senter for teknologi og samfunn

STS

Knut Holtan Sørensen

Providing, Pushing, Policing and Participating. Towards a New Architecture of Technology Policy.

STS-working paper 7/01

ISSN 0802-3573-178

arbeidsnotat
working paper

senter for teknologi og samfunn
institutt for tverrfaglige kulturstudier
norges teknisk-naturvitenskapelige universitet
7491 trondheim
tlf: +47 73 59 17 88 / fax: +47 73 59 15 27

norwegian university of science and technology
department of interdisciplinary studies of culture
centre for technology and society
n-7491 trondheim, norway

Providing, Pushing, Policing and Participating. Towards a New Architecture of Technology Policy[1]

Knut H. Sørensen

Abstract

The paper analyses the performance of technology policy in the transport sector and its potential for reforming the modern practice of mobility, above all with respect to issues of sustainability. It starts out by a brief critical review of technology policy studies, observing that the main bulk of this research literature is too narrowly focussed on innovation. The paper then presents four case-studies of technology policy in transport, made as part of the European research project Intepol. On the basis of these cases, the argument is made that one needs to change the architecture of technology policy. In particular, it is important that technological and social options are better integrated and that the scope of technology policy is broadened to include issues of infrastructure, regulation and participation.

Technology Policy Discourses - An Overview

As an academic discourse, technology policy studies are a recent phenomenon. There is an older practice, of course, since governments have been engaged in technology for centuries. One of the problems we face when we try to map the academic interest is the important overlap with science policy. J. D. Bernal's seminal work, "The social function of science" from 1939, describes many concerns that are shared between science and technology policy. The ideology of Big Science, which came after the war, represented an effort to link science and technology policy concerns through the framework of what later came to be called the linear model of innovation. This framework implies a differentiation between basic science, applied science, development and marketing of new technology, and the assumption that new technologies emerged along the route from basic via applied science through development. Thus, the interest in new technologies was translated into a need to invest in basic and applied science.[2]

Work performed through OECD slowly came to transform this ideology and to provide a framework to distinguish between science policy and technology policy. This move started from the argument that research and development, R&D, a term that covered both science and technology, played a critical role in the economic growth of modern societies. However, since Big Science did not unambiguously deliver, it was seen as necessary also to provide support for

development and dissemination of technology. These arguments formed the basis of later recommendations to member countries to establish innovation policies to promote economic growth. The promotion of economic growth has remained the *sine qua non* of technology policy, even if it has included other political aims as well.[3]

Thus, technology policy as an intellectual concern may be seen as an off-spring from the development of science policy studies to cater for the increasing interest in the economic results of investments in R&D.[4] This has produced a rather narrow focus on the interaction of science and technology and on the economics of innovation, which needs to be superseded.

There are substantial challenges in the exploration of technology policy as an academic as well as a practical activity. These challenges are related to the ambiguous nature of technology as a policy object. First, since policy main is focussed on sectors, it is difficult to observe the practice of technology policy because it will be integrated in sector policies. Most public sectors have no tradition for making technology into an explicit policy concern. Second, development of technology is often perceived as something that should be left on its own to produce good results. Acts of regulation or support should be general in nature and be directed at the application, rather than design or implementation. Third, the idea of social management of technology represents a temptation to make suggestions that invoke problematic notions of masterminding the common good, which have to be resisted. Thus, to conceptualise technology policy in transport is no small task.

Policy analysis in general is a well-established academic discipline. However, there is little explicit concern with technology. What we find in standard textbooks is basically an eclectic mix of macro/micro economics for problem definition and a strong case-orientation on the problem in question.[5] The main goal is to support decision-making intent on optimising the allocation of resources, usually by way of supporting an efficient market. Thus, market failures are a central concern of policy analysis.

Another important aspect of policy analysis is its applied orientation and focus on providing recommendations to policy-makers. Thus, there is a strong normative aspect. The applied focus is supported by the dominant interest in case studies where one explores concrete real-life problems to evaluate the relative efficiency of available policy instruments, instruments dominantly perceived to be of either a financial or legal nature. In the policy analysis discourse, technology is not a policy instrument. It is regarded as a tool that actors may use in order to respond properly to a policy instrument. Thus, in the policy analysis discourse, technology is not a proper object of policy in itself. However, indirectly, it may be a wished-for response from actors supposed to respond to policy measures, for example so-called green taxes.

In the literature on the economics of innovation, which is the most important body of research to be concerned with technology policy, the main interest is to provide insights in the way technological innovation and diffusion may be supported. It covers the details of the innovation process as well as the

relative importance of different aspects of social organisation of companies and sectors. Important insights provided by the literature include concepts like learning economy, the interactive model of innovation and innovation systems.[6] However, this framework is not sufficient for our purposes, above all because innovation is the only main focus. Thus, very important activities related to the development of infrastructure and regulation of technology are placed backstage or even made invisible. Thus, when one surveys the literature on technology policy, the main impression may be summarised briefly in the following manner:

- Technology policy, as an academic field, is very diverse along several dimensions, including theoretical and methodological approaches, sectors and technologies covered, and assumed audiences. This makes the literature difficult to summarise in a compact manner.
- Academic studies of technology policy are generally descriptive in their orientation, and the field appears to be rather under-theorised. On the other hand, technology policy studies are intersected by other research on technology, including innovation studies, evolutionary economics, history of technology, and social shaping of technology research. These approaches provide a much-needed impetus to conceptualise technology policy.
- The literature that explicitly addresses technology policy is not large, and most of it is concerned with technology policy as innovation policy or research & technology policy. Also, frequently, science policy and technology policy are discussed as two sides of the same coin. It is in fact quite common that studies that claim to analyse technology policy have limited themselves to study R&D or innovation programmes, programmes to stimulate innovation in SMEs, and similar topics. This bias is particularly striking when one is concerned with a sector like transport, where the major issues is much closer linked to concerns about the shaping and building of infrastructure and the regulation of transport in modern society.
- We also need to note that technology policy studies seem to be left nearly untouched by mainstream work in political science and policy analysis.

These observations indicate that the definition of technology policy is not a trivial matter, mainly because of the problem of scope: what objects are supposed to be managed? From our perspective, we need a broader understanding than the one provided through the common tendency to reduce technology policy to innovation policy. Innovation is of course important, but we also need to consider issues related to infrastructure and regulation. In addition, there is an important democratic agenda to pursue, related to issues like public participation and the role of experts. Thus, as a first approximation, we will define technology policy as an activity that covers the following four broad sets of socio-political concerns:

- stimulation of innovation (economic growth),
- construction of infrastructure
- regulation (protection and standards)
- democracy and public participation.

These concerns challenge public as well as private actors, though the main focus of the chapter is with public actors. Technology policy may be seen, we will argue, as basically implemented through public institutions (including the legal system), but also by influencing private actors through other means. But also private actors contribute, for example through the setting of standards or by their efforts to influence public policy.

The rationale behind this definition is that, historically, public technology policy has emerged from two sets of concerns:

- The development of a national infrastructure of communications, energy supply, and knowledge.
- The need to set up requirements and to supervise industry in order to protect the general public from dangerous technology, e.g. workers' protection legislation and steam boiler regulations.

Public agencies have been established in order to cater such concerns: on the one hand, PTTs, railroad boards, roads and highway authorities, and electricity boards, on the other, workers' protection agencies, steam boiler control boards, and environmental protection agencies could be mentioned as a few examples. Thus, there emerged a regime where a "mercantilist" concern to secure national preconditions for economic development coincided with a social state concern "to keep technology straight". We will call this *the regime of technological systems policy* because its main objective is to build and control technology, not to invent or innovate. The "mercantilist" concern has substantially been held in check by trade agreements, but these agreements have tended to leave space for protection of new technologies. Arguably, this regime dominates until 1980-85 when *the regime of research and technology policy* began to unfold. It is in this period that technology policy is explicitly and systematically linked to a concern for economic growth where new technologies are seen as precondition for such growth.

In the regime of technological systems policy, the main instruments are large-scale construction projects (e.g. building highways, constructing railways, or making telephone or radio systems) and legal systems for standards and requirements related to specific technologies and/or specific applications. There is a role for knowledge-producing institutions like laboratories and universities, but this is mainly related to their assumed ability to make discoveries and inventions available. With the possible exception of prestigious, large-scale demonstration projects, new technologies are supposed to emerge in response to market needs. This does not mean that technology policy is demand-oriented - in fact, during this regime policy is not really concerned with demand at all. Basically, it is concerned with the management of supply and regulation of supply conditions.

During the regime of research and technology policy, we see that demand-orientation becomes much more important. Development of technology is supposed to be inspired and controlled by demand interests voiced by market actors, and technology policy develops tools to safeguard such links. However, ironically, the policy instruments are used to support the supply side, the

developers of technology, rather than helping the demand side, the users, to formulate and develop their needs and requirements.

This irony is related to the way the user-producer relationship has been configured in technology policy discourses as an expression of liberal economic ideology. The user is primarily a customer whose needs *should be* taken into consideration (and preferably be predicted). However, the role is a passive one, mainly centred on the decision to appropriate/buy or not. The active part is mainly attributed to the producer, who in order to make a sell, needs to inquire about the users' needs and work to satisfy them. Thus, the user is constructed as a passively demanding object, a source of information that has to be explored, but above all a candidate to be persuaded that the producer has the better ideas. The relationship is definitely configured in an asymmetrical manner, which makes open-minded interactions between "supply side" and "demand side" concerns difficult.

Technology Policy from an STS Perspective

Recently, efforts have been made to use insights from science and technology studies (STS) to guide technology policy. There are several advantages to be gained. First and foremost, the understanding that technology is socially shaped also facilitates the identification of the series of decision-making that usually is related to the design and implementation of new technologies. Thus, new technologies may be supported in a more sustained fashion. Second and related, science and technology studies extend the space of technological development to include the use and regulation of innovation. This implies an extension of technology policy as well. Third, insights from science and technology studies allow more realistic evaluations of potentials of new technologies, including the need to combine technological and social strategies in order to achieve particular aims.[7]

The main weakness of traditional technology policy discourses is that they tend to produce arguments that reflect technological determinist assumptions. The innovation discourse of evolutionary economics is of course an exception, but this approach has - from our point of view - other limitations. Most important is the neglect of infrastructure and regulation concerns, but the focus of innovation studies is also too much upon new technologies. Also, it tends to neglect the importance of culture. It is on this basis that we argue that one should turn to STS as a different source of inspiration to reformulate and improve the understanding of technology policy.[8]

It should be noted, though, that the "translation" from STS to technology policy is not straightforward. Technology policy (and for that matter, science policy) were never a STS favourite. The main reason is probably that STS research has been very much artefact-centred. This focus tends to bring policy issues backstage because usually policy is more broadly oriented. To a large extent, technology policy studies and STS have moved along different

trajectories. The results of STS research outlines the micro dynamics of technological R&D, while technology policy studies have been much more concerned with structural processes and systemic properties of R&D and innovation.

Arguably, technology policy studies have been under-theorised and have lacked good concepts that allow the analysis of the shaping of policy as well as the transformation and non-transformation of policy into practice. STS-studies, on the other hand, have been characterised by a bias that probably overestimates the ability of scientists and engineers to influence policy processes. Some recent work suggest interesting ways of overcoming the divide, see e.g. Latour's study of the failed transport system ARAMIS.[9] In fact, there is no reason not to include policy localities into the STS type of analysis, using concepts emerging from STS contributions.[10]

One obvious point of departure is to note that much of technology policy efforts have reflected the so-called linear model of innovation. This implies a rather naive supply-side focus with emphasis on R&D and the diffusion of R&D results as the main features. Technology policy has often failed for this reason. It has been too focussed on R&D and reflecting too strong a belief in the ability of R&D to provide change. We could call this the autonomy fallacy, because it is related to the belief that technology will provide impacts when left on its own. To many politicians, new technology is so potent that impacts will emerge, independently of human action. This observation is of course due to a strange way of not seeing human action in new technology projects, which forms the basis of the widespread belief in technological determinism.

The social shaping of technology perspective has developed as a major source of criticism of traditional technology policy. The conceptualisation of this perspective has been a major effort of new European initiatives in the establishment of social studies of technology.[11] In many ways, it is inclusive and rather flexible.[12] Social shaping has been used as a methodological starting-point, in opposition to approaches that, either explicitly or implicitly, adhere to the notion of "technological determinism". The latter conceives technological development as relatively independent of its socio-economic context, while the same development is supposed to circumscribe and direct social change. Social change thus becomes a forced outcome of a given technological development, a view seriously limiting options for change by giving priority and legitimacy to the visions produced by the involved technological constituencies. From the position of technological determinism, it is not so important to identify possibilities to guide technological development toward social and political priorities. The idea of a demand oriented technology policy is very much a break with such assumptions, but it is above all a constructive alternative.

In contrast to the traditional views, social shaping-perspectives explicitly seek an understanding of innovation and implementation of technology by exploring the relevant social processes. These include the negotiations, the networks, the translations and the stabilisation that influence further development and uses of a sociotechnical system.[13] It is important to highlight the emergence

of different technical options and the choices made between them *at every stage* in the generation and implementation of technological change in the transport/mobility systems. A range of 'social' factors - economic, political, cultural and institutional, as well as narrowly 'technical' considerations - affect which options are created and selected, and thus influence the content of a specific technology policy. This expresses the need to integrate a concern for demand, for users and for the shaping of technology that takes place after the so-called development or design stages. This means that we need to consider *social learning*.[14]

Economists and economic historians became interested in social learning through studies of productivity that showed continuous improvements over very long periods of time without any investments in new technology. Arrow[15] called the phenomenon *learning by doing*. A related phenomenon is *learning by using*. Rosenberg[16] suggested this concept to describe the process through which a user (client, customer) familiarises a given piece of technology and develops her or his skills in making use of it. While learning by doing provides a basis on which to make production more efficient, learning by using may help to create new sociotechnical practices.

The difference between learning by doing and learning by using is chiefly one of perspective. What is learning by doing for one company is learning by using when seen from the company that supplies, e.g. the machinery. The main issue is the importance of the linkages between users and producers, and these may be both forward and backward. To innovate successfully, producers may depend critically on information from users, and vice versa. This is the basis of the idea of *learning-by-interacting*.[17]

Learning-by-interacting is affected by systemic qualities of a given regional or national economy, even by international relations. Channels of communication, codes of conduct, and conceptualisations may develop over time and may also be the object of public policy. Some stability in inter-firm relations is also needed, in order to provide necessary preconditions for the stable forward and backward linkages needed to perform learning-by-interacting.[18] From this perspective, the system of production may be seen as a system of learning or a *learning economy*. However, learning processes may be tacit, and the ideas of a learning economy suffer from insufficient awareness of the problem of making tacit knowledge explicit and thus transferable. The challenge is not just to construct communication channels, but also to provide explicit information of sufficient quality. It may prove necessary to look in greater detail to the codification as well as translation and transfer of experience. In particular, the process of giving scientifically argued *advice* to policymakers is very important and of great consequence to the understanding of an interactive technology policy.[19]

This may also provide a reminder that economists and economic historians have not been sufficiently sensitive to the social and cultural processes that constitute users' transformation of a given piece of technology into/onto practices. Social learning is more than learning-by-interacting. It may be characterised as a combined act of discovery and analysis, of understanding and

meaning, and of tinkering and the development of routines on many different levels of society. In order to make an artefact work, it has to be placed, spatially, temporally, and mentally. It has to be fitted into the existing, heterogeneous networks of machines, systems, routines, and culture.[20]

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

To develop a technology policy that integrates a concern for demand side aspects, we need to address the following three areas:

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

Together, they span a wide space of sociotechnical institutions and actions.
To proceed, we also need to keep in mind the *diachronic* aspects of development and use of technology. To insist that users' actions matter is also to insist that these actions, and by implication - the resulting "impacts" of technology - develop over time and can only be properly analysed by integrating temporal sensitivities and concerns.

This suggests some features of thinking in a new technology policy approach:

- Emphasis on the flexibility of interpretation of technology and the need to study change over time.
- Integrating a concern for design as well as for use of technology, analysing supply-side as well as demand-side aspects, technology as well as culture.
- Move of focus from artefact to system and infra-structure.
- More conservative ambitions. Technology should be "orchestrated" rather than controlled, institutionalised rather than managed.
- Feedback from various user groups will be critical to the policy process, in particular in early stages. Sociotechnical experiments may prove to be an important element to get such feedback, but not the only such instrument.

This means that public authorities become conductors, rather than controllers or managers of technology policy.

Economic arguments play a central role in such technology policy discourse as well as in the discourses on technology strategy taking place in companies. The present interest in so-called green taxes makes this even more relevant when one is concerned with the way environmental issues are taken care of within these discursive frameworks. Thus, it is necessary to look more closely at the role of economic arguments in technology policy discourses. From an STS point of view, the status of economic arguments appears to be taken too much at face value. For

example, the assumption that increased taxes lead to increased prices that lead to decreased consumption appears as almost impossible to challenge, even if there is a lot of evidence that counters this type of argument. Generally, one needs a framework where one may question economic facts as well as the "green-ness" of given technological options.

As a concept, technology policy signals a need for knowledge and expertise to be able to participate in such policy-making. Also, it may be interpreted as a belief in a strictly rational management of technological change, as a basis for master plans for social development. The policy discourse itself does not suggest such an understanding, as it is conversing with uncertainty and limited rationality. However, the whole relationship between technology and society in modern discourses is often interpreted as being in conflict with democratic ideals like popular influence or participation.[21]

Jasanoff[22] points to the central role of experts in the development of science policy, which by implication should hold for technology policy as well. This means that the technocratic temptations are fairly strong. Since technology is not a policy instrument but at best a tool provided in response to other instruments, this may further mean that technology policy is not a direct concern of Parliaments and high levels of government. Thus, we may suspect that technology policy is indeed practised in rather closed circles of lower-level government, maybe in interaction with industry. This facilitates technocratic ways of working, since there is lesser direct democratic control.

To conclude this overview, our framework for analysing technology policy is based on four concepts: providing, policing, pushing and participation. We know that these dimensions are important, but we do not know how nor how they interplay. This is an important challenge.

To begin with, we are interested in alternative ways of performing technology policy. Second, we are critical about the tendency to assume that it is easy to distinguish between technological concerns and social concerns about the way that technology will (or will not) be developed. To look for issues of:

- providing,
- pushing,
- policing
- participation

would provide such a start.

However, it may prove difficult to identify these dimensions of concrete technology policy. First, they may not be identifiable in the policy situation. Second, in concrete examples, one may have easier access to one or two of the four dimensions.

Given those considerations, we are mainly concerned to be able to analyse concrete efforts of implementing or reshaping technology policy, with an emphasis on transport. Or, rather, we are interested in studying a set of challenges emerging from efforts to think about technology in relation to transport: the transport problem, the land use problem and the car problem. It should be noted

that there is no simple solution to any of them, in fact, technology policy in transport may prove to be a much simpler affair of not making policy reflection. Thus, the most important task would be to study concrete instances where technology policy may surface, but with a suspicion that it will not. In fact, technology policy may not be practised as anything that resembles the topics covered in this chapter. That is also an option that has to be considered.

Technology Policy in Transport - Some Examples

The Intepol project started from the following initial premises and goals:[23]

- To clarify the need for a more reflexive technology policy in transport planning
- To explore the role of modern ideas of mobility for the modern transport paradigm
- To spell out some strategies for integrating technological and social/political concerns.

In addition, there is the need to support environmental sustainability and participatory practices in relation to person transport.

The main aim was to overcome the tendency to formulate technology policy, either as technology-driven/supply driven or as basically an issue of social measures/supply led. In particular, we wanted to emphasise the need to transcend the three most common versions of such policies:

- the belief in taxes and relative prices as the main problem-solving mechanism
- the assumption that extension of roads and other infrastructure is the most important solution
- the belief in education of the public by information.

Three main challenges has been put forward in the existing research literature on transport and mobility.[24] The first may be called the transport problem, which above all includes the task of providing sufficient transport capacity. This is the basic issue in traditional transport research as well as transport policy. The second is the so-called land use problem, which comes from the vast demands for land posed by modern transport. This is particularly pressing in city areas where land is a very scarce resource. Here, we are confronted with the complex interaction between modern mobility and the spatial organisation of modern society. The third challenge should be called the car problem, due to the particular features of the kind of mobility praxises that have emerged in parallel to the diffusion of the private car as the dominant mode of transport. The land use problem is intimately related to this challenge, but the problem inventory includes emissions, noise, accidents and resource depletion.

Within the framework of the Intepol project, 18 case studies have been conducted, covering eight countries. In the following, we shall look at the results from some of them that are particularly interesting in terms of identifying the contours of a different way of perceiving and practising technology policy.

Th!nk Electric - A Sustainable Branding of Sustainable Mobility[25]

Electric vehicles appear to be a radical solution to quite a few of the problems of a mobility regime based on private cars: reduced emissions, less noise, less resources and reduced area use due to the combination of light weight and battery-powered motors. However, in policy terms, the establishment of EVs as a real alternative to gasoline-powered vehicles has proved to be difficult. EVs raise infrastructural challenges because of the problems of making charging of batteries easy. Above all, EVs pose a challenge to the cultural definition of a car and the performance of mobility, since speed and range are much less compared to the standard gasoline powered car.

In this case, we have study the development of a Norwegian electrical car, the Th!nk. There are at least three possible stories to tell about Th!nk that are important to the analysis of technology policy. The first is the story of entrepreneurship and the willingness to go against prevailing beliefs in the impossibility of producing cars in Norway. The second story narrates the shifting political climate of support, including the observation that the Norwegian government never contemplated the possibility of establishing anything like a niche – a protected space – for developing a Norwegian EV. The third story highlights the efforts made by the actors behind Th!nk to inscribe their car in a different vision of mobility – an urban, more sustainable form of transport.

The third story is perhaps the most prominent one, since it emphasises the need to do technological and cultural work in parallel. The entrepreneurs behind Th!nk saw that to be able to sell substantial quantities of the car, they needed people to think differently about their mobility needs and the defining quality of a car. The standard car is designed in a sporty manner, for great speed and length of drive. Arguably, urban driving does not call for any of these qualities.

The initial step of developing Th!nk was to produce a concept car, in a dual meaning. On the one hand, Th!nk was designed to look different from the standard cars. On the other, Th!nk was marketed by reference to a concept of mobility that emphasised urban needs and sustainability.

A major strategic problem was to fund this development. Lack of financial support from Norwegian actors lead to a bankruptcy. However, Ford bought the company to allow continued production of Th!nk. This has meant that the initial effort of redefining the concept of modern mobility has become less prominent, although it is difficult to see that EVs stand any chance without such a redefinition.

From Congestion to Urban Quality - The Strasbourg Approach to Tackle Transport Problems[26]

Strasbourg is an ancient French city with a medieval centre on the bank of the Rhine River. During the 1980s, congestion increased to what were considered unbearable levels while levels of pollution exceeded the WHO standards

regularly. The Strasbourg approach was not just to see this as a transportation problem but also to redefine the challenges to be about 'urban quality' - to get an attractive city centre with much less noise and pollution.

To achieve this, the city developed a comprehensive plan, seeking to discourage car use while at the same time developing clean, attractive and efficient alternatives. Public participation was an important element in the decision-making process. Focus of attention became the new Strasbourg tram, which was explicitly designed to look attractive and to be integrated into the urban landscape. Cheap park and ride facilities at the town's periphery and high parking rates in the centre should encourage people to use the tram.

In the mid-1990s, the most important elements were realised. The approach was successful in the sense that the tram and the P+R facilities became heavily used. The inhabitants of Strasbourg think the quality of their city has improved drastically.

A particularly important feature of the Strasbourg case in relation to technology policy is in the efforts to combine several instruments to achieve success. They did not just build a new tram line, they did so while at the same time introducing access limitations and P+R facilities, doing a lot also to make the tram line attractive to users.

Will Telematics Move in Concert? Social Shaping of Transport Telematics[27]

Telematics is one of the new technologies that are considered to be a promising tool to improve transport. In principle, the technology offers possibilities to introduce new facilities in vehicles, like information and navigation devices, as well as new tools to optimise or improve control of the transport system. Several large R&D project with EU funding have been initiated to support such developments. Experiments have been performed to study the use of telematics as the basis of access control, road pricing and traffic information. This means that the study of transport telematics offers excellent opportunities to analyse social shaping processes, since there are different options with quite different features to choose from.

This case analyses social shaping of telematics in a German context, with emphasis on a set of experiments in the city of Hanover. We have concentrated on four projects that have been carried through in Europe and Germany; PROMETHEUS, DRIVE, CONCERT and MOVE.

In the German context, neither access control nor road pricing seems to be politically acceptable applications. Thus, in Hanover, the experiments focus on the provision of traffic information, in order to optimise the use of the available network of roads. The idea was that congestion might be reduced, perhaps avoided, if car drivers were given better information about traffic conditions on the different tracks along which they could choose to drive to get to where they wanted to go.

The common thinking behind transport telematics is definitely supply side driven. Transport telematics is usually perceived as a technical fix, an application of technology to solve social problems related to transport. The interaction that is emphasised, is basically interaction between supply side actors and public policy makers.

The process of shaping transport telematics translates between technological options and policy demands. When some applications, like road pricing, are deemed as politically impossible, it means that the effort in Hanover was not just to optimise transport flow. It was also an effort to optimise the use of transport telematics, given quite severe political constraints.

Road Pricing in Trondheim[28]

Road pricing is not new concept. Toll roads have existed for centuries. However, use of new information and communication technology has added some new features. The technology has become virtual, and the bar has been replaced by radio signals. In principle, a car owner may install an electronic piece behind the front window mirror. The fee is then automatically withdrawn from the owners' bank account every month. Moreover, it has become possible to differentiate rates according to time of day. It is the latter feature that has made modern toll roads into road pricing systems.

One of the sites where such a road pricing scheme has been introduced is in the city of Trondheim in Norway. Initially, the city was only planning for a toll road system in order to fund improvements of local roads and highways. Such extra funding was needed because the projects were low on the priority list of the government.

The introduction of the toll road system initially raised three major challenges:

- public acceptance
- the relatively high cost of collecting money through standard technology
- flow of traffic.

A local company then launched an electronic solution. By use of acoustic surface wave technology, a chip could be used to identify cars passing the collection points, allowing a cheap way of collecting money. The development of this technology started as a local collaboration between this company and the road and highway authorities. Later, national support was enrolled.

When the technology, named Q-free, was installed, it was soon discovered that it allowed rates to be differentiated temporally. After some time, this was exploited by a transformation into a road pricing system with higher rates during rush hours and free passes during nights and week-ends.

It should be noted that public acceptance was secured by reference to environmental arguments in combination with improved quality of local roads. Moreover, public convenience with quick passes and no queuing in front of the toll road bars probably was important as well. Nevertheless, acceptance is not

given in the future. Road pricing may loose out, for social and political reasons. Already, in 2001, many local politicians have been promising that the system will be closed down in a few years.

Towards a New Architecture of Technology Policy

The architecture of traditional technology policy in transport may be summarised in the following way:

- It is dominated by infrastructural concerns, but regulation plays an important role, in particular as a critical concern that invites an interest in developing new practices.
- It is practised in a situation where highway projects are political commodities, to be negotiated between local constituencies and national actors in the transport field, where political support may be exchanged for national economic support.
- The dominance of infrastructural concerns seems to render the technology policy aspect of transport planning invisible.
- Highway plans are deliberated and negotiated in a situation characterised by the fact that mobility has become publically constructed as a "human right". This leads to a situation where a growing demand for transport becomes "natural". Mobility is left as an opaque aspect of the present transport paradigm. It is a taken-for-granted, untouchable and invisible property of technology policy in transport.

The challenges to be met in developing new technology policy practices in transport above all includes the following:

- The lack of explicit technology policy thinking in the transport discourse
- The stability of the common problem definitions in the transport sector
- The unfettered growth in personal mobility, above all related to private cars
- The role of the car industry and car constituencies, in particular the fact that innovation tend to be driven by industry rather than by regulatory concerns. The main bulk of resources available for innovation is spent on the traditional car and its needs, rather than the development of new forms of transport.

As a point of departure for further analysis, we should note that the efforts to perform experiments to provide new sociotechnical solutions to the transport problem, tend to be organised by local actors and has substantial autonomy from the car industry. This is evident from the Intepol cases.[29] There may be at least two reasons for this. First, these local experiments work mostly with infrastructure and public transport to achieve a modal shift for private cars to public transport. These are areas where the car industry has a limited role. However, once cars are more directly involved, like in the transport telematics case that highlights experiments in Hanover, we observe at once the car industry's influence. Second, the car industry may in fact have a positive interest in the local experiments because the future of the motorcar probably hinges on the ability of

public authorities to implement strategies that reduces the perception of the car as the most important problem of the transport sector. A modal shift from private cars to public transport may in the long run be beneficial to the car industry, because it will make the use of cars more comfortable. Congestion is probably the greatest of all challenges to the car constituencies.

Counter to the pessimism that sometimes emerge from the transport discourse, there is clearly some room for change, a room that the case studies have tried to explore. The existence of this room for change does not mean that we have come across a number of success-stories. In fact, there are few obvious successes to narrate. Rather, what we can study are efforts that try to bend structures, circumvent entrenched habits and effecting small-scale changes that holds some potential for a greater impact.

These efforts pursue different strategies to achieve their reform aims, strategies that use a wide variety of policy instruments and tools. Taking stock of the Intepol cases, we have observed the following main set of strategies used to cope with the transport problem:

- *Modal shifts* by persuading people to use other means of transport than the private car. This includes not just public transport, but also bicycles.
- *Emission management*, either by improved technology (e.g. the three-way catalyst or improved engines)
- *Demand management*, either by use of taxes (e.g. road pricing to reduce traffic or change its temporal distribution), by traffic information (e.g. road telematics to help car drivers to use the road systems more efficiently), by infrastructural means (e.g. physically induced modal splits) or by facilitating new forms of ownership (e.g. car sharing)
- *Support of introduction* of new transport technologies, like EVs, electrical buses or high speed trains, through public R&D, subsidies, special arrangements like lower taxes or particular tax exempts (free parking, free use of toll roads) or by managing large scale investments, like EUs engagement in high speed train networks.
- Efforts to *redefine culturally* the meaning of mobility and mobility technologies.
- Use of *heterodox planning procedures* that tries to tackle transport problems more broadly, rather than to try to fix problems gradually and individually.

Of course, these strategies of technology policy in transport are not exclusive. In fact, they may only be effective if two or more of them are combined. Still, they have some quite interesting properties.

First, we should note that, basically, they do combine technological and social elements. Neither technological fixes nor social amendments seem to suffice on their own. They are joined, although in different ways.

Second, they cover quite a wide variety of different options. Arguably, many strategies are based on pragmatic bricolage, the use of available policy instruments and tools, where the possibility of innovation may reside in their combination rather than the emergence of completely new elements. This is, by

the way, also in line with the classic reasoning of Joseph Schumpeter on innovation.

Third, there are radical implications of some of the strategies, in particular the efforts to achieve changes in the cultural definition of mobility and mobility technologies. This strategy marks a quite new approach to achieve changes in the transport sector, based on insights in the importance of the way that mobility and the related technologies are branded. Thus, in principle, one breaks away from the rather instrumental and overly rationalist thinking that has dominated the transport discourse for a very long time.

Still, it may be a puzzle why challenges tend to be local. Why do we not observe more concerted actions from national or even supra-national institutions? The Intepol case studies do not offer any clear explanation for this, other than in the observation that local actions quite often are supported by national institutions. However, there is considerable sense in trying out new arrangements on a smaller scale before they eventually are implemented more broadly. Local experiments may take greater risk and be more radical than national policies may do. From this perspective, the interesting question turns out to be the way experiences from local experiments and projects may be diffused and made use of on a broader scale.

The initial idea of the Intepol project was that there was considerable room for improvement in the thinking about as well as the performance of technology policy, not just in the transport domain but quite generally. We thought that it would be possible to identify practices that could be characterised as an interactive technology policy, a technology policy based on interaction between technological and social concerns. The case studies should help us spell out these abstract ideas more clearly and more concretely.

In the beginning, the idea of an interactive technology policy centred on the potential advances by overcoming the distinction between policies that were either technological or social. In the early stage of our research, this was supplemented by the theoretical discovery of the need to integrate infrastructure, regulation, innovation and participation as basic ingredients in the performance of technology policy. A synthesis of the theoretical observations made in sections 1 and 2 and the case studies introduced in section 3, suggest that an interactive technology policy (ITP) would be characterised by:

- Broadness in the conception of its space of action, covering the concerns of infrastructure, regulation, innovation and participation
- A dynamic understanding of the implementation of sociotechnical arrangements and thus a long-term engagement in the management of the resulting social learning processes
- A constant engagement in the search for new ways of combining social and technological options
- Sensitivity towards the need for concerted action, to influence several features of a system at the same time

- Conscious about the importance of user configurations and the potential impact of established user cultures on the outcome of the introduction of new measures and instruments
- An openness towards user involvement and discussion that is also robust in relation to conflicts.

In turn, this implies particular emphasis on:

- Interactivity between social and technological elements
- Interactivity between different concerns (infrastructure, regulation, innovation and participation), also implying that all these issues would need to be taken into consideration a priori.
- Interactivity between involved actors, including an emphasis on participatory practises
- Interchanges of knowledge and experience, e.g. between local projects
- Establishment of protected spaces for development along these principles.

Our initial conception of ITP was based on the optimistic idea that it would be commonplace to find the sort of reflective activity that we have called technology policy among actors who utilise technology as an element of political projects or efforts of reform. In fact, the case study material raises the issue whether technology policy in transport is just another fancy name for good old-fashioned transport planning.

Still, technology clearly plays an important role in most transport projects. Technology provides the tools for constructing and providing most of the infrastructure and services as well a creating presumptions that new ways of constructing and providing will be made available. Technology embeds the conservatism emerging from entrenched infrastructure and practices, as well as the radicalism that is created by new options to recreate and remake practices. But how may we distinguish between technology policy in general and our idea that there is a new technology policy paradigm called interactive technology policy (ITP) to be identified and developed?

Based on the above observations, it should be clear that a first boundary criterion of ITP has to be that one can identify conscious efforts to plan and discuss in terms of technology policy. ITP has to mean that there is an explicit engagement with technology as a policy concern.

Throughout this paper we have emphasised the need to combine technological and social options or measures into combined sociotechnical strategies. This has to be the second boundary criterion. No ITP without it.

We cannot sensibly discuss technology policy without underlining the difficulties encountered when one tries to translate politics into viable policy instruments and tools. Far too often, this translation process is perceived as a rationalist exercise of analytical thinking where the policy experts put political decisions into action. Again, we may observe the technocratic temptations alluded to throughout this volume.

To understand the translation process, it is important to keep in mind that it is dynamic and in principle open-ended in terms of outcomes. We may perhaps understand this in a better way by using Latour's concepts of delegation and

programme/anti-programme.[30] Delegation refers to act of replacing human action by technological arrangements. For example, the building of road bumps force drivers to drive slowly, irrespective of the amount of police surveillance. Delegation acts are at the hearth of efforts to create programmes that influence or direct human response, for example to choose public transport instead of one's private car, to avoid driving in city areas that would be destroyed by increased traffic or to drive with less emission by the use of a catalyst or electrical vehicle. All Intepol cases describe one or more such programmes.[31]

The activation of programmes may elicit responses where other actors try to counter the implicit delegation, for example by re-delegation or reconfiguration. The programme of road pricing to reduce private car traffic or at least to change its temporal or spatial distribution may be countered by an increased willingness to pay the taxes demanded by the road pricing system.

In this respect, the translation process is embedded in the logic of social conflict. Thus, an interactive technology policy cannot be expected to do away with disagreements, tensions, disputes or controversies. In fact, the gain that should be expected would be an improved ability to cope with and learn from conflicts.

These remarks suggest two more boundary criteria, sensitivity towards the public or the users and conscious efforts to learn from experience. The first of these emphasise what we consider to be the most import form of interactivity, namely openness and ability to reflect on users' needs and requirements by considering configuration processes in a critical and constructive manner. The second underlines the importance of organising for learning.

To summarise, we will argue that the following to be the basic elements of ITP and the criteria we would claim to distinguish the paradigm:

1. Problems are approached and solutions developed by considering technology a constituent of appropriate policy-making. Thus, technology policy type of reasoning may be identified.
2. Technological and social elements should be combined in the making of policy.
3. Openness towards and ability to reflect on users' needs and requirements.
4. Some institutionalisation of learning processes.

The Intepol cases have been made in the domain of transport and mobility. This means that the arguments we have made to identify and describe an interactive technology policy are related to practices observed in this domain. Thus, we cannot claim general validity for the ITP without considering this limitation.

The possibility of claiming that ITP is generally applicable and of general interest depends on at least three concerns:

1. The difference between ITP and other major efforts to theorise technology policy
2. The extent to which the transport domain is fundamentally different from other domains of technology policy, making the experiences narrated in the Intepol cases irrelevant to the practice of technology policy in other domains.

3. Whether the problems of the transport sector are so particular that the scope of ITP thinking, as outlined in this report, is too narrow to make ITP interesting to use in other technology policy domains.

Regarding the first concern, the main point is our claim that technology policy studies are basically descriptive and that the field is not very well developed. Our outline of the ITP does not provide a comprehensive theory of technology policy, but it offers a considerable theoretical basis for the reasoning behind the paradigm.

There is no doubt that the transport sector has a number of characteristic features that distinguish it from other sectors. To assess these features and their implications in any fundamental way is difficult without entering into a large debate about the nature of modern societies. In the conception of the Intepol project we made the alternative argument that the transport sector could be seen as a hard case for ITP. If we could argue the relevance of ITP for the transport domain, it would follow that it would be relevant for most other.

The characterisation of the transport domain as a "hard case" was based on several observations. First, that the transport problems were great and that the sectors had considerable problems in finding solutions. Second, that the transport sector did not seem to have much activities that reasonably could be labelled technology policy, even if technology seemed to be very much at the forefront of development strategies in the domain. Third, that the sector traditionally was dominated by public institutions, with many private actors dependent on public subsidies. Fourth, that the sector appeared as rather conservative in its way of thinking.

Still, we think there are good reasons to think that the technology policy challenges encountered by actors in the transport domain will have distinct similarities to those confronting actors in most other sectors. The arguments that transport should be considered a "hard case" do not mean that the transport sector is peculiar, just challenging.

One should also take into consideration that the ITP paradigm is a mindset rather than a recipe. Local conditions are always very important to the concrete practice of technology policy, for cultural and political reasons, but also due to differences in the availability of relevant resources. But, of course, there is still a lot of work to be done to make the idea of the ITP paradigm clearer and more easily applicable.

Notes and References

1. The paper is based on the project 'Towards an Interactive Technology Policy', funded by EU, Targeted socio-economic programme (SOE1-CT97-1057). The other participants in the project, from the Danish Technical University (Ulrik Jørgensen and Birgitte Munch), Norwegian University of Science and Technology (Øyvind Thomassen) and Twente University (Boelie Elzen), have provided very important input. More information about the project and its findings may be found in B. Elzen, U Jørgensen, K H Sørensen and Ø Thomassen, *Towards an interactive technology policy. Implications from the social shaping of mobility and transport*

policies for a new technology policy paradigm, Enschede: University of Twente, 2001.

2. See e.g. Brooks, 'National Science Policy and Technological Innovation', in R. Landau & N. Rosenberg (Eds), *The Positive Sum Strategy* (Washington DC, National Academy Press, 1986), pp. 119-167.

3. C. Freeman et al. (Eds), *Technology and the Future of Europe. Global Competition and the Environment in the 1990s* (London, Pinter Publishers, 1991); L.M. Branscomb (Ed), *Empowering Technology. Implementing a U.S. Strategy* (Cambridge, MA, MIT Press, 1993); A. Elzinga & A. Jamison, 'Changing Policy Agendas in Science and Technology', in S. Jasanoff et al. (Eds), *Handbook of Science and Technology Studies* (Thousand Oaks, CA, Sage, 1995), pp. 572-597.

4. See e.g. C. Freeman, *The Economics of Industrial Innovation* (Penguin, Harmondsworth, 1974); S. Encel, & J. Ronayne (Eds), *Science, Technology and Public Policy. An International Perspective* (Oxford, Pergamon Press, 1979).

5. See e.g. D.L. Weimer & A.R. Vining, *Policy Analysis: Concepts and Practice* (Englewood Cliffs, NJ, Prentice-Hall, 1992).

6. See e.g. S.J. Kline & N. Rosenberg, 'An Overview of Innovation', in Landau & Rosenberg, *op. cit.*, Ref. 2, pp. 275-305; C. Freeman & B.-Å. Lundwall (Eds), *Small Countries Facing the Technological Revolution* (London, Pinter Publishers, 1988); R.R. Nelson (Ed), *National Innovation Systems. A Comparative Analysis* (New York, Oxford University Press, 1993); C. Edquist (Ed), *Systems of Innovation* (London, Pinter Publishers, 1997).

7. See e.g. K.H. Sørensen & R. Williams (Eds), *Guiding Policy, Shaping Technology: Concepts, Spaces and Tools*, (London, Edward Elgar, forthcoming, 2001).

8. See also K.H. Sørensen, 'Social Shaping on the Move. On the Policy Relevance of the Social Shaping of Technology Perspective', in Sørensen & Williams, *ibid.*

9. B. Latour, *ARAMIS or the Love of Technology* (Cambridge, MA, Harvard University Press, 1996).

10. See Sørensen & Williams, *op. cit.*, Ref. 7.

11. T. Cronberg, & K.H. Sørensen (Eds), *Similar Concerns, Different Styles? Technology Studies in Western Europe*, COST Social Science (Brüssel, DG XII, 1995).

12. See R. Williams & D. Edge, 'The Social Shaping of Technology', *Research Policy*, 25, 1996, pp. 865-899; Sørensen & Williams, *op. cit.*, Ref. 7.

13. W. Bijker, T. Hughes & T. Pinch (Eds), *The Social Construction of Technological Systems* (Cambridge, MA, MIT Press, 1987); B. Latour, *Science in Action* (Milton Keynes, Open University Press, 1987); J. Law (Ed), *A Sociology of Monsters. Essays on Power, Technology and Domination* (London, Routledge, 1991); W. Bijker & J. Law (Eds), *Shaping Technology/Building Society* (Cambridge, MA, MIT Press, 1992).

14. K.H. Sørensen, 'Learning Technology, Constructing Culture. Socio-technical Change as Social Learning', STS Working Paper no 18/96 (Trondheim, Centre for Technology and Society, 1996).

15. K. Arrow, 'The Economic Implications of Learning by Doing', *Review of Economic Studies*, 29, 1962, pp. 155-173.

16. N. Rosenberg, *Inside the Black Box: Technology and Economics* (Cambridge, Cambridge University Press, 1982).

17. E.S. Andersen & B.-Å. Lundwall, 'Small National Systems of Innovation Facing Technological Revolutions: An Analytical Framework', in C. Freeman & B.-Å. Lundwall (Eds), *Small Countries Facing the Technological Revolution* (London, Pinter Publishers, 1988), pp. 9-36.

18. *Ibid.*

19. See S. Jasanoff, *The Fifth Branch. Science Advisers as Policy Makers* (Cambridge, MA, Harvard University Press, 1990).

20. K H Sørensen, *Technology in use. Two essays on the domestication of artifacts*, STS working paper 2/94 (Trondheim: Centre for Technology and Society, 1994)

21. A. Feenberg, *Questioning Technology* (London, Routledge, 1999).

22. Jasanoff, *op. cit.*, Ref. 19.

23. See B. Elzen et al., Ref 1, for more details about the project.

24. K.H. Sørensen, *Rush-hour Blues or the Whistle of Freedom? Understanding Modern Mobility*, STS working paper 3/99 (Trondheim: Centre for Technology and Society, 1999)

25. For details and methodology, see T. A. Undheim, 'Th!nk Electric - A Successful Branding of Sustainable Mobility?', in B. Elzen, U. Jørgensen, K.H. Sørensen & Ø. Thomassen, *Tackling Transportation Problems around the World - Case-studies Used in the INTEPOL Project*, Annex Report to Final Report from the INTEPOL Project (Enschede, University of Twente, 2001).

26. For details and methodology, see M. Popkema & B. Elzen, 'From Congestion to Urban Quality - The Strasbourg Approach to Tackle Transport Problems', in Elzen et al., *ibid.*

27. For details and methodology, see R. Bye & R. Næss, 'Will Telematics Move in Concert? Social Shaping of Transport Telematics: The Case of Germany', in Elzen et. al., *op. cit.*, Ref. 25.

28. For details and methodology, see Ø. Thomassen, 'Taxing Towards Future? The Discourse on Road Pricing', in Elzen et. al., *op. cit.*, Ref. 25.

29. Elzen et. al., *op. cit.*, Ref. 25.

30. B. Latour, 'Where Are the Missing Masses? The Sociology of a Few Mundane Artifacts', in Bijker & Law, *op. cit.*, Ref. 13.

31. Elzen et. al., *op. cit.*, Ref. 25.