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ACTION VERSUS ANALYSIS

MAKING SENSE OF TECHNOLOGY STUDIES IN NORWAY

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ACTION VERSUS ANALYSIS.
MAKING SENSE OF TECHNOLOGY STUDIES IN NORWAY[1]

1. A whiter shade of pale? Some methodological remarks

To write about the Norwegian reception and adaption of the perspective of "social shaping of technology" raises several important and troublesome concerns. First, the concept of "social shaping" lends itself to flexible interpretations because there is no unanimous definition of it. Thus, the article has to work out a definition of the concept that is fruitful as a tool to analyse the Norwegian situation. Second, and as a consequence of this, the writing is an exercise of discursive power to decide what is inside and what is outside this research field. Even "technology studies" is not a readily defined discursive field in the Norwegian context; it has to be constructed. To write about it is to try to give it a history, a sociology and a philosophy. Third, what is to be gained by the writing exercise? Should it be an informative narration about previous and ongoing research, or should one take evaluative stances? Or, is the point to make sense of the mess by looking for developments, controversies, centres of gravity or by imposing some theoretical perspective that supposedly is capable of making order? Fourth, from which position is one allowed to write about one's own field of research?

Since the reader probably has asked these and similar questions even before this booklet was opened, both parties to the text should be aware of the difficulties. Anyhow, the general idea is to write an account of technology studies in Norway that informs about research that has been carried out and about some of the research communities that are active in the field. At the same time,

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[1]This article is part of the COST project "Social shaping of technology" which has initiated a comparative effort to make national reports on the state of this kind of research in the participating counties. The article will be printed in the collection *Similar concerns, different styles? European Approaches to the Social Shaping of Technology* (eds. T Cronberg & K H Sørensen, Brüssel, DG XII, 1995). In writing this overview, I have to a great extent made use of the work of my collaborators Thomas Dahl, Stig Kvaal, and Øyvind Thomassen on Norwegian philosophy of technology (Dahl 1994), Norwegian history of technology (Thomassen 1994) and on the efforts of the Royal Norwegian Council for Industrial and Scientific Research to support social studies of technology (Kvaal 1994). The work has been supported by a grant from the Norwegian Research Council, Programme on Information Technology and Society.

I wish to present some thoughts about possible characteristics of the Norwegian efforts. Research fields like technology studies always have a local and an international flavour. Researchers address problems that preferably may meet with local as well as international interest, and they grapple with the problems using local as well as international interpretative resources. In particular, living in a small country makes you more conscious of these dualities. A British or French case may make implicit claims of universality, while a Norwegian or Belgian one is always taken to be indicative of particular regional processes.

The "natural" way of writing up a study of a research field is to do an internal history, mapping out the emergence, diffusion and synthesis of different ideas and problemsets. However, according to the standards of the STS field, this should be taken to be no less than an expression of the original sin. The second pitfall is of course the external history, trying for example to make Norwegian technology studies into a typical outcome of Scandinavian social democracy. On the other hand, to write a proper constructivist account turned out to be too demanding in terms of double entendres and tongues-in-cheeks. Anyway, the story is of course coloured by the point of observation of the author who has played his part.

A few more disclaimers might be added. This article is not an inventory of all relevant Norwegian research. Although it would have been a manageable exercise to produce a commented bibliography of Norwegian efforts, to me it appeared tiresome to write as well as to read. Instead, I wanted to make an overview that could serve as a basis of making sense of Norwegian studies of technology. How has the field been constructed, with what resources, and through which controversies? Is there any reason why non-Norwegians should bother with Norwegian research in this field?

To make this task reasonable, I have chosen to take a middle road in the issue of how to define the object of study. Even if the study of technology has been on the margins of Norwegian social science and humanities, a pretty large number of people from various disciplines has on occasion touched upon the theme. I have mainly chosen to include sustained efforts in my story, leaving some single stunts in the shelves of the libraries.

Also, in Norway as in most other countries, there are research efforts that primarily intend to give guidance to the development of technology strategies on the firm level. Since I feel that the raison d'être of technology studies is to provide a critical discourse, I have chosen not to include this literature.

The story is based on two main sources. One consists of the written output of technology studies research: books, articles, reports, and papers. The other is planning documents, annual reports, evaluations, etc. that have been produced to provide funding or to guide institutional developments in the field. The resources for the study did not allow for the interviews and the more detailed archival work needed to give the story more flesh and blood.

A field in search of a history usually finds a pre-history. So could also have been the case for Norwegian technology studies. As Jon Elster (1982) has pointed out, the clergyman and social scientist Eilert Sundt contributed a nice, well-crafted and full-blown evolutionary account of innovation in the building of small boats in his article on *Nordlandsbåden*. However, we should resist the urge for a long history. While there are some forefathers who wrote what could be considered as technology studies, they did not have any offspring.

Consequently, technology studies in Norway is proposed to be of quite recent origin. In fact, the story could have been started around 1980. However, a very late starting point might lead to a certain blindness to the impacts of some enduring traditions which have affected technology studies in important ways. We need to make a somewhat broader assessment to identify some of the contingencies that have shaped our field.

2. The post-war reconstruction of Norway: Building technology, shaping society

In 1971 the Norwegian iron and metal workers' union initiated a research project that was to study the consequences of the introduction of new computer systems in Norwegian industry. The study grew out of a worry that the union might be side-stepped by the development and implementation of new technology. "To avoid impairment of the position of employees, it is necessary that the trade union movement ... builds a stronghold of knowledge at least comparable to that available to employers. (...) We have to train our members and their representatives, and we have to make use of the reservoir of knowledge to be found in research institutes and by consultants" (Nygaard 1980).

To some extent, this study signals a change of mood in the labour movement in Norway towards technology. In the reconstruction period of the Norwegian economy, from 1945 to 1960, the main concern was to establish affluence and welfare. New technology was a means to achieve economic growth, but of limited importance compared to labour and capital. Nevertheless, the labour movement -- including the social democratic party -- had a positive attitude towards science and technology. In fact, fractions of the social democratic party were among the most important supporters of political initiatives to promote the development and implementation of new technology (Kvaal 1991).

The golden 1960s confirmed the belief in science and technology as pillars of progress. The students' movement, the first seeds of environmental consciousness, the war in Vietnam, and the struggle against Norwegian membership in the European Union coincided to signify a change in the ideological climate. The Norwegian labour movement became more concerned

with the quality of working life, rather than being singularly focused on wages and employment rights (Sørensen 1984a, b).

Consequently, when Norway entered the 1970s, the attitude towards technology had changed to become more critical. The ground was prepared for a critical discourse on technology. Intellectuals, reading Marcuse and other works of the Frankfurt school, later Braverman (1974) etc., in principle provided an available resource of cultural pessimism and critique of technology. Still, no Norwegian parallel to Jaques Ellul rose to public presence.

In fact, the fate of the study initiated by the Norwegian iron and metal workers' union indicates the strength of a different undercurrent in Norwegian culture. In the words of the researchers contracted to do the study, they suddenly became aware that their work appeared irrelevant to shop stewards and union representatives. "But we were not able to make the representatives see any direct link between our research plans and what they could do concretely the union, locally, regionally, and nationally. *There was no connection between research and the options of action*" (Nygaard 1980). To communicate, the researchers found that they had to develop an action-oriented research strategy. They had to find out what representatives needed to know in order to be able to bargain about new technology. The "iron and metal study" was transformed into a programme of union participation in the development and implementation of new technology; from a pessimistic statement of the future, to a plan of action. Technological determinism was rejected, not as a result of analysis, but as a matter of principle. New technology should not mean that workers lost their ability to influence industrial relations.

Thus, the belief in technology as progress was not replaced by a pessimistic concern about technological shaping of social relations, but rather by an ambiguity: A wish to retain the progressive aspects of technology, its effects as a force of production, while observing the necessity to act to shape new technologies. This does not mean that technological determinism is not important in Norwegian culture as a figure of speech, but rather that Norwegian studies of technology came out of a belief in the potential for human action to make a difference. To observe the strength of this intellectual tradition, we should go yet a few years further back in history to study the so-called Norwegian Industrial Democracy programme and the establishment of a Norwegian school of socio-technical analysis.

3. The socio-technical legacy

When Einar Thorsrud was able to persuade the Norwegian Federation of Labour Unions (*LO*) and The Norwegian Employers Association (*NAF*) to make a joint venture of supporting his Industrial Democracy Programme (IDP) in 1962, he initiated a research effort that claimed to be concerned with the interrelationship

between social and technical elements of work. The IDP was established to put into practise some of the ideas developed at the Tavistock Institute of Social Relations in London about "joint optimalization" of the social and technical systems as a way to produce real industrial democracy and, by inference, strengthen democratic participation in arenas outside the workplace.

From 1962 onwards, a series of field experiments were undertaken to implement partly self-managed groups in a few Norwegian companies. These experiments were supported by the National Federation of Trade Unions as well as the Norwegian Employers' Association. Technology was considered to be an important part of the experiments, although no one intended to introduce new technologies during the experiments. Rather, technology was considered to be a contingency of industrial democracy. The important issue was how to exploit the technical slack that could be found at the shop floor (Emery & Thorsrud 1969, 1976).

In many overviews of technology and work, the sociotechnical tradition is left out (see e.g. Allen 1992). This may result from the fact that it does not easily fit into the controversies dominating this discourse: Upgrading versus degrading, alienation versus freedom. Sociotechnical theory also represented a partial break away from technological determinism. The basic idea was to reshape workplace organisation by changing technical as well as social conditions. The organisation of work was not a singular outcome of workplace technology, even if the analysis of tasks -- central to the sociotechnical approach -- was subsumed to an analysis of production technology.

The IDP thus gave an important contribution to maintaining and developing a concern for workers' participation to make them able to influence their conditions of work, and to argue the primacy of action over analysis. While the Norwegian technology studies field presently has an ambiguous relationship to these values, they form an important part of the discourse and contributing to a pressure to retain "political relevance" as a prime criteria of quality.

There has been a long-standing controversy over the IDP and the sociotechnical legacy. What was achieved through the field experiments? Have there been any lasting impacts in the companies taking part in the programme? (Gulowsen 1975, Elden 1979, Sørensen 1980, Gustavsen & Hunnius 1981, Moxnes 1981). In the most positive views, it is argued that the IDP paved the way for the legal working life reforms of the late 1970s, including the Agreement on participation.

Einar Thorsrud started his work with the IDP in Trondheim, at the Institute for social research in industry (*IFIM*) which was established in 1959. When he left IFIM in the mid-1960s and moved to the Work Research Institute (*AFI*) in Oslo, IFIM still continued to work on the IDP. Slowly, the profile of the institute changed, and through the 1970s it transformed its sociotechnical legacy. Also AFI, which became a sociotechnical stronghold under the leadership of Einar Thorsrud, has changed its profile considerably since the mid 1970s. It is

now much less concerned with technology, and their research strategies have changed (Elden 1979). A major part of their current activities has been organisational development, based on concepts like dialogue and learning (Gustavsen 1992).

The transformations at IFIM were more consequential to technology studies in Norway. The changes were spurred by several important influences. In the aftermath of the student revolt, the IDP and the sociotechnical tradition were harshly criticised as a subtle strategy to exploit workers and to sidestep the power bases of trade unions. Marxist oriented approaches from Germany (e.g. Kern and Schumann 1970, Medner 1975, Negt 1968) and from the US and Great Britain (e.g. Braverman 1974, Friedman 1977) made a considerable impact. Slowly, feminism also made headway into Norwegian worklife research. In addition, the work of Kristen Nygaard with the Norwegian iron and metal workers' union provided much inspiration, in Norway as well as in Denmark and Sweden. It paved the way for the idea of doing research work only for unions, not the traditional two-party arrangements of the sociotechnical tradition.

In the decade 1975-1985, IFIM became a kind of greenhouse of an interesting and fruitful blend of approaches to technology and working life. The sociotechnical tradition was confronted with different marxist interpretation of industrial sociology as well as with growing concerns for women's situation and the research needs of trade unions. The common concern was workplace reform and workers' participation in technical and organizational change (see Elden et al. 1982, Rasmussen et al. 1990). A closer reading would trace the emergence of at least four different, if overlapping, approaches:

* A critical appreciation of sociotechnical theory to develop ideas of participatory research (e.g. Elden 1982, 1986; Elden et al. 1980)
* A blend of Anglo-American and German industrial sociology to analyse technology and work in Norwegian industry (e.g. Nylehn & Skorstad 1982, Rasmussen 1984, Skorstad 1993) or to study participation (e.g. Levin 1981).
* The development of a workshop-based method to help workers analyse and learn about their own conditions, based on an interpretation of Negt (1968) (Rasmussen & Finne 1982)
* A comprehensive effort to study women and technology, not only in industrial settings, but also office automation, electronic homeworkers, female engineers, and housework (e.g. Lie & Rasmussen 1983, Lie 1985, Kvande 1982, 1984, Lie et al. 1987, see also Berg & Lie 1995).

Somewhat formulaic, we could say that the sociotechnical approach of the IDP was mainly concerned with influencing the social shaping of technological impacts. In the transformations occurring at IFIM, the agenda also included the analysis of how technological impacts were socially shaped and an emerging interest in the social shaping of technology. What happened was a move so-to-speak upwards, from only analysing the impact world to also studying

development and design. In the new IFIM studies, technology was perceived as a tool of management and of patriarchy to subsume workers and women under a managerial, respectively patriarchal, logic. But how did technology get the ability to mediate social control? Under what circumstances could technology be shaped to have different impacts?

The interest in these issues was inspired by the seminal work of David Noble (1979, 1983) on numerically controlled machinery. Noble produced the first detailed account to indicate how social interests were so-to-speak embodied in a new technology. His analysis suggested that the traditional sociotechnical interventions came too late. Capitalist technology would have capitalist impacts, independent of the way tasks were organised. It should be emphasized that Noble's impact primarily was to inspire people to study R&D and design. Also, it is in many ways appropriate that the best "counterexample" to Noble's rather politcally determinist account came from Norway. Håkon With Andersen (1988) provided us with a study of Norwegian development of NC-technology where scientists worked together with skilled workers, not management, to develop a technology that came to be used in US naval yards.

Noble's NC-study influenced the emerging technology studies community in Norway at a time when working life research in Norway enjoyed quite generous funding. A few years later, a substantial part of this funding had gone, forcing working life researchers of the applied social sciences to reorient themselves. The hot topic of the mid-1980s was not quality of working life, but management of innovation (see section 6).

There is an obvious irony in the fact that when working life researchers became more concerned with the social shaping of technology, they also experienced economic pressure to move their analytical focus to design and innovation. However, this move did not mean an easy opportunity to develop a more solid position regarding social shaping of technology. The practical interest in innovation was not how innovations were shaped, but rather how innovations could be made more successfully. Thus, the IFIM greenhouse met with difficulties in providing a stable environment in which technology studies could be developed.

Also, there were competing research communities. The Norwegian computing centre, where Kristen Nygaard had been employed, continued to do work with trade unions, to some extent in colloboration with IFIM (e.g. Elden et al. 1980). They also worked on organisational aspects of computers and on computers and employment (Fossum 1982, Nord 1983).

The "Multi-disciplinary group for the study of work and society" (*AHS*) at the University of Bergen hosted a different trajectory out of post-Braverman industrial sociology. To some extent, they followed the international trend in labour process analysis, moving into increasingly detailed empirical analysis of shop-floor politics. For example, there was a substantial output of historical studies of industrial companies and local unions (e.g. Olsen 1984, Jøssang 1987)

as well as of the engineering profession and the introduction of taylorism in Norway (e.g. Halvorsen 1984, Michelsen 1989, Halvorsen 1993).

However, the important characteristic of the AHS group was their emerging (and sustained) interest in comparative analysis of industrial organisation and industrial relations. The main source of inspiration was the comparatively oriented perspective of the so-called LEST-group that criticised the traditional universalistic assumptions of organisation theory. Observed comparative differences in the structuring of organisations generated an interest in the impact of the so-called societal dimension of work organisation and the relationship between technology and work (Maurice et al 1980, Rose 1985).

In particular, AHS began to study the impact of the educational system upon working life relations. They started with a focus on engineers (Halvorsen 1984, 1994) but also included the analysis of industrial training, technical education, skills and the social construction of skilled workers (Sakslind 1990, Korsnes 1990). Technology came to play an ambiguous role. It was important as a stage for social processes, but in most cases it remained in the background of the AHS analyses. For example, their interest in studying engineers was primarily to analyse their role as managers rather than their construction of technology. Thus, their focal point was the politics of work rather than the politics of technology (Halvorsen et al. 1988).

However, the strong emphasis on historically informed analysis in the AHS group was indicative of a more general trend in the development of technology studies in Norway. In November 1981, the Forum for history of technology was established to support the development of historical studies of technological change in Norway. The Forum provided an arena not only for historians interested in technology, but also for engineers and social scientists. Also people from IFIM and AHS participated in this organisation. The broad engagement made the Forum into an important springboard for technology studies in general, not just history of technology.

4. Economic history meets engineers and social historians: The shaping of Norwegian history of technology[2]

It is not surprising that engineers are interested in the history of technology. Much of the early work in this field was done by this profession rather than by historians. When history of technology emerged as a concept in Norway in the late 1970s, however, it quickly became an arena of professional struggle. One distinguished engineer, Helmer Dahl, came at a late stage in his career to initiate a course in the history of technology at the Norwegian Institute of Technology, he wrote a textbook on the topic (Dahl 1984), and otherwise stimulated interest

[2]This section is mainly based on Thomassen (1994).

in the topic in the Norwegian Engineers Association (*NIF*) as well as in the Royal Norwegian Research Council for Science and Industrial Research (*NTNF*). NIF helped to start the Forum for History of Technology and remained for several years its most important sponsor.

From 1978-1980, the journal of NIF, *Teknisk Ukeblad* ("Technology Weekly") published an exchange about history of technology. What was its topic, and who should do it? Was it best practised by historically interested engineers or by technically interested historians? (Thomassen 1994:14ff). The exchange was indicative of the different aims of the field. History of technology could educate the public as well as the engineering profession about the importance of technology and engineers to modern society, but it could also provide a basis for analysis the social shaping of technology as well as social impacts of technological change.

The people participating in the first yearly meetings of the Forum of the history of technology witnessed several interesting controversies about how the field should be developed. In addition to the exchanges between historians and engineers, there were debates about push and pull, external versus internal approaches, about economic versus social history of technology, and about innovations versus impacts of technology as the object of study (see e.g. Sejersted 1987 and Andersen & Stang 1984).

A major force in this development was Francis Sejersted, professor of economic history at the Department of history at the University of Oslo. Sejersted and a group of students had made a study of industrial development in Norway in the 1930s that came to focus on the innovative capacity of companies during the years of economical crisis. Under the heading of "growth through crisis", Sejersted and his collaborators argued that the 1930s had been a period of rapid technological change, contrary to the common perceptions of the period as one of stagnation and conservatism (Sejersted 1982). It is perhaps not surprising that this argument spurred an interest in the work of Joseph Schumpeter and the emerging post-Schumpetarian literature on the international scene (e.g. Freeman et al. 1982). During the mid-1980s, Sejersted developed a sophisticated theoretical basis for historical studies of technology, based in particular on the work of Nathan Rosenberg (1976, 1982), Thomas Hughes (1983) and Nelson & Winter (1982).

Sejersted was joined by a group of promising young historians who made important work on e.g. the history of the Norwegian institute of technology (Hanisch & Lange 1985), the Norwegian Industry Bank (Lange & Hanisch 1986), and the engineering industry in Norway (Lange 1989). Other historians participating in the Forum produced several company histories with a technological focal point, e.g. on IBM in Norway (Nerheim & Norvik 1986) and about Norgas, a welding company (Nerheim 1983). While most of the studies focused on the 20th century, there was also a sustained interest in the analysis of

Norway's early industrialisation and technology transfer to Norway in the 19th century (Bruland 1989, 1991).

Of particular significance was Håkon With Andersen's analysis of technical change in a large Norwegian shipbuilding company in the period 1935-1970. He was one of the participants in the controversy on history of technology who argued the importance of analysing impacts in the beginning of the decade. In his book about the transformation of shipbuilding (Andersen 1989), he develops a compromise between the two concerns, social history versus innovation. Also, the book indicates a breakthough in the historical professionalisation of the field. It combines the different perspectives, economic as well as social history, innovations as well as impacts, by making use of approaches and methods developed in particular by American historians of technology (see Staudenmaier 1985). Contact between Norwegian historians of technology and the SHOT (Society for the History of Technology) community in the US was frequent during the 1980s, and the SHOT influence on Norwegian developments was quite strong.

The so-called Electronic Industry History Project which started in 1984, became the perhaps most important vehicle for this influence. This relatively large project was headed by Sejersted who collaborated with historians Andersen, Basberg and Collett, and economist Skonhoft. A wide range of historical studies emerged (see Wicken 1994), and many students were trained in the history of technology.

The "Electronics history"-project confirmed the principled emphasis on technological development and innovation, rather than the study of "technological impacts". This controversy was in reality closed. It also marked a focused and sustained interest in knowledge-producing institutions and their role in the development of a new industry. This was a shift from previous work, but consistent with international developments in history of technology.

Another shift took place gradually in the course of the project. The initial idea was to have a collaboration between (economic) historians, economists and engineers to draw upon innovation theory as it emerged from the interface between history and economics, but with economic history as the point of the departure. However, history as a discipline came to be the centre of gravitation of the work. In this sense, the shaping of the "Electronics history"-project is evidence of the success of the historians in appropriating the field of history of technology as a field mainly for professional historians, even if economists were invited to participate.

Gradually, other sources of inspiration than economic history and evolutionary economy made their impact. The new sociology of technology as well as cultural history and new social theory provided different sets of angles to the problem of understanding the role of the electron in modern Norwegian society (Andersen 1994a, 1994b). Economic history no longer provided the dominant approach to the analysis of technological change. History of technology

should make use of a much wider set of intellectual resources (see e.g. Østby 1995).

However, as a community, history of technology in Norway did not stabilize. The shifting sources of intellectual inspiration is one indication of this. A more important issue is the fact that to historians, history of technology appeared to be a problematic emblem. Some of the senior figures returned to economic history or they gained positions as general historians. While the historians won the struggle with engineers and social scientists and thus could appropriate history of technology as a historical domain, they no longer reproduced the community as such. Instead, history of technology was gradually replaced either by the field of general modern history or by technology studies that developed into the new arena where historians met with sociologists, anthropologists, philosophers, and political scientists to make sense of technology. In some sense, the turning point of this development was the establishment of the Centre for technology and culture in Oslo and the Centre for technology and society in Trondheim in 1988.

A strong impact of historically informed arguments and historical methods nevertheless is a defining feature of technology studies in Norway. The 1980s was a formative decade in this respect.

5. Technology in a welfare state: Human values versus social planning

In 1984, the board of the Norwegian Academy of Science appointed a working group of 12 people to propose the establishment of an independent, interdisciplinary institution to promote human values through research. The group consisted of prominent people from the sciences, technology, and the humanities as well as from industry. In its report, the group pointed to the way modern technology threatened traditional values, and the ethical and moral problems it created. "The issue of taking care of human values in a technological society has become so great a problem that it should be given the same priority as research in advanced technological fields".[3] The conclusion was obvious. Norway needed an institute to study technology and human values. The remaining challenge was to obtain funding for such an institution.

It may seem a paradox that this suggestion, based on a sustained worry about the impact of modern science and technology, came from scientists and engineers in a period that saw the establishment of a modern innovation policy in Norway. More problematic was the fact that this group of concerned people was unable to link up with existing research communities with a thoroughly

[3]*Teknologi og menneskelige verdier. En rapport til Det Norske Videnskaps-Akademi*, Oslo 1985, p. 9.

critical view on new technologies, simply because there were no such communities.

Of course we may find critical discourses on technology in relation to the political radicalisation that took place in the late sixties and the seventies. In the writings of people related to the emerging ecological movement, the dominant "industrialism" was identified as a major concern and obstacle to a sustainable future. However, this meant that modern technology was analysed mainly as an outcome of capitalism or consumerism and not criticised as such. An influential book on regional development in Northern Norway by the sociologist Ottar Brox (1966) is a case in point. Brox criticised government policy because it led to centralisation and eroded traditional ways of life, for example by replacing small fishing boats with larger and more technologically advanced ships. Thus, the challenge was to establish an alternative policy that would support a more "appropriate" technology.

Also, Norway lacked (and lacks) a tradition of philosophy of technology.[4] One may argue that Arne Næss and a few others (e.g. Sigmund Kvaløy) in the development of an ecophilosophy during the 1970s implicitly constructed a critical philosophy of technology too (Næss 1976, Hofset & Vinje 1975, Kvaløy 1973). Næss was in particular concerned with man's place in a greater totality, and he demanded that engineers and other experts should develop a greater interest in and capacity to reflect on the practical implications of a concern for the wholeness of the natural world. Kvaløy came perhaps closer to a strict philosophy of technology in his criticism of modern technology for its support of the complicatedness of industrialism rather than the complexity of nature. However, both Næss and Kvaløy represented a critique of modern industrialisation rather than of modern technology. What characterize their approaches is above all the insistence on the necessity of political action. (Næss as well as Kvaløy participated actively in the protests against the construction of dams for new hydroelectric power stations.) Their views made considerable impact in the early environmental debates in Norway, but it is difficult to trace them in the later emergence of technology studies.

Of greater importance was the work of the sociologist Dag Østerberg. He developed an analysis of technology in which technology was studied as materialised social relations that interacted with human action without determining it (Østerberg 1974, Østerberg 1986). Østerberg worked from classical sociology which he combined with Sartre's ideas of a dialectic of humans and their social environment. Human action was perceived to be so-to-speak embedded in materiality and could not be understood without reference to this materiality. The result was a sociology of technology that insisted on the need for sociology to reflect upon the material nature of moderns societies. It was

[4]This argument is forwarded with a more detailed analysis by Dahl (1994) who provides the main source of inspiration for this section.

in principle open to the idea that technology was socially shaped, and it offered conceptual tools for the analysis of implications of modern technology to human action. Unfortunately, no sustained efforts were made to proceed with empirical analysis, neither by Østerberg nor other Norwegian sociologists.

However, Tom Johansen (1992) has taken Østerberg's ideas further, combining them with Pierre Bourdieu's concept of habitus. He is concerned with the impact on social organization of on the one hand the requirements of the local social community, and on the other hand, structural demands that provide an objective and impersonal environment. Johansen analyses the way material frames in an objective, impersonal manner shape human action through their demands, established technical knowledge and the production of rules that produce normative links between technology and action. Johansen argues that modern society leads to an increased dominance of structural demands. When modern humans believe themselves to be free and masterful, they overlook the fact that they act under a form of coercion emerging from the material surroundings.

Critical views on modern technology have also been voiced by the philosopher Ragnar Fjelland (1983, 1985). Fjelland's approach is closer to the international debate on autonomous technology (Winner 1977), but he was most concerned with the ability of modern science and technology to transform Nature and the human condition. Trond Berg Eriksen, a historian of ideas, has in several books acted as a spokesperson for some of the critique of technology found in international philosophy of technology and media studies (Eriksen 1987, 1990).

The conclusion remains that the critique of technology has not found any professional stronghold in Norwegian academic life, even if many intellectuals remain critical of many aspects of modern life. The main reason is probably that Norwegians, on the whole, are quite trustful. They believe the government and the experts to be able to control technology, as long as they are reminded that control is necessary. This is related to the long-term efforts in Norway to promote ideas of social planning and to develop applied social science research to support social planning. The development of technology studies in Norway has been decisively shaped by efforts to do research to provide a knowledge base for regulating modern technology.

There are two major fields of applied social science that are of particular interest here: technology and working life, and physical planning. The first of these fields has already been discussed and its implications analysed (see section 3). In the present context, one should note that the applied social science research into technology and working life in Norway displays a quite delicate balance between pessimistic concerns and an optimistic belief in the potential for improvements. The socio-technical school was based on a "principled optimism". After 1975, Norwegian working life research was much more influenced by critical discourses, in particular the post-Bravermanian and the feminist. Still, neither the autonomous technology view nor the strong deskilling thesis gained

a real foothold. In some sense, the parallel to the ecophilosophy view is striking. The main objective of a critical discourse is to stimulate action.

Applied social science research in the area of physical planning became more instrumental, and less influential. Institute for Transport Economics (*TØI*) was established in the late 1950s and became a major influence in highway planning and traffic engineering. The Norwegian Institute for Urban and Regional Research (*NIBR*), initiated in 1963, represented in some sense a more critical approach with its concern for the problems of regional development.[5] However, both institutes came primarily to work on short-term, practically defined problems originating from regional and national planning authorities, including ministries.

A related effort, more interesting from our point of view, was the research undertaken by the Norwegian Telecom to study the implications of new and old telecommunication technologies. In particular, they made a series of social experiments from the late 1970s and onwards, to explore videotext systems, electronic payment systems, cable television, etc. (see Mathiesen 1985, 1987, Mathiesen et al. 1991, Hetland 1994). Similar methodologies were also employed in experiments with telecottages (Hetland 1994). The main aim of the experiments was to evaluate market opportunities for the Norwegian Telecom, but they also provided important insights into the contingencies of technological development.

TØI and NIBR were established as parts of the Royal Norwegian Research Council for Science and Industrial Research (*NTNF*). NTNF's main interest was the funding of technological R&D to support the Norwegian industry. R&D to support public planning was a peripheral concern. In the 1970s, there was an increased political interest in applied social science research related to social planning. This resulted in the establishment of a research council for applied social sciences.

In the late 1970s, also NTNF decided to organize its social science activities in a different way and established a small programme on "Technology and society". This programme was meant to support a wide set of activities: organisation and working life, transport, and housing. In theory, the programme was based on the belief that applied social science could provide knowledge that was useful to industry, both to stimulate innovation as well as to improve the efficiency of diffusing and implementing new technologies. Thus, NTNF was enrolled in the belief that applied social science could be useful, even to industrial decision-making. This should have set the scene for a serious effort to establish a technology studies community in Norway.

[5]See Østby 1995 and Thomassen 1992.

5. Innovation policy takes command?

Internationally, the early 1980s saw the emergence of sustained efforts to develop and implement innovation policies in most OECD countries. The interest in innovation policy was motivated by the economic crisis and the belief in the growth potential of electronics and information technology. The result was the initiation of a lot of microelectronics and information technology programmes (Buland 1995). In the wake of these programmes came also a small trickle of money that critically contributed to the promotion of technology studies.

This pattern may also be observed in Norway, although it became established somewhat late here, compared to most other OECD countries. In 1985/1986 the Norwegian government finally launched an information technology programme. This signalled a shift in industrial policy, away from a regime based on demand management and support for particular industries to a regime based on innovation support (Buland 1995).

The shift was very important to the development of technology studies, although in a contradictory way. What happened was that the funding for social studies of technology and working life was cut severely. Instead, money became available to study innovation and how innovation might be promoted.

As suggested previously, there were several possible inroads to analyse innovation. Economic history came to approach innovation as a problem of technological history, informed by a post-Schumpeterian focus (see section 4). Working life researchers came to the field emphasising the work process of innovators, in most cases engineers, as well as organisational aspects, including participation. The issue was also approached from political science, economics, business administration, and geography (see e.g. Karlsen 1990).

In principle, the study of innovation as an activity linked to the engineering profession could draw upon two decades of research on Norwegian engineers. Again, Einar Thorsrud is a pioneering figure. Around 1960, he initiated several studies to analyse the situation of engineering students as well as engineers' working conditions (Thorsrud 1960, Holter 1961, Stemerding 1968, for an overview see Halgunset 1979). The emerging picture of the Norwegian engineer was of a professional with a paradoxical career. Young engineers were employed with technical work that they were overqualified to perform. Later, they became managers. This was a job they were -- at least formally -- underqualified to do (see Sørensen 1988).

Norwegian research on engineers during the 1960s and the 1970s thus painted a picture of a profession with little engagement in innovation. The emphasis is upon careers, lack of autonomy, and a problematic relationship between formal education and professional practice, in short a picture similar to the one found in the Anglo-American literature (see e.g. Ritti 1971). The research performed at the AHS centre in the 1980s picked up the idea of engineers as a profession of management and as salaried staff. They had gained power and

prestige, but only slight impact on practical technical work (Halvorsen 1993, 1994). Thus, engineers were of limited importance to innovation because they managed and because they lacked sufficient "industrial" qualifications. In addition, it was argued that new information technology like CAD represented a trend towards a deskilling of engineers and a threat to engineers' possibility to be creative (Finne 1982). On the other hand, as Halvorsen argues, the way engineers act in the shaping of organisation of Norwegian companies is important as a factor that so-to-speak shapes the way technology interacts with workers.

Nevertheless, the 1980s has arguably been a decade of definitive transformations of engineering work and of the profession of engineering, transformations that became highlighted through research on the performance of industrial innovation. While engineers lost out to MBAs as a managerial profession, technical work seemed to become much more demanding in terms of analytic skills and technological knowledge (Gjøen 1988, Levold 1990). Also, R&D work gained increased visibility if not independent organisational status (Tøssebro & Berg 1988, Levold 1990). However, lack of autonomy and sustained efforts to routinize innovation remained a problem in the sense that radical ideas met with a lot of managerial resistance in many Norwegian companies (Tøssebro 1985, Tøssebro & Berg 1988).

The concern for innovation as a strategy to regain economic growth meant that innovation research was situated in a more general concern to understand the nature of economic cycles. In Norway in the early 1980s, economic cycles became a unifying interests to the emerging community of technology studies, in spite of the fact that few projects directly addressed this issue. The analysis of so-called long waves was of particular interest. The idea of 30-40 year cycles in the economy, originally formulated by Kondratieff and adapted by Schumpeter, re-emerged on the international scene through the work of Chris Freeman et al. (1982), Gerhard Mensch (1979), Ernst Mandel (1980) and others. The intriguing problem generated was how the explain the swing from crisis to growth (Fagerlid 1982). While Mandel argued the importance of large "external" system-shocks like wars, the Freeman-Mensch controversy about the relative timing of "basic innovations" argued -- with Schumpeter -- that generic new technologies provided the basis for the turn upward in the economy. Even if one dismissed the quite determinist idea that the capitalist economy had to have a wave-like character, this debate supported the idea that it was important to study innovations and provided a structural framework for the discussion.

In many ways, innovation was a unifying and productive concept to the Norwegian technology studies community. Its political and strategical attractiveness was helpful in the efforts to fund new research. Still, it would be misleading to argue that innovation provided the basic inroad to technology studies. It became neither intellectually nor in terms of research funding of dominant importance. In fact, in the establishment and development of new institutions of technology studies during the late 1980s and the beginning of the

1990s, innovation gradually lost out as unifying concept. It was (and is) important, but only as one of several agendas. In fact, in spite of the political emphasis on innovation and change, the support available to research on these topics remained limited.

Probably, the best indication of this fact is the fate of the efforts to support research on technology and society, initiated by the industrial research council (NTNF).[6] Throughout the 1970s NTNF had given considerable support to applied social science. In December 1983, the council decided to establish a social science programme to make these efforts more visible and to increase the interaction between social sciences and technological R&D.

The programme committee initiated a prospective study to map out research needs in the area as a basis for formulating a research strategy. The document had the interaction of technology and society as its main perspective.[7] It started with the observation that new technology was of great importance to economic growth, but the main argument was one of reciprocal shaping of technology and society. The analysis was mainly of a structuralist kind, but it lead to the proposal of a wide spectrum of research tasks that should be addressed.

In 1986, shortly after the strategy document had been discussed, the programme was reorganised and renamed. It was now called "Technology and society". Its general task was "to stimulate research that may increase the insights in and the options for action related to development of technology and social change". In practice, the programme had to provide for long-term obligations related to research in transport, regional development, risk, and organisation and innovation. But the programme committee explored new options, including research on technology and everyday life.

Even if innovation was an attractive concept, and even if it was acknowledged that successful diffusion and implementation of new technology was dependent on organisational and cultural change, NTNF proved to be unable to cater to this kind of research. Managing the programme on "Technology and society" proved to be a frustrating exercise to the members of the committee. Without any real options to develop this kind of research, the committee resigned in 1990.

This does not mean that NTNF was unimportant to the development of technology studies. For example, they provided about half of the support for the Electronics History Project (see section 4) as well as grants for several innovation studies at different research institutes. Also, NTNF co-funded a programme on "Management and innovation in companies" 1990-92, a programme that

[6]The analysis of NTNF's activities is mainly based on Kvaal (1994).

[7]Committee for applied social science: "Utkast til perspektivanalyse", Oslo 1985.

supported a considerable effort to promote applied, company-oriented innovation research.[8]

In addition, NTNF gave birth to a centre for the study of innovation and economic policy. In the mid-1970s, NTNF established a research group to take care of technology policy and related issues, the *Gruppen for ressursstudier* (GRS). GRS performed a wide variety of studies on behalf of NTNF, covering quite different aspects of technology policy, regional issues, and industrial strategies (see e.g. Gulowsen & Veie 1987). However, it was closed down in 1990, to be -- temporarily -- replaced by a research programme called "*Fremtidsrettet teknologipolitikk*" (Future-Oriented Technology Policy Programme) in 1991, a programme that led to the establishment of the "Studies in technology, innovation and economic policy"-group (STEP-group).

The STEP-group, headed by economist Keith Smith, has become the most important research centre in Norway on economic analysis of innovation and technology policy. Their main approach is evolutionary economy (Smith 1992, 1994a), and the STEP-group has developed close links with similar communities in Europe, like SPRU and MERIT. Thus, this group has become the main research centre to carry forward an innovation concern related to macro-economic approaches. In particular, they have made important contributions to the empirical study of the level of R&D and innovative activities in different companies and industries, and the economic effects of such activities. They have also made great efforts to establish databases on R&D and innovation (see e.g. Nås & Riiser 1994, Nås, Sandven & Smith 1994, Smith 1994b). The STEP-group also perform advisory functions to several ministries and the Norwegian Research Council and thus fulfils some of the instrumental expectations of innovation studies.

The position of the STEP-group is partly an outcome of the fact that most economists at the University departments have shown little interest in the analysis of technology and innovation. However, some individuals do work in the area and, perhaps not surprising, most of them collaborate or have collaborated with the STEP-group on issues concerning technology, economic growth and international trade (see e.g. Fagerberg 1988a, 1988b, Klette 1990, Skonhoft 1992). At the University of Oslo there is also a small group of economic geographers interested in spatial aspects of innovation and patterns of industrialisation (see Asheim 1990, 1992, Haraldsen 1994).

Of the groups engaged in research on technology and working life, it was primarily IFIM that became engaged in innovation and innovation policy research. From 1987 it has hosted a quite large activity in these areas, partly in cooperation with Department of organisation and work science (ORAL) at the Norwegian institute of technology (see Finne 1993, Karlsen 1995). Main contributions from their work include the organisation of R&D and innovation

[8]NORAS-NTNF: *Ledelse og innovasjon i bedrifter. Sluttrapport*, Oslo 1993.

activity in companies (Tøssebro 1985, Tøssebro & Berg 1988), characteristics of spin-off processes (Tøssbro 1986, Brandth & Skaar 1991), innovation policy (Tøssebro & Buland 1987, Klev 1993), participation and organisation development (Ingebrigtsen 1994), and new technology transfer strategies (Levin 1993, Finne et al. 1993).

Compared to earlier work at IFIM, these efforts represent an interesting change in the conceptual relationship towards technology. During the socio-technical period, technology was mainly perceived as a frame of action, the effects of which could be modified by reorganisation (semi-autonomous groups, etc.). In the decade from 1975, technological change in companies was seen a challenge, even a threat, to workers. New technology did not represent any advantage, on the contrary it was often perceived a management tool. The task of researchers was to inform about the problems and to support trade unions to manage the challenges. In the recent period, the main challenge to IFIM researchers has become to support the development and transfer of new technologies. Still, workers' and trade unions' participation are highly valued and perceived as a potential resource. However, technology became conceptualised in a more positive fashion. It was mainly percieved as a positive element. These changes are not specific to IFIM. They are indicative of a more general transformation of Norwegian research on technology and everyday life, although there are other aspects to consider, too (see Finne 1990). For example, the work done on so-called Japanese production concepts has been very much concerned with the potential deterioration of the quality of working life inherent in "lean production", "just-in-time", etc. (Skorstad 1994, Nilssen & Skorstad 1994).

Studies on technology policy/innovation policy have originated also from other quarters. The Institute for Studies in Research and Higher Education has published mainly on science policy issues (see Skoie 1994 for an overview) and higher education, but also on public procurement policy (Søgnen 1984), R&D programmes and their implications (Brofoss 1993, Mathisen 1994), and on the organisation of R&D institutes (Mathisen 1989, Skoie & Ødegård 1990).

Of present interest, one should also mention policy analysis activities concerning science, technology and sustainable development at the Center for international climate and energy research (*CICERO*) in Oslo (e.g. Andresen et al. 1994) and at the Fridtjof Nansen Institute (*FNI*) in Oslo (e.g. Lunde 1991).

6. Institutionalization: Social shaping and ethical challenges

In 1988, two centres for technology studies were established in Norway. The Centre for technology and culture (TMV) in Oslo was started by the Norwegian Research Council for the Sciences and the Humanities (NAVF) and affiliated with the University of Oslo. This meant that the initiative of the Norwegian

Academy of Science to establish a research center to investigate the moral problems of modern science and technology finally had produced results.

It may seem strange that such moral concerns surfaced during a period of technological optimism and belief in the ability of innovations to produce economic growth. However, the optimism was not unfettered and concern for environmental problems and ethical challenges could be found in many quarters, including engineers and engineering students. The cultural and political climate of the 1980s was ambiguous.

The leading figure in the establishment and development of TMV was, not very surprising, professor Francis Sejersted. With him came a strong commitment to history of technology as a basic ingredient of the centre. However, TMV soon became the interdisciplinary group it was expected to be, with added emphasis on philosophy and politics of technology. Still, history of technology has remained dominant activity (see section 4).

The University of Trondheim, with the Norwegian Institute of Technology as its main pillar, took its own initiative to establish Centre for technology and society (STS). It granted the centre two positions that became filled by historian of technology Håkon With Andersen and sociologist of technology Knut H. Sørensen. The establishment of STS was based on activity in Trondheim to construct an interdisciplinary community for technology studies since the early 1980s. The contract research-based Institute for social research in industry (IFIM) was an important resource, but the emerging technology studies community also interested people from various parts of the university, in particular the departments of economics, history, and sociology. Thus, both TMV and STS could benefit from "a flying start".

Both centres also benefitted from the fact that several research programmes gave support to basic research in technology studies. Of particular importance was NAVF, later the Norwegian Research Council's (NFR's) programmes that supported social science research on technology, in particular information technology. This programme funded research at both centres, in addition to several other departments and institutes, among them AHS and IFIM. It proved particularly important to the development of a sociology of technology, but it also provided a general stimulus to the social sciences to address issues of technology through concepts like learning processes, tacit knowledge, gendering, negotiation processes, meaning and the production of symbols.[9]

Both centres had history of technology as an important activity and were linked through joint projects, in particular the Electronics History Project. Their profiles nevertheless became different. While STS from the start was a centre dominated by history and sociology, TMV combined history with philosophy and

[9]For details, see K H Sørensen, ed (1992): *Teknologi og samfunn - Informasjonsteknologi. Programmets virksomhet 1986-1992*, Oslo: NAVF.

history of ideas. STS began to develop a constructivist basis for its approaches, while TMV kept a stronger link to critical theory.

Internationally, a new interdisciplinary sociology of technology emerged during the latter half of the 1980s. Of particular importance was the collection edited by Bijker, Hughes & Pinch (1987) and Bruno Latour's launching of actor network theory in his *Science in action* (Latour 1987). This work was favourable received, in particular at STS, because it addressed some of their concerns: the debunking of technological determinism and the search for viable alternatives that could take the historical and social analysis of technology in new and exciting directions. This implied a principled move away from the analysis of technological impacts to the social shaping of technology (see the programmatic review essay Sørensen & Andersen 1988). The essay reviewed in addition to Bijker et al. and Latour, Cockburn (1985), Noble (1984) and Clark et al. (1985), from one point of view a quite diverse collection of books, but quite typical of the research interests at STS when the centre was established.

Consequently, to many Norwegian sociologists of technology it became important to study the processes "behind" the development of technology, to enter the laboratories, the universities, the R&D units, the design departments, etc. (see e.g. Sørensen 1987, Hatling 1989, Håpnes 1989, Levold 1990, Sørensen & Levold 1992, Sætnan 1991, 1995, Berg 1994a). Even if constructivism, in particular actor network theory, was accepted as an interesting point of departure, some re-translations (see Law 1995) were sought for. On the one hand, since Norway is a small country and imports most of its technology, there appeared to be serious limitiation to an approach that strongly priveleged "the laboratory" to other arenas. In addition, many felt uneasy with the perceived lack of ability of constructivism to handle properly problems of power, institutions, conflict, and stability (see also Law 1991).

At least four retranslations may be observed. First, a move to integrate a concern for institutions and institutionalisation -- the meso level -- in the analysis of technology (Sørensen & Levold 1992). Second, a move to integrate political processes and to extend the concept of a laboratory in order to be able to analyse the construction of a national information technology policy (Buland 1995), the way local governments in Norway appropriated computer technology (Brosveet 1995) or the construction and implementation of a policy of energy efficiency in the heating and ventilation industry (Hubak, Sørensen & Novakovic 1995).

The third re-translation was caused by the fact that Norwegian sociologists of technology retained an interest in the "impact problematic". They started around 1990 to formulate a constructivist programme to analyse "technology in use". A main effort related to the STS centre has been the study of the role of the modern car in Norway, the interrelationship between a national process of modernisation and the cultural appropriation of an imported artifact. In this interdisciplinary project of historians, sociologists, and social anthropologists, it was important to do away with the common understanding that made users of

technology appear as passive consumers who somnabulantly adapted to artefacts. To some extent, it proved meaningful to talk about the "Norwegian car" because the political institutions that regulated it, the cultural meaning of cars, and the practice of driving turned out to be shaped by Norwegian relations and traditions (see Sørensen 1991, Thomassen 1991, Hubak 1992, Stenøien 1992, Lamvik 1994, Sørensen 1994a, Østby 1995).

Thus, an interest in the field of technology and everyday life was conserved and developed (Sørensen & Berg 1991). Other studies included home computers (Aune 1992), hackers (Håpnes & Sørensen 1995), videotext (Berg & Håpnes 1992), children's use of technology (Vestby 1988, and energy conservation in households (Aune, Sørensen & Lysne 1995). A sustained criticism of the conception of users as passive (Berg & Aune 1994, Sørensen 1994b) was combined with theoretical inspiration from technosemiotic concepts from actor network theory (script, programme/anti-programme, etc., see Akrich 1992, Latour 1992) and cultural studies (Silverstone & Hirsch 1993). The result is an approach that describes the transformation of an artifact to a techno-social practice as the outcome of a process of *domestication* (Sørensen 1994b, Håpnes & Sørensen 1995).

The fourth re-translation is the feminist one. How may the otherwise attractive constructivist theories be employed to analyse the relationship between gender, technology, and science? The feminist concern has a relatively long history in Norwegian technology studies, emerging in particular from the work on technology and women's work at IFIM from 1978-1987 (see section 3 and Berg & Lie 1995). In accordance with the traditions of industrial sociology, the gender-technology relation was originally perceived as an impact relation: new technologies shaped and reshaped women's work, both the paid and the un-paid. The IFIM studies suggested however, that gender was a crucial factor in the design of some technologies, and in particular in the division of labour which proved to be so important to the "impacts" (Lie et al. 1987).

The feminists thus came to make the same move as the rest of the technology studies field in the late 1980s when they started to analyse the assumed gendered shaping of technology. Different approaches were used to study different fields. Kvande & Rasmussen's (1990) important study of female engineers argued that women tended to have somewhat different concerns that men in technological decisions. Sørensen's (1992) study of R&D scientists suggested that women tended to choose different problems and problemfields than men, but that male and female R&D scientists were socialised into the same value systems with regard to how research work should be performed. A study of female students in computer science showed that they felt alien to the dominant masculine culture in the field. They experienced to be marginalised and had different opinions of what was interesting with computers that most male students. Thus, computer science in Norway appeared to be a culture hostile to women, and in fact very few women chose to take this education compared to

most other disciplines in engineering and the sciences (Rasmussen & Håpnes 1991).

The feminist retranslation of constructivism is related to the other retranslations, in particular in its interest in power relations and in the issues arising from the analysis of practical and symbolic aspects of uses of technology. But it is above all an insistence that one should always look for gender in the analysis of technology because gender -- in some way -- tends to shape social relations, and thus -- by implication -- should be taken to do so with sociotechnical relations. One cannot assume that gender so-to-speak will reveal itself to the observer without some sensitivity to the importance of such relations (Berg & Lie 1995). On the other hand, the persistent anti-determinist quality of constructivism opens up interesting possibilities for studying the reciprocal shaping of gender and science/technology which would be of benefit also to the feminist project. Recent Norwegian efforts to exploit this potential is in particular inspired by the work of Donna Haraway (1989, 1991).

However, this new sociology of technology remained controversal in Norway. The main reason for this is its assumed unhelpfulness in the formulation and analysis of pressing moral and political issues of technology. The arguments are similar to those put forward by Langdon Winner (1993) who has been a frequent visitor to Norway. The counter-argument is that these problems are related to the constructivist practice rather than being inherent in the approach (see e.g. Berg & Lie 1995). Another issue is the strict dismissal of technological determinism by constructivism. While there is a general agreement that the traditional technological determinism (the "strong" version) represents a false view, it is maintained that one should retain a "weak" or "soft" version because technology tends to conserve certain action patterns. Technology does not make change impossible, but difficult (see Krogh 1994). Thus, there is a basic disagreement in Norway about the concept of technology and the conceptualisation of the relationship between the technical and the social.

This is also evident from other efforts to analyse the importance and meaning of information technology. A "soft" determinism may for example be found in the community of people working with communications and electronic media at the University of Oslo (Rasmussen & Søby 1993). A different set of approaches is found in the small community of people that work on issues like cognitive science and the impact of information technology on professional knowledge (Lahn 1995, Sinding-Larsen 1988, Kirkebøen 1993). It should be noticed that Lahn who works at the Work Research Institute (AFI) in Oslo, represents a link to sociotechnical theory which is a source of inspiration.

The sustained efforts by reseachers at the TMV centre to develop an ethically concerned approach to technology and modern life have sought inspiration from different quarters. They have drawn more explicitly on philosophical discourses, partly Habermasian critical theory, but also other approaches. While the TMV community have engaged in debates about

constructivism (see Sejersted & Moser 1992, Moser 1993), major efforts have been put into inquiries about the modern "suspension of ethics", of moral concerns versus market "realities" as the basis of evaluating the modern project, and the manageability of modern science and technology (Sejersted 1991, Nielsen 1995).

The ethical concerns are of a more general characters than an ethics of technology. In fact, these developments at TMV point out of technology studies in the sense that modern ethical problems are analysed as expressions of the modern strive for efficiency or the erosion of traditions. Kjetil Jacobsen's (1994) analysis of technocracy and politics in Norway 1917-1953 moves in the same direction. Technocratic ideas emerged from the engineering profession, but they became appriopriated in a wider Norwegian culture.

A different approach to the value problems of modern technology has emerged from a historical analysis of risk and risk management. A study of the Norwegian classification company "Det norske Veritas" (Andersen & Collett 1989) has been influential through its analysis of the development of a semi-private system of regulation of technology. A major point is the identification of institutions that exercise control over technology, not because they control research and design, but because they regulate implementations and uses. This observation has been integrated in a more general effort to produce an analysis of technology, environment, and values -- perhaps ironically -- strongly influenced by constructivism (Andersen & Sørensen 1992).

7. A Norwegian appropriation of technology studies?

When one compares the field of technology studies in Norway with technology studies in other West-European countries, a striking feature is the absence of technology assessment activities. Norway never got any public institution to take care of technology assessment and public debates about technology. It is not clear why the situation here in this respect is so different from that in for example Denmark or the Netherlands. However, it seems that Norwegian politicians mainly have believed that the information available from the technological and scientific expertise was a sufficient basis for decision-making, even if they did not always follow the advice given.

Still, some of the demand for technology studies has originated in the ministries. They have wanted information about e.g. the quality of working life, the level of innovation activity in different industries, or alternative transport systems. Thus, it is unclear how different the "demand structure" of Norwegian technology studies is, compared to other countries.

Another lacunae is the study of public technology controversies. Some work in this field could have been mentioned. For example, there are studies of controversies related to hydro-electic power and nuclear power-planning

(Andersen 1980, Andersen & Midttun 1985). Dahl (1993) has studied the impact of the environmental movement on technological change in the pulp and paper and the titanium dioxide industries, while Sætnan (1995) has analysed controversies regarding the use of obstetric ultrasound and mammography in general screening. Still, these are exceptions.

The problem of characterising Norwegian technology studies should perhaps be posed in a more positive manner: what are the strongholds? However, this is a problematic question because of the variety of relevant Norwegian research. One could mention gender and technology, technology and working life, technology and everyday life, innovation survey methodology -- all of them areas where Norwegian research present interesting contributions. I believe the really challenging question is whether there really is anything particularly Norwegian about our technology studies.

The history of the field may, from one perspective, be summarised by identifying four partially overlapping stages:

a. *The sociotechnical period* (1957-1970) which established a non-determinist, participation-oriented, and action-oriented programme of technology and working life.

b. *The critical period* (1970-1985) which saw the emergence of a critical view of new technologies, emphasising the role of trade unions, women, and new social movements as constituencies that should get in control of the development and implementation of technology.

c. *The innovation period* (1980-onwards) which gave rise to a more optimistic and instrumental view of technology as the basis of economic growth.

d. *The technology-and-culture period* (1985-onwards) which has promoted historical and sociological analyses of the interrelationship of technology and culture, partly of an optimistic kind, emphasising local options for action, partly pessimistic and concerned with ethical and environmental problems.

In all four periods, there have been important international inputs to Norwegian analyses. During the first, sociotechnical theory was transferred from Tavistock institute, even to the point of a transfer of researchers. The work of critical period was very much based on Anglo-American and German literature, while Norwegians in the innovation period was inspired from the UK and the US. The international impact on the fourth period is somewhat broader, but no less distinct. One could conclude from these observations that Norway, as a small country, practices a very open "academic economy"!

This conclusion is not particularly glossy and it is - at least slightly - misleading. Norwegian sociotechnical research was not quite the same as the work performed at Tavistock Institute, our blends of US, UK, German, and French industrial sociology was distinguishable - even from similar developments in Sweden and Denmark.

Some of the characterising qualities of technology studies in Norway is of externalist origin. The Scandinavian trust in public institutions, the relatively harmonic industrial relations, the belief in social planning, and the acceptance of a public industrial policy are important dimensions here. One could add to this list a belief in the virtue of participation and equality and an optimistic concern for the potential for human action. My interpretation of the impact of these dimensions is that Norwegian technology studies are:

- empirical rather than theoretical,
- pragmatic rather than principled,
- intending to be applicable, at least in the long term.

There is also considerable agreement about the importance of ethics, values, issues of equality (gender as well as social classes) and environmental issues. In fact, these are areas which probably will gain in importance.

However, this does not mean that the field of technology studies in Norway is or will be free from internal controversies. The productive disagreements found here will resemble the ones found internationally, for example about the strength of institutional arrangements, system versus action perspectives, and the role of the normative in the analysis of technology.

In fact, one could envision a Norwegian effort to find compromises here in order to develop a kind of "pragmatic" version of technology studies. From my point of view, I would expect that this "pragmatism" would involve a greater sensitivity to normative issues, to power and inequalities, and to the role of conflicts (see e.g. Berg & Lie 1995, Hård 1993). A somewhat different trajectory is suggested by developments within Norwegian history of technology where technology is perceived as integrated into efforts of studying modern history more generally. An interesting effort here is the large study of the development of the Norwegian "steel town" Mo i Rana which has been approached through a multitude of different issues (see e.g. Børresen 1995). Some are recognisable within a technology studies framework, others are not. A related effort, on a smaller scale in terms of resources, is Jon Gulowsen's work on industrial development in Northern Norway (Gulowsen 1992).

This points to the importance of the relationship between technology studies and the traditional discplines represented in the field. There should be no doubt that this relationship is strained, also in Norway. One obvious problem is that technology studies has not been institutionalised academically. This means that work within the field also should be recognisable as history, sociology, philosophy, etc. The strained relationship has some advantages. It supports a situation where the technology studies field continously has to be confronted with developments within the disciplines, and vice versa. This may enrich technology studies and allow the field to have impact on the disciplines.

On the other hand, one does of course run the risk that field of technology studies becomes squeezed or grinded by displinary concerns and conflicts over

resources. One should be aware of the fact that technology studies in Norway, despite its considerable growth in the last decade, is vulnerable.

References

Adler, P ed (1992): *Technology and the future of work*, New York: Oxford University Press

Akrich, M (1992): "The de-scription of technical objects", in W Bijker & J Law, eds: *Shaping technology/building society: Studies in socio-technical change*, Cambridge, MA: MIT press

Andersen, H W (1988): "Technological trajectories, cultural values and the labour process: The development of NC machinery in the Norwegian shipbuilding industry", *Social Studies of Science*, 18, 465-482

Andersen, H W (1989): *Fra det britiske til det amerikanske produksjonsideal*, Trondheim: Tapir forlag

Andersen, H W (1994a): "State, strategy, and electronics. Research in the political economy of post world war II Norway", *History and Technology*, 11, 145-164

Andersen, H W (1994b): "Mennesker, meninger og medlemmer. En skisse av nye muligheter for en kulturhistorie", i Andersen, H W et al., eds: *Clios tro tjener. Festskrift til Per Fuglum*, Trondheim: Department of history 1994

Andersen, H W & G Stang, eds (1984): *Historiske studier i teknologi og samfunn*, Trondheim: Tapir forlag

Andersen, H W & J P Collett (1989): *Anchor and balance. Det norske Veritas 1864-1989*, Oslo: Cappelen

Andersen, H W & K H Sørensen (1992): *Frankensteins dilemma. En bok om teknologi, miljø og verdier*, Oslo: Ad Notam Gyldendal

Andersen, S S (1980): "Conflict over new technology: The case of nuclear power planning in Norway 1972-74", *Acta Sociologica*, 23 (4), 297-310

Andersen, S S & A Midttun (1985): "Conflict and local mobilization: The Alta hydropower project", *Acta Sociologica*, 28 (4), 317-335

Andresen, S et al. (1994): *"Scientific" management of the environment? Science, politics and institutional design*, working paper 1994:4, Oslo: Center for international climate and energy research-CICERO

Asheim, B T (1990): "Innovation diffusion and small firms: between the agency of the lifeworld and the structure of systems", in N Alderman et al., eds: *Technological change in a spatial context*, Berlin: Springer Verlag

Asheim, B T (1992): "Flexible specialisation, industrial districts, and small firms: a critical reappraisal", in H Ernste, ed: *Regional development and contemporary industrial response: Extending flexible specialisation*, London: Belhaven Press

Aune, M (1992): *Datamaskina i hverdagslivet. En studie av brukeres domestisering av en ny teknologi*, STS report 15/92, Trondheim: Centre for technology and society

Aune, M, K H Sørensen & H Lysne (1992): "Energy concerns and the choice of dwelling", in A Persson, ed: *Sustainability and the reinvention of government.*

A challenge for energy efficiency, Proceeding of the 1995 ECEEE Summer Study, Stockholm: NUTEK

Berg, A-J (1994a): "A gendered socio-technical construction: The smart house", in C Cockburn & R Fürst-Dilic, eds: *Bringing technology home. Gender and technology in a changing Europe*, Buckingham: Open University Press

Berg, A-J (1994b): "Technological flexibility: Bringing gender into technology (or was it the other way round)?, in C Cockburn & R Fürst-Dilic, eds: *Bringing technology home. Gender and technology in a changing Europe*, Buckingham: Open University Press

Berg, A-J (in collaboration with T Håpnes) (1992): *Den tapte nysgjerrigheten - om tvilende Minitel-brukere*, report STF82 A92005, Trondheim: Institute for social research in industry

Berg, A-J & M Aune, eds. (1994): *Domestic Technology and Everyday Life - Mutual Shaping Processes*, COST A4 vol.1, Brussels: DGXII

Berg, A-J & M Lie (1995): "Feminism and Constructivism: Do Artifacts have Gender?", *Science, Technology and Human Values* 20 (3), 332-351

Bijker, W, T Hughes & T Pinch, eds (1987): *The social construction of technological systems*, Cambridge, MA: MIT press

Brandth, B & S Skaar (1992): *Knoppskyting - planlagt hagebruk eller tilfeldig frøspredning*, Trondheim: Institute for social research in industry

Braverman, H (1974): *Labor and monopoly capital*, New York: Monthly Review Press

Brofoss, K E (1993): *Innsatsområdene som forskningspolitisk virkemiddel*, Oslo: Institute for research and higher education

Brosveet, J (1995): *EDB inn i kommunene! Kommunedatatanken i aktørnettverksperspektiv*, Trondheim: Centre for technology and society

Brox, O (1966): *Hva skjer i Nord-Norge?*, Oslo: Pax

Bruland, K (1989): *British Technology & European Industrialisation: The Norwegian textile industry in the mid-nineteenth century*, Cambridge: Cambridge University Press

Bruland, K, ed (1991): *Technology Transfer and Scandinavian Industrialisation*, Oxford: Berg publishers

Buland, T (1995): *Den store planen. Norsk satsing på informasjonsteknologi 1987-1990*, Trondheim: Centre for technology and society

Børresen, A K (1995): *Drømmer av stål. A/S Norsk Jernverk fra 1940-årene til 1970-årene*, Department of history, Trondheim: University of Trondheim

Clark, K B et al., eds (1985): *The uneasy alliance. Managing the productivity dilemma*, Boston, MA: Harvard Business School Press

Cockburn, C (1985): *Machinery of dominance*, London: Pluto Press

Dahl, H (1984): *Teknikk-kultur-samfunn*, Oslo: Ingeniørforlaget

Dahl, T (1993): *Ordering nature. Environmentalism as a cultural phenomenon*, unpublished PhD-dissertation, Roskilde: University of Roskilde

Dahl, T (1994): "Teknikkfilosofi - mellom andsfravær og handlingslammelse", *STS working paper* 6/94, Trondheim: Centre for technology and society

Elden, M (1979): "Three generations of work-democracy experiments in Norway", i C L Cooper & E mumford, eds: *The quality of working life in Western and Eastern Europe*, London: Associated Business Press
Elden, M (1982): "Deltakerforskning. Om å arbeide med forandring gjennom forskning", *Tidsskrift for samfunnsforskning*, 23(5-6), 609-626
Elden, M et al. (1980): *Fagbevegelsen og EDB i prosessindustrien*, Trondheim/Oslo: Institute for social research in industry/Norwegian computing centre
Elden, M et al. (1982): *Good technology is not enough*, Trondheim: Institute for social research in industry
Elster, J (1983): *Explaining Technical Change*, Cambridge/Oslo: Cambridge University Press/Universitetsforlaget
Emery, F E & E Thorsrud (1969): *Form and content of industrial democracy*, London: Tavistock publications
Emery, F E & E Thorsrud (1976): *Democracy at work*, Leiden: Nijhoff
Eriksen, T B (1987): *Briste eller bære. Posthistoriske anfektelser*, Oslo: Scandinavian University Press
Eriksen, T B (1990): *Budbringerens overtak. Perspektiver på skriftkulturen*, Oslo: Scandinavian University Press
Fagerberg, J (1988a): "Why growth rates differ", in G Dosi et al.: *Technical change and economic theory*, London: Pinter
Fagerberg, J (1988b): "International competiveness", *Economic Journal*, 98 (391), 355-374
Fagerlid, O (1982): "En oversikt over marxistisk kriseteori", *Vardøger* 12, 15-85
Finne, H (1982): *Fra tegnebrett til terminal*, Trondheim: Institute for social research in industry
Finne, H, ed (1990): *Fra redskap til budskap*, Trondheim: Institute for social research in industry
Finne, H (1993): "Forskning om innovasjon og bedriftsutvikling ved IFIM og ORAL 1987-1993", working paper 2/93, Trondheim: Institute for social research in industry
Finne, H, M Levin & T Nilssen (1993): *Strategisk bedriftsutvikling på norsk*, Trondheim: Institute for social research in industry
Fjelland, R (1982): *Det teknologiske imperativ og teknologiens grenser*, Tromsø: Department of social sciences
Fjelland, R (1983): *Vitenskap som livssyn*, Oslo: Scandinavian University Press
Fossum, E, ed (1982): *EDB og arbeidsliv*, Oslo: Tanum-Nordli
Freeman, C, J Clark & L Soete (1982): *Unemployment and Technological Innovation. A Study of Long Waves and Economic Development*, London: Pinter
Friedman, A (1977): *Industry and labour*, London: Macmillan
Gjøen, H (1988): *Endelig på rett plass? Om endringer i norske sivilingeniørers yrkesgrunnlag*, STS report 5, Trondheim: Centre for technology and society
Gulowsen, J (1975): *Arbeidervilkår. Et tilbakeblikk på Samarbeidsprosjektet LO/NAF*, Oslo: Tanum
Gulowsen, J (1992): *Industri og samfunn i Nord-Norge*, Bodø: Nordlandsforskning

Gulowsen, J & E Veie (1987): *Bedriftsstrategier i 1980-årene*, Oslo: Gruppen for ressursstudier
Gustavsen, B (1992): *Dialogue and development*, Assen, Maastricht: Von Gorcum
Gustavsen, B & G Hunnius (1981): *New patterns of work reform*, Oslo: Scandinavian University Press
Halgunset, J, ed (1979): *Sivilingeniørers utdanning og yrke. 20 års forskning ved IFIM*, Trondheim: Institute for social research in industry
Halvorsen, T (1984): *Profesjonalisering - Taylorisering. Ingeniørar mellom leiing og arbeidarmotstand*, report no 9, Bergen: MORAL-prosjektet
Halvorsen, T (1993): *Profesjonalisering og profesjonspolitikk. Den sosiale konstruksjonen av tekniske yrker*, unpublished PhD-dissertation, University of Bergen
Halvorsen, T (1994): "Taylorismen i Norge. Ideologi og profesjonaliseringsstrategi", *Working paper* no 86, Oslo: Centre for technology and culture
Halvorsen, T, O Korsnes & R Sakslind (1988): "Arbeidspolitikk som forskningsprogram. Perspektiver og problemer", working paper 1988-5, Bergen: AHS
Hanisch, T J & E Lange (1985): *Vitenskap for industrien. NTH - En høyskole i utvikling gjennom 75 år*, Oslo: Scandinavian University Press
Hanisch, T J & E Lange (1986): *Veien til velstand*, Oslo: Scandinavian University Press
Haraldsen, T (1994): *Teknologi, økonomi og rom - en teoretisk analyse av relasjoner mellom industriell og territorielle endringsprosesser*, Lund: Lund University Press
Haraway, D (1989): *Primate visions: Gender, Race, and Nature in the World of Modern Science*, New York: Routledge
Haraway, D (1991): *Simians, Cyborgs, and Women. The Reinvention of Nature*, London: Free Associations Books
Hatling, M (1989): *Entreprenør eller leverandør? Om teknologiske FoU-institutt sine relasjoner til industribedrifter*, STS report 9/89, Trondheim: Centre for technology and society
Hetland, P (1994): *Exploring hybrid communities. Telecommunications on trial*, unpublished PhD-dissertation, Roskilde: University of Roskilde
Hofseth, P & A Vinje, eds (1975): *Økologi. Økofilosofi*, Oslo: Gyldendal
Holter, P A (1961): *Ingeniøren og hans stilling*, Trondheim: Institute for social research in industry
Hubak, M (1992): *Den forførende bilen - markedsføring som sosioteknisk handlingsfelt*, STS report 16/92, Trondheim: Centre for technology and society
Hubak, M, K H Sørensen & V Novakovic (1995): "Prices, punishment or pedagogics? How Norwegian energy-conservation policies affect heating and ventilation engineering", in A Persson, ed: *Sustainability and the reinvention of government. A challenge for energy efficiency*, Proceeding of the 1995 ECEEE Summer Study, Stockholm: NUTEK
Hughes, T P (1983): *Networks of power. Electrification in Western Societies 1880-1930*, Baltimore: The Johns Hopkins University Press

Håpnes, T (1989): *På sporet av en profesjon. Om framveksten av høyere EDB-utdanning i Norge*, STS report 10/89, Trondheim: Centre for technology and society

Håpnes, T & K H Sørensen (1995): "Competition and collaboration in male shaping of computing: a study of a Norwegian hacker culture", in K Grint & R Gill, eds: *The gender-technology relation: Contemporary theory and research*, London: Taylor & Francis

Hård, M (1993): "Beyond harmony and consensus: A social conflict approach to technology", *Science, technology, and human values*, 18 (4), 408-432

Ingebrigtsen, B (1994): *Samarbeid om omstillinger*, Trondheim: Institute for social research in industry

Jakobsen, K A (1994): *"Efter oss kommer overfloden". Teknokratisk moderniseringsideologi i norsk politikk og samfunnsvitenskap 1917-1953*, Oslo: Centre for technology and culture

Johansen, T (1992): *Kulissenes regi mellom ting og tekster*, Oslo: Scandinavian University Press

Jøssang, L G (1987): *Arbeidsprosessar og arbeidarpolitikk ved Stavanger Electro Staalverk A/S 1911-1940*, report 1987-2, Bergen: AHS

Karlsen, J I, ed (1990): *Technology transfer and innovation in mixed economies*, Trondheim

Karlsen, J I, ed (1995): *Omstilling eller bevaring? Det norske innovasjonssystemet*, Trondheim: Institute for social research in industry

Kern, H & M Schumann (1970): *Industriarbeit und Arbeiterbevusstsein*, Frankfurt aM: Europäische Verlagsanstalt

Klette, T J (1990): *Four essays on industrial policy under imperfect competition*, "Økonomiske doktoravhandlinger", Oslo: University of Oslo

Klev, R (1993): *The political construction of a technology transfer programme*, unpublished PhD-dissertation, Trondheim: Department of organisation and work science

Korsnes, O (1990): "On the social construction of the skilled industrial worker", working paper 1990-4, Bergen: AHS

Kvaal, S (1991): *Drømmen om det moderne Norge. Automasjon som visjon og virkelighet i etterkrigstiden*, STS report 13/91, Trondheim: Centre for technology and society

Kvaal, S (1994): "Teknologi og samfunn-forskning - Et stebarn i NTNF- familien? Komité for samfunnsforskning og Komité for teknologi og samfunn", *STS working paper* 5/94, Trondheim: Centre for technology and society

Kvaløy, S (1973.): *Økokrise, natur og menneske. En innføring i økofilosofi og økopolitikk*, Oslo: snm

Kvande, E (1982): *Kvinner og høgre teknisk utdanning. Rekruttering og rekrutteringstiltak*, Trondheim: Institute for social research in industry

Kvande, E (1984): *Integrert eller utdefinert? Om kvinnelige NTH-studenters studiesituasjon og framtidsplaner*, Trondheim: Institute for social research in industry

Kvande, E & B Rasmussen (1990): *Nye kvinneliv: Kvinner i menns organisasjoner*, Oslo: Ad Notam

Lahn, L C (1995): *Yrkeskompetanse i støpeskjeen: en eksplorerende analyse av handlingsregulering og ny teknologi i ingeniørmiljøer*, Oslo: Work research institute

Lamvik, G (1994): *Et eventyr på hjul. Et antropologisk blikk på amcar-kulturen*, STS report 21/94, Trondheim 1994

Lange, E, ed (1989): *Teknologi i virksomhet. Verkstedindustri i Norge etter 1840*, Oslo: Ad Notam

Latour, B (1987): *Science in action*, London: Open University Press

Latour, B (1992): "Where are the missing masses? The sociology of a few mundane artifacts" in W Bijker & J Law, eds: *Shaping technology/building society: Studies in socio-technical change*, Cambridge, MA: MIT press

Law, J (1991): "Introduction: monsters, machines and sociotechnical relations", in J Law, ed: *A sociology of monsters. Essays on power, technology and domination*, London: Routledge

Law, J (1995): "Traduction/trahison: Notes on ANT", paper presented at the NECSST/EASST workshop on 'Social thepry and social studies of science", Bielefeld, May 9-13

Levin, M (1981): *Fagforeningers handlingsressurser*, Trondheim: Institute for social research in industry

Levin, M (1993): Technology-transfer as a learning and developmental process - An analysis of Norwegian programs on technology-transfer", *Technovation*, 13 (8), 497-518

Levold, N (1990): "Ingeniørarbeidet - bransjeskapt eller lokalt konstruert?", *STS working paper* 13/90, Trondheim: Centre for technology and society

Lie, M & B Rasmussen (1983): *Kan "kontordamene" automatiseres?*, Trondheim: Institute for social research in industry

Lie, M (1985): *Fjernarbeid - vegen til det gode liv?*, Trondheim: Institute for social research in industry

Lie, M et al. (1987): *I menns bilde. Kvinner-Teknologi-Arbeid*, Trondheim: Tapir

Lunde, L (1991): *Science or politics in the global greenhouse? A study of the development towards scientific consensus on climate change*, report 1991/8, Oslo: The Fridtjof Nansen Institute & Center for Economic Analysis

Mandel, E (1980): *Long waves of capitalist development. The marxist interpretation*, Cambridge: Cambridge University Press

Mathiesen, K O (1985): "Mellom forskning og praksis: Forsøk med telematikk", *Sosiologi i dag*, no 2, 55-71

Mathiesen, K O (1987): "Field trials: What's the use?", in L Qvortrup et al., eds: *Social experiments with information technology and the challenges of innovation*, Dordrecht: Reidel

Mathiesen, K O et al., eds (1991): *Nye nettverk. Telekommunikasjon i samfunnet*, Oslo: Gyldendal

Mathisen, W C (1989): *Mellom akademia og marked. Styring av forskning i instituttsektoren*, Oslo: Institute for research and higher education

Mathisen, W C (1994): *Universitetsforskeres problemvalg - akademisk autonomi og styring gjennom forskningsprogrammer*, Oslo: Institute for research and higher education

Maurice, M, A Sorge & M Warner (1980): "Societal differences in organizing manufacturing units: A comparison of France, West Germany, and Great Britain", *Organisation Studies*, 1 (1), 59-86.
Mendner, J (1975): *Technologische Entwicklung und Arbeitsprozess*, Franfurt aM: Fischer
Mensch, G (1979): *Stalemate in technology*, Cambridge, MA: Ballinger
Michelsen, S (1989): *Oljeindustri og petroleumsingeniører. Relasjoner mellom arbeid og utdanning i Rogaland 1971-1982*, report 1989-2, Bergen: AHS
Moser, I (1993): *Teknologi i samfunnsteori: Forskyvninger og forflytninger*, TMV report 4, Oslo: Centre for technology and culture
Moxnes, P (1981): "Hvordan gikk det med samarbeidsprosjektet LO/NAF?", *Tidsskrift for samfunnsforskning*, 22 (4)
Negt, O (1968): *Soziologische Phantasie und exemplarisches Lernen*, Frankfurt
Nelson, R R & S Winter (1982): *An Evolutionary Theory of Economic Change*, Cambridge, MA: Belknap/Harvard University Press
Nerheim, G (1983): *Gassflamme og lysbue*, Oslo: Scandinavian University Press ?
Nerheim, G & H W Nordvik (1986): *Ikke bare maskiner. Historien om IBM i Norge 1935-1985*, Oslo: Scandinavian University Press
Nielsen, T H, ed (1995): *Tidens verdier. Variasjoner over moral og samfunn*, Oslo: Scandinavian University Press
Nilssen, T & E Skorstad (1994): *Just-in-time - en produksjonsform for norsk industri?*, Trondheim: Tapir
Noble, D (1979): "Social choice in machine design: The case of automatically controlled machine tools", in A Zimbalist, ed: *Case studies on the labor process*, New York: Monthly Review Press
Noble, D (1984): *Forces of production*, New York: Knoph
Nord, E (1983): *EDB og sysselsetting*, Oslo: Norwegian computing centre
Nygaard, Kristen (1980): "Oppbygging av kunnskaper i fagbevegelsen", in J H Bjørnstad & T Bjaaland, eds: *Arbeidsmiljø og demokratisering*, Oslo: Tiden
Nylehn, B & E Skorstad (1982): "Teknologi og organisasjon", *Tidsskrift for samfunnsforskning*, 23 (5-6), 499-518
Næss, A (1976): *Økologi, samfunn og livsstil*, Oslo: Scandinavian University Press
Olsen, O J (1984): *Makt og motstand. En studie av bedriftsorganisasjon og fagorganisasjon ved Eidanger Salpeterfabriker 1945-1970*, Bergen: MORAL-prosjektet
Nås, S O & V Riiser (1994): "FoU i norsk næringsliv 1985-1991", *STEP report* 2/94, Oslo: STEP
Nås, S O, T Sandven & K Smith (1994): "Innovasjon og ny teknologi i norsk industri: En oversikt", *STEP report* 4/94, Oslo: STEP
Rasmussen, B (1984): *Fagarbeid og ny teknologi. Innføring av NC-maskiner i verkstedindustrien*, Trondheim: Institute for social research in industry
Rasmussen, B & H Finne (1982): *Et spørsmål om miljø. Fagforeningsopplæring i miljøarbeid*, Trondheim: Institute for social research in industry
Rasmussen, B, K H Sørensen & T Nilssen (1990): "Ny teknologi og arbeidsmiljø: Hva betyr medvirkning?", in D Bunnage et al.: *Ny teknologi, arbejdsorganisation og arbejdsmiljø. Et nordisk perspektiv*, Copenhagen

Rasmussen, B & T Håpnes: "Excluding women from the technologies of the future?", *Futures* 10 (December), 1107-1119
Ritti, R R (1971): *The engineer in the industrial corporation*, New York: Columbia University Press
Rose, M (1985): "Universalism, culturalism and the Aix group: promise and problems of a societal approach to economic institutions", *European Sociological Review*, 1 (1), 65-83.
Rosenberg, N (1976): *Perspectives on Technology*, Cambridge: Cambridge University Press
Rosenberg, N (1982): *Inside the Black Box*, Cambridge: Cambridge University Press
Sakslind, R (1990): "Flexible technology and social relations in industry. Adaptation to NC-technology in Norwegian mechanical-engineering enterprises", working paper 1990-3, Bergen: AHS
Sejersted, F ed. (1982): *Vekst gjennom krise*, Oslo: Scandinavian University Press
Sejersted, F (1984): "Rutine eller valg? Om ulike forutsetningers konsekvenser for teorier om teknologisk endring", Working paper no 2, Oslo/Trondheim: Teknologihistorieprosjektet
Sejersted, F (1987): "Social Science and the History of Technology in Norway", Working paper no 30, Oslo/Trondheim: Teknologihistorieprosjektet
Sejersted, F (1991): *Teknologi og kultur*, Oslo: Centre for technology and culture
Sejersted, F (1993): *Demokratisk kapitalisme*, Oslo: Scandinavian University Press
Sejersted, F & I Moser, eds (1992): *Humanistic perspectives on technology, development and environment*, TMV report no 3, Oslo: Centre for technology and culture
Silverstone, R & E Hirsch, eds (1992): *Consuming technologies. Media and information in domestic spaces*, London: Routledge
Sinding-Larsen, H (1988): *Artificial language and language: old questions in a new key*, CompLex 7/88, Oslo: TANO
Skoie, H (1994): *Science policy studies in Norway*, Oslo: Institute for research and higher education
Skoie, H & E Ødegaard, eds (1990): *De teknisk-industrielle forskningsinstitutter i 1990-årene*, Oslo: Institute for research and higher education
Skorstad, E (1993): *Fra menneske til maskin. Teknologisk utvikling og endringer i arbeidsvilkår*, Oslo: Ad Notam Gyldendal
Skorstad, E (1994): "Lean production, conditions of work and worker commitment", *Economic and industrial democracy*, 15 (4), 429-455
Smith, K (1992): "The future of science and technology policy", working paper 1/92, Oslo: Innovation studies group
Smith, K (1994a): "New directions in research and technology policy: Identifying the key issues", report 1/94, Oslo: STEP-group
Smith, K (1994b): "Interactions in knowledge systems: Foundations, policy implications and empircal methods", *STEP report* 10/94, Oslo: STEP
Skonhoft, A (1993): "Catching up and falling behind, a vintage model approach", working paper 18/92, Oslo: Innovation studies group
Skorstad, E (1993): *Fra menneske til maskin. Teknologisk utvikling og endring i arbeidsvilkår*, Oslo: Ad Notam Gyldendal

Staudenmaier, J M (1985): *Technology's storytellers. Reweaving the Human Fabric*, Cambridge, MA: MIT press

Stemerding, A (1968): *The careers of engineers*, Trondheim: Institute for social research in industry

Stenøien. J (1992): *Å fare eller frykte. Et regimeskifte i trafikksikkerhetsdiskursen*, STS report 18/92, Trondheim: Centre for technology and society

Sætnan, A R (1991): "Rigid politics and flexible politics: The anatomy of a failed hospital innovation", *Science, Technology, and Human Values*, 16 (4), 419-447

Sætnan, A R (1995): *Just what the doctor ordered? A study of medical technology innovation processes*; STS report 25, Trondheim: Centre for technology and society

Søgnen, R (1984): *Offentlege innkjøp som industripolitikk*, Oslo: Institute for research and higher education

Sørensen, B Aa (1980): "Handlingsorientert aksjonsforskning", in J H Bjørnstad & T Bjaaland, eds: *Arbeidsmiljø og demokratisering*, Oslo: Tiden

Sørensen, K H (1984a): "Arbeidsmiljølovgivningen og kampen om arbeidsforholdene i Norge - et historisk riss", *Vardøger* no 15, 26-79

Sørensen, K H (1984b): "Forskning for fagbevegelsen? Om vilkårene for arbeidsforskning i Norge", *Vardøger* no 15, 106-140

Sørensen, K H (1987): "Deciding technology", *STS working paper* 1/87, Trondheim: Centre for technology and society

Sørensen, K H (1988): "Sivilingeniørers utdanningssystem og karrieremønster: En norsk modell?", *STS working paper* 11/88, Trondheim: Centre for technology and society

Sørensen, K H (1991): "The Norwegian car. The cultural adaption and integration of an imported artefact", in Sørensen & Berg.

Sørensen, K H (1992): "Towards a feminized technology? Gendered values in the construction of technology", *Social studies of science*, 22 (1), 5-31

Sørensen, K H, ed (1994a): *The car and its environments. The past, present, and future of the motorcar in Europe*, COST A4 vol 3, Brüssel: DG XII

Sørensen, K H (1994a): "Technology in use. Two essays on the domestication of artifacts", *STS working papers* 2/94, Trondheim: Centre for technology and society

Sørensen, K H & H W Andersen (1988): "Teknologi - fra konsekvensskapende til samfunnsskapt", *Sosiologi i dag*, no 3, 81-99

Sørensen, K H & A-J Berg, eds (1991): *Technology and everyday life: Trajectories and transformations*, report no 5, Oslo: NAVF-NORAS-NTNF

Sørensen, K H & N Levold (1992): "Tacit networks, heterogeneous engineers, and embodied technology", *Science, Technology & Human Values*, 17 (1), 13-35

Thomassen, Ø (1991): *Bil i by. Trafikkplanlegging i Trondheim i 1960-åra*, STS report 14/91, Trondheim: Centre for technology and society

Thomassen, Ø (1992): "Forskning for fysisk planlegging. Ein reiskap i reisinga av det moderne Norge", *STS working paper* 7/92, Trondheim: Centre for technology and society

Thomassen, Ø (1994): "Teknologiryttere og andre cowboyer. Norsk teknologihistorisk forskning 1970-1995", *STS working paper 14/94*, Trondheim: Centre for technology and society

Thorsrud, E (1960): *Studie- og undervisningsforhold ved Norges Tekniske Høgskole*, Trondheim: Institute for social research in industry

Tøssebro, J (1985): *Om tekniske innovasjoner. Organisasjons- og ledelsesaspekter*, Trondheim: Institute for social research in industry

Tøssebro, J (1986): *Om knoppskytning fra teknologiske miljø*, Trondheim: Institute for social research in industry

Tøssebro, J & Berg A-J (1988): *Innovasjonsvirksomhet: Organisering av teknisk FoU-arbeid*, Trondheim: Institute for social research in industry

Tøssebro, J & T Buland (1987): *Informasjonsteknologi og innovasjonspolitikk. Om valg og utforming av hovedinnsatsområdet informasjonsteknologi*, Trondheim: Institute for social research in industry

Vestby, G (1994): "Constructing childhood: Children interacting with Technology", in Berg & Aune

Wicken, O (1994): *Elektronikkentreprenørene. Studier av norsk elektronikkforskning og -industri etter 1945*, Oslo: Ad Notam Gyldendal

Winner, L (1977): *Autonomous technology. Technics-out-of-control as a theme in political thought*, Cambridge, MA: MIT press

Winner, L (1993): "Upon opening the black box and finding it empty: Social constructivism and the philosophy of technology", *Science, technology & human values*, 18 (3), 362-361

Østby, P (1995): *Flukten fra Detroit. Bilens integrasjon i det norske samfunnet*, Trondheim: Senter for teknologi og samfunn

Østerberg, D (1974): *Makt og materiell*, Oslo: Pax

Østerberg, D (1986): *Fortolkende sosiologi*, Oslo: Scandinavian University Press