastructure supporting the appropriation work

The discussion of the various research projects is supposed to show that currently no canonical form of support of appropriation work is available. However, some recurring moments are recognizable, for example 'integration in the use context', 'support of active participation', 'support of communication-, cooperation- and networking processes'. In these network of different actors (like users, power users, administrators, developers, etc.) the software artefact plays the role of a boundary object among the different actors. Based on these insights we set up a list of fundamental requirement on a software-technical infrastructure support for appropriation work more efficient.

Taking the embodied user experience into account: Normally experience is embodied, formed by the practical activities where action and perception constitute a unity (Hakkarainen et al. 2004). In this process the user interface (as the semiotic skin of the boundary object) plays an important role and therefore the appropriation infrastructure should take this into account, interweaving the shared infrastructure directly into the use context. Practically this means that software systems should posit a direct activation mechanism (cf. Wulf and Golombek 2001 ; Stevens and Wiedenhöfer 2006) that simplify the transfer between usage, usage discourse and usage appropriation. It should also support the expression and the reflection of the embodied experience. e.g. by graphical annotation tools (cf. Pipek 2005).

Discourse infrastructure: The software system should integrate a shared discourse infrastructure to foster the social process of sense making and negotiation around the used technology. Discourses can be related to the own application usage, intertwined with experiences of other actors or negotiations of common interpretations. It should also include the reference to the related tailored artefact, as well as to other additional components and software.

Cooperative Tailoring: The software system should integrate means for cooperative tailoring. These include all technical aspects of individualizing of the software system as well as the management of repositories. Those store and manage ready-made components as well as tailoring artefacts.

Additional Appropriation support: Beside the communication support, an appropriation infrastructure should support appropriation by automatic generated user recommendations. It underlines the importance of analysing individual and collective use histories (Bell et al. 2006). Taken the social perspective on appropriation seriously, the (semi-)automatic adjustment of the system is only facet. The other important feature of the analysis of the use histories, is to give recommendations for "similar" users, usage expertise to his usage context and identification of appropriation trajectories.

Based on these requirements we have developed software architecture for the next generation of an integrated Eclipse appropriation and provisioning infrastructure (cf. Stevens et al. 2007). In addition, we use these lists as an analytical lens for a technology comparison (cf. Draxler et al. 2008).

4   CONCLUSION

In trying to apply the DOI (Rogers, 1995), to systematize our action research oriented projects on technology diffusion processes in practice, we have come aware that we cannot express important aspects in the vocabulary of DOI. In particular, it marginalized the user creativity in IT adoption process. In order to bring these phenomena into the centre of a theoretical reflection, we adopt the appropriation term of Marx (cf. Poole/DeScantis, 1989) taken a bird's eye and an actor perspective into account. Taken social as well as learning processes into account is the basic link between our conception and the conceptions within DOI theory. Below these similarities, DOI interprets this term from an information processing paradigm, where our neo-Marxian approach is grounded in 'practice' as a paradigmatic term. Also, the research interests are slightly different: DOI was developed to inform a change agent, how an outsider can make the implementation of a new technology more efficient. Instead, our perspective is grounded in a Design Science perspective that targets the creative, self-organizing appropriation processes we observed and that suggests to offer support for negotiation and sensemaking, because the establishment of usages perceived as helpful cannot be operationalized in a deterministic, anticipable way. Though we are aware that any support we offer will also undergo a process of appropriation, we would expect our communication/negotiation/tailoring tools to require less cognitive effort than the technology on 'first order' appropriation.

In particular, we described a preliminary answer to this challenge for the design of information systems. We need to develop a theory of practice, but it is not helpful to base this theory only on causal relations between the technology, the organizational context and adoption patterns. We also need to capture the essence of the creative activities of appropriation and continue with a activity-centric theoretical reflection that gives an orientation for design decisions. We showed that the historical-materialistic conception of appropriation of Marx can give a theoretical fundament for these considerations. We illustrated this by applying two neo-Marxian approaches to understand the socio-technical as well as the evolutionary, learning-oriented facets of appropriation. We applied these to systematize several examples from four different research projects, and presented fundamental requirements for appropriation support, which can guide us and other designers to enhance their IT artefacts in order to acknowledge that in fact every software is social when we develop a design perspective that transcends the design of 'technology' towards a notion of 'design of technology usage'.

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