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LEARNING TECHNOLOGY, CONSTRUCTING CULTURE

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LEARNING TECHNOLOGY, CONSTRUCTING CULTURE.
Sociotechnical change as social learning[1]

1. Introduction

The critique of technological determinism and of the linear model, formulated from two decades of research from the perspective of social shaping (or construction) of technology, has efficiently eroded the idea that social action is so-to-speak embodied in technology. There is no analog to biological DNA or other master molecules that contain a programme that directs the construction of bodies.

Research in communication studies has also mirrored this shift in approach away from an "impact" and technologically determinist model. There has also been a shift from viewing audiences (consumers) as passive to see them as active. New media with increasing levels of interactivity make it even more important to rework the conceptualisation of design as well as consumption (see, e.g., Silverstone 1994, Morley 1992).

The importance of the phenomenon of *social learning* as a basic feature of the dynamics of sociotechnical development, emerges from this insight. Since there are no well-defined determinate impacts of technology, we need to find other ways to analyse how impacts are made. To emphasize technological change as social learning represents a different strategy to face this challenge.

The concept of technology is usually employed to analyse "hardware", the material nature of things and their meaning. When we look at information and communication technologies, in particular areas like multimedia, we are reminded that we need to focus more explicitly on the content of these technologies when they function as media that convey, not only meaning, but explicit messages. Thus, in this paper, the word technology is meant to include content as well as the more traditional material aspects.

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[1]This paper is an outcome of "Social learning in multimedia" (SLIM), a project funded by the European Union through the "Targeted Socio-Economic Programme". The work reported here draws a lot from a long-term engagement in and debates about these issues among my colleagues at the Centre for Technology and Society, Norwegian University of Science and Technology, Trondheim. The paper has also benefited from comments from a participants in the SLIM project.

A first approximation of what is meant by "social learning" may be given by reference to so-called evolutionary models of development of technology that have a long history in technology studies (see, e.g. Gilfillan 1935). Their basic operating principle is the combination of the processes of the production of *new variations* through "hybridization" or "mutation" and *selection*, respectively. Gilfillan (1935:10) argues that "*The inventors are led by perceptions of the possibility and need of making easily enough some recombinations of elements of the "prior art" and milieu*". Thus, inventors are led by social learning about needs as well as their experience in making and applying things. They learn to be able to invent and to innovate.

In terms of "selection", we also need conceptual tools to gain a better understanding of the ways artifacts and systems are culturally appropriated and made part of (or rejected by) a given social system. Obviously, invention and innovation in some sense produce disembodied and disembedded knowledges and artefacts. To become successful, they need to be reembodied and reembedded. How may we proceed to analyse these aspects of socio-technical changes, and for what purpose?

The main idea to focus on social learning is to provide both a critical and a constructive input to technology policy. Technology policy in most OECD counties, including the European Union is too focused on technological change in a narrow sense. Primarily, one is concerned with innovation to promote economic growth and national (or regional) competitiveness, based on development of new technologies. This focus produces a problem of diffusion, partly in the transformation of technological R&D into marketable innovations, partly in getting these innovations implemented and making them profitable. The concern for users becomes secondary, which is problematic for two reasons. First, it makes innovation less efficient. Second, it produces technologies that are not adjusted to users' demands and on occasion may run counter to users' needs or even may be harmful to them.

In this paper, I will review four main theoretical resources in order to clarify how social learning may be understood and analysed. I shall start out from some contributions to the analysis of innovation, including evolutionary economics and economic history, that explicitly have used the notion of social learning. While there are a lot of important insights to be elicited from this literature, it is too narrowly concerned with systemic qualities. Thus, there is a need to turn to action approaches that cover a different terrain. I will make use of a techno-semiotic focus, which highlights efforts to design the social learning of users, as well as cultural studies and the analysis of the appropriation of technology. Finally, I will comment upon the issue of regulation and how social learning may be understood in such a context.

When we study "social learning" in response to the problems of understanding what happens to technology in society, this implies an emphasis of

both *spatial* and *temporal* aspects. Giddens (1991) points to the process of time and space distanciation as a basic feature of high modernity, a feature related to the qualities of modern technologies. In spatial terms, we face the challenge to understand how technologies are made to work when they are "displaced" into now location through movement from laboratory to consumption, or from one country to another. The literature on technology transfer is insistent exactly on this point: disembodied knowledge is insufficient. Knowledge has either to be embodied (transfer of people as well as technology) and/or to be developed locally through learning (Bruland 1991).

Still, the greatest contribution from reflecting on social learning as a process through which the cultural influence of technology is produced, is related to its temporal dimension. This focus invites us to rectify an obvious and far-reaching weakness in most efforts to theorise the relationship between technology and culture. They tend to neglect its "microhistory" through their emphasis on synchronous features of this relationship.

Also, in a sense, a concern for social learning implies a need to reconsider the traditional conceptual split between design and use. When we focus on social learning, we are studying a phenomenon that gives input not only to the use of technology but also to its design. Both users and designers learn, but not necessarily from each other. Individuals learn, but so do institutions and societies.

However, when using the term social learning, we have to be careful to avoid two pitfalls. First, it is necessary to emphasize that we do not invite a "cognitive turn" in social studies of technology. The message is not to replace an anthropological-historical-sociological gaze by a psychological one. What we want to achieve by studying social learning is to be able to highlight the temporal dimension of sociotechnical change, and thus to clarify the processes that may explain the particular features of a given "trajectory" of "technological impacts". Thus, "social learning" is a term that signifies basic features of sociotechnical change, above all related to *change over time*. It characterizes the importance of the enculturation of technology that happens in the aftermath of radical innovations, but it is not a psychological concept. Thus, we do not draw upon general theories of learning.

Second, as we shall see later, the term learning has often been used as a proxy, perhaps most clearly in the innovation literature. When one observes changes, e.g. in productivity, that occurs while the technology remains the same, this is attributed to learning as if this concept explains what has been going on. The process is thus reduced to be about the honing of skills, the improvement of users' capabilities to employ, e.g. a given set of machinery. To avoid this pitfall, it is necessary to give a more precise meaning to the term of social learning and how it may lead to the use of supplementary concepts. In particular, it should be emphasized that processes of social learning cannot be taken as free of conflict, power and interests. On the contrary, conflict, power and interest has to be

assumed as inherent qualities of these processes of reembedding universalized technology.

2. Learning processes in innovation

Economists and economic historians became interested in social learning through studies of productivity that showed continuous improvements over very long periods of time without any investments in new technology. Traditional production functions could not explain this phenomenon, either than by introducing a trajectory of shifts that could be described as a learning curve.

Arrow (1962) calls the phenomenon *learning by doing*. The idea is that workers, individually as well as collectively, develop more efficient ways of employing machinery through their experience from use. The effect is well known, but it has usually been taken to be limited to a short period of time, regarded as an "introduction" to the new equipment. However, learning by doing may improve efficiency of production over a very long period of time.

A related phenomenon is *learning by using*. Rosenberg (1982) suggests this concept to describe the process through which a user (client, costumer) familiarises a given piece of technology and develops her or his skills in making use of it. While learning by doing provides a basis on which to make production more efficient, learning by using may help to create new sociotechnical practices.

From the perspective of innovation, both these processes of learning are very important as sources of information on how to make improvements. To analyse the experiences from producing a given piece of equipment is important to be able to make process innovations that may be the basis of further improvements in productivity. Similarly, to get access to what users have learnt about their products and what deficiencies and potentialities they have discovered, is invaluable information to those engaged in product innovation. On this basis, one may develop a model of innovation that highlights social learning. Learning by doing, learning by using, and management's learning by making mistakes are then the three main ingredients (Maidique & Zirger 1985).

However, one should note that the difference between learning by doing and learning by using chiefly is one of perspective. What is learning by doing for one company is learning by using when seen from the company that supplies, e.g. the machinery. The main issue is the importance of the linkages between users and producers, and these may be both forward and backwards. To innovate successfully, producers may depend critically on information from users, and vice versa. This is the basis of the idea of *learning-by-interacting* (Andersen & Lundvall 1988).

Learning-by-interacting is affected by systemic qualities of a given regional or national economy, even by international relations. Channels of communication, codes of conduct, and conceptualisations may develop over time and may also be

the object of public policy. Some stability in inter-firm relations is also needed, in order to provide necessary preconditions for the stable forward and backward linkages needed to perform learning-by-interacting (Andersen & Lundvall 1988). From this perspective, the system of production may be seen as a system of learning or a *learning economy*.

The idea of social learning that may be observed in this work on innovation, highlights the productive nature of this knowledge. To be aware that the use of technology implies learning, in one form or another, is of strategic economic importance to companies as well as nations. Also, it invites a more dynamic reading of what happens to technology after it leaves, so-to-speak, the drawing boards of its designers. Thus, we are reminded that we have to study these processes of learning when analysing the emerging of new technologies like multimedia. To say something meaningful about the construction of new practices, of new needs, and new demands, one needs knowledge about what people learn when they "do" or "use" these technologies.

Evolutionary economics also helps to identify the different constituencies that have to be studied. We need to look at those who produce, e.g. multimedia, as well as those who use. In addition, following Maidique & Zirger (1985), there are managers and boards who develop and carry out strategies and experience successes and failures. In the end, their perception of what may be digested from the various learning processes has a decisive influence on the development of technology.

However, for all its important insights, the innovation literature tends to leave us in the dark about the nature of learning technology. What processes is taking place? For example, one could describe learning as discovering the intentions of designers. From this perspective, what happens through learning is that the technology finally may unfold its full potential. What the term learning really signifies then is a *delay*. Users have to spend too much time to discover the inscriptions of the artifacts and their meaning because they are insufficiently trained. Consequently, learning by doing could be short-circuited by an effective training programme.

Clearly, this is not the concern of Rosenberg, Lundvall *et al.* They mean to describe a process that transcends any kind of preconceived training. But what is it?

We may approach the question by deconstructing the topic called *diffusion of technology*. The concept of diffusion comes from thermodynamics where is describes a process of intermingling molecules as a result of random thermal agitation. In relation to technology, diffusion has come to mean the process through which new artifacts or ideas become spread in society (Rogers 1983). Still, there is a carry-over from physics because diffusion tends to be modelled in similar ways, using a probability model commonly called the S-curve. Thus, diffusion is a systemic quality, depending on features of the system where diffusion is taking place, e.g. temperature or GNP per capita.

When oxygen molecules are diffused with nitrogen, they remain oxygen. This is not the case with technology. To talk about diffusion of technology is to take the conservative perspective that technology is ready-made when it leaves the factory in brown boxes. It is a gross underestimation of the creative efforts that very often is needed to be able to employ an artifact in a productive and profitable way. To quote Rosenberg (1979:75): "*The diffusion process is typically dependent on a stream of improvements in performance characteristics of an innovation, its progressive modification and adaption to suit the specialized requirements of various submarkets, and the availability and introduction of other complementary inputs which decisively affect the economic usefulness of an original innovation*".

In the last decade, several concepts have been developed as alternatives to diffusion to avoid its notions of systemic necessity and passive adoption. For example, Fleck (1988) argues that implementation should be seen as a strategic site of innovation. Here, new technologies have to be matched with the locally embedded demands made by users. Fleck describes this process by the concept of *innofusion*, to emphasize the synthesis of innovation and diffusion taking place through the "learning by struggling" to get technology to "work".

The main problem with the way economists and economic historians have conceptualised social learning is thus their lack of concern for the social and cultural processes that constitute users' transformation of a given piece of technology. In a sense, they have black-boxed the phenomenon in way which is characterised by an instrumental bias but also by insufficient understanding of the problems of communicating the outcomes of social learning.

Thus, to focus on the phenomenon of social learning has both a critical and a constructive impetus. It encourages a profound criticism of the idea that diffusion of innovations may be universally characterised as a passive act of adaption and adoption. Also, it highlights the necessity of transformations, not primarily in physical terms, but rather with respect to the understanding of what needs the artifact is supposed to meet, how it may be employed to this end, and what improvements that would make the artifact more beneficial.

However, we should note that - in particular in its economic version - social learning tends to be analysed and described in terms that suppress conflict and controversy. Learning "more efficient" employment of machinery may of course be based on increased skills, but often this process is situated in conflicts between workers and managers (Skorstad 1994). Thus, what appears to be learning could be argued to be the outcome of changes in relations of power. Thus, we have to be sensitive to this tendency to "neutralise" what learning is and to amend it.

Social learning is thus more than learning-by-interacting. It may be characterised as a combined act of discovery and analysis, of understanding and meaning, and of tinkering and the development of routines. In order to make an artifact work, it has to be placed, spatially, temporally, and mentally. It has to be fitted into the existing, heterogeneous networks of machines, systems, routines,

and culture (Sørensen 1994). Thus, to analyse social learning is not only about action. We have to address issues of meaning and identity as well. Here, we have to rectify the economists' rather singularly instrumental understanding of human activities. By doing this, hopefully we make room also to see the implications of power.

3. Control through technology: The semiotic configuration of social learning

Callon (1987) and Latour (1987) argue that design as well "diffusion" of technology should be understood as processes of *translation*, through which the meaning of the innovation is changed to cater for local needs and interests. The innovator needs to be active to build the necessary network of suppliers, maintenance people, and users, and this demands a dynamic process of developing attractive scenarios and reshuffling of interests and responsibilities. In the end, however, the fate of the innovation remains in the hands of the users. It is their eventual re-translation of a new artefact, their social learning, which is decisive.

In the sociology of technology, this point is made by stressing that technologies may be understood in different ways, that there is a flexibility of interpretation (Bijker, Hughes & Pinch 1987, Latour 1987). Methodologically speaking, technologies may be perceived as texts and the act of using them may be seen as comparable to the act of reading. This means that both the symbolic and the action aspects become important.

While the *interpretation* of technology may be flexible, this does not mean that technology itself should be seen as flexible. Clearly, the material nature of technology matters. Also, technologies are designed for certain ends. Designers work from images of use, and they have their ideas of how their designs should be employed. Thus, at least intentionally, efforts are made to achieve control through technology. Phrased differently, we could say that designers try to configure the kind of social learning that - according to their point of view - should take place when their design is put to work, in order to make it function "properly".

While it seems pretty obvious that technological artifacts affect human action, it has proven difficult to conceptualise the features of the human-machine relationship without falling back into deterministic arguments. The most common approach has been to try to identify features of technology that may control human action. This has resulted in sophisticated classification tools, in particular within industrial sociology and psychology, used to assess the consequences of new technology in terms of demand for qualifications and impacts on the quality of working life (see, e.g. Bright 1958, Kern & Schumann 1970). These tools were mainly applied to address the archetypal problem of the human consequences of

factory automation: upgrading, degrading, polarisation, or no effect (Haug et al. 1978).

In the light of the more recent critique of technological determinism, this quest for tools to characterise technology in terms of impacts is clearly problematic. This has been recognised in industrial sociology as well. Here, the analysis of technology and work has, for the last couple of decades, been dominated by contingency thinking and emphasis on local processes and relations (Adler 1992). Still, some want to retain the idea that there is a "soft" determinism of technology which may be observed in the present tendency of technological development to spur increased levels of skills among industrial workers (Adler 1992, Thomas 1994).

From the spirit of the new sociology of technology, efforts have been made to apply semiotic concepts to get a new handle on the problem. While the fruitfulness of these efforts is controversial, they may help to highlight some of the challenges of analysing social learning. Arguably, three issues are at stake in this effort. The first is how we may observe and characterise the efforts of designers to shape technology to influence human action in order to control it. The second is how we may observe and characterise the material results of these efforts. The third is the efficiency of this effort of control of users of the artifact under scrutiny. To what extent may we predict the outcome of the use of technologies?

The most convincing results have been achieved with regard to the first problem. Akrich (1992) and Latour (1992) claim that we may interpret the endeavours of designers as efforts to inscribe certain preferred programmes of action by users in the design of a given artifact or technological system. Designers visualise a script of preferred reactions to the artifact, and they try to shape the technology in order to make these reactions as mandatory as possible. In a similar vein, Woolgar (1991) describes software design as efforts to configure users. Also, on a more normative basis, Norman (1988, 1992) has argued the need to improve the design of artefacts to make their "affordances" more efficient. His view is that most designers are insufficiently able to produce easily readable scripts and thus design technologies that are too difficult to use. Norman's argument is compatible with the semiotic analysis of Akrich and Latour to the extent that they agree that design is about inscribing preferred human action into artefacts. (They may, however, disagree about the readability of these inscriptions).

A basic point from semiotics is that the interpretation of a text is dynamic and thus, *in principle*, flexible. There is no universal meaning of signs. This does not mean that texts (or artifacts) always will be read and understood in different ways, only that we cannot be certain that a given meaning always comes through, regardless of context. There may be different codes of interpretation available, the text may be situated in a controversy over its meaning, and shifts may occur in the

meaning of the elements of the text. And, most important, new "readings" may be invented.

Thus, we may characterise the material outcome of inscriptions in terms of the intentions of designers, but we cannot assume that the materiality has a given meaning. Intentions have to be translated into material form, while material form has to be retranslated when artifacts are put to use. In the end, this means that the predictability of the outcome of employment of technologies remains uncertain because of the flexibility of interpretation of technology. This is a very basic outcome of decades of research into the social shaping of technology.

On the other hand, the flexibility of interpretation is not disconnected from the cultural circumstances of this act. The "coding" of human action as well as of technological artifacts is always performed in a cultural landscape of power and hegemony, of preferred readings, and available resources of interpretation. The flexibility of interpretative acts in relation to technology is bounded, as is evident from feminist work (Cockburn and Ormrod 1994) but also from techno-semiotic quarters (e.g. Callon 1991, Latour 1996). Still, there is a widespread agreement that, even if some outcomes, some interpretations, are more probable than others, the "consequences" of technology are unpredictable *in principle*.

The semiotic approach to the analysis of social learning and sociotechnical change is basically concerned with the transformations that are made when artifacts are displaced or moved in cultural spaces. What happens in the laboratory or at the drawing table when differences of interest shall be reconciled into the same design? What further translations prove necessary in order to enroll new people into the network of users of the innovation? Thus, the approach offers interesting and important concepts to analyse these spatial acts, but its principled neglect of cognitive issues seems to hamper the conceptualisation of time and of time-related aspects like learning. In Latour's analysis, social learning becomes more of a game between the programmes of designers to control users (or at least make them comply with simple rules of action) and the anti-programmes of users to come around the materially embedded dictates of designers (Latour 1992). Of course, this is an important example of social learning as learning-by-interacting that highlights the potential for conflicts between designers and users. Still, it limits the analysis of social learning to such interactions. To broaden the scope, we now turn to cultural studies.

4. The appropriation of technology

To transcend the identification of social learning with learning-by-interacting, we may perceive social learning from an anthropological or ethnographic perspective as *appropriation of technology*. In this way, we emphasize that technology has to become encultured (or embedded) in order to function (Silverstone & Hirsch 1992, McCracken 1988, Lie & Sørensen 1996). The challenge is to be able to

analyse in greater detail the nature of "learning by using". What is the scope of such learning, what is achieved, how does it affect "technological impacts" and how may such insights be helpful to the design of better technology?

An example of relevant anthropological analysis is the work of Emily Martin (1987, 1994). She studies how medical concepts like menstruation and immunity are appropriated and transformed to give meaning and guidance in a local context. From a scientific point of view, this results in a distortion of medical facts and consequently a failure to "really understand" the concepts. However, as Martin shows, most people do not appropriate scientific concepts to emulate scientists or professionals. They try to make sense of their own lives and relevant natural phenomena from their cultural framework.

Other important sources of inspiration are studies of consumption and media studies. Their focus is particularly on the symbolic aspects of technology and the need to analyse how artifacts acquire their significations. For example, McCracken (1988) emphasizes the necessity to give meaning to material objects. Without meaning, artifacts remain artificial and alien. He finds that people employ many rituals to this end: possession rituals, maintenance rituals, grooming rituals, etc. Silverstone, Hirsch & Morley (1992) uses the concept of *domestication* to describe how artifacts are integrated into what they call "the moral economy of the household". Their approach focuses on the way households are both "economies of meaning" and "meaningful economies". It highlights the interaction between economic and symbolic transactions within the household and between the household and the outside world. Moral economies are negotiated spaces. To domesticate an artifact is to negotiate its meaning and practice. Metaphorically, this concept shows the need to "tame" facts and artifacts that are taken from a "wild" outside world and put into a domestic setting. Thus, domestication is a way of theorising what the cultural appropriation of technology is all about.

Basically, domestication is necessary both to make artifacts work and to make sense. Both action and meaning are important. Artifacts have to be:

- *acquired*, either bought or in some other way made accessible.
- *placed* which means that they are situated in a physical, symbolic and mental space.
- *interpreted* to be given *meaning* within the household or a similar local context of identity as well as *symbolic value* to the outside world.
- integrated into *social practices* of action (Silverstone, Hirsch & Morley 1992, Lie & Sørensen 1996, Sørensen et al. 1996).

The process through which these tasks are performed, is what we call domestication. Domestication is done by individuals or households as well as institutions and other collectives, even nations.

Strategies of domestication thus involve the following three main dimensions: (1) practical, (2) symbolic, and (3) cognitive. In the practical dimension, domestication brings forward a pattern of usage. How shall the artifact

be employed? What are the practical implications of a given set of knowledge? Symbolic efforts are about production of meaning and the relationship between meaning, identity, and the public presentation of self. The cognitive work is related to learning about the artifact or the intellectual appropriation of new knowledge.

The importance of this perspective to our understanding of social learning is above all that it emphasizes that social learning involves the creation of meaning as well as practical efforts to make technology work. The interpretation of an innovation is of great importance to its eventual success or failure. The reinterpretation of the camera from a professional to an amateur artifact (Jenkins 1975) or of the VCR from a tool for broadcasting companies to a household appliance (Roosenbloom 1982), extended in a dramatic fashion the market for these products. To struggle to define the car as sustainable or non-sustainable is maybe the most vital agenda for the car manufacturing industry. The future role of multimedia may depend on the public understanding of this technology in terms of moral acceptability (is it harmful to children, does it purvey "pink services", is it mainly "toys for the boys", etc.)

Meaning is projected internally as well as externally. The objects we use, should be compatible with our personal identity as well as with the perception of self that we want to convey to an outside world. This is one of the reasons why some technologies are met with greater enthusiasm from some groups of people than other. Reactions towards new technologies that are often labelled "resistance", may on closer examination prove to be rooted in this dynamic of meaning: The common interpretation of the innovation is not in accordance with our self identity. Women may feel that the use of certain artifacts, e.g. computers, contradicts their perception of femineity (Berg 1996). Social workers may see computers as "anti-social" and thus signifying a different concept of their work than they want to have (Lie 1997).

A second important feature of the domestication perspective on social learning is that it reminds us of some of the trivial challenges that have to be solved in order to make things work. In particular, it points to the necessity of constructing routines that may provide an efficient and reasonable homogeneous action environment (see also Nelson & Winter 1982). The artifact has to be fitted into given systems of division of labour, one has to identify the tasks that have to be performed and the skills necessary to do these tasks, etc. Until routines have been developed that run with acceptable smoothness, the artifact has not been successfully implemented.

This does not mean that these routines are inscribed in the artifact, just waiting to be discovered. What we see, is that people construct different routines and different meanings from the same artifact. Of course, these processes of construction are contingent. They may be affected by class, ethnicity, and gender, but also by age.

Aune (1992, 1996) describes how one may identify at least four different groups of home PC users: *extenders* who bring PCs into their homes to facilitate overtime and blur the distinction of home and work, *explorers* who use PCs to try out new software or hardware and to figure out what the computer could and how to make additions to extend its use, *gameplayers* who played with computers to have some fun and kill some time, and *gamefreaks* who were passionately engaged in gameplaying activities. In a similar vein, Håpnes (1996) analyses computer hackers to find that even among this extreme group of computer users quite different styles of working with and thinking about computers are on display.

Vestby (1996) shows how the use of the telephone by parents and their children, and the access of children to use microwave ovens, tv-sets, VCRs, and PCs, are embedded in parents' and children's efforts to obtain control and autonomy. These technologies are domesticated to reflect modern (Norwegian) ideas of childhood and parenthood. In this case, a well-established technology like the telephone becomes part of a new practice and begins to signify ideologies of education because a family enters the transitory stage between having children who are too young to be left on their own, and teenagers old enough to be expected to take care of themselves. Probably, in these families, the telephone is redomesticated again when the children get older.

The learning that takes place here, definitely transcends the learning-by-interacting scheme. From some point of view, of course, one may argue that this is learning by using. To get access to these forms of learning could be very profitable to producers of the relevant artifacts. Nevertheless, the learning processes are more complex and composite. Just in relation to the instrumental task of making use of a PC, a host of different learning strategies may be identified (Aune 1992, Sørensen et al. 1996):

a. *experimentation* which emphasizes the identity between using and learning, in combination with information from other users.

b. *tinkering* where you learn in a pragmatic manner what you need to know in order to perform necessary tasks.

c. *analysis* which emphasized overview and general understanding of software.

d. *training*.

Learning by trial-and-error is of general importance, but in addition users get information and knowledge from each other and through a host of different channels. The learning economy observable on the macro level has its parallel in local learning communities.

Again, we have to remind that the employment of different strategies is not accidental. We learn in collaboration as well as in conflict, and our preference for some strategies of learning as well as of domestication implies some evaluation of local strategic possibilities. Not because we maximise the efficiency and efficacy of our actions, but because these actions necessarily are situated in and shaped by local contingencies.

What is the outcome of social learning in terms of domestication of technology? Clearly, like in all learning there is an act of coping with or mastering a given artifact or technological system, of gaining some understanding. To some groups, this is a pragmatic issue - to do, is to know. Thus, over time, appropriation leads to *trivialisation* (Weingart 1989). The artifact in question appears as natural, it is employed in a matter-of-fact like way, even if only a tiny majority have any deep knowledge about it or understand how it works (Turkle 1984). To other groups, the lack of transparency is a challenge to be overcome. To know is to do. Knowledge is a prerequisite for proper or relevant action.

But again, as indicated in this paragraph, social learning is not just the acquisition of skills and knowledge. When we emphasise domestication, we highlight the construction and reconstruction of culture as old and new combinations of artifacts, skills, knowledge, and social relations into, according to current glossaries, "seamless webs" of small sociotechnical systems.

This means that users are attributed agency. They are no longer passive consumers, fed by industry. In line with the idea of "active audiences" from media studies (e.g. Silverstone 1994), users are perceived as struggling with the socio-material relationships that they seek or encounter in their everyday life. Domestication is a way of conceptualising this struggle. While this gives an emphasis to the potential flexibility of the interpretation of artefacts and the way they are employed, material objects cannot be taken to be completely malleable. Users are constrained and supported by material as well as cultural features of the situation, but the domestication perspective insists that the clarification of constraints and supports should be an outcome of the research process, rather than being a point of departure for analysis.

According to the classic formulation by Hirschman (1970), consumers have three main avenues of action available: exit, voice, or loyalty. They can reject the product, the can make protests about it, or they may remain loyal to the producer. The concept of domestication allows us to work out these reactions in greater detail. In particular, what is seen as loyalty from a marketing point of view, may in fact be a creative act of transformation. These acts are seldom voiced, but to know about them may be critical to the improvement of the product. In this sense, one may relate domestication to the idea of constructive technology assessment (Rip, Misa & Schot 1995).

This idea may be taken even further when one is concerned with the content of technology, in particular in relation to media. Hall (1980) has used Hirschman's concept to develop the idea that messages may be decoded in three main ways: through a preferred (or hegemonic) reading, through an oppositional reading, or through a negotiated reading where the preferred and the oppositional systems are mixed. Domestication of, e.g. multimedia technologies, thus implies not only a placement of the artifact in a cultural and physical space, but also the

development of interpretative routines to produce a locally acceptable understanding of the messages.

Domestication is a way of describing social learning about technologies through micro-analysis of how they become (or not become) appropriated. We may observe different arenas, usually taken to belong to different levels of society, in order to produce the "thick descriptions" we ideally need to make sense of the process. At the same time, people also learn to domesticate through experience. This is another aspect of social learning which implies that domestication has to be analysed as an interactive process. Social learning is about domestication, but domestication is also an outcome of social learning.

The interactivity of domestication should be supported to be efficient. The dominant understanding of use of technologies as a product of skills that preferably should be expressing a universal standard, makes *invisible* the efforts of people to domesticate technology - not only to the outside world, but also to themselves. This makes learning more difficult.

Coping with technology is made easier by a developed consciousness about one's own capabilities and skills, and about the space available for transformations. Such consciousness promotes the interactivity of domestication as a practice and domestication as a process of learning how to appropriate technologies. Clearly, education and training as well as cultural attributions (gender, class, ethnicity, language) may impact the understanding of oneself and one's relative abilities. This has to be explored further. In the end, the aim should not just be to provide functional skills and make technologies easier to use. It is at least as important to provide skills related to information management and development of a critical approach to the symbolic aspects of technology and the media content.

The analysis of how technologies become appropriated is not just an academic exercise. Policy implications will be addressed explicitly in the final section of the paper, but one should note that there are important issues to pursue, not only related to "learning by using" and the possible use of such insights to industry, but also with regard to public education and engagement in technology policy. This is of course related to regulatory activities, another set of arenas where social learning is important to analyse. Regulation is no less exempt from learning than research and development in technology.

5. Learning by regulation?

What we may call *regulatory constituencies* are often left out of innovation studies and the analysis of technology. Contrary to popular beliefs, there are sustained efforts in most countries to regulate new technologies, e.g. by mandating certain qualities. These efforts of regulation have proved to be an impetus of innovation because they may make certain innovations quite

profitable. In some cases, we may even identify actions that imply that developers of technology are forced to make certain innovation. The field of multimedia provides us with important examples of the importance of regulatory action. In relations to government institutions, we have the efforts to ban pornography, the controversies around encryption programmes, telecommunication policy, etc.

Also private actors make efforts of regulation, e.g. by trying to impose standards, producing infrastructure, and - more generally - by trying to enroll political constituencies as well as costumers and clients to join in on their visions and designs. In principle, regulatory activities are as much as any innovation effort embedded in learning about technology and the efficiency and non-efficiency of the efforts of regulation. They have to be added to the map. Thus, *learning by regulation* represents another form of learning by using which we have to examine.

Many technologies demand an infrastructure in order to work. Efforts to develop such infrastructure are necessary in order to pave the way for new technologies. Often, infrastructure has to be constructed on a national scale. In those cases, we have a particularly good opportunity to study how a larger social unity, e.g. a nation, appropriates the technology. In fact, we may argue that even nations perform domestication when they produce the economic, political, and cultural work needed to integrate new systems or artefacts. Østby's (1994, 1995) study of the politics of cars in Norway provides an illuminating example. The large-scale introduction of cars meant that a host of different institutions had to be set up to regulate and promote this technology. While there clearly were efforts to learn from other countries, the resulting actions had to address Norwegian culture. In the present context, three aspects may be highlighted. First, the importance of the highway authorities and the transport research and development community as the main builders of the emerging car system. Second, the substantial level of conflicts taking place when the system had become entrenched and the "side effects" had become more prominent. Third, how the promotional work of motivating the use of cars was shared between the motor industry and governmental agencies.

The first observation may be seen as an instance of learning-by-interacting, because the highway authorities and the R&D community early on entered into close collaboration. One could argue that the R&D community represented an organised process of social learning. On the other hand, the increased concern for environmental risks in relation to an entrenched technology meant that a different type of learning made its way.

Petroski (1985) has made the interesting argument that engineers learn primarily through making mistakes. Immediately, this creates concern about unnecessary risks involved in new technologies, and that is a mistake. If Petroski is correct, and he probably is, a strict containment of engineers to make them avoid risks would at some point create even larger risks. This will be due to the dangers of believing in risk-free technologies, a belief that makes one less careful

about running and regulating technologies. In addition, even apparently risk-free, small-step, changes in technology may cause breakdowns and serious accidents.

This presents regulators with a serious dilemma. If they make regulations too strict, to produce risk-free technology, it is difficult to obtain the necessary concern for risks and sufficient ability to manage and cope with serious accidents. Thus, accidents may have more serious consequences. On the other hand, if regulations are too relaxed, there may of course be too many accidents.

Regulation is not just located in government institutions, and the institutions we traditionally perceive as regulatory, may also be engaged in the promotion of technology. While there is a host of different functions - design, production, promotion, use, maintenance, and regulation - these functions are often combined in some clusters. Learning by regulation is consequently linked to other forms of learning. A particularly interesting example could be the dual role of the government as both user and regulator of technology. Is there any communication between these two roles?

There are relatively few studies that address these issues from the point of view of technology. Regulation is more commonly perceived in terms of expertise and expert controversies that highlight particular features of debates about technological options (e.g. Nelkin 1993). Closer to our concerns are developments in so-called constructive technology assessment (Rip, Misa & Schot 1995). Here, social learning as learning-by-regulation is identified as a means to improve technology. This means, at least to some contributors to the field, that the challenge is to support learning-by-regulation and to improve communication about such learning. Social experiments have been identified as a method to simulate learning-by-regulation, but of course, such experiments may just as well produce inputs to the promotion of the technology because they emulate learning by using as well.

One could argue that learning-by-regulation is the basis of efforts or programmes like "total quality control" as well as current changes in government regulatory strategies with their move from central supervision and control to systems of local accountancy. The common feature is a move towards institutionalising local responsibility for quality and risk. Then, the important task becomes the setting of standards.

Standards are both technical and social in the sense that they may affect technical specifications of the product as well as features of the organisation of work. Many engineering communities have accumulated a lot of expertise in negotiating standards in order to ease the ability of products or systems of functioning "universally". On occasion, efforts of negotiating standards fail, leaving it to the market to pick a winner.

There are good reasons to believe that standard-setting is of great importance as acts of shaping social relationships. In general, learning-by-regulation has been grossly neglected as a process through which technology and society are reciprocally shaped.

Also, the notion of interactive domestication reminds about the potential importance of making visible local creativity in different setting to promote local regulation and standard-setting within the space for such activities made by governments and/or companies. To advance local consciousness about the importance of local action may in the end be a very important tool of regulating technology.

6. Dimensions of social learning

A concern for studying social learning is important to the understanding of innovation and technology policy for several reasons. First, the emphasis on learning-by-interaction and the related concept of economies of learning means to focus on the *ability to learn from production and use of technologies*, and to *communicate the outcome* of such learning. In this way, we see the importance of both forward and backwards (probably also "sideways") linkages between actors in a national (and international) economy. The policy challenge then becomes the development of instruments that may facilitate the establishment of such links and to provide better institutions and instruments for communication. While this challenge has been advocated through OECD and evolutionary economics, it is unclear whether there have been sustained policy efforts to cope with these tasks.

Second, this perspective *broadens the agenda of technology policy* to include activities usually covered under the concept of diffusion. When one acknowledges the need for creativity in order to be able to gainfully employ new technologies, one discovers the need to support and stimulate, but also to regulate, this creativity. In fact, what is conceptualised as "unintended consequences" of new technologies appear as unintended only because one has limited the outlook to the arena of R&D and design. To include user constituencies in the analysis mean a greatly improved ability to map intentions.

However, this also demands a different understanding of and greater concern for what users do. To make use of the insights emerging from studies of social learning, one has to transcend at least simplified (and simplistic) beliefs in the market as a mechanism of communication. To return to Hirschman's (1970) frame of reference, the consumer has - in particular in mass markets - only a choice between exit and loyalty, and thus very limited possibilities of communication with producers/designers. As noted by some economists and discussed in section 2 of this paper, a well-functioning learning economy demands a greater stability of economic relations and more developed patterns of communication than those held up by idealised market forces alone.

Fortunately, many companies see this and make efforts to reproduce user-producer relations, at least on a semi-permanent basis. There may also be need for new institutional arrangements to which governments - locally, nationally, and

even supranationally - may give decisive contributions. However, there is probably need for policy measures to encourage this form of thinking. Also, even more important, it may be attractive to educate to a greater extent the public about their importance to the development of "appropriate" technologies, the importance of their critical judgements, and the aggregate impact of the way they domesticate technologies.

Social learning, as described in this paper, is multidimensional and multi-level. I have emphasized three domains:

- the learning economy of networks of producers and users,
- the appropriating constituency of users
- the constituency of regulation.

Together, they span a wide space of sociotechnical institutions and actions. We cannot expect that these domains will be sufficiently similar to be analysed in the same way. In fact, their "internal" features as well as their relationships with each other need to be more fully explored through empirical analysis.

However, the main analytical feature of the concern for social learning is the insistence that we need to keep in mind the *diachronic* aspects of development and use of technology. To insist that users' actions matter is also to insist that these actions, and by implication - the resulting "impacts" of technology - develop over time and can only be properly analysed by integrating temporal sensitivities and concerns. Similarly, the gravest danger of focussing on 'social learning' is probably the inherent tendency to neglect conflict and controversy. Learning is usually analysed in rational and conflict-free terms because of the instrumental aspect of educational concerns. We need a constant reminder to look for "blood, sweat, and tears", to investigate resistance and neglect, because this is also part of the appropriation and non-appropriation of technologies.

Keeping this in mind, the focus on "social learning" holds three promises. First, it directs us to a set of analytical tools that allow a better understanding of how technologies come to shape and be incorporated in cultures. The application of such tools will in turn provide an improved knowledge base for innovation as well as for regulation of technologies. Second, it sensitises us to the importance of temporalities. Too often, the main concern is to speed up processes of technological change, e.g. by making "transfer mechanisms" more efficient. When we take the importance of social learning into consideration, we have to acknowledge that important things happen in period of use which may be difficult to speed up. Third, it holds a key to a widened as well as an improved set of strategies of regulating technology in modern societies.

Thus, there is an analytical as well as a normative side to social learning. There is always social learning of technology to be observed, from which new knowledge and ideas may be elicited and warning takes. At the same time the process of social learning should not be taken as "natural", it may be improved. That would amount to "double-loop" social learning which could be taken to be a proper aim of knowledge societies.

7. Literature

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