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Implications from the social shaping of mobility and transport policies for a new technology policy paradigm

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Implications from the social shaping of mobility and transport policies for a new technology policy paradigm

Final report

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Edited by
Boelie Elzen — Ulrik Jørgensen — Knut H. Sørensen — Øyvind Thomassen

Coordinator :
Centre for Studies of Science, Technology and Society
University of Twente, Netherlands
Dr Boelie Elzen

Partners:
Technical University of Denmark,
Ulrik Jørgensen
University of Trondheim, Norway,
Knut H. Sørensen,
University of Trondheim, Norway,
Øyvind Thomassen

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Foreword

Within the Fourth Framework Programme of Research and Technological Development, the *Targeted Socio-economic Research Programme (TSER)* had as main objectives to increase European knowledge across three targeted areas – evaluation of science and technology policy options, research on education and training and on social exclusion and social integration. Research was undertaken through the funding of translational research networks of high quality, which were sought to provide policy relevant findings that could have an impact on the social and economic development of Europe.

The insights and information that the reader will obtain in the following pages constitute the main scientific findings and the associated policy implications of the research project – ***Towards An Interactive Technology Policy - Implications From the Social Shaping of Mobility and Transport Policies for a New Technology Policy Paradigm.***

This project brought together 4 research teams in a collaborative endeavour lasting 30 months.

The abstract and executive summary presented in this edition offer to the reader the opportunity to take a first glance on the main scientific and policy conclusions, before going into the main body of the research provided in the other chapters of this report.

The research reported in this publication should not be viewed in isolation. Over 300 research projects and thematic networks in the wider area of the social sciences have been funded under the Fourth and the Fifth Framework Programmes of Research and Technological Development. These collaborative research efforts involving more than 2000 European research teams have made significant advances to knowledge, support policy-making in Europe and have laid the foundations for the development of a European research community in the social sciences.

The Sixth Framework Programme, through *Priority 7 'Citizens and Governance in a Knowledge Based Society'*, is building on the progress already made and aims at making a further contribution to the development of a European Research Area in the social sciences and the humanities.

I hope readers find the information in this publication both interesting and useful as well as clear evidence of the importance attached by the European Commission in fostering research in the field of social sciences and the humanities.

Andrew Sors
Acting Director

CONTENTS

PREFACE

This report marks the conclusion of the the INTEPOL project, the acronym standing for "INteractive TEchnology POLicy". This report is the result of close colaboration between the four authors although primary responsibility for each of the chapters has been devided as follows:

- Boelie Elzen: Chapters 1, 4, 5, 9.
- Ulrik Jørgensen: Chapter 7.
- Knut H. Sørensen: Chapters 2, 3, 10.
- Øyvind Thomassen: Chapters 6, 8.

We have discussed each other's chapters frequently to ensure that they are tuned towards each other so that the report reads as a coherent whole that eventually leads to the proposition of the Interactive Technology Policy Paradigm described in final chapter. We therfore see this report of a joint product, each of us taking responsibility for the whole content.

Chapter 1

INTRODUCTION

1.1. From the technical annex

This report concludes the EU funded project "Towards an Interactive Technology Policy" (INTEPOL). The objectives set forward in the Technical Annex are as follows:

The project aims at developing a new basis for formulating technology policy called an interactive technology policy paradigm (ITP). The approach will be elaborated specifically for the domain of passenger mobility but an assessment will be made of the generaliseability of the approach. More specific objectives of the project are:

- to present an overview of the main 'currents of thought', i.e. various disciplinary approaches toward solving the problems of passenger mobility;
- to analyse empirically and present an overview of the socio-cultural embeddedness of passenger mobility in eight countries;
- to analyse empirically and present an overview of 'traditional' technology policies in eight countries (including the EU-level) aiming to solve societal problems related to personal mobility; by a comparative analysis we will analyse why specific approaches either failed or were successful;
- to analyse empirically and present an overview of innovative technologies and policies in eight countries to tackle the problems of passenger mobility; we will include the supranational/federal, as well as the national/state and the local levels;
- to develop an ITP geared towards attacking the problems of passenger mobility;
- to assess the generaliseability of an ITP and present it in a general form that will allow using and testing it in other domains as well.

The idea behind the project is to transcend the common problems with technology-policies, due to the fact that they either focus on supply side factors (technological options) and neglect social and cultural issues, or on demand side factors (social options) and thus neglect the dynamic features of technology. The ITP is meant as an effort to facilitate interactivity in technology policy.

The effort to develop the ITP will be grounded in an analysis of the case domain of personal mobility. The work needs such an empirical grounding in order to get a sufficiently detailed understanding of the dynamics of technology policy. Personal mobility has been chosen because it exemplifies a deeply entrenched technology (private cars) that is used in a way that has proven to create substantial problems for modern societies, because traditional policies mainly have failed, and because there is a very large number of experiments going on in this domain which could be very relevant to the ITP.

Public authorities have developed various types of policies to deal with the problematic aspects of socio-technical change. They generally reflect either *supply-side* or *demand-side* strategies. Such strategies have specific advantages and disadvantages that

make them better suited in some situations than others. However, when addressing deeply entrenched technologies, like the private car, energy generation systems, or sewage systems, they seem in general to fail. Neither of the two approaches works very well because they take one dimension of the relevant socio-technical domain as given. Supply-side strategies cater new technologies with the assumption that users will use them in the same fashion as existing options. Thus, the social side is taken as given. Demand-side approaches constitute the mirror image: they attempt to transform user patterns while technical options are seen as constant. Consequently, we need an alternative that takes care of both aspects. This is one important characteristic of what we will call an *interactive technology policy*.

A second central characteristic is derived from the observation that social and technological change are intimately connected and that socio-technical change is of a very heterogeneous nature. In this project, we want to develop a new framework for technology policies in which both technological and social/cultural options are seen as interactively dynamic. To do so, we will draw on recent developments within social studies of technology, in particular the so-called social shaping of technology-perspective.

The heterogeneous nature of socio-technical change implies a need for a change in the paradigm of technology policy to remove it from an artefact-centred, supply dominated perception. Policies will have 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 policies will have to create room for *social learning* among developers, suppliers, users and regulators of technology.

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, but also 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 would mean a greatly improved ability to map intentions.

The above implies that an 'interactive technology policy' has two central characteristics that distinguishes it from traditional technology policies, notably:

- in terms of focus it emphasises both the supply and demand side of technological change;
- in terms of methodology is stresses a process of continuous interaction (hence the adjective 'interactive') between a wide range of actors that can be characterised as *learning by doing*.

Based on insights from the field of social studies of technology and earlier work by the partners, we may suggest some probable features of an interactive technology policy:

- 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 both supply-side and demand-side aspects, both technology and 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. Socio-technical experiments may prove to be an important element to get such feedback, but not the only such instrument.

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

In such general terms, these points may not be controversial. However, they need to be detailed both positively and negatively. Empirical investigations usually provides more insights into how actions may fail than how they may succeed. Still, these insights are important and there is a lack of empirical efforts to do such mapping. Our study is meant as an effort to rectify this.

However, detailed studies may also provide examples of successes as well as a more analytical understanding of the mechanics of technology policy. By collecting a sufficiently large amount of comparative material, we believe it will be possible to outline an integrated technology policy in a constructive manner as well.

1.2. The methodology

The first step in the study was to produce an overview of the 'state of the art' along two dimensions. The first dimension is related to our analytical/theoretical interest notably the domain of technology policy. Deliverable 1 contains an overview of technology policies with an emphasis on the transport domain in a variety of countries, European as well as the US and Japan. (Elzen et al. 1999a) The second dimension is related to our empirical domain of traffic and transport. It provides an overview of what can be called 'mobility studies', the academic field that analysis the traffic and transport domain and was submitted to the commission as Deliverable 2. (Sørensen 1999)

The second step was to sketch some provisionary 'main characteristics' of an ITP. A basic starting point already implied in the project description was the acknowledgement that technical change and societal (behavioural) change go hand in hand. This has been extensively demonstrated and analysed by the field of 'Science and Technology Studies' (STS) and therefore we have used STS insights to develop some initial ideas on what these main characteristics might be. This initial analyses was submitted as a chapter of Deliverable 1.

The deliverables 1 and 2 set the stage for the actual development of the ITP. We sought to root this in a detailed analysis of a considerable variety of case studies. Based on the analysis in the deliverables, this variety had 3 different dimensions:

- geographic variety: we chose cases from several European countries as well as from Japan and the US;
- variety in terms of mobility aspects, covering the full range of problematic aspects of current traffic and transport systems;
- variety in terms of 'ITP' aspects, covering the full 'playing field' of aspects relevant for ITP.

Eventually, we ended up with 17 case studies that, together, covered the complete portfolio of aspects needed. Collecting data on these cases, analysing it and writing it up into research papers constituted step 3 of our methodology.

The next step was to develop 'empirical generalisations' from these case-studies which, in practice, was carried out in an iterative process: initial generalisations led to

additional empirical questions that were sought to answer in the further empirical work. In the technical annex, we suggested we would carry out the empirical generalisations along three dimensions in three different workpackages, notably:

- WP-2a: technological and cultural basis of modern personal mobility;
- WP-2b: reducing emissions and congestion within the existing system: the social and technological dimensions of current transport policies;
- WP-2c: innovative technologies and policies: "alternative" cars and new forms of mobility;

In the course of the work, however, it appeared this did not work too well. Especially our suggestion to distinguish 'innovative technologies and policies' from 'conventional' appeared to be problematic as in pracice many approaches appeared to be a mix of innovative and conventional elements. This eventually led us to carry out step 4, the empirical analysis across the case studies, under four headings, notably:

- Institutionalisation of mobility (a combination of parts form initial WP-2a and 2b)
- The societal embedding of mobility (largely rooted in initial WP-2a)
- Technical approaches to tackle emission problems (rooted in initial WP-2b)
- Room for change in the mobility domain (rooted in initial WP-2c)

This set the stage for the final step in the analysis, notably putting flesh to the bone of the initial outline of the ITP developed in step 2.

1.3. This Report

The chapters of this report largely follow the steps above but they have been somewhat more streamlined to develop a continuing and consistent argument. In short, this argument is described below in the form of a summary of the main findings from each chapter.

Chapter 2: Transport Cultures and Mobility Discourses

This chapter gives an overview of social science research on the mobility and transport. It is based on Deliverable 2 from the INTEPOL project. The review focuses on the following five topics:

- socio-economic issues of transport and mobility;
- historical and political-economic aspects of transport and mobility;
- mobility, land use and urban planning;
- mobility habituation and its cultural underpinnings;
- new technologies, transport and mobility.

We use four metaphors or images to represent four very important determinants of modern mobility: Henry Ford, Le Corbusier, the community of highway engineers and the movie industry in Hollywood. They highlight four different ways of thinking about mobility and mobility regimes.

Ford is the inventor of the car as an object of mass consumption, to be produced cheaply through the technology of the conveyor belt. The French architect Le Corbusier represents the thinking about cities and physical planning that made car-based mobility a chief premise. This kind of thinking has shaped the physical structures of modern society to sustain demands for flexible mobility, best met by the private car. The construction work of highway engineers has supplemented the efforts of city planners.

Their shared vision of a future with a high level of mobility, mainly based on the use of private cars, has been the basis of self-fulfilling prophecies about the need for more and better roads and extended car ownership. Finally, the cultural industry - with Hollywood as the dynamic centre - has moulded the visions of engineers and architects into attractive as well as profitable dreams about freedom and self-fulfilment through mobility and cars. There have been many communities of actors that have helped shape the society of high mobility. The present mobility regime, with its strong car dependence, has undoubtedly resonated very well with the dreams of most people about autonomous and comfortable transport.

Thus, the chapter identifies many important challenges in furthering the understanding of the underpinnings of modern mobility, to be explored in the empirical work of INTEPOL.

Chapter 3: Technology Policy Discourses: Dimensions for thinking about the social management of technology

This chapter presents an overview of the state of the art of technology policy studies.[1] It begins by noting that the field is characterised by rather descriptive contributions. A prominent exception is evolutionary economics, which has contributed the idea of a learning economy as a way of characterising the important processes of exchanging experiences to facilitate learning among actors linked in supply/demand chains.

The chapter moves on to argue that the focus of much technology policy studies has been too singularly focussed on innovation. It argues the importance of broadening the agenda to include four dimensions:

1. Infrastructure;
2. Regulation;
3. Innovation;
4. Participation.

The ambition of the INTEPOL project is taken to be to be able to analyse developments along all four dimensions, establishing a new kind of architecture of technology policy studies. Inspiration in this work is particularly taken from science and technology studies, including recent work on regime shifts and strategic niche management.

Chapter 4: A Kaleidoscope of Approaches - The practice of technology policy in the transport domain

This chapter is based on Deliverable 1 from the INTPOL project which gives an overview of technology related policies in the transport domain in a large number of European countries, the EU, Japan and the USA. This overview shows a wide variety of approaches that attempt to orient innovation and change in the transport sector towards societal needs. Despite these efforts some problems appear to be rather elusive, especially the problems of congestion and emission of greenhouse gases. Also the problem of emission of pollutants, although there is some optimism, leaves a lot to be desired, especially in a variety of ‘hot spots’.

In the preceding chapter, we distinguished four main dimensions of technology related policies, notably infrastructure development, regulation, innovation and participation.

[1] Rather than technology policy *practice*, which is discussed in the nex chapter.

The overview in this chapter has resulted in the identification of a variety of weaknesses in current policies that have been related to these dimensions as follows:

- *infrastructure developement*: The enormous emphasis on infrastructure in terms of funding by the EU as well as national states is likely to continue the trend that new infrastructure attracts new traffic and increases the general level of mobility. There is insufficient attention to how this emphasis might affect general traffic patterns and, hence, insufficient attention for its general sustainability impacts.
- *regulation*: Current and planned future standards for vehicle emissions in effect protect the use of gasoline and diesel and create a barrier towards the market-uptake of alternatives that have demonstrated advantages.
- *innovation*: A major problem is that many innovations are produced loose from the networks in which they should eventually function and that it appears difficult to fit them in later. Although this problem has been long recognised and policy makers try to address it no suitable approaches have yet been demonstrated.
- *participation*: The EU has started to co-operate more with industry in the process of setting standards for the emission of pollutants as well as on curbing CO_2 emissions. Whether this improved or speeded up the process of reducing emissions is doubtful, however. The reason is that this is a very narrow form of participation that does not include actors that have sustainability as there number one priority.

Chapter 5: Introduction to the Empirical Studies

This chapter discusses the various dimensions represented in the empirical studies for the INTEPOL project. It also contains a brief summary of each of the 17 studies we eventually selected as well as a table giving an overview of the main findings from each study on some of the crucial dimensions for the project. The case studies themselves have been elaborated as autonomous papers and they are all included in an annex report to this report. (Elzen et al. 2001)

Chapter 6: Institutionalisation of Mobility

The chapter focuses on changes in the institutionalisation of mobility, especially in relation to the congestion problem. It argues that technological and institutional innovations to deal with problems of traffic congestion are increasingly initiated and developed by individuals and private enterprises. Concurrently, over the past two or three decades there have been significant reforms in public planning at different administrative levels.

The influence of the automobile on city development provides ample opportunities for mobility, although the opportunities are unevenly distributed. At the same time, cities have encountered serious problems related to mobility ever since they came into existence. Congestion is one of the most obvious examples of how travel demand has outcompeted the possibilities of transport supply. Mobility, once viewed as a goal itself, has become a major problem in modern cities. Technological improvements migh help alleviate some of the side effects, especially of car use, but it can never solve the problem alone.

The chapter argues that the demand for mobility and the problems of traffic congestion are deeply rooted in cultural patterns that reflect certain values cherished by most people in the industrialised world. Therefore, to reduce congestion it is necessary to change some of those cultural patterns, which implies a need to change behavioural patterns.

This chapter uses a 'socio-technical' approach to suggest efforts which combine national, regional or local policy initiatives with innovations or initiatives by individuals or private enterprises. A socio-technical approach will thus help to 'open up' the congestion-problem, rather than to use a traditional supply-/demand-side approach. This approach illustrates that cultural patterns and institutional innovations are insufficiently covered in traditional supply-/demand-side approaches.

Chapter 7: Tinkering with the Untouchable - Transforming mobility needs and policy instruments

The topic of chapter 7 is the role of contemporary views of mobility, and how these views are expressed in discussions and studies about transport developments and transport policies. Mobility is seen as a cornerstone for the functioning of a modern society and its cities most often being the nodes of their organisation. To stay in touch with a number of different places may not only be part of the everyday institutionalised organisation of life, but also be an intrinsic part of satisfying the need for rest and maintaining personal identity.

Mobility as a precondition for the functioning of the economic system and an untouchable aspect of a modern human need is most often taken for granted. The unlimited access provided by roads serving the car system is only in very few situations regulated beyond the obvious safety and congestion reasons. Almost all the cases, we have been studying comply with this fact.

The problem is also addressed by discussing the relevance and ethical aspects of what could be phrased as a 'human right to mobility'. This discussion is extended to include the responsibility for others entering the space of transport and even further to the responsibility for making transportation become sustainable in both social and environmental terms.

The chapter concludes in an overview over the attempts to tinker with the transport system studied in the cases. This is followed a discussion of the policy perspectives coming out of quetioning how mobility needs are translated into transport demands, and in pointing to the need for experimentation and policy adjustments to reflect the complexity and the heterogenious group of actors involved shaping the transport and traffic of the future.

Chapter 8: Emissions and Omissions - Technocratic approaches to tackle pollution from motor vehicles

By the mid-1950s it became widely recognised that automobile emissions contributed substantially to photochemical smog in major US metropolitan areas, particularly those prone to atmospheric inversion layers. The US federal authorities first initiated governmental regulation of automobile emissions in the late 1960s and, starting with the model-year 1975, catalytic converters became mandatory. In the 1980s European countries and the EU followed the Americans by developing their own standards.

The US case on the introduction of emission standards is discussed as an example of how enacting standards can promote technological innovation. This was realised despite opposition from the auto-industry against the new standards in the US as well as Europe. The European industry argued that strict standards would impede the development of new engine technologies like the lean burn, which, as the paper argues,

in effect was not the case. Instead the emission standards helped to open up several new routes of technological development.

The paper discusses how governmental regulation reflects the meaning and culture of car driving in society at large. This makes the process of regulation and enacting standards more complex than just an attempt to realise 'neutral' technical standard. More than eliminating emissions, emission standards represent a professional judgement (or a social contract or compromise between social groups or/and professional groups) about what is acceptable.

Chapter 9: Exploring the Room for Change

Two main groups of problems of the traffic and transport domain relate to vehicle emissions and congestion. Concerning the former, the general assumption is that current and planned standards will solve the problem. Concering congestion, although policy-makers stress the need for intermodality, in practice the dominance of the car is taken for granted. Both views are challenged in this chapter.

Concerning emissions, the current standards in effect protect the use of gasoline and diesel and create a barrier towards the market-uptake of alternatives that have demonstrated advantages. Tighter, non-discriminatory standards along with differentiated tax-incentives for users could bring emissions much further down than the existing and planned regulations.

Concerning congestion, our case-studies contain a variety of examples of considerable changes on the scale of limited size projects. The main challenge is to try and learn more from these projects and not directly judge them in quantitative terms but in qualitative terms. By combining findings from a range of different projects the contours of a 'sustainable mobility system' may become visible.

In view of the above, an interactive technology policy for the traffic and transport domain needs to include the following elements:

- An exploratory part: try to learn in detail on the basis of concrete experience how promising new elements of a new mobility regime can work in practice. This exploration can be carried out retrospectively (on the basis of past projects) or as a pro-active strategy by setting up projects designed to explore specific issues.
- A part to stimulate the development and market uptake of clean and energy-efficient vehicles through a combination of standards and financial incentives.

Chapter 10: Towards and Interactive Technology Policy in Transport

This chapter is an effort to synthesise INTEPOL findings with regard to the possibility of developing a new paradigm of technology policy. It starts out by discussing some of the defining features of the traditional model and the way this model is presently challenged. These challenges include:

- 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.

The chapter argues further that alternatives to the traditional model like strategic niche management or learning economy cannot be observed the INTEPOL case material.

Instead, we see the need for two mindshifts: (1) Questioning mobility, and (2) Developing combined socio-technical strategies that extend beyond local circumstances.

Suggestions for a new paradigm of an interactive technology policy (ITP) and its features are developed, partly from the theoretical considerations in chapter 3, partly from the INTEPOL cases. We argue that the following are 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 indentified.
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.

Finally, the chapter considers to what extent ITP may be consider to have validity outside the transport domain, and it is argued that it does have general potential as a technology policy paradigm. In the end, it is also noted that the dual merit of the INTEPOL project of providing new knowledge about the transport domain as well as about technology policy may represent the most fruitful way of studying technology policy. Probably, technology policy should not be studied without at the same time analysing the domain in which it is practised.

Chapter 2

TRANSPORT CULTURES AND MOBILITY DISCOURSES

2.1. Introduction: Constructing the issue of mobility

The study of transport is a well-established part of RTD activities in industrialised societies. The physical movement of people as well as goods represent a considerable challenge in an era where trade is becoming regionalized and globalized, while travelling is a part of the definition of welfare. This raises planning problems, technological trials, and policy difficulties. The intellectual understanding of this challenge is, however, at least as demanding. Here, we are facing some interesting ambiguities, to be explored in this literature review. We want to analyse the way that transport cultures and mobility have been treated in previous research, in order to identify important findings and critical issues that should be pursued in an analysis of technology policy related to the challenges of modern mobility.

In the EU report *Transport in a fast changing Europe* from 1990 the following observations are offered:

> *(T)ransport hits the core of society. It is one of the few activities, which both give form to and express our turn-of-the-century European civilization. It gives a structure to space and our concept of space. It shapes and reflects our way of life and our cultures. It contributes to economic development, whereas the economy depends on good transportation. The functioning of society, indeed its very nature, largely depends on the quality and design of the transport system. (...) Today, a threat hangs over European transport*. (EU 1990, p.5)

The challenge described in the report is the growth of traffic, which has brought about a level of transport that in many places is outstripping the capacity of local infrastructure. This creates congestion and inefficient traffic as well as air pollution and excessive levels of noise and dust. There is a transport problem, but also an environmental challenge. Note, however, that the quote does not distinguish between transport of goods and people. To us, this distinction is very important because of the different meaning and practice that should be attributed to the two forms of transport.

The standard solution to the transport problem is of course to improve and extend infrastructure capacity. Basically, this means to build more and better roads. In addition, transport policy is concerned to achieve a better use of existing infrastructure as well as to develop systems of public transport. However, from this perspective, the demand for transport is more or less taken for granted. A high level is perceived as positive, as an expression of welfare and growth.

On the other hand, a strong concern for environmental problems from transport seems to produce a focus mainly on strategies to bring about reduction in the use of cars. In particular, the need to regulate traffic in urban centres or to cater improved transport

technologies is emphasized, but mainly related to the potential for lower emissions from cars and less consumption of resources. In policy discourses and public debates, private cars have become increasingly demonised as the incarnation of the modern environmental problem. They use too much natural resources, they pollute and they have destructive impacts on urban life and urban space (see, e.g. Kay 1997, Nadis & MacKenzie 1993 and Zuckerman 1991; or for an elaborated critique of this approach, Dunn 1998).

Still, car ownership as well as car utilization is increasing. Arguably, this pattern of growth is inherent in the logic of the private car. From this angle, the motor car provide the underpinnings of the dominant form of mobility. This artefact brings people around, when they want and where they want. With a not uncommon determinist slant, the American sociologist William F. Ogburn some decades ago noted that:

> *The inventor of the automobile has had more influence on society than the combined exploits of Napoleon, Genghis Kahn, and Julius Caesar* (cited after Allen 1957:107).

The point is that the car is believed to be the major cause of modern mobility. Without it, people would have walked or taken the railway or a boat.

Clearly, this is too simplistic. Mobility, understood as an embodiment of defining qualities of modernity like change and movement (Berman 1983), is a much older idea than the car. Before the industrial revolution, most people never travelled outside a narrow space around their living-place, with the sea travels of a minority as an exception.

The modernisation process from 1750 and onwards started a steep increase in the amount of transport performed. In fact, historians talk about a "transport revolution" that began by the making of a network of canals and continuing by the construction of railways (see, e.g., Cowan 1997, ch.5, Wolf 1996). The craft of building canals is quite ancient, so the development of canal networks in Europe and Northern America was clearly a response to the transport challenges related to the industrial revolution. This also means that the transport of goods was of particular importance.

The car meant a continuation of this momentum, in particular with respect to people. The level of person transport in the industrialised nations has increased throughout the 20th century, with a growth in the order of magnitude of 2500-3000 per cent. The car performs around three quarters of this transport. This makes it the dominant mode of achieving mobility, but not the cause. In fact, it may prove more important to observe that the car meant the introduction of a particular understanding of mobility that emphasizes flexibility, individual freedom and speed. Moreover, we should take notice that the entrenchment of car-based person transport is fairly recent. In Western Europe, the growth of car-based transport of people took off as late as around 1960.

The fact that the motorcar performs around three quarters of the total personal transport work means that it is a basic constituent of the "transport problem". The major question that we want to raise, however, is whether the basic challenge may be reduced to a car regulation issue. May we solve the transport problem by limiting the use of motorcars, rather than extending their infrastructure basis?

The choice of focus in this chapter, mobility rather than transport or cars, indicates that we believe that the "transport problem" needs to be discussed in a different framework. While we do not deny the need to control the increase in car traffic, maybe even to

reduce it considerably, we think it is necessary to consider carefully the knowledge base to develop strategies to this end. In particular, we think it is important to shift the focus away from the rather narrowly defined "transport problem" to a broader agenda concerned with a greater set of options to manage the demand for movement. We have chosen to do so by investigating the concept of mobility as a possible key to a different strategic understanding of the issues at hand.

What do we mean by 'mobility'? It is important to note that it is not meant to be synonymous with traffic or transport. Dunn (1998:143) defines it as "the potential for movement", in contrast to the "revealed mobility", which is the actual number of kilometres travelled, or "access", which tells about the ability to get from one place to another. Knie (1997) introduces a related understanding of the concept, but with greater emphasis on the need to retain a critical edge. Thus, he emphasizes that mobility is about the construction of possibilities for movement, rather than the actual traffic.

While we are sympathetic towards Knie's concern, we believe that we need to have a focus not just on mobility possibilities but also on mobility needs. Thus, in this chapter, the concept of mobility is used in a somewhat broader manner to designate the potential ability as well as need to travel. Thus, the analysis of mobility is basically about the performance, real as well as symbolic, of the catering of physical movement in society. In this manner, we believe it is possible to get a better understanding of the so-to-speak driving forces behind the increase in transport, in particular the transformation of potential personal mobility into the use of private cars. However, when reviewing the literature, we face the same problem that Knie identifies, the tendency in transport studies to use mobility and transport interchangeably.

As a point of departure, we should take notice that the demand for mobility is not just an exercise in Say's law: to extend demand to get it equal to supply. Modern people are not mobile just because it is possible or because it is expected. There is something about the act of moving around and the meaning of being transported that has to be emphasised. Thus, we have to be cautious not to perceive mobility as being basically an instrumental issue and an object of rational economic decision-making. Instead, one should raise questions like why there is such a large demand for mobility, in particular through private cars, and may this demand be reduced?

To proceed with the analysis of such issues, we will also introduce the concept of *mobility regimes* in order to highlight the historical and cultural basis. A mobility regime is spanned by a number of dimensions:

- the physical shaping of cities and landscapes,
- the available transport systems,
- the relationship between mobility and economic, social and cultural activities,
- the meaning attributed to mobility.

Of course, a major issue is the nature of regime shifts, and in particular the potential of regulatory measures to bring about such shifts. This leads to a concern for the way that physical planning or transport technology policy has managed mobility concerns.

Through a survey of relevant literature[2], the chapter will explore the potential of scrutinising mobility rather than vehicles, to allow a critical approach to the analysis of mobile-ness. This extends the focus, from the analysis of the car and the physical infrastructure of transport to include the practice and meaning of movement, from the facilitators of mobility to the need itself. Consequently, the chapter is concerned with understanding mobility rather than the car or transport as such. We will explore different ways of approaching the mobility issue, and the consequences of choosing one or the other avenue, with particular emphasis on work in history and the social sciences.

However, the literature that addresses physical mobility as defined above, is sparse. Thus, it has been necessary to make use of a broader approach that utilises available research on transport as well as the car. This means that we try to translate the discussion of the standard "transport problem" and the "car problem" to identify insights and findings that are relevant to the challenge of understanding modern physical mobility. In so doing, of course, the standard questions about transport: how much and how to develop suitable systems, have to be asked. However, the translation from cars and transport to mobility extends the problem-focus as well as bringing in demand-side issues. We believe that this move holds promises to improve on the rather narrow-minded and rationalist transport discourse as well as a rather moralistic discussion of cars, even if these approaches provide a lot of interesting knowledge.

2.2. Approaches to mobility

The literature on transport and the "transport problem" is vast, varied and difficult to summarise in a brief format. In some sense, it is also paradoxical in its shifts between worries that transport grows too much and too fast on the one hand, and concerns that transport may stagnate or even decline on the other (see, e.g. Jansen et al.1985, Nijkamp et al. 1990). However, its most important quality is its embedded-ness in a planning discourse. Transport studies are mainly performed as knowledge input to several areas of physical as well as economic planning. This makes them less useful for our purposes.

From a historical-sociological point of view, the most striking aspect of transport and mobility is probably the way it is taken for granted. Clearly, the very large increase in mobility of the 20th century as well as the gigantic technological apparatus set up to provide the required amount of transport, constitute a very influential social drama. Nevertheless, this drama is only hinted at in most work in general sociology or social theory. This probably reflects that physical mobility is perceived as a derived quality, as something performed to achieve other goals, and thus not very interesting. However, one might also suggest that social theory in this respect falls victim to the widespread instrumental fallacy of reducing mobility to transport needs.

[2] It should be noted that we have not tried to make a comprehensive review of the research on transport issues. This literature is simply too vast and too varied to make such an exercise meaningful, not to say doable. We have made use of standard search techniques, using various combinations with "mobility" as the search basis, but this gave a rather modest result. Just to use "mobility" raised other problems, because there is a substantial literature on social mobility that raises a very different set of issues. Thus, we have supplied the computerized search with inputs from previous studies of auto-mobility, as well s a computerized searches using the citation snowballing potential of the ISI database. The paper has no pretensions of giving a complete picture, but - given the professional departure from history and social science - the review should be reasonably broad in its coverage of different approaches and research traditions.

An interesting expression of the way transport and physical mobility is a doxa of social theory, is Anthony Giddens' analysis of modernity (1990). The phenomena he is concerned with, like the change of meaning of time and space, the dialectic of dis-embedding and re-embedding, the circularity of the universal and local, clearly depend on the socio-technical system of mobility. However, the nature of this system is neither explored nor problematised. It disappears in the process of abstract analysis.

In contrast, available historical literature provides important insights. Flink (1988) is perhaps still the best overview, providing an analysis of the role of the motorcar in the development of modern US society. Clearly, this story has to be concerned with the growth of the gigantic car manufacturers, but other aspects are as important. Above all, the construction of the infrastructure, in particular the system of roads and highways, is important. On the other hand, Flink reminds us that we have to keep in mind the establishment of what he calls the automobile-refrigerator complex, a new practice of shopping and management of food supply to households, and thus a quite dramatic change is the organization of everyday life:

> *By midcentury, the automobile had become, to the American housewife of the middle classes, what the cast-iron stove in the kitchen would have been to her counterpart of 1850 - the vehicle through which she did much of her most significant work, and the work locale where she could be most often found* (p. 164).

There is an strong relationship between industrial development and evolving socio-cultural practices that has to be studied.

Clearly, the analysis of mobility and the underlying causes of mobility demand should be undertaken on a broad scale. For example, Nijkamp et al. (1990:22-24) argue that such a study should be undertaken through reference to four broad themes:

- socio-economic context analysis, that focus the attention of the influences of exogenous socioeconomic conditions upon spatial patterns of interaction
- technological context analysis, that deals with the implications of changes in the technological "environment" upon the spatial behaviour of individuals or groups in our society
- behavioural analysis, that focus attention on motives, constraints and uncertainties facing individuals, households and groups when taking decisions regarding transport, communications and mobility
- policy analysis, that concerns the evaluation of actions, usually policy instruments or measures of decision making agencies regarding transport.

They find that the growth in demand for mobility is related to demographic and household changes, including an increase in labour market participation, particularly amongst women. The rise in personal income, combined with the evolution of car habits, is also of prime importance. However, the impact of technological change and policy is found by Nijkamp et al. to be rather ambiguous, with no clear-cut pattern of relationship.

The kind of argument provided by Nijkamp et al., is more or less shared by most authors that address the issue. It locates the dynamics of demand for physical mobility in the socio-economic development and structure of modern society. To a considerable extent, this makes a long-term growth in mobility unavoidable, even if it is problematic to manage. Regulation is mainly possible to influence the way mobility is practised;

public rather than private transport, limiting traffic in certain areas like city centres, and managing the temporal and spatial characteristics of traffic flow.

A possible contrast is of course the literature that voices criticism of the role of the motor car and the high priority given to mobility concerns in modern society. This tradition includes such work as Mumford (1961, 1963) and Jacobs (1961) who bluntly argue that modern traffic is destroying modern cities. There is also the consumerist argument that cars are too expensive and of too low quality (e.g. Nader 1965), and the environmentalist view that cars consume too much resources and pollute extensively (e.g., Schneider 1971, Renner 1988, Lowe 1990, Zuckerman 1991, Nadis & MacKenzie 1993). Finally, one may add the analysis of cars that emphasizes the economic interests related to the widespread use of automobiles, and how this has been facilitated through the demise of public transportation (e.g., Wolf 1996).

The explanations of mobility demand in this literature vary. A comprehensive view is found in Kay (1997). She shares the view of many car critics that the modern car represents a kind of technological imperative (Ellul 1964), a logic that seems to evolve on its own, with few if any alternatives. However, Kay also identifies the following factors:

- present land use policy that tends to spread houses, workplaces and service institutions over wide areas, thus planning for people to have great need for physical mobility
- the low quality and availability of public transport
- the cheapness of driving, due to extensive public subsidies of the infrastructure and the "hidden costs" of cars.

If one compares the approach of, e.g., Nijkamp et al. with the approach of, e.g., Kay, there is of course a striking difference in the style of argument and writing. However, perhaps surprising, there is a considerable overlap in concerns as well as in explanations. This suggests that it may be less fruitful just to juxtapose "critical" and "non-critical" approaches to mobility, but rather to look at more specific agendas. We have chosen to focus on the following:

- socio-economic issues of transport and mobility
- historical and political-economic aspects of transport and mobility
- mobility, land use and urban planning
- mobility habituation and its cultural underpinnings
- new technologies, transport and mobility.

Of course, this choice as well as the following discussion is flavoured by an intellectual point of departure in history and sociology as well as in science and technology studies.

Some concerns cut across the above-mentioned issues. In particular, there are environmental considerations and policy affairs. Environmental arguments, at least when they are extended to include the quality of urban life and city planning, are the main reasons to ask critical questions about mobility, independent of the approach used to pursue these questions. Without such arguments, mobility would be mainly a technical problem of flow management.

Policy affairs are a different matter, and they have a somewhat paradoxical role in the mobility discourses. Clearly, the work on mobility is meant to influence policy, and a lot of it is motivated to improve the knowledge base of transport planning and mobility demand management. However, this means that often, policy is sidestepped as an object

of analysis. One makes observations about deficiencies in present policy measures, but these deficiencies are mainly analysed as planning problems (e.g., the use of insufficient or wrong measures, discoveries of "side-effects" of the measures applied, etc.). The problem is within the professions of planning, rather than in the policy forming process. Also, the critical literature on cars often purveys a simplistic image of policy as a monolithic field of insiders and outsiders, rather than as a process filled with struggles and disagreements.

2.3. Addressing transport, analysing mobility?

As indicated above, the literature review could not be performed as simply a review of the state of the art of mobility studies because mobility is not the major focus of most of the relevant literature. A review of the state of the art of transport studies or the history and sociology of cars would not be appropriate either, because that might move the focal point away from mobility. In the discussion of the "main currents of thought" below, we have mainly tried to give an outline of how mobility is approached and through which terms it is analysed, rather than to identify "the research front" of each topic.

2.3.1. Socio-economic dimensions

The literature that elucidates the socio-economic dimensions is very large indeed. It represents the most common approach to the analysis of mobility and transport, and probably also the one that is best developed (see, e.g., Cole 1998, Oum et al. 1997, Button 1993). From this point of view, transport is basically an economic activity that reflects the economic conditions of mobility as well as its economic role, to be analysed by standard micro-economic methods and theories (see also de Rus & Nash 1997). The long-term increase in transport activities found across the industrialised world is an expression of, and a condition for, economic growth. Thus, increased mobility is a necessary part of modern economic development.

This is evident from many economic indicators, for example infrastructure investments, cost of public infrastructure agencies, transport costs as part of private consumption expenditure, and the level of employment in the transport industry (Bjørnland 1997). The long-term growth is found in personal mobility as well as in the transport of goods. The latter development is of course also a reflection of the growth of international trade.

There are a lot of sophisticated efforts to model transport demand and forecasting, including studies of transport costs, pricing of transport services and price elasticity, as well as studies that evaluates policy efforts to affect transport systems (de Rus & Nash 1997, Oum 1997, Button 1993). However, we will not enter detailed discussion of the findings since this literature is less relevant from our point of view. This is due to the fact that transport economics is only marginally interested in the broader issue of mobility as a political and cultural phenomenon.

Nevertheless, there is the interesting point made that transport often is a derived demand, rather than a good in itself (Verhoef 1996, Cole 1998). Cole mentions some exceptions, like two-hour Concorde 'supersonic experience' flights around the Bay of Biscay (p. 18), but the main conclusion is that *Transport is a service rarely in demand for its own characteristics* (Cole 1998: 17). Nevertheless, when he lists six major factors that affect demand: physical characteristics of what is to be transported, price, relative prices charged by different modes or different operators, passenger income,

speed of service and quality, this allows us to see that transport as well as mobility cannot be analysed in a purely instrumental, objectivist mode. In particular quality is very much a subjective dimension.

Transport has for a long time been a public concern, and as noted by Bjørnland (1997) it has been one of the best sheltered sectors of modern economies. This makes it difficult to assess the economic efficiency of transport system, in particular because there are many hidden costs and subsidies. Nevertheless, economics has provided a much-used tool-kit to regulate transport and mobility, namely taxes and relative prices. One example of this is road-pricing schemas that are thought to be efficient means of creating more "optimal" flows of traffic in time and space (see, e.g., Jones & Hervik, 1992). The elegance of relative prices as a means of regulating traffic lies in its assumed ability to influence the logic of the decision-making of individuals without interfering with their ability to cater economic optimisation. The continued growth of personal mobility in the face of increased usage of transport taxes suggests that the tool-kit is not as efficient as economists may want us to believe. *When formulating regulatory road transport policies, it should never be forgotten that the demand for road transport is a derived demand. Unless sufficient adaptations take place in the factors behind that demand ..., direct regulation of road transport is likely to be frustrated by inelasticity of demand, which lowers the social feasibility by increasing the distributive impact of regulatory taxation relative to the efficiency impact* (Verhoef 1996:248, see also OECD 1997). However, there are other ways of applying transport economics, for example in the performance of cost-benefit analysis of infrastructure investments, the so-called 'integrated transport policy' of combining different transport modes, and direct regulations (Cole 1998, 241 ff).

By way of conclusion, we find the observation that mobility is embedded in economic growth as very important, even if the argument is based on historical data and cannot be taken as a statement of a necessary relationship. The understanding of transport as a derived demand rather than as a good in itself is important also as a way of characterising mobility (even if there are important modifications to this thesis). Further, there is no doubt that the organisation of economic activities like industry and trade and the economic evaluation of transport options have a large impact on the level of transport as well as on the choice of transport channels. However, the fact that the economic system has a great influence on transport raises new questions about the historical emergence and long-term social shaping of the current mobility pattern. How come that transport, in particular by car, gained such a large economic and cultural importance?

2.3.2. Historical and political-economic aspects of mobility

Historical studies of mobility and car-use do not challenge the observation that transport is related to economic development, but they provide us with different insights in the dynamics of the sector. In particular, historians have emphasized the role of politics in the shaping of mobility patterns and the transport system by juxtaposing public transport, in particular railways, buses and urban transit systems, and the private mobility based on the use of cars.

Flink's (1988) study is perhaps the most comprehensive analysis of the emergence of the American car culture. Here, the automobile manufacturers are the most important players as he maps out their various strategic moves to give the motorcar its dominant

role in US society. The success of these moves, however, depends on the interplay between economic interests, politics, and culture. The car is not forced upon society, but it is made attractive, not just by itself, but through the development of a system of roads and highways that makes driving more efficient and pleasant, while at the same time, public transit alternatives gradually become less available. An everyday culture evolves, with considerable mobility needs, due to the dispersed physical structure of housing, workplaces, and service institutions, and the emergence of a style of life and human activities that are highly car dependent.

Wolf (1996), in his account of the mainly European history of transport, compares the development of the railway and the car system. His argument, basically similar to Flink's, is that the railway system lost out as an alternative to the car because of political decisions. According to Wolf, the car system was chosen because it gave greater possibilities for profit. The car system offered much better prospect for private industry than the public railway system. In addition, Wolf maintains that the car is better suited the culture of capitalism, a culture that produces unfulfilled needs, alienation, and powerlessness that somehow may be overcome by car use and ownership.

Whatever framework one may want to apply, it is clear that the large car companies have been strategic actors in the production of the modern pattern of mobility. From the turn of the century, they put a lot of efforts into making cars cheaper and more generally available. Large marketing efforts helped to establish them as a prime and branded good of modern society (see, e.g., Tedlow 1990). The companies lobbied for more and better roads (Flink 1988). However, here they found the community of highway engineers more than willing to be of service (Seely 1987). In a country like Norway, without any car manufacturing, highway engineers played a decisive role in the establishment of the car-based system of mobility so characteristic of modern industrialised societies (Østby 1996, Sørensen 1991).

The integration of the car also meant that the car became part of political programmes of modernization (Ling 1990, Østby 1996) as well as a constitutive part of modern urban planning (Bottles 1987, Wachs & Crawford 1992, Thomassen 1997). Thus, while one should not underestimate the political and economical influence of the large car manufacturers, the political economy of modern mobility is more complex in its anatomy that just the car industry. Arguably, the car had properties that were particularly well suited to be translated into a wide set of political, economical and even professional interests. These translations need to be considered more carefully in order to understand their dynamics and their influence upon mobility.

As should be expected, the historical literature suggests a succession of mobility regimes, from the low mobility regime of pre-modernity through the transitory regime of canals and railways, to the car-based high-level mobility regime of the post 1945 period. However, to understand the nature of the latest regime, we need to explore other approaches as well. In particular, there are two sets of arguments that need to be considered more carefully. First, there is the role of physical planning and the meaning of the physical structure of modern industrialised countries. Have modern societies been built to crave mobility, and has this resulted in a technological entrenchment of a high level of mobility? Second, there is the issue of the cultural underpinnings of mobility. Is there a culturally produced pattern of mobility that shapes not just the amount of travel, but also how travel demands should be met?

2.3.3. Mobility, land use and urban planning

The development of railway systems around cities facilitated the emergence of sub-urban housing. It meant that the middle class could live in countryside-like housing areas, away from the unhealthy and immoral cities, while still working in them (Tarr 1988). This introduced a spatial differentiation between work and home that could only be overcome by increased mobility.

However, it was the idea of the private car that really accelerated this process. In North America, cities were transformed to allow large highway systems to go through them (Flink 1988, McShane 1994). Most European cities have not allowed such drastic changes, but the overall pattern is clear. Urban planning began to have the private car as a basic premise of mobility, and this allowed an idea of urban space as dispersed and widespread. Cities could be made to enable distinct functional specialization of areas, as industrial spaces, shopping spaces, residential areas, and so on. The precondition of the flexible mobility of the private car also came to be a necessity. Increasingly, urban life demanded a car-based mobility (Wolff 1996, Kay 1997). The paradox is striking. To allow people to live in green residential areas outside the cities, ever more land had to be used for roads and highways, leaving less and less green areas for housing.

Increasingly, this paradox has been noted in the literature, and urban planning research has explored the nature of the relationship between car use and the spatial structure of cities (e.g., Banister et al. 1997, Banister 1996, Kenworthy & Laube 1996, Newman & Kenworthy 1989, 1996). Several studies have demonstrated a strong correlation between population density and car use, or urban form and automobile dependency (e.g., Handy 1996, Næss et al. 1996, Næss 1995, Bieber et al. 1994). Literally, modern cities have an in-built demand for car-based mobility that cannot easily be dismissed. This has of course many consequences for the nature of modern urban life and the culture of cities (Whyte 1988).

The lock-in between urban form and car use is not unavoidable. There is a wide set of actions possible to change the link between urban form and car use, not just by replacing private mobility by public transport, but also by circumventing the growth in mobility demand (Hensher 1993, Bieber et al. 1994, Newman et al. 1995, Newman & Kenworthy 1996, Banister et al. 1997, Hall 1994, Bartholomew 1995, Marshall 2000). The latter set of actions includes efforts to increase housing density and to reverse functional specialisation of urban spaces. In addition, the issue of transport costs and relative prices is being raised also in this literature. For example, Newman et al. (1995) argue that these concerns need to be integrated in physical planning. Also, there is some hope that new information and communication technologies may help to make traffic more efficient, or even to reduce the need for physical mobility.

The strong link between urban form and car use is not a display of technological determinism. Many of the authors cited above argue that the relationship is embedded in widespread ideas about urban living and lifestyles that reinforce the demand for physical, car-based mobility. Thus, culture and social values need to be considered and maybe reformed if one wants to reduce the present level of car dependency (Newman et al. 1995, Bieber et al. 1994).

2.3.4. Mobility habituation and its cultural underpinnings

Physical mobility, as noted, increased very substantially in the 20th century. In Western Europe the major part of this increase took place after 1945, linked, of course, to the growth of car ownership in the same period. Nevertheless, it is important to note that the large demand for personal mobility is a fairly recent phenomenon. As discussed in the previous sections, this reflects economic growth as well as changes in urban form, but it is also an expression of cultural processes. How come that the present level of mobility is so seldom problematised, so often taken for granted? Why have modern men and women so easily adjusted to increased physical mobility?

The latter question could, as previously indicated, be addressed in an abstract manner by reference to the experience of modernity. This is an experience that is about movement and where mobility is a very basic constituent (Bermann 1983). Modernity means growth and change. Thus, increased mobility fits very well with the trajectory of modernisation in the Westerns societies also in a cultural sense.

However, much of the work on cultural aspects of mobility is mainly exploring the car as an object of cultural studies. We get to learn that the car has been integrated into the arts as well as popular culture, as a stage for human actions but also as a sort of actor in itself (Dettelbach 1976, Lewis & Goldstein 1983, Jennings 1990). A particular emphasis has been put on "irrational" aspects of the automobile. Sachs (1992) shows how the car has been an object of desire, an infatuation of modern man - and woman. Thus, there is something immoral about it (Bayley 1986).

Nevertheless, many would follow Henri Lefebvre when he maintains that the car is the leading object of modern society. It controls, he argues, human behaviour in the different spheres, from economy to speech: *The car is a status symbol, it stands for comfort, power, authority and speed, it is* ***consumed as a sign*** *in addition to its practical use, it is something magic, a denizen from the land of make-believe (...) The Leading-Object has not only produced a system of communication but also organisms and institutions that use it and that it uses* (Lefebvre 1971 [1968]:102-103).

To a surprising degree, however, the culturally oriented literature sidesteps the issue of mobility to focus on the cultural qualities of the car as an object. The focus on meaning leads to a concern for the car's symbolic characteristics and its cultural integration (see, e.g., Jennings 1990). This comes across strongly in studies of car-based sub-cultures as well, like Lamvik's (1996) about an American Car Club in Norway and Rosengren's (1994) analysis of a male motoring community in a small Swedish community. These contributions also emphasize the way that the motorcar allows some, basically male, groups to perform a critique of everyday life by breaking away from the bureaucratic routines of their work and households.

Similar arguments may be made about the symbolic nature and importance of other transport technologies. Dimendberg (1995), for example, shows how movie images of roads and highways portray the technology in a romantic fashion and supports what he calls "the will to motorization". In this way, we may be lead to believe that it is the technologies of mobility, rather that mobility itself that constitutes the modern culture. However, both Lamvik and Rosengren show that the act of moving around is an important aspect of the car-based sub-cultures, even if it is the cultural qualities of the cars (American cars or the Volvo Amazon) that are the defining properties. Baudrillard makes a similar, poetic observation as Lamvik, that American cars produce a different

experience of driving than European: “The way American cars have of leaping into action, of taking off so smoothly, by virtue of their automatic transmission and power steering. Pulling away effortlessly, noiselessly eating up the road, gliding along without the slightest bump ..., braking smoothly, but instantly, riding along as if you were on a cushion of air, leaving behind you the old obsession with what is coming up ahead, or what is undertaking you” (Baudrillard 1988:54). If we move further into the kind of cultural statements made by Jack Kerouac in his famous 1957 novel *On the road*, we learn that mobility as well as the vehicles of mobility is important. “Road novels” support dreams about movement even more than dreams about cars.

The cultural integration of the car as an object and mobility as routine practice may of course also be observed from studies of everyday life. One of the most telling descriptions is found in the perhaps most famous of the sociological community studies, Helen and Robert Lynd’s analysis of “Middletown” from the inter-war period. They cite people who say they rather would have a car than food, and they conclude:

> *If the word ‘auto’ was writ large across Middletown’s life in 1925, this was even more apparent in 1935, despite six years of depression. (...) Car ownership was one of the most depression-proof elements of the city’s life in the years following 1929 - far less vulnerable, apparently, than marriages, divorces, new babies, clothing, jewellery and most other measurable things both large and small. (...) (S)ince 1920, the automobile has come increasingly to occupy a place among Middletown’s ‘musts’ close to food, clothing, and shelter* (Lynd & Lynd 1937:265-67).

When the car became a must, it is because mobility becomes a must. It may be argued it was “accidental” that the car became the prime vehicle of mobility (Wolf 1996), although it should be noted that this accident in many ways was in line with dominant features of the modern liberal ideology: *When given choices ... most Americans act so as to preserve family life and family autonomy. The single-family home and the private ownership of tools are social institutions that act to preserve and to enhance the privacy and autonomy of families* (Cowan 1983:150). Americans may be more strongly embedded in this ideology than Europeans, but probably not much.

The establishment of a practice of high individual mobility, based on the private car, thus seems to be in tune with the ideology of individualism. One might even argue that the automobile helped to change the ideas of mobility, individuality, and autonomy, and tied them together into a new value complex “automobilism” (Burkart 1994, see also Tengström 1992). However, it is also related to the establishment of new activities, like camping (Belesco 1979), and the transformation of old ones, like shopping, that extend the space that is considered to be within reach. Increasingly, everyday life activities have become demanding in terms of mobility. The domestication of the motor car, its cultural, economic and political appropriation, has intersected so many parts of modern life that mobility has become an integrated dimension of modernity (Sørensen & Sørgaard 1994).

This means that to be brought up in modern society means to be socialised to cars and individual mobility (Hjorthol 1998, Aune 1998). An extended space of everyday life, an individual freedom to move around, has become nearly a doxa of modernity, a more or less taken for granted aspect of a modern lifestyle. Arguably, mobility has become a political right in itself. It seems to have turned into one of the basic freedoms of modern democracy.

Still, of course, the system of mobility reflects pattern of social inequality, including gender. Access to transport is not equal. Children and elderly people use public transport more frequently than the middle-aged, and women more often than men. This reflects inequalities in car ownership (Hjorthol 1998). Also, cars have different meaning to men and women and form the backbone of the construction of gendered mobility practices (see, e.g., Sørensen & Sørgaard 1994, Tengström 1992, Scharff 1991, McShane 1994:149ff). On the other hand, these differences are changing, and the gendering of the meaning of cars is not simply that cars have masculine connotations (Hubak 1996). The importance of cars is not so much along the dimension of have-have not, but rather in terms of the kind of car you drive. The cultural meaning of car-based mobility is increasingly a matter of differences between different brands and models.

The cultural aspects of mobility are complicated and raise many challenges to cultural analysts (Miller 2001). No wonder that the dynamics of the current regime is not well understood, as noted earlier. Clearly, there is a strong cultural basis for the present level of mobility as well as for its particular reliance on the private car. Thus, to change today's mobility practices would imply quite profound cultural changes. That does not mean that changes are impossible. However, to bring about changes, one needs to consider carefully the cultural underpinnings of mobility. In particular, strictly fiscal or technological strategies should be viewed as insufficient.

Of course, the present mobility regime has developed in tandem with changes in technologies related to transport. The main thrust of this process has been growth. Technological innovations have made transport relatively cheaper and helped to increase availability as well as capacity. Since technological change has been a dominating response to the "transport problem", we need to consider the implications of this for mobility.

2.3.5. New technologies and mobility

As previously mentioned, there is general agreement that technological change is important to the analysis of transport and mobility. Nijkamp et al. (1990) include "technological context analysis" as one of their four dimensions of mobility determinants. They argue that we need to deal with the implications of changes in the technological "environment" upon the spatial behaviour of individuals or groups in our society. The conclusion is that these implications are ambiguous. Some innovations are made to increase physical mobility, others, like telematics, have the potential to facilitate a reduction. This observation regarding new technologies and mobility is perhaps the most important one (see Carter 2001).

Hepworth & Ducatel (1992) emphasizes the growing interdependence between transport and information technology. They argue the possibility of a trade-off between telecommunications and transport, but above all, they emphasize the way that new information and communication technologies may be used to change the conditions of performing transport:

- "the logistical revolution", based on the potential for improved planning of transport and electronic document interchange.
- electronic road pricing, which introduces new means of regulating traffic as well as funding the infrastructure
- improved passenger information systems, which may make public transport systems more user friendly.

Much effort has been put into the development of new technologies to improve the efficiency of transport. Road Transport Informatics (RTI) is an interesting example where information technology is developed to improve the capacity of existing networks of roads and highways, and even to reduce the number of accidents (Juhlin 1997). If RTI is successful, it may facilitate increases in mobility, but it may also provide means to reduce it or to reshape the way mobility is practised (Wootton 1999).

The major effort is nevertheless concerned with the possibilities of constructing technological alternatives to or improved versions of the gasoline-driven motorcar. Nadis & MacKenzie (1993) argues that new technology could make cars, and thus mobility, more sustainable through the reduction of emission and less fuel consumption. However, they claim, this potential is not made use of. The automobile industry has for a long time been unwilling to engage in such innovations. Hård & Jamison (1997) maintains that the gasoline engine has become established as the only "real" car engine, through its symbolic power, its embedded-ness in organizational structures, and the strong tradition of behaviour that has developed with this engine and that demands the qualities of the gasoline powered car. Thus, there is a dominant image of the car that makes it difficult to replace by alternatives like electrical vehicles.

This means that any development of an alternative car would need strong political support, either through legislative actions that force the construction of technology to become "alternative" or by the creation of market niches that allows radical innovations to find sufficient demand (Schot et al. 1994, Kemp et al. 1998). There is also the interesting argument that such alternatives need to be developed by outsiders to the car industry (Truffer & Dürrenberger 1997).

The emergence of modern mobility has clearly depended upon the development of different transport technologies, including the car itself as well as road and highway construction (see, e.g., Flink 1988). However, the role of ideas about the advantage of mobility as shaping forces in this development remains unclear. We know that highway engineers already at the turn of the century catered such ideas (Sørensen 1991), but the emerging car industry was seemingly more concerned about the potential of the automobile to increase comfort and to serve as an icon of wealth. The modern mobility regime is not very well explained by reference to the development of new technologies.

However, it is difficult to see that the modern mobility regime may be reformed without the use of new technologies. Since the potential for technology-related changes may be found throughout the whole system of transportation as well as in most human activities generating mobility needs, there are a great number of possible candidates for scrutiny. However, due to the thoroughly social nature of mobility, the analysis of technological options have to be performed in tandem with the study of the economic, political, and cultural dynamics of the present and future regimes.

A particular challenge is to understand the emergent changes in the new perceptions of space, relations, belonging and identity that seem to be emerging together with the present development and appropriation of information and communication technologies (see, e.g., Crang et al. 1999). The ideas of "virtual" social practices, in particular those performed through the Internet, could have considerable impact on the need for physical movement

2.4. Main currents of thought about mobility: Ford, Le Courbusier, Hollywood, and the Highway Engineers

The identification of "main currents of thought" about mobility may be made by reference to the various disciplines and professions engaged in such studies. For most purposes, this would not be very fruitful because the strategy would basically produce just another account of differences between disciplines. Moreover, the number of "main currents" would be impractically large for analytical use. In fact, with a few exceptions where history of technology is the most important, the analysis of mobility is found in a small number of interdisciplinary areas: transport studies, urban planning and the critical discourse on cars. This might lead to the conclusion that there are three main currents of thought about mobility. The first is the so-called *transport problem*, where the challenge is to find solutions to the problems raised by the current, high level of mobility. Contributors may take notice that mobility is influenced by economic growth and the standard of living, but the main concern is to predict and manage increased flows of traffic. This means that mobility is made into a backstage issue, while transport and instrumental reasoning around the transport problem remains the front-stage concern.
The second main current of thought is the *land use problem*, a subject matter particularly for urban planners. They perceive mobility as an interactive outcome of land use, car use and urban form. The main challenge they are concerned about is the possibilities of change of land use policy and the principles of urban planning.

The third and final main current of though may be labelled the *car problem*. This literature takes a critical stance towards the role of the motorcar and the modern dependence on car-based mobility. In particular, the critique is based on observations of pollution, excessive use of resources, and the reshaping of cities into traffic machines. Many authors are also concerned to analyse the process through which modern mobility came to be so car-dependent as it presently is.

Arguably, we could use four metaphors to represent four very important determinants of modern mobility: Henry Ford, Le Corbusier, the community of highway engineers and the movie industry in Hollywood. They highlight four different ways of thinking about mobility and mobility regimes.

Ford is the inventor of the car as an object of mass consumption, to be produced cheaply through the technology of the conveyor belt. Without this invention, mobility would have developed in a very different manner and probably with much slower growth. Many studies argue, explicitly or implicitly, that the car industry was the main instrument behind the shift from public to private transport and the instalment of the car as a modern necessity. Much effort of marketing and lobbying has been made to achieve this result. Today, the economic interests related to the manufacturing and maintenance of cars still are very strong and with considerable influence upon the different dimensions of transport and traffic policies. Mobility is strongly embedded in these interests.

The French architect Le Corbusier may represent the thinking about cities and physical planning that made car-based mobility a chief premise. He emphasised that society needed "a new type of street" that should be a "factory to produce traffic". His *The City of To-Morrow and Its Planning* provides us with the following suggestive images: "(The) sky-scrapers will contain the city's brains, the brains of the whole nation. (...) Everything is concentrated in them: apparatus for abolishing time and space,

telephones, cables, and wireless; the banks, business affairs and the control of industry; finance, commerce, specialisation. The station is in the midst of the sky-scrapers, the Tubes run below them and the tracks for fast traffic are at their base. And all around are vast open spaces. There need be no limit to the number of motor vehicles, for immense parking areas linked up by subterranean passages would collect together the host on wheels which camps in the city each day and is the result of rapid individual transit. (...) One can only come to one conclusion; that the city which can achieve speed will achieve success" (Le Corbusier 1987: 187-89).

This kind of thinking has shaped the physical structures of modern society to sustain demands for flexible mobility, best met by the private car. The problem is not just the way buildings are scattered over large areas, but also the functional differentiation between areas of work, services and residence. Changing the urban and sub-urban landscapes to facilitate a new mobility regime will be expensive and difficult.

The construction work of highway engineers has supplemented the efforts of city planners. Their shared vision of a future with a high level of mobility, mainly based on the use of private cars, has been the basis of self-fulfilling prophecies about the need for more and better roads and extended car ownership. Finally, the cultural industry - with Hollywood as the dynamic centre - has moulded the visions of engineers and architects into attractive as well as profitable dreams about freedom and self-fulfilment through mobility and cars. There have been many communities of actors that have helped shape the society of high mobility.

This means that we should be careful to avoid the uncritical adoption of the view proposed by much of the car problem literature, namely that the present high level car-based mobility is the result of a design by car manufacturers and oil companies to curb public transport. The present mobility regime, with its strong car dependence, has undoubtedly resonated very well with the dreams of most people about autonomous and comfortable transport (Dunn 1998, Sørensen & Sørgaard 1994). Even if one is critical of the way that the car-based mobility has changed the modern landscape and cities and of its environmental impacts, the cultural underpinnings of this practice cannot be easily dismissed.

2.5. Research questions

The review presented in this chapter shows that, given the concerns of the INTEPOL project, the dynamics of the demand for mobility is not very well explored in the available literature. The transport problem approach is too much based on socio-economic indicators to come to grips with the issue, while the land use problem approach is too singularly focussed on land use and urban form, i.e. physical and structural aspects of mobility. Even the car problem literature tends to sidestep the issue, maybe because it does not resonate well with normative ideas that most people should be willing to travel less.

From the latter point of view, of course, it would be important to study whether it is in any case possible to imagine a modern society without cars. The argumentative thrust of this chapter gives the private car a strategic role in the construction of a time-space distanciated late modern society. Does that imply that a radically different pattern of car use with a considerable reduction in physical mobility is inconsistent with our notions of modernity?

This question points to at least three important issues. One concerns the importance of *face-to-face relationships* and the possibilities of transforming such interactions into something which may be mediated electronically, e.g. through telephones, videophones, e-mail, and so on. Could physical mobility be replaced by "telepresence"? The second relates to the potential for a *reconfiguration* of the present, car-based pattern of *mobility praxis*, in particular with regard to the mobility produced through leisure and shopping. Preliminary studies also indicate that another type of cars may imply changes in user praxis. Can we envision a return to a more locally embedded form of life without regaining a pre-modern bounded-ness? The third issue is *the spatial organization of society* and the need to rebuild it. What would be the preconditions of accepting a way of living based on a society, which - in physical terms - is more intimate and connected?

These issues all imply a questioning of the widespread image of modernity as the ever-changing, mobile and globalized system, beset with speed and range, as well as confronting the physical network constructed with the motorcar as its prime vehicle. The obstacles for such changes are not just residing in the solid entrenchment of the car network and our cultural relationship with the car (Sørensen 1992), but also the simultaneous, even more solid, entrenchment of the concept of modernity. To remain with our present constructions of what it means to be modern, we need to come to grips with the problems of private cars in a different manner.

Of course, the literature surveyed in the preparation of this chapter proposes many examples of less dramatic actions. There are efficient policy options to reduce car use in cities (see, e.g., Pucher 1998, Banister et al. 1997, Newman 1996, and Newman and Kenworthy 1996) and to explore the potential of combining direct and indirect (fiscal) regulations with improved public transport (e.g., Kenworthy & Laube 1996, Newman 1996, Hall 1994 and Hensher 1993). Often, such policies are implemented locally and on a basis of perceived local crises of transport and/or environment (Bratzel 1999).

Banister (1997) argues that it is primarily through urban planning that one may reduce the need to travel. However, many if not most authors argue a broader and more complex approach (see, e.g., Wootton 1999, Dutton 1998, Pucher 1998 and Kay 1997). It should be noted that there are examples of successful policies (e.g., Pucher 1998, Newman 1996), and perhaps even more important, that there are considerable country wise and city wise differences in mobility and mobility regimes (Newman & Kenworthy 1996, Newman 1996).

Dunn (1981) contrasts US and European transport policy and concludes that there are three crucial differences:

- the nature of the priorities given to certain transportation modes,
- the scope accorded to market processes in the transportation sector,
- the ends and means of authority exercised in that sector.

Above all, Dunn notes that:

> *Europeans tend to have a different image of the ultimate social meaning of transportation than Americans. While they recognize the need for efficient methods of moving people and goods from one location to another, they are in general not so enraptured by the very process of motion as Americans. They tend to give greater weight to the societal costs of transportation and be somewhat more sceptical of the benefits of additional increments of transportation capacity above what seems adequate to the task* (Dunn 1981:165).

This may make mobility reform a more viable prospect in Europe than in North America.

The development of reform strategies is, as it should be evident from this survey of relevant literature, a controversial matter. Given the importance of values and politics to the evaluation of the car and our present mobility regime (compare, e.g., Kay 1997 with Dunn 1998), we should not expect anything else. However, it is somewhat disappointing to observe the lack of efforts to integrate a concern for reform with a historical-sociological understanding of mobility and an interest in the potential role that may be played by new technologies. Usually, new technologies are perceived as an issue in itself, to be studied with a focus on the processes of innovation or on the barriers to make use of them. The transport problem approach takes the potential on board, but does not make much of it. The land use problem approach neglects it, while the approach of the car problem displays a deep ambiguity towards new technologies. In this respect, the literature surveyed here does not examine the potential of thinking transport and mobility in relation to a policy oriented towards technology that would seek to develop socio-technical strategies of reform.

Having said that, this review has supported the initial assumption about the gains of considering mobility, rather than transport. This allows a much broader focus and, in particular, a greater concern for the way mobility needs are produced and the nature of the mobility regimes that are shaping the conception of the "transport problem".

2.6. INTEPOL issues

Clearly, mobility represents a very important challenge to modern society, in terms of resources, pollution, climate problems, accidents, and popular politics. There is, as noted, a widespread belief that these challenges will be met through the development of new technologies. However, it is by no means clear what sort of technologies that are supposed to carry the day, nor can we find any convincing indication of that proper strategies to influence development of relevant technologies are under way.

This raise some interesting questions to the idea that technology is socially shaped. Social shaping implies that there are actors and interests that influence decisions to make on or the other design. In the case of transport, there seems to be an abundance of actors and interests to the extent that the social shaping process appears either as over-determined or as contradictory.

Consequently, it is important to investigate the way that mobility concerns and interests enter technological development in the transport sector, and in which way mobility is conceptualised in such instances. In particular, we want to see if there are changes going on related to the understanding of mobility and the way it is supposed to be managed.

Of course, this raises important issues about technology policy and the way such policies are understood and practised. For this reason, we have found it necessary also to review relevant literature on this topic. It is to this task we turn in the next chapter.

Chapter 3

TECHNOLOGY POLICY DISCOURSES - Dimensions for Thinking about The Social Management of Technology

3.1. A tricky object

The previous chapter identified three main currents of thought about mobility:

- the transport problem
- the land use problem
- the car problem.

While acknowledging their importance, we also made critical remarks about the lack of concern for technological options as well as the tendency to reify mobility needs and traffic growth. Furthermore, the question about the possibility of developing a radically different pattern of car use with a considerable reduction of physical mobility reminds us about considerable socio-political challenges. These challenges become particularly pressing in the light of the environmental problems related to the current practice of car-based mobility.

When we turn to technology policy as an arena where we assume such issues may be explored, it is with the expectation that this field of inquiry offers insights that may help to explore strategies to counter the problems we identified in chapter 2. In line with our assumption that technology is an important part of such strategies, but not a strategy in itself, we are particularly concerned with the ability of technology policy to integrate social and technological dimensions.

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 (see, e.g., Brooks 1986).

Work performed through OECD came slowly 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 economy. 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 encountered other political aims as well (Freeman et al. 1991, Branscomb 1993, Elzinga & Jamison 1995).

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 (see, e.g. Freeman 1974, Encel & Ronayne 1979). 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.

This chapter will provide a brief overview and analysis of technology policy studies. For this purpose, we will use the framework of science and technology studies (STS) partly as a tool for a critical assessment of the state of art, partly to suggest a broader agenda of issues that needs to be pursued in our project. The main challenge is to provide concepts and dimensions that may be used in the empirical analysis of concrete examples of the exercise of technology policy in the transport area to cope with the challenges of mobility.

As indicated in chapter 2, there is an increasing awareness in transport studies of the need to explore innovation and the potentials of new technologies. However, there has been few, if any, academic efforts to analyse transport policy as technology policy. This means that the literature surveyed in this chapter mainly is concerned with technology policy in general or related to industrial or innovation policy, rather than having a focus on transport.

This observation may also serve as a warning that 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 focused on sectors, it is difficult to observe the practice of technology policy because it will be integrated in sector policies. Most public sectors, including transport, 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.

3.2. Technology policy studies - a brief overview

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 (see, e.g., Weimer and Vining 1992). 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.

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 (see, e.g., Kline & Rosenberg 1986, Freeman & Lundwall 1988, Nelson 1993, Edquist 1997). However, to us, 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 extremely difficult to summarise in any 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 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.

In both cases, public agencies have been established in order to cater these 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 major policy 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 needs in the market. 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.
This issue may invoke traditional images of the difference between a "North-American" and a "Japanese" model of innovation. The former is assumed to be R&D-driven, taking ideas from the lab-bench and based on the assumption that users/customers may be persuaded to buy the new invention. The latter is supposed to be user-driven in the meaning that innovation and new designs start out from an analysis of users' needs. However, users' needs are constructed in the development process, for example by integrating proxy users into the design process or by other techniques for simulating user participation. So the asymmetry is not broken, only modified.

There is a different sort of agenda that emerged from debates about industrial democracy in the 1960ies, often referred to as worker or user participation. While this may be perceived as a kind of design methodology, in Scandinavia the concept of participatory design has entered into the system of tariff agreements as well as the legal regulation of working life (Sørensen 1998). While the efficacy of these ideas is debatable, they may at least remind us that there are democratic concerns and practices in relation to technology policy that we need to consider.

The previous discussion mainly treats technology policy from a process perspective, where the important issue is to map and analyse the various aspects of the performance of technology policy, including the perception of its objects. However, we also need to be concerned about the places where technology policy is enacted and the construction of arenas or spaces for such discussion and decision-making. Mainstream policy analysis study policy in hierarchical terms, usually as top-down, eventually challenged by bottom-up approaches. This tends to imply a focus on political institutions, which clearly are of great importance, but their ambiguous relationship towards technology may make them of less consequence. Thus, we may need to be concerned with the construction of other arenas where technology policy is discussed and performed.

3.3. Contributions from science and technology studies

Recently, efforts have been made to use insights from science and technology studies 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 a more realistic assumption of the potentials of new technologies, including the need to combine technological and social strategies in order to achieve particular aims (see, e.g., Sørensen & Williams 2001).

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 we argue that one should turn to science and technology studies (STS) as a different source of inspiration to reformulate and improve the understanding of technology policy (see also Sørensen 2001).

In order to utilise recent work in the field of science and technology studies (STS), we will in particular converse with "social shaping of technology" (SST) and "constructive technology assessment" (CTA). It should be noted, though, that this "translation" is not straightforward. Technology policy studies (and for that matter, science policy studies) 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 also suggests interesting ways of overcoming the divide, see, e.g. Latour's (1996) study of the failed transport system ARAMIS. In fact, there is no reason not to include policy localities into the STS type of analysis, using concepts emerging from STS contributions (see Sørensen & Williams 2001).

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 focused 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 belief in autonomous technology and consequently 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 (Cronberg & Sørensen 1995). In many ways, it is inclusive and rather flexible (see Williams and Edge 1996, Sørensen and Williams 2001). 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 on the one hand, relatively independent of its socio-economic context. On the other hand, 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 away from such assumption, 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 (Bijker et al 1987, Latour 1987, Law 1991, Bijker & Law 1993). 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* (Sørensen 1996).

One effort to integrate a perspective that emphasises such temporal change is the field of 'constructive technology assessment' (CTA). CTA seeks to 'broaden' the process of technological development in its early stages so that the problems that various actors may have with specific characteristics become visible early on. If this information is fed back into the design process some possible societal problems, that would have been hard to counter once the technology would have become established, could be avoided. From this point of view, it is important both to create arenas of learning (social experiments) as well as to communicate the outcome (see Rip, Misa & Schot 1995).

From a narrower analytical point of view, 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 (1962) called the phenomenon *learning by doing*. A related phenomenon is *learning by using*. Rosenberg (1982) 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 backwards. To innovate successfully, producers may depend critically on information from users, and vice versa. This is the basis of the idea of *learning-by-interacting* (Andersen & Lundvall 1988).

Learning-by-interacting is affected by systemic qualities of a given regional or national economy, even by international relations. Channels of communication, codes of conduct, and conceptualisations may develop over time and may also be the object of public policy. Some stability in inter-firm relations is also needed, in order to provide necessary preconditions for the stable forward and backward linkages needed to perform learning-by-interacting (Andersen & Lundvall 1988). From this perspective, the system of production may be seen as a system of learning or a *learning economy*.

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 (see Jasanoff 1990).

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 (Sørensen 1994).

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, but also 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.

That observation demands a different understanding of and greater concern for what users do. To make use of the insights emerging from studies of social learning, one has to transcend at least simplified (and simplistic) beliefs in the market as a mechanism of communication. To quote Hirschman's (1970) frame of reference, the consumer has often - in particular in mass markets - only a choice between exit and loyalty, and thus very limited possibilities of communication with producers/designers as well as with regulators. As noted by some economists, a learning economy demands a greater

stability of economic relations and more developed patterns of communication than those held up by idealised market forces alone.

Fortunately, many companies see this and make efforts to reproduce user-producer relations, at least on a semi-permanent basis. There may also be need for new institutional arrangements to which governments - locally, nationally, and even supra-nationally - may give decisive contributions. However, there is probably need for policy measures to encourage this form of thinking. Also, even more important, it may be attractive to educate to a greater extent the public about their importance to the development of "appropriate" technologies, the importance of their critical judgements, and the aggregate impact of the way they domesticate technologies.

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 socio-technical 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. Key concepts here may prove to be entrenchment and domestication of technology.
- 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. Socio-technical 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.

Also, recent contributions within STS suggest that one needs a particular focus on:

- Constituency building and translation of scenarios/vision/leitbilder, in the context of technology policy formulation as well as in concrete technological projects.
- The configurative ability of technologies, for example their ability to help institutionalise new patterns of human action.

What appears to be particularly important, is to do away with preconceived notions of hierarchically organised levels in relation to technology policy. We believe we have to start out with a concept of *localities*, rather than levels, in order to be sensitive to autonomous innovation and reversals of traditional hierarchical relations. This means that the traditional distinction between top-down and bottom-up strategies has to be

transcended. What becomes important is the linking and non-linking of technology policy localities that may move in many directions simultaneously.

This is for example evident from the efforts to use LNG as a fuel in buses and other public transportation in Norway. Here, we can observe that policy localities include research institutions, Ministry of Transportation, Ministry of Petroleum and Energy, Regional and Local Authorities, Bus companies, and oil companies. While there are some traditions of predefined hierarchy among them, the promotion of LNG appears to follow a quite complicated and rather anarchistic pattern of interaction between these localities (Gjøen, 2001).

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.

3.4. Technological regimes and strategic niches

Few people question that the present traffic and transport regime causes major societal problems and that there is a need for considerable change. Ironically, there is no lack of ideas or technical knowledge to improve the situation drastically. The problems are related to economic, political and cultural barriers. On the basis of general insights from the STS field there are in particular two major obstacles to implement these alternatives in practice:

Different actors have different expectations of what is most promising and what would be worthwhile to make large investments in. This creates controversy and a general uncertainty. One of the consequences is that – lacking consensus – various actors try to minimise the risk of lost investments or prestige by only taking very small steps.

The alternatives have to compete with an existing system that is deeply rooted in society in a variety of ways. Alternatives have to compete with existing infrastructures (e.g. for refuelling), existing modes of production, existing consumer preferences, existing legislation tailored to the current situation that works as barrier for certain alternatives, etc.

To characterise the current situation it is helpful to use the notion of *socio-technical regimes,* which are rule-sets that are build up around a dominant technology and grant it stability (Kemp et al. 1998). Regimes are not static but inherently dynamic. However, the dynamic is severely limited. Within the regime, innovation takes place continuously, but it tends to be conservative with incremental changes. Actors outside or on the margins of the regime are much more inclined to take risks by attempting to introduce radical alternatives. Such radical changes, however, are likely to fail because they do not correspond properly with the rule-set and could threaten various interest groups, or actors who tend to resist such changes.

The latter point reflects a general characteristic of innovation processes, sometimes referred to by the term 'path dependency' or 'technological trajectories' (Dosi 1982), concepts that have been coined to describe the inherent tendency to conservatism in much development of technology. New developments tends to be restricted by existing technology and the way this is socially embedded. Thus, typical incremental innovations lead to what has been called *regime optimisation,* which means that the problems encountered are dealt with by optimising the existing regime in specific directions. A possible alternative is *regime renewal,* which implies much more profound changes. Regime renewal has much more promise to solve the problems at hand but is also much more difficult to realise.

Regime renewal is difficult to realise because a large set of interrelated barriers impedes more radical change. These may include:

- technological factors
- government policy
- cultural and psychological factors
- market factors
- production factors
- infrastructure and maintenance
- possible undesirable societal and environmental effects of new technologies.

Despite these barriers, radical change may still take place because new technologies, when they are not (yet) ready or able to compete with existing technologies, are initially developed and experimented with in 'protected spaces'. Various actors protect these technologies assigning a long term potential to them. These actors are also prepared to invest time, money and/or effort in their further development. Such protected spaces may be called *technological niches*. (Elzen 1999c, Hoogma 2000) These niches may develop to the point that they can be economically sustainable and in some cases even transform an existing regime quite radically. An example is the personal computer that drastically changed office work in less than a decade. The concept of a 'technological niche' should not be mixed up with a 'market niche'. The latter refers to a subsection of a larger economic market with specific characteristics, like the market for advanced sports cars. These characteristics are taken to more-or-less fix the size of that market. A technological niche, by contrast, initially needs 'outside protection' to survive. After a period of development and learning, however, the protection needs to be taken away after which one of the main targets becomes market expansion. Thus, a technological niche represents a specific phase in an innovation process, preceding market development, whereas a market niche represents a specific type of market (Elzen 1999c).

Three major processes are taking place in the development of niches and their relations with existing regimes:

- coupling and changing of expectations,
- articulation (or learning) processes,
- network formation.

Actors in a specific regime (like traffic and transport) have expectations about the potential of various new technologies and they are inspired by these expectations in their subsequent actions in relation to these technologies. In their actions they try to convince others of their own views and try to make them co-operate towards the same ends. If a certain expectation is widely shared between different actors they will all

work in the same direction attempting to realise it. A strong coupling can thus give expectations a self-fulfilling character. We can distinguish three different characteristics of expectations that are important in understanding how they determine further developments:

- *robustness*: an expectation is more robust when it is shared by a larger variety and number of relevant actors;
- *quality*: an expectation is of high quality when it is supported by ongoing developments (innovations that have been demonstrated; co-operation between important actors);
- *specificity*: a specific expectation (for example "electric cars will be suited for commercial traffic in cities") will be realised more easily than an ill-defined one (for example "the future belongs to electric vehicles").

During the process of niche development, societal embedding of the new technology must be realised. Societal embedding implies that the new technology is integrated into the structure and culture of society. This process can be described in terms of a number of articulation processes, also referred to as learning processes. These processes can be seen as an attempt to overcome the various barriers listed above. The following articulation processes can be distinguished:

- *technical aspects and design specifications*: required adjustments, potential for economies of scale, overcoming initial limitations;
- *government policy*: what changes in fiscal policies and other legislation are necessary to stimulate use of the technology?
- *cultural and psychological meaning*: which symbolic meaning can be given to the new technology? For example, can it be labelled and promoted as safe, environmentally benign and/or modern?
- *market*: for whom (which users) is the new technology produced and what are these consumers' needs and requirements?
- *production network*: who should produce and market the new technology and fuel?
- *infrastructure and the maintenance network*: which complementary technologies, capabilities and infrastructure must be developed and by whom? Who takes care of maintenance? Who is responsible for recycling or waste?
- *societal and environmental effects*: what effects does the new technology have on society and the environment?

A niche will require the formation of a new network of actors: networks of producers, users and third parties have to develop around new technologies, together sustaining their development. The chances for a new network increase when (Elzen et al. 1996):

- certain actors in the network are willing to put in a lot of effort, sometimes working against the trends in the existing regime, to complement the network;
- the capacity (for example financial- or R&D capacity, legislative power) of the actors already involved to reach their aims is greater;
- the activities of the involved actors are better tuned to each other;
- the already existing network is closer to success; the actors in the network will then make a greater effort.

Under the right circumstances, technological niches can develop into new regimes or drastically transform existing regimes. An important question is how public policies can stimulate this to happen.

The usual classification of policy instruments distinguishes coercive measures (commandments and prohibitions), measures in conformity with the market and social measures. This classification, however, is not well suited as a framework for technology policy as it says more about the characteristics of the concerned measures than about the process of technology development.

New socio-technical regimes do not appear suddenly by 'overthrowing' existing regimes. Arguably, from the perspective discussed here, they are a result of persistent growth of technological niches to the point that they start challenging the existing regime and from there on gradually gain the upper hand. Policies could exploit this by targeting what Rip and Kemp (1998) have called 'modulation' of the existing dynamic. This can be achieved by making intelligent use of technological niches that are present in the regime. By strategic and co-ordinated action, an attempt can be made to put pressure on the existing regime along with stimulation of the development and growth of technological niches.

Above, we discussed three main processes the development of niches and their relations with existing regimes, notably the formation and coupling of expectations, articulation processes, and network formation. To stimulate each of these processes, three strategies can be followed: technology inducement, strategic niche management, and network management.

Technology inducement occurs when technology developers feel compelled by external circumstances to develop and market technologies with specific characteristics. Policy-makers can create such an external environment by influencing the expectations of a specific technology. California's ZEV-mandate (including later amendments) is a good example. This mandate has a strong coercive character but it is also possible to give technology inducement a more rewarding character, using it like a 'carrot' rather than a 'stick', e.g. by creating buyers consortia for new technologies. A third, indirect form of technology inducement is the stimulation of competing technologies (for example by stimulating LPG and/or natural gas vehicles which will put pressure on the development of cleaner diesel technology) and the creation of price advantages for new technology (purchase subsidies, tax advantages).

Technology inducement does not necessarily benefit a specific targeted technology. The California mandate about zero emission vehicles is an important example. Possibly one of the major effects of the mandate has been the development of electric drive-trains in general which the major auto-makers now primarily see of relevance for hybrid and fuel cell cars rather than for battery electric vehicles. Thus, technology inducement often functions as a catalyst for innovation of a wider range of technologies.

New technology still has to prove itself and faces many barriers. Policy-makers can help to overcome these barriers by starting or stimulating socio-technical experiments. These experiments should focus on gaining experience via the seven articulation processes mentioned above. To make these articulation processes lead to a technology that functions in practice, it is necessary to co-ordinate the activities of a wide range of actors. The (policy) approach targeting this co-ordination is called *strategic niche management* (SNM) (Weber et al. 1999).

Learning in experiments should be organised so that the participants get a chance to develop new ideas and try them out. For example, users should be asked not only to fill out questionnaires but also to experiment with their mobility demand. Follow-up should

be given more attention than is often the case in current practice, as well as making the findings accessible to others that might be interested in comparable issues. Therefore, pilot and demonstration projects are a central part of SNM.

Actors with vested interests in other technologies will generally not be interested in stimulating a new, competing technology. Such actors may participate for defensive reasons but will rarely show any real initiative. To let a niche grow, specific new actors must be involved (for instance entrepreneurs who believe in a new technology) and the activities of existing actors and their interactions must be changed. New network relations should be developed in which the new technology can function as desired. *Network management* should help such a network to come into being and guide the establishment of the relations needed.

We could say that technology inducement primarily attempts to influence developments in the existing regime, either to push it in a specific direction (e.g. to lower vehicle emissions) or to improve the chances that niches develop and grow. Strategic niche management focuses on the niches themselves. Network management is necessary to make the niches survive and develop but also to create the links with the existing network via which the niches may eventually transform the regime.

Thus, we can distinguish two groups of basic technology policy strategies to move towards a sustainable transport regime. The first strategy, technology inducement, seeks to put pressure on the existing regime to move in a predetermined direction by trying to achieve rather well defined objectives. By itself, this approach typically leads to optimisation of the regime in the short term.

Strategic niche management (SNM), by contrast, is primarily an exploration strategy for possible alternatives in technological niches. The emphasis is on learning rather than on short-term change. It focuses on alternatives that do not fit the existing regime but that do have certain characteristics that make them promising in relation to problematic aspects of the existing regime. An example at the vehicle level is EVs that have the potential of very low chain emissions when combined with sustainable electricity production. At the level of transport concepts various types of inter-modal chains are examples.

The three abovementioned strategies, technology inducement, strategic niche management, and network management, do not represent an easy solution to the problem of instigating regime shifts. Technology inducement is often not viable, and strategic niche management may run the risk of protecting the wrong developments or miss out on the timing when the niche strategy should be stopped. While we may recognise the challenges related to protect new technologies so that may challenge established ones and support the phasing-out of established, efficient, but unwanted technologies, it is not easy to make the right choices. Moreover, of course, there is the issue of how such choices should be made and by whom.

3.5. Experts, social movements and technocratic fallacies

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 (Feenberg 1999).

Jasanoff (1990) 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.

Such criticism has been raised from social movements for several decades, not the least related to transport and its environmental impact. Highway authorities have been severely taken to task as unresponsive to popular protests related to highway plans and similar projects. To some, highway authorities were the incarnation of technocracy in modern society (see Østby 1995).

Such concerns are surprisingly absent from the discourse on technology policy that has been reviewed in this chapter. In fact, one might argue that there is some technocratic persuasion even among the social scientists working with technology policy. This is due to their eagerness to offer expert advice without considering the democratic context of decision-making. We need to be sensitive to technocratic practices, not just in the analysis of transport technology policy but even in our efforts to develop alternative strategies.

3.6. Towards a new architecture of technology policy?

The INTEPOL project started from the observation that there were serious defects in traditional technology policy, not the least in its application to transport. In particular, we made the critical note that traditional supply side measures in technology policy were too technically oriented. They tended to transform all problems into technological challenges. On the other hand, traditional demand side measures tended to be too narrowly focussed on social measures. Above all, there has been and still is a strong tendency to transform all problems into issues of relative prices. Thus, the main policy tool to influence developments in transport becomes taxes.

However, as the review in this chapter has shown, there are interesting and promising theoretical concepts that may provide an intellectual basis to rethink technology policy in a way that redresses the simplistic choice between either technological or fiscal measures. On the basis of a combination of ideas coming out of evolutionary economics and the new history and sociology of technology (STS), it is possible to see the contours of a different paradigm of technology policy. The issue is how this paradigm may be described, what challenges we may identify as important tasks to improve it, and how it may be made use of. Our task is primarily to explore different sorts of technology policy practices, to analyse what may be learnt from them and to study the circumstances under which they are performed. This means that we have to be concerned with the scope, the dimensions and the actors of technology policy in transport.

The basic quality of such a new paradigm would presumably be that it is able to integrate supply and demand side concerns into socio-technical strategies where technological and social measures become amalgamated. However, we may not be able

to find instances of such an interactive technology policy paradigm. Thus we have to be sensitive to other qualities as well.

The great achievement of evolutionary economics has been to make concerns for innovation into one of the major policy concerns of modern societies. This has made new technology into a main item on the political agenda. However, the interest in new technology has tended to produce a too narrow understanding of the broader set of challenges facing policy-makers in technology-related areas like transport. The definition of technology policy that we have proposed in this chapter is an effort to transcend these limitations. In fact, we have argued that technology policy covers a terrain that could be summarised as a relationship between the concerns for innovation, infrastructure, regulation and participation. While innovation remains important, we are reminded that policy issues related to technology transcend the interest in the new and the profitable.

The dynamics of the suggested four dimensions of technology policy are of course rather different. The building of infrastructure is a large-scale constructive effort on the part of government, very much characterised by openly political considerations about national welfare, but also about regional interests. Highways are not built for profit, and while arguments about efficiency may be forwarded, they are seldom decisive. Arguably, development of technology is contained within the logic of governmental decision-making, but strongly influenced by professional and institutional interests because of the tendency that the building of infrastructure becomes the responsibility of highly specialised, large organisations like national PTTs, railway companies or highway directorates. This means that development of technology operates on a long time-scale and is shaped by supply-side concerns that users should get want they need (or, more accurately, want they are seen to need), rather than want they want.

Nevertheless, traditional building of infrastructure represents a very interesting challenge in our case because, at least in principle, users participate in the decision-making in the sense that decisions are made by politicians elected by users qua citizens. Thus, we are made sensitive to the fact that elected participators may not mediate the interests of the users because they operate within a logic that may transform these interest or make them irrelevant or invisible.

The regulatory efforts have a different logic because they are mainly oriented towards the shaping of technology through standards, either by *specifying interfaces* between different sort of technology, like telephones and telephone centrals, or by *specifying requirements regarding maximum or minimum characteristics*, for example levels of risk. Regulation is thus not about developing technology, but rather about a *reduction of the space of development of technology* or a simultaneously

In light of the challenge to develop a new paradigm of technology policy, it would be important to note that learning processes related to regulation is highly relevant to the understanding of the way social specifications and specification strategies may or may not work. Traditionally, we may observe that there are distinctly different ways of organising regulatory efforts (see Andersen & Sørensen 1992):

- direct control of quality of technology by governmental institutions
- direct control of quality of technology by private institutions (that may or may not be legally recognised by government)
- indirect control by specifying systems to control quality of technology.

The innovation policy concern, so important in the last couple of decades, operates from a complete different logic. It represents a systematic effort to stimulate the industrial capacity to innovate, through a series of different policy instruments related to R&D, financial possibilities, institutional arrangements, governmental procurement, etc. In contrast to the infrastructure concern, where the aim is to facilitate the flow of goods, people and information through a *provision logic*, and the regulation concern, where the aims is to standardise interfaces and risks through a *policing logic*, innovation policy aims to promote new technologies. Thus, it represents a *pushing logic*.

The fourth logic: that of *participation,* is embedded in democratic ideals and practices. Clearly, technology policy is situated in institutions that are expected to be influenced through popular elections. In that sense, participation is already integrated. However, a lot of popular debate, even popular protest, is concerned with technology. There is good reason to believe that debates and protests have considerable influence, not just when outcomes are seriously contested, but also as a proactive strategy to avoid protests and problems.

Historically, traditional technology policy may have been characterised as a system where the provision and policing logic operate side by side in a rather unproblematic manner. From a provision point of view, it is fruitful, maybe even necessary, that standards are made, regarding interfaces as well as risks, because provision in itself should be standardised. That is because public services are expected to be standardised in order to be fair.

The introduction of the pushing logic of the innovation concerns suggests that building of infrastructure, as well as regulatory efforts, have to be viewed in the light of the way these activities affect innovation. The innovation concern is thus made a part of the thinking about infrastructure as well as about regulation. Building of infrastructure may for example create opportunities for new innovations in the national industry. An example of this is the emerging relationship between the part of electronics industry interested in highway electronics on the one hand, and highway and road directorates on the other. Regulatory activities may facilitate or impede efforts of innovation of national industries, see, e.g., standard setting related to television or mobile telephony.

This makes technology policy more complicated and technology policy constituencies more heterogeneous. Interaction is no longer a problem of liking demand and supply concerns, but also to see how linking processes leads to the transformation of criteria to evaluate successes and failures within technology policy realms.

Finally, we need to emphasise that in order to avoid any technocratic notion about the possibility to have experts fine-tune technology policy, we need the concept of reflexive modernity. This is because technology policy has to be embedded in a concept of reflexive negotiation spaces, rather than rationalist decision-making spaces. In turn, this reminds about the fourth dimension introduced in the beginning, namely public participation.

This notion is not just an effort to include the ideal of direct democracy in the realm of technology policy. Public participation in the development of technology has far too often been turned into a romantic idea that everyone may take part on an equal footing. However, even if one acknowledge the importance of expertise, it remains a challenge to provide public accept, not to say public enthusiasm, for new technological solutions. This means that strategies of public involvement need to be searched for and thoroughly considered.

Thus, 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 the technology will (or will not) 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 more simple 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.

Chapter 4

A KALEIDOSCOPE OF APPROACHES - The Practice of Technology Policy in the Transport Domain

4.1. Introduction

Within the INTEPOL project we have produced an overview of technology policy in a large number of European countries, the EU, Japan and the USA. Emphasis in this overview was on technology related policies in the transport domain. (Deliverable 1; Elzen 1999a) In this chapter we will present the main findings of this overview.

We will not follow Deliverable 1 in the sense that we will produce an overview country-wise but, rather, the various sections will highlight topics of specific interest for the INTEPOL study. We will start by presenting some general findings on technology policy. Next, we will present some general transport trends and challenges that form the starting point for many of the policies analysed. The following section, 4.4, forms the heart of this chapter and discusses the variety of policies used to tackle the transport challenges identified in the previous section. We discuss attempts at local, national as well as EU levels and also briefly present some US approaches that are distinct from approaches in Europe. In the next section we specifically address some characteristics from the policies pursued at the different levels. We summarise and assess the main findings in the final evaluation and in the conclusion identify some main weaknesses of the approaches described. These will form one of the starting points to develop the 'integrated technology policy' which is the main objective of the INTEPOL study.

4.2. General Technology Related Policies

4.2.1. National technology policies

Industrialised nations and their governments have long recognised the importance of technology and technical development for the economy. As economic growth has traditionally be seen as the key indicator of a country's wellbeing governments have sought to stimulate economic growth, partly through innovation policies. These policies hardly targetted the content of innovation but, rather, sought to create a good 'innovation climate' that would help and stimulate companies to innovate in sectors where there expertise lay.

In Norway, for instance, the initial focus after the war was on the traditional strongholds in the economy. From the mid 1980s there has been some move towards a more demand-oriented technology policy. Actors like the 'Royal Norwegian Council for Scientific and Industrial Research' and the 'Norwegian Union of Industrial and Employers' asked for a larger orientation towards the economic market and a regime of 'user control' of research funding. Public funds should only be granted directly to industry. Through demand for new technology, industry should decide what kinds of

research were relevant. This kind of 'demand', however, was implemented via means which in reality remained supply-oriented.

As in many other countries, technology policy in Norway has often had distinctly contradictory and not very well coordinated features. This is partly caused by the way technology policy has been embedded in a regulatory system characterised by Keynesian measures from 1945 until about 1985. This meant that technology policy was seen, partly as unnecessary (because demand would create sufficient opportunities for development and use of technologies), partly as a very segmented and limited exercise related to concrete measures in certain sectors like transport and telecommunications, and partly as protective measures to regulate the use of technologies to minimise risks associated with their use.

These features are only slowly changing, mainly because there are few influential spokespersons for technology on a national policy level. Technology remains outside the standard toolkit of politicians. However, at a sectorial level, there is a greater interest in technology policy. Engineers have a much stronger voice in the transport sector than in politics at large, and the example of road pricing indicates a very interesting amalgamation of economic and technological measures. (Thomassen 1999)

In Denmark, a similar pattern can be observed. Technology policy was traditionally established and developed as part of economic policy, meaning policies to foster economic growth and empolyment rates by increasing the rate of innovation and diffusion of new technologies. Contemporary technology policy, however, is not primarily seen as a part of economic policies, but targets other kinds of problems such as better environmental performance, reducing ethical tensions, producing social equity (equal distribution of skills), changing demographic patterns etc. Thus, technology policy is now seen as policy measures and discussions aiming at transforming technologies, not only for economic purposes but also attempting to influence specific design characteristics.

This change in emphasis in technology policy in Denmark is also reflected in its institutional embedding. From being the exclusive domain of the Ministry of Industrial affairs (National Agency for Trade and Industry) technology policy is now an integrated part of the policies of a range of sectorial ministries like the Ministry of Transport, the Ministry of Environment and Energy, the Ministry of Research and Communication, the Ministry of Nutrition, Agriculture, and Fishing, etc. (Jørgensen and Munch 1999)

In the Netherlands, policy regarding technology initially also targetted economic growth. In the second half of the seventies a two track oriented policy emerged. Next to economic concerns, a need was acknowledged to make technological development fulfill societal needs. Emphasis remained on the former concern, however, with attempts to raise the national R&D budget and sponsorship of research in sectors considered strategic. In the mid 1980s it appeared that there was a serious problem, not so much in the development of new technologies but in bringing them to the market. Another problem was that the interaction between universities on the one side and trade and industry on the other was not as effective as it was assumed to be. This resulted, among others, in the founding of eighteen 'Regional Innovation Centres' that had the task to translate knowledge to small and medium-sized enterprises.

Although the need to address societal needs was frequently mentioned, the measures which were taken were directed at an improvement of the diffusion of technologies and

an improvement of the societal embedding of technology in Dutch society. The focus in technology policy remained on the stimulation of innovation, and society should be massaged to adopt these newly developed technologies. Society should adapt to technological development implying there is much more focus on supply side than on demand side. (Popkema 1999)

4.2.2. EU-level technology policies

Although there are important nuances, general technology policies all through the 20th century have been principally an instrument of economic policy attempting to enhance a countries industrial base in the international competition. This is clearly reflected in the attempts to develop a technology policy at the European level with the advent of the European Union. An explicit desire of fair and enhanced economic competitiveness in the EU has been and continues to be the driving force behind several political initiatives. The strive for competitive ability obviously actualizes economic questions, but it also has political implications.

In 1984 the clustering of specific programmes under a broader umbrella led to the establishment of the *framework programmes*. The framework programmes are multi-annual programmes aimed to coordinate and give strategic direction to the EU's R&D policies and activities (Luukkonen 1998, 601, Nugent 1999, 340). Today the EU is managing its 5th framework programme (FP5).

In 1985 the EUREKA programme came into existence. It was launched not as an EU programme, but as a loose intergovernmental initiative designed "to develop and exploit the technologies crucial to global competitiveness and a better quality of life".[3] EUREKA projects tend to focus more on the development of marketable products and services than on pre-competitive research, as the EU's FPs do. The EU joined the EUREKA in 1985, but in the first years EUREKA was often bitterly critcised by Commission officials, who viewed it as detracting political support for the Union's own programmes (Peterson 1996, 178; Peterson and Sharp 1998, 7f)

With the so-called Single European Act ratified in 1987 and later the Maastricht Treaty in 1993, the Union was finally given competence in research and technology. Both Treaties made it clear that the objectives of EU policy were, first to strengthen Europe's science and technology capabilities, and, second to promote its competitiveness at an international level (Peterson and Sharp 1998, 8). The Treaties meant completion of the single market, and the competitive discipline imposed by this forced national industry to restructure radically. Thus the single market program became the most important instrument of Union industrial policy in the late 1980s (Dinan 1994, 368).

The ongoing FP5 sets out the priorities for the EU's R&D activities for the period 1998-2002. Its objective is to respond to the major socio-economic challenges facing Europe. To maximise its impact, it focuses on a limited number of research areas combining technological, industrial, economic, social and cultural aspects.[4] There are four thematic- and three horizontal programmes, besides the Euratom FP. The titles of the programmes indicate an explicit concern for societal needs, e.g. "User-friendly information society" (IST), "Competitive and sustainable growth", including key

[3] http://www3.eureka.be/Home/, 07.02.2000.
[4] http://cordis.lu/src/i_005_en.htm, 11.11.1999.

actions such as “Sustainable mobility and intermodality” and “Energy, environment and sustainable development”.[5]

Over the past decades there has been an increasing effort to develop a successful R&D policy. However, it seems like there still is a way to go. Among several problems, one is the attempt to establish a common and integrated EU policy. According to Peterson (1996, 182), a “common European interest” in such a policy exists mostly in the Commission’s rethoric. The EU’s R&D policy tools are viewed by member states mainly as opportunities for bringing benefits to their national industries via transnational menus (ibid.). Enhanced competitiveness, the prime objective and driving force behind many R&D initiatives is yet another problem. Compared to the US and Japan, the EU is still lagging behind in the high-tech sector. The RTD programs appears inadequate in this respect, and ESPRIT had only limited success (Dinan 1994, 372). In addition, the total EU research investment is well below that of its major competitors (Peterson 1996, 180).[6]

However, there also has been a positive development. The framework programmes are steadily growing and R&D accounts for more EU funding than any other policy area apart from agriculture and regional development. The EU programmes are furthermore more focused on leading edge technologies or new applications of existing technologies than many of the individual member states (Peterson 1996, 182).

4.3. General Transport Trends and Challenges

Countries in Europe as well as in other parts of the world face a variety of challenges in connection with traffic and transport. Historically, especially since World War II, the growth of mobility has been considered the mirror image of economic growth and prosperity. Gradually, a well functioning traffic and transport system became seen as a prerequisite for a modern society, especially the road-based system with cars to facilitate passenger mobility and trucks for freight transport.

The growth of mobility, however, had its negative sides and public authorities have seen it as their task to tackle these. These include congestion, the emission of locally polluting subtances from vehicle tailpipes and the emissions of CO_2 that contribute to global warming.

4.3.1. Congestion

When initial infrastructures appeared insufficient, public authorities saw it as their task to create more and better roads and to ‘redesign’ cities so that most destinations could by accessed easisly and safely by road-vehicles. After several decades, however, it appeared that the hunger for road and parking-space was insatiable. New infrastructure only seemed to attract new traffic and problems soon re-emerged in a aggravated form. During the 1980s it appeared that the problem had undergone a qualitative change when it became increasingly difficult to find or create space for new roads. Across Europe, transport planners started to acknowledge that, except for specific bottle-necks, new road-infrastructure would not solve the problem.

[5] The programmes have their respective websites: http://www.cordis.lu/ist/home.html, http://www.cordis.lu/growth/home.html and http://www.cordis.lu/eesd/home.html, 07.02.2000.
[6] http://cordis.lu/src/i_005_en.htm , 12.01.2000.

In the meantime, the problem got worse as the demand for transport was and still is steadily growing. Within the EU, traffic has grown more or less constantly for the last 20 years with annual growth-rates of 2.3% for freight transport and 3.1% for passenger transport.[7] The volume of passenger kilometres by car, train and bus in Western Europe has increased by 246% between 1965 and 1989. (Rienstra et al. 1996)

Theoretically, public transport could provide at least part of the answer. Until World War II, public services supplied the lions share of passenger transport in most countries but this changed radically during the 1950s and 1960s. With the rapid expansion of car-use, cars became also seen as a symbol of prosperity and government attention for public transport decreased in most countries. Many services were discontinued although a certain minimum was upheld with government support for those who could not afford a car, for those who preferred riding over driving themselves and to give some relief to congestion problems that already started to emerge. The share of public transport in terms of passenger kilometers dropped to 10-20% in most West-European Countries.

When the structural nature of congestion problems became recognised during the 1980s, public transport rose on the policy agenda in many countries. Investments were planned and made to increase and improve services. At the same time, campaigns were launched to encourage people to make a modal shift, i.e. to use public transport rather than their private car. Although there were some (local) successes it appeared this did not solve the problems in most cases. At the turn of the century, the car is used for about 80% of the passenger-kilometers travelled in the EU[8] and 73% of EU households possess at least one car.[9] During the last decades, road transport has grown significantly more rapidly than train and other public transport, and this trend is even more pronounced in the freight sector than for passenger transport. Forecasts of a doubling of road traffic within the EU between 1995 and 2015 are not uncommon. (Johnson and Turner 1997, 50, 60, Nijkamp et al. 1998, 310)

4.3.2. Polluting emissions

Congestion, however, is only part of the problem. Especially in the 1960s, with the growth of car-use, the exhaust emissions from cars and trucks caused so much pollution that this became recognised as a serious health hazard. Especially the emission of three substances caused problems, notably carbon monoxide (CO), hydrocarbons (HC) and nitrous oxides (NO_x).

To minimise air pollution, the emission of these substances were regulated. Such regulations were initiated in the US especially by the pioneering state of California where air pollution in several regions was extremely poor. Although pollution is especially a local or regional phenomenon, the problem could only be tackled at a national level by forcing carmakers through legislation to produce cleaner cars.

This has been successful to the extent that cars sold at the beginning of the 21st century are an order of magnitude cleaner than cars sold in the 1960s. This does not mean, however, that the problems are solved. Especially the emissions of nitrous oxides (NO_x) remain a source of concern, where transport is responsible for 63% of all emissions of

[7] http://europa.eu.int/scadplus/leg/en/lvb/124040.htm, 10.11.1999.
[8] http://europa.eu.int/comm/transport/tif/5_passenger_transport/ch5_passenger_modal_split.htm also gives the modal split per country.
[9] http://europa.eu.int/en/comm/eurostat/compres/en/6199/6106199a.htm, 07.02.2000.

this substance.[10] While the general trend is that vehicle emissions go down there is also a trend towards more diesel cars that may increase especially the NO_x emissions since diesel cars emit about 2.5 times as much NO_x than gasoline cars.

Furthermore, pollution is not evenly distributed and may get extremely bad at certain locations under specific circumstances, e.g. on a series of consecutive hot summer days in big cities with very dense traffic. Congestion implies a lot of slow-moving or stand-still traffic which increases the emissions per vehicle kilometre driven. Under such circumstances health warnings are given to people with respiratory problems while in ancient cities the effects of pollution become increasingly visible in the deterioration of ancient buildings and structures. Transport planners in many big cities therefore think more radical measures are needed to curb the hareful effects from vehicle emissions.

4.3.3. CO_2 emissions

CO_2 emissions, which are directly related to the use of fossil fuels as source of energy, are not currently regulated. Transport is responsible for 31% of the EU final energy consumption with road transport being responsible for 83 % of this share.[11] As fossil fuels are by far the largest source of energy the share of CO_2 emissions is close to this. In 1997, transport accounted for 28 % of overall EU emissions of CO_2, 84% of which came from the road sector.

Since the concern about global warming became recognised at the political level in the late 1980s the EU has sought to curb CO_2 emissions from the transport sector. In 1995, the target was formulated to stabilise emissions in the year 2000 at the 1990 level. However, In the period 1990-1997 CO_2 emissions from the transport sector have risen 1.7 % per year.[12] There are no firm data yet for the later period of the decade but it is not unsafe to extrapolate this trend which would render a growth close to 20% rather than the targetted stabilisation.

Under the Kyoto protocol most nations have committed themselves to reduce CO_2 emissions in the coming decade although the new Bush administration in the US recently announced it no longer feels committed to these targets. The EU and other nations strongly protested and stated CO_2 reduction should remain a major objective. Also in Europe, however, there are few concrete activities that can be expected to realise this objective.

4.4. Tackling The Problems

4.4.1. Introduction

The problems above have been described at a general, European-wide level. Nationally and locally, however, there are large variations. This is reflected in differences in what lower-level authorities consider as the most important problem and what should receive most attention. This translates into a wide variety of actions and measures attempting to tackle these problems. The following sections give a brief overview of these attempts.

[10] http://europa.eu.int/comm/transport/tif/1_general_data/ch1_overview.htm
[11] http://europa.eu.int/comm/transport/tif/7_environment/ch7_energy_consumption.htm
[12] http://europa.eu.int/comm/transport/tif/7_environment/ch7_energy_consumption.htm

4.4.2. Congestion

Traffic congestion can have a variety of negative effects that put a burdon on society and individuals, such as:

- Slow movement of business traffic (including freight transport) with high economic costs;
- Poor accessibility of business areas with increasing economic costs;
- Extra emissions due to slow-moving and stand-still traffic;
- Nuisance to motorists because of 'lost time';
- Increasing unsafety for cyclists and pedestrians due to increased traffic density and more annoyed motorists;
- Decreasing quality of city life with increased traffic density.

The local manifestations of these problems vary widely due to a variety of reasons including historically grown road networks, lay-out of cities and business areas, available alternatives like public transport services, cycling culture, different interpretations of what is problematic, etc. This has also translated into a wide variation in attempts to tackle these problems. Below, we will give some examples of this diversity under two different general inroads, notably (1) to extend or enhance the capacity of the existing road infrastructure and (2) to stimulate a modal shift and discourage the use of (private) road vehicles.

Infrastructure provision

Until the 1980s most countries sought to facilitate the growth of car-use by building new roads. Gradually, however, transport planners across Europe started to realise this would not solve the problem as expansions of the road network were rapidly saturated again by the growth of car-use. Furthermore, it became more-and-more problematic to find space for new roads, especially in densily populated areas with the largest problems. The result is that across Western Europe road construction is no longer seen as a means to solve congestion problems in and around urban areas and spending on road infrastructures has decreased considerably over the past 15 years. There are still road construction programs but these mostly seek to connect peripheral or underdeveloped regions to the major centres (e.g. in the former Eastern Germany, Spain, Norway).

Another infrastructure focus is the removal of specific bottle-necks by the creation of new links which often takes the form of building of new bridges or tunnels. Such projects can be found across Europe, in several cases supported by the EU from regional development funds or from the Trans-European Network programme (see below). Such projects are also often motivated by a considerable degree of local or national prestige.

To tackle the current congestion problems the emphasis has shifted from building of new roads to making more efficient use of existing infrastructures. Such measures usually take a long time to implement and/or imply that existing roads will not be available for some time. Most of these options are still in the consideration or planning stage. These include:

- Narrower lanes and, hence, more lanes per stretch of road. This will decrease road safety, however. In the long term, automatic vehicle guidance might make this option feasible but this is likely to take several decades to implement on a reasonable scale.

- Use the ‘hard shoulders’ on highways that are currently not available for traffic and used for safety purposes. This also meets with considerable opposition from the safety standpoint.
- More ‘intelligent’ road use via road telematics. The EU as well as several European nations are working on this. Especially Germany has high expectations of this option (Bye and Næss 2001) as does Japan (Hoogma 2001).
- Spread road-use more evenly across the day via selective supply and/or roadpricing.

Across Europe, the road pricing option currently receives most attention. (Melby 2001) This triggers a lot a debate partly because there are various definitions of road pricing in use some of which trigger massive resistance. We use road pricing as a generic term for a variety of measures and practices which involve levying charges for the use of a road. A flexible road pricing scheme would require the direct charging of a fee for the motorist’s use of a given stretch of road at a given time. In principle, there is not much new about this idea. In several parts of Europe, motorists have to pay for the use of highways (e.g. in France and Italy) as well as for using tunnels and bridges. These revenues are typically used to finance and maintain these infrastructures.

In the 1990s, however, the idea to use roadpricing to mitigate transport externalities gained support, especially from the European Commission. The EU supported the idea to levy charges to discourage people to use specific stretches of road, either permanently or during specific time-slots (e.g. during rush-hour or on week-days). Among transport planners there is widespread enthusiasm on this possibility but motorists, their associations and ‘car-minded’ political parties rally against it. Paying for new infrastructure is one thing but paying for infrastructure that has hitherto been free is something quite different.

Nonetheless, in many European countries road pricing remains high on the agenda. Recent technological breakthroughs in automatic road use charging have brought electronic road pricing much closer to reality. These new technologies are moreover being backed heavily in Japan, the US and in Europe by universities, research institutions and powerful industries such as defence, oil, electronics, semiconductor and motor manufacturers; industries which all are looking for new markets. (Marvin and Slater 1997, 307) So far, however, only a few road pricing systems are in operation, while there are a number of electronic toll collection systems in use (e.g. in Norway, Italy, France, and Japan). (Hau 1998, 39)

In most countries considering the issue, road pricing is seen as a general measure to curb congestion that should apply to all traffic, for passengers as well as for freight, for business as well as for private purposes. In some countries, most notably the Netherlands, it is also seen as an option to prioritise traffic that is most valuable to the economy. (Popkema and Elzen 2001a) The main background is that the Dutch (freight) transit sector is large with Rotterdam harbour and Schiphol airport as two ‘mainports’ for freight (as well as passengers). Dutch road hauliers carry 27% of all international road freight in Europe. There is even a dedicated branch/lobby organisation for the transit-sector under the name ‘Holland International Distribution Council’. Especially the city of Rotterdam, being responsible for good connections to the world’s largest harbour, tries to use road pricing to ensure ‘free way’ for freight transport to and from the harbour.

Across Europe, the lack of public support is probably the greatest obstacle for implementing road pricing. It will be a serious challenge to persuade the public that road pricing is an appropriate means to tackle congestion problems.[13]

Although the building of new roads is no longer seen as the general means to fight current congestion, the building of new infrastructures is still high on the political agenda, especially at the EU level. The main reason is that existing infrastructures have been designed and constructed following national needs and priorities with the result that Europe has a transport patchwork rather than network. Furthermore, the patchwork has large holes with various missing rail, road and waterway links.

To remedy this situation, the EU currently puts enourmous efforts and resources in the development of the so-called Trans-European Networks. TENs are modern and technologically advanced infrastructures concerning transport, energy and telecommunications. TENs for transport (TENT) is by far the dominant TEN-sector. (Johnson and Turner 1997, 45)

The aim of the TENs policy is to transform the 15 networks into a single network of European dimension. Bottlenecks will have to be removed and missing links created. Remote and outlying regions of the Union will be integrated into the system. So, progressively, will the EFTA countries and other parts of Europe.

The European Commission has prepared a TENs design which it estimates will cost around 400 billion Euros to realise by 2010. All of the projects in the design have been approved by the Member States concerned and several are already underway while many more are still at the planning stage. Financing is a problem given the very large sums involved so strenuous efforts are being made to attract private capital for many projects .

The Commission's design proposal for TENs defines 70,000 kms of railways, including 22,000 kms of new and upgraded track for High Speed Trains and 15,000 kms of new roads, of which nearly half in the regions on the outskirts of the union, to complete a 58,000 km network already largely built. Further targets include combined transport corridors and terminals, networks of inland waterways and sea ports together with 267 airports.[14]

The application of telematics is essential in the building of TENs for transport. More effective coordination and harmonisation between adjacent traffic management areas is especially relevant in the TEN context. Regarding road transport, the immediate priority is the implementation of a basic interoperable telematics infrastructure for the

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[13] The main stumbling block to public acceptance seems to be how the issue of *equity* is handled (Langmyhr 1996, 1, Jones 1998, 283). Considerations of road pricing and equity should deal with principles for allocating burdens and benefits. The goal must be that road users feel that they benefit from the implementation of road pricing, and that they are "compensated" for their toll payment by satisfying some commonly accepted notion of fairness (Hau 1998, 47).
The Commison's Green Paper on fair and efficient pricing in transport adresses such questions. The objective of the Commission is to ensure that prices reflect costs so that businesses and citizens base their decisions on the right price signals. The principles underlying this strategy are inter alia that charges should be linked as closely as possible to the underlying costs. This will enhance both the equity and the cost-effectiveness of the system. Charges should hence be highly differentiated. Moreover, the price structure should be clear to the transport user. To impose additional charges for simple revenue raising purposes is likely to lead to distortions, according to the Commission, and these costs should rather be compared with alternative ways of raising revenues (European Commission 1995b, 39).

[14] http://europa.eu.int/pol/ten/transp_en.htm, 10.11.1999.

collection, validation and dissemination of information to road users on a European scale. The first step is to be based on the radio data system-traffic management channel (RDS-TMC) on major trans-European traffic corridors. In the longer term, tools for incident detection, travel and traffic information services, electronic debiting systems for automatic fee collection or access control purposes and satelite positioning systems will be developed. Also for train, a traffic management system is being developed. It is inteded to replace incompatible national signalling and management equipment. Safety and reliability will also be significantly improved.[15]

Of the 14 priority projects,[16] planned to be completed by 2010, 80 per cent of the financial spending is destined for rail, while road transport will receive about 20 per cent of the investment. (Johnson and Turner 1997, 61) This reflects the EU's objective to emphasise rail to obtain a better balance between different transport modes.

Summarising, the construction of new infrastructure is no longer a principal option to curb road congestion. Large current projects are mainly intended to remove important bottle-necks or to connect currently underdeveloped regions. Across Europe, traffic planners expect more from measures to make more efficient use from existing infrastructures (e.g. via road telematics) or from economic measures to charge for use of the most problematic parts of road during the most problematic periods.

Modal shift

The measures mentioned above are mostly intended to aleviate highway congestion. Within urban areas it is much more problematic to increase the capacity of existing infrastructures or to implement road pricing schemes. Huge numbers of cars continue move around slowly, take up a lot of road and parking space and make the city unsafe for pedestrians and cyclists. The problem can only be tackled in a sustainable way by reducing the numbers of cars implying people would have to make more use of public or private transport services.

Across Europe, public transport planners agree that it is important to realise a modal shift but at the same time many are sceptical on whether this can actually be realised. Still, most local authorities try to stimulate a modal shift through a variety of measures, including:

- limited access zones
- limit parking facilities for cars or increase parking fees
- better facilities to use, rent and park bicycles
- new and improved public transport services
- car sharing
- awareness campaigns

[15] http://europa.eu.int/pol/ten/transp_en.htm, 10.11.1999.

[16] In December 1994, the Essen European Council endorsed 14 TEN priority projects. The projects are in no way completed, but in the period 2000-2006, also the largest projects will move into full construction phase. The 14 projects are: (1) High Speed Train/Combined Transport North-South; (2) High Speed Train (Paris-Brussels-Cologne-Amsterdam-London); (3) High Speed Train South; (4) High Speed Train Paris-eastern France-southern Germany; (5) Conventional rail/combined transport Betuwe line; (6) High Speed Train/Combined transport France-Italy; (7) Greek Motorways PATHE and Via Egnatia; (8) Multimodal Link Portugal.Spain-Central Europe; (9) Conventional Rail Link Cork-Dublin-Belfast-Larne-Stranraer; (10) Malpensa Airport, Northern Italy; (11) Fixed rail/road link between Denmark and Sweden-Øresund Fixed Link; (12) Nordic Triangle; (13) Ireland-United Kingdom-Benelux road link; (14) West Coast Main Line (UK) High Speed Train/Combined Transport North-South

These options are briefly discussed below.

Limited access zones

Especially old European cities with medieval centres are worried about heavy traffic in their centres which makes it more difficult to exploit these places as tourist areas. Also, the exhaust emissions from cars damage ancient buildings and structures. Especially cities in France and Italy are starting to close down (parts of) their centres for motorised traffic, seeking to enhance the quality of these centres.

Not only old cities but also many others have started to create pedestrian zones. A common experience is that retailers in the closed down area are quite opposed initially while people who were used to driving through the area also protested. After a while, however, the vast majority of people in the streets as well as the retailers start to value the new situation highly and would not want to go back.

There are many variations to such measures. Some cities partially close down specific areas, e.g. by limiting access to specific parts of the day or to specific types of (clean) vehicles. They may exempt certain categories of permit-holders like residents, etc.

Typically, the limited access area is so small that it can easily be transferred on foot so that no alternative transport is needed. Some cities with larger closed down areas are experimenting with clean alternative forms of transport, e.g. hybrid buses in Bologna.

Limit parking space or increase parking fees

Although limiting parking space is considered in various cities it is very difficult to implement this due to protests from car users, residents and retailers. 'Lack of parking space' is typically considered a bigger problem than 'too many cars'. Few cities have therefore dared to actually reduce parking spaces.

A possible alternative is to drastically increase parking fees. Until recently, parking fees were just seen as a source of revenu and not as a policy instrument to try and change people's travel habits and stimulate a modal shift. This is starting to change, though. Across Europe, cities are trying to use differentiated parking tariffs to induce people not to use their car to go into the city. A typical approach is to create P+R facilities at the periphery of the city where parking is made much cheaper than in the centre and offer a ticket for public transport at low or no cost. With some noticeable exceptions, however, few people tend to use this facility to combine modes.

Cycling facilities

Traffic planners are aware that just making life more difficult for the car-user is not enough and that it is important to offer functional and attractive alternatives. In countries with a bicycling culture like Denmark and the Netherlands attempts are made to stimulate cycling further. In the Netherlands, many such activities are co-ordinated under the 'bicycle masterplan'. Concrete actions include creating separate bicycle lanes between as well as within urban areas; offering good (roofed) bicycle parking facilities at train stations and renting bicyles at stations in cities as well as a variety of stations in the countryside for outdoor recreation. Taking along bicyles on trains is a service valued by bicycle-owners but railway companies in most countries are not so keen on this. The Netherlands also provides tax-incentives for bicycle commuting.

The bicycle culture is probably most developed in the Netherlands where cycling provides about 7% of all passenger kilometers. It appears to be rather difficult, however,

to increase this further and it is therefore not a working option to provide congestion relief. The same is true in most other countries, whether they currently have either a high or a low share of cycling. It seems that the share of cyclists is a national cultural phenomenon that is difficult to increase.

New and improved public transport services

Traffic planners in most cities think that a modal shift principally requires better or improved public transport services. For budgettary reasons, the preference is to improve existing services, either by increasing the capacity of vehicles or increasing the frequency of services. These measures, by themselves at least, do not really appear to help, though.

In response, public transport planners increasingly start to think in terms of 'modal chains', recognising that people need more than just a service from one public transport stop to another. They also start to worry about transfer points, (dynamic) information on schedules of services, 'quality', etc. This has led to a wide variety of attempts to provide P+R opportunities, information services, creation of 'missing links', etc. Some of these include rather innovative technolgies and transport concepts, including:

- Short term rent of vehicles at public transport stations in several European cities; these projects feature automatic unlocking of vehicles and payment. Some schemes use electric vehicles try and tackle congestion and pollution problems at the same time.
- A so-called 'people mover' (automatic vehicles) from a trainstation to a business park in Rotterdam.

With these innovative schemes as well as with more conventional approaches the common experience is that people hardly make a modal shift, unless a combination of measures is taken at the same time. The combination is to make public transport more attractive and functional while, at the same time, making the use of the private car unattractive. A good example is the city of Strasbourg in France that has built a new tramway line with a frequent service along with good P+R facilities, cheap parking with free tramticket at these facilities, high parking tariffs in the city centre and physical barriers to traverse the city by car. (Popkema and Elzen 2001b) To implement such a combination of measures, however, takes a considerable degree of political courage and a 'long breath'.

Car sharing

Strictly speaking, car sharing is not a form of modal shift although several European transport planners have come to see it as an option to change mobility patterns by combining it with other measures. In the 1990s, some professional car-sharing organisations have started to develop in Germany, the Netherlands and Switzerland, partially supported by national government programs and/or EU funds. The principal advantage of car sharing is that fewer cars are needed to satisfy several peoples mobility needs which at least reduces the number of parking spaces needed which saves precious urban space.

The reason for governments to support these intiatives that users of shared cars also tend to look more critically at their transportation needs. As a car is not readily available at the doorstep they have to make an additional effort to make a reservation and get a car. Payment is more relative to the actual use of the car implying it is rather expensive to use it for short trips. This makes it more attractive to use either a bicycle or public

transport for certain trips. One organisation in the Netherlands, Greenwheels, has sought to integrate this by offering attractive combinations of Greenwheels membership along with railway or local public transport (seasons-) tickets.

Although car-sharing is definitely growing in many countries its overall market share is still negligible. Car-sharing not uncontested because sceptics argue that it attracts people that would never use a car otherwise. Surveys indicate, though, that the overall balance is positive and that it can be optimised by an appropriate design of the schemes.

Awareness campaigns

In several countries, public authorities have tried to make their citizens aware of their responsibility towards society and to call them to pollute less, use their car less often and/or choose alternative modes of transport. The general experience is, though, that these campaigns have little or no effect.

4.4.3. Polluting emissions

EU - Emission standards

Especially in the 1960s, with the growth of car-use, the exhaust emissions from cars and trucks caused so much pollution that this became recognised as a serious health hazard. Especially the emission of three substances caused problems, notably carbon monoxide (CO), hydrocarbons (HC) and nitrous oxides (NO_x).

To minimise air pollution, the emission of these substances were regulated. Such regulations were initiated in the US especially by the pioneering state of California where air pollution in several regions was extremely poor. As of 1975 all new cars sold in the state had to be equipped with a new device, the catalytic converter, that converts some of the harmful emissions into less harmful ones. In 1977 this requirement became mandatory across the US Some years later a new device became available, the so-called three-way-catalyst (TWC) that effectively reduces all three of the substances mentioned. This became mandatory in the US in 1983.

With the advent of the European integration, emission regulation in Europe has become the competence of the European Union that also sought to mandate the use of the catalyst. However, a big controversy developed between various memberstates that basically reflected differences in interest between the various national carmakers. Industries in southern European countries mainly produced relatively small and cheap cars for which the increase in cost by the TWC would be relatively high. Especially German industries, however, produced larger and more expensive cars for which this was less of a problem. Southern European states argued that mandating a TWC reflected unfair competition which went against basic rule #1 of the EU. This stalemate prevented effective legislations for many years but with the increasing air pollution in the 1980s agreement could eventually be reached and the TWC became mandatory in the EU as of 1 July 1992.

These regulations have drastically reduced emissions from vehicles in the 1990s but the problems are by no means solved. Especially the emissions of nitrous oxides (NO_x) remain a source of concern, where transport is responsible for 63% of all emissions of

this substance.[17] While the general trend is that vehicle emissions go down there is also a trend towards more diesel cars that may increase especially the NO_x emissions since diesel cars emit about 2.5 times as much NO_x than gasoline cars.

In the near future, the European Commission will tigthen emissions further, closeley cooperating with the European car and oil industry through the auto-oil program. Although the Commission tended to follow the industry in what was considered feasible it was at the same time under strong pressure from the European Parliament that wanted stronger emission regulations in line with those in the US and Japan. This process led to the definition of new emission standards for passenger cars indicated as EURO II (January 1996), EURO III (January 2000) and EURO IV (January 2005). For heavy duty vehicles (lorries) there are also EURO V standards defined for 2008.[18] This indeed brings the European standards more or less in line with those in the US and Japan although precise comparisons are impossible due to differences in test cycles and definitions of the regulated substances. The standards in the US state of California, though, are considerably more stringent (see below).

Alternative fuel vehicles

An alternative route to reduce vehicle emissions is to use alternative fuels, i.e. other than diesel and petrol. Vehicles running on liquefied petroleum gas (LPG) produce substantially lower emissions than gasoline and diesel on all regulated pollutants while their CO_2 emissions are comparable to diesel which are 20% lower than for gasoline. Emissions from vehicles running on natural gas (mostly CNG - compressed natural gas) have emissions comparable to LPG vehicles. CNG can also be produced from organic waste (biofuel) with the perspective of substanally lowering CO_2 emissions (by 50% or more) when considering the complete ('well-to-wheel') fuel cycle.

These gaseous fuels have considerable market shares in a small number of countries. LPG is widely used in cars in the Netherlands and has a market share of about 15%. CNG is quite common in Italy but especially for heavy duty vehicles (buses).

Vehicles running on gaseous fuels are no standard products for most vehicle producers implying they are more expensive than conventional vehicles. Furthemore, they require a refueling infrastructure that is lacking in most countries. Without a deliberate policy and government incentives it is unlikely their market shares will grow substantially. Governments across Europe are interested in reducing vehicle emissions by stimulating the use of gaseous fuels but the incentives provided thus far are not enough to overcome the market barriers and 'conservatism' from vehicle buyers. Furthermore, there are differences of opinion on which fuel to stimulate: France, for instance, is more inclined towards CNG while the UK has higher expectations of LPG. In Sweden there are sizeable programs on biogas which is used in some cases in a 'normal' commercial setting. This is the case with the Linköping bus fleet that runs on biogas produced from local municipal waste. In the 1990s, many US bus companies have partly or completely

[17] http://europa.eu.int/comm/transport/tif/1_general_data/ch1_overview.htm
[18] http://europa.eu.int/comm/transport/tif/7_environment/ch7_emission_standards.htm gives the values for each of the regulated substances (including particulate matter for diesel vehicels).

converted to CNG. Except for the need to create a fueling facility, CNG has become competitive to diesel while producing far lower emissions.[19]

Except for the countries where gaseous fuels already have a sizeable market share, attempts to stimulate conversion are mostly in an experimental stage. Partners in such experiments often include local transport authorities, a fleet owner (often buses or lorries), a vehicle maker and a national R&D organisation. Although these technologies are 'proven' in various other countries there still appears to be a need to demonstrate their usefulness locally before attempts can be made to stimulate their wider use.

The alternative that has received the widest attention in the 1990s is electric propulsion. This interest in electric vehicles (EVs) gained an enormous impetus from the so-called ZEV-mandate (zero emission vehicle) in California from 1990 that forced automakers to sell certain percentages of ZEVs as of 1998 (see section on 'US Policies' further below).
Local authorities are very much interested in EVs because they produce no local emissions. They do produce emissions at the powerplant generating the electricity which depend on the fuel type used. These emissions, however, are produced at places where they are less harmfull to the public health while they are easier to control than emissions from millions of vehicles. Furthermore, emissions from conventional vehicles are much higher in cities than the test results indicate because of cold start emissions, idle running engines and slow moving traffic.

In the aftemath of the California mandate a wide variety of EVs has been produced but these are difficult to sell because they are expensive, especially due to the high cost of battery. Furthermore, their range per battery load is limited to 50-100 km but it also appears there are still sizeable markets for such vehicles as many applications do not need longer daily ranges. Still, the market treshold is high and public authorities that would like to see wider application of EVs face considerable problems to actually realise this. They would either have to provide huge incentives or they would have to develop binding legislation. Either route is risky, partially because EV-development is still in considerable flux and because there is also considerable opposition against stimulation of EV-use.[20]

Automakers have low expectations of the market prospects of EVs. By the beginning of the 21st century only the two big French automakers PSA and Renault have produced of the order of thousands of them but even they think EVs are primarily an intermediary product en route to more marketable concepts like hybrid electric vehicles (HEVs) and Fuel Cell Electric vehicles (FCEVs). The French EVs are basically conversions from conventional vehicles. A variety of small companies have developed quite different types of EVs notably small 'city-cars' using synthetic material for the car-body. In contrast to conventional cars such designs can be economically produced in low volumes. In 1998 one such company, the Norwegion firm Pivco, was bought up by Ford. Thus Ford became the first of European and American the major automakers to offer such a city-car by the name of TH!NK. (Undheim 2001b) They were preceded by Toyota and Nissan, however.

[19] This latter point plays a more prominent role in the US than in Europe because in the US diesel has a general image of being dirty and unhealthy. As a result, there are virtually no diesel cars in the US while in Europe the share of diesel cars is growing in several countries.
[20] The vicissitudes of EVs are further elaborated in Chapter 9.

The development of HEVs has thus far been primarily industry driven. Although there is a big government-industry program in the US under the name of PNGV the largest world-wide stimulus came from Toyota when it launched the Prius HEV in Japan late 1997. Early 2001, 50,000 of them were sold worldwide. (Calstart News Notes 26 March 2001) All other automakers soon responded by annoucing hybrid products for the years to come. Public authorities welcome this as hybrids are considerably cleaner than conventional vehicles while their energy efficiency can be two times as good.

To develop a market, HEVs face the same problems as other AFVs notably that they are more expensive than conventional vehicles. Governments in most countries at present have no programmes to stimulate the market uptake of hybrids although in many countries there are programs to fund demonstration projects with AFVs, including HEVs. The Netherlands does stimulate the market introduction of the Prius (the only HEV currently on the Dutch market) by excempting it temporarily from the "BPM", a vehicle sales tax of about 30%.

For the longer term, after 2005, industry as well as public authorities have high expectations from FCEVs. Such vehicles produce no emissions of pollutants while driving. At the level of the overall fuel chain, emissions depend upon the way hydrogen is produced. A zero-emission fuel chain could be realised by producing hydrogen through hydrolysis of water using electricity produced from renewable sources. Current prototypes of fuel cell vehicles are mostly buses. With government support there are demonstration programs with these vehicles in Canada and the US, especially in California. The European Commission will support a European demonstration programme with fuel cell buses in several European cities which is planned to start by the end of 2002.

Local initiatives

Local authorities across Europe very much like to see cleaner vehicles in their towns and cities. They see few opportunities, however, to actually realise this. The strongest instrument they have is to close down parts of the cities for specific categories of vehicles and create so-called 'limited access zones' (discussed in an earlier section). When they consider using this instrument they trigger immediate oppositon from local residents and/or retailers that want their property to be accessible by car. Local authorities then feel compelled to offer an alternative which they cannot provide. Gaseous fuels are much cleaner but it is extremely difficult to make an effective ruling that would only allow such vehicles into limited access zones. The 'easiest' to implement would be to create 'zero-emission zones' that would only allow the use of electric vehicles or the use of hybrids in electric mode. Although many cities would like to realise this, the high cost of such vehicles constitute a huge barrier.

To explore such options further, virtually all large European cities engage in demonstration projects with alternative fuel vehicles. Many of such projects are partially supported by R&D funds from the European Union and/or from national R&D programs. The size of the projects varies from just one vehicle to hundreds of them. The ambitions also vary widely: sometimes these vehicles just replace conventional vehicles; in other cases the use of AFVs is further stimulated by supportive measures and/or they are embedded in wider changes of mobility patterns. Some examples:

- In Bologna (Italy), a hybrid busservice is used in connection with a limited access zone.

- Many cities offer free parking and/or free charging for electric vehicles.
- Several cities have projects (some concluded) with short-term rental of EVs in combination with other means of transport, including Martigny (Switzerland), Turin (Italy), St. Quentin en Yvelines (France). Other cities are planning projects using such schemes.

Experiences from such projects help to define what type of vehicle might be well suited for what type of application. A major stumbling block, however, appears to be the high cost of such vehicles. Still, in some cities there is sufficient political will and 'leading edge consumers' can be found that are willing to pay the price in view of the environmental benefits. Rome, for instance, had 40 electric minibuses running in 2000 and planned to acquire more of them. (Undheim 2001a)

US policies to tackle vehicle emissions

Many elements of the policies discussed above can also be found outside Europe, especially in car-dependent nations like Japan and the USA. Especially in the USA, however, there are also a number of additional elements that will be briefly discussed below. (Cf. Elzen 1999b)

The US Federal government has taken various initiatives to promote technological advances that should lead to the introduction of so-called 'alternative fuel vehicles' into commercial use. There have been several legislative and executive actions that have driven the Federal government to increase its acquisition and utilisation of AFVs. These include the Clean Air Act Amendments of 1990 and the Energy Policy Act of 1992. Furthermore, the state of California has endorsed specific the low-emission vehicle regulations. The main provisions of these regulations are briefly discussed below.

Energy Policy Act

The Energy Policy Act (EPAct) is primarily driven by oil-import and energy-security concerns. The act requires government fleets and fuel providers (electric utilities, natural gas companies, petroleum companies) to start converting their fleets to alternative fuels (other than diesel and petrol), as of 1993 (for federal fleets), 1996 (state fleets and utilities) or, in the case of electric vehicles, as of 1998. Since 1999, also private fleets had to start to convert. Alternative fuels include, for instance, methanol, natural gas, electricity. In EPAct there is specific attention for electric vehicles and it provides various incentives to stimulate their introduction. These include tax incentives and funds for demonstration and fueling infrastructure programs.

To help achieve the EPAct targets DOE has developed various programs, one of which is the so-called 'Clean Cities Program'. Within this concept various actors at the local level are invited to come together to create a local network that cooperates on the introduction of alternative fuel vehicles. These actors may include fleet-owners, local authorities, developers and producers of alternative vehicle technologies and other interested parties. DOE supports these local networks with a handbook and teaches them how to set goals, how to work together, how obtain grants, how to advertise, how to use consultants, etc.

Clean Air Act (Amendments)

The Clean Air Act was passed in 1970 and provides the most encompassing air-quality legislation in the US The act itself does not have any provisions for clean vehicles *per*

se. It requires states and cities to submit plans to the US Environmental Protection Agency (EPA) about how they will attain air quality standards. It divides cities depending on how bad their air quality is for both ozone and carbon-monoxide into marginal, moderate, serious, severe, and extreme areas. Depending on how bad the air quality is, the local authorities have to take measures to reduce the problem. In view of growing environmental concern the act was strengthened in 1990 with the so-called Clean Air Act Amendments which explicitly address transportation issues by formulating National Ambient Air Quality Standards and by looking more closely at emission sources.

California Low-Emission Vehicle Regulations

To fulfill its commitments under the Clean Air Act, the California Air Resources Board (CARB) in September 1990 approved the Low-Emission Vehicle and Clean Fuels regulations. (Jørgensen 2000) These regulations establish four new classes of light- and medium-duty vehicles with increasingly stringent emission levels: transitional low-emission vehicle (TLEV), low-emission vehicle (LEV), ultra-low-emission vehicle (ULEV), and zero-emission vehicle (ZEV).

The regulations also established a decreasing fleet-average standard for emissions of non-methane organic gases.[21] For the model year 1994 this standard equaled the federal standard but then it became stricter in the following years until it will be four times as low in 2003. Auto manufacturers can meet the fleet average NMOG standard using any combination of TLEVs, LEVs, ULEVs, and ZEVs they choose provided the share of ZEVs meets a minimum target (see below). Compliance with these emission standards can be achieved with the use of advanced vehicle emission control technology, cleaner-burning fuels, or a combination of the two.

In keeping with the goal of reducing motor vehicle emissions to the lowest level feasible, CARB included a ZEV requirement as part of the Low-Emission Vehicle regulations. Starting in 1998, two percent of the vehicles produced for sale in the state had to be zero-emission vehicles. This percentage increased to five percent in 2001, and to ten percent in 2003. There would be a bi-annual review of progress in the ZEV area on the basis of which CARB could ammend the provisions if deemed appropriate.

To provide flexibility in meeting the ZEV mandate, CARB adopted a credit trading provision as part of the LEV regulations. If a manufacturer chooses to produce and sell more than the mandated percentage of ZEVs, that manufacturer will earn credits. These credits can be retained and used by the manufacturer in later years, or sold to another manufacturer that chooses to produce less than the mandated percentage of ZEVs.[22] Given the $5000 fine per vehicle for large vehicle manufacturers that fail to meet the targets these credit can be an attractive source of income for smaller companies by selling them to large companies.

The automakers very much opposed the ZEV mandate, arguing there wourd be no market for EVs because such a vehicle would be heavy (due to the heavy battery), have

[21] This largely overlaps with the hydrocarbons that are regulated in Europe. In the US, however, methane is not included in the regulated hydrocarbons as, unlike the other hydrocarbons, methane does not contribute to the formation of smog. Methane is a greenhouse gas, however, that is 40 times as reactive as CO_2.

[22] CARB 1994a, 6-8. Further information on the CARB low-emission vehicle program can be found at: http://www.arb.ca.gov/msprog/levprog/levprog.htm

a limited range and be expensive. Start-up companies, component developers and other innovators, however, saw this as a challenge and demonstrated a variety of innovations. In 1996, after a bi-annual review, CARB concluded that it would not be feasible to sell 2% EVs in 1998 but that progress, especially as demonstrated by the smaller entrepreneurs, justified to uphold the 10% sales requirement in 2003. This was reconfirmed after the fifth bi-annual review in the year 2000. The ZEV requirement has been somewhat relaxed, however, in the sense that 'partial ZEV credits' will be given for hybrid electric vehicles that meet certain standards as well a for a new category of vehicles under the acronym of SULEV (Super ultra low emission vehicles).

The Califonia ZEV mandate has provided an enormous boost for EVs worldwide. So far, however, this has not led to noticeable market shares for EVs. The federal alternative fuels programme has especially benefitted natural gas vehicles, most noticeably for buses. Many bus companies have started to convert their fleets towards natural gas an a substantial number of them have completely eliminated diesel use. Some companies also use hybrid electric buses.

4.4.4. CO_2-emissions

As the vast majority of road vehicles runs on fossil fuels the CO_2 emissions from road vehicles are proportional to their fuel consumption. To realise a reduction of CO_2-emissions, the European Commission has been looking for ways to develop standards for vehicle fuel consumption. These met with strong opposition from industry that very skillfully played out national differences thus effectively blocking action from the European authorities until 1998. That year, when the EU environment ministers threatened industry to develop binding legislation, the European automaker's organisation ACEA (which also includes major US automakers) offered to voluntarily cut carbon dioxide emissions from automobiles by 25 percent over the next 10 years. This was accepted by the ministers and confirmed in a voluntary agreement.

Under the agreement, the automakers must cut average automobile fuel consumption to 5.8 liters per 100 kilometers. This should cut CO_2 emissions from new cars to 140 grams per kilometer (g/km) compared to an average of 186 g/km by the late 1990s. Although the cut in CO_2 emissions would save 85 million tons of CO_2 emissions per year by 2010 , the amount represents just 15 percent of the cuts the European Union has committed to as part of its Kyoto commitments. It can even be doubted whether this commitment will lead to a lowering of overall CO_2 emissions from transport as there is no such commitment for other vehicles and numbers of cars are continuously increasing.

In a communication from the European Commission (1998a), further policy approaches to reduce CO_2 emissions are described. These include improved logistics, introduction of pricing in all modes of transport, land use planning and promotion of different and more environmentally friendly transport modes than car use. Improving the share and quality of public transport is considered crucial in any strategy towards more sustainable transport patterns. Public transport is more energy efficient per passenger kilometer and is less polluting than cars (or air travel). Thus there is a scope to increase the attractiveness of public transport through extension of network coverage, capacity and frequency, enhancement of speed and accessibility, reduced or simplified fare stuctures, improved comfort and security, expanded parking at main transit terminals etc. (OECD 1997, 20; Potter and Enoch 1997, 271)

4.5. Different Levels of Technology Related Policies

4.5.1. Local and National level

Local attempts to tackle transport problems tend to focus on the near term, seeking more to implement 'proven technologies' than to develop innovative solutions. At the national level, most countries have transport innovation programs, the size of which varies widely.

Traditionally, national technology related policies on transport have mainly dealt with big infrastructure projects. For instance, in the 1990s the Danish Ministry of Transport has primarily been occupied with the planning and execution of the three big construction projects: the Great Belt fixed link, the Sound fixed link (between Sweden and Denmark) and the Femur Belt fixed link (between Denmark and Germany). In Norway, at lot of attention went to creating a trunk road along the long Norwegian coast which, due to the many fjords, involved the construction of many bridges and tunnels. (Thomassen 2001a) In the Netherlands, in the late 1990s several big projects were instigated including the Betuwe line (a high capacity freight railway connection between Rotterdam and the German hinterland) and a high-speed railway line between Amsterdam and Brussels to complete the Amsterdam-Paris connection.

When environmental degradation rose on the political agenda governments sought to regulate the emissions of polluting substances. With the progressing European integration this has become the jurisdiction of the European Union. Following the EU priority to create a common market national states have to follow the European legislation. The European Commission is very sensative on this which became evident, for instance, when it charged the Netherlands of unfair competition in the late 1980s when the Dutch government tried to stimulate the early introduction of the three-way catalyst through tax incentives ahead of the EU regulation.

Regulation also takes place at the local level, e.g. through regulating traffic flow, creating barriers for car-use or limiting car access to parts of the city. Such measures can be inspired by safety considerations and, increasingly, by city liveability considerations. Although still a small minority, more-and-more cities seek to increase the quality of parts of their centres as a nice place to stay and stroll by eliminitating car-traffic, sometimes in connection with the creation of P+R facilities. Strassbourg in France is widely considered as a good practice example. To curb emissions in the city centre, some towns (especially towns with midieval centres in France and Italy) have expressed interest in only allowing electric vehicles in their centres.

Although such policies can help to (partially) solve problems using technical means their 'innovation inducing' potential is rather limited. Although there is much talk of the need for innovation at local and national levels actual innovation projects and programs are small. Concerning the development of cleaner vehicles, this is mainly considered a task of the industry who can apply for a variety of stimulation funds from the European level. Most countries do have bodies stimulating and funding some work on alternative propulsion technologies (e.g. based on natural gas, electricity, biofuels) but these funds are only a small fraction of overall transport budgets.

The most innovation prone country is clearly France. The French government finances several transportation research programs which is in line with the tradition of large budgets for scientific and technological research. Examples are the programs for the TGV

high speed train, the Airbus passenger airplane, the Ariane spacecraft, and the nuclear energy program. In the early 1990s, the French government concluded an agreement with the French auto-industry and the national electricity company EdF on the development of electric vehicles. Various municipalities also invest in the development of and demonstration projects with EVs. Many other projects are funded by ADEME, the French agency for energy concervation, like projects with natural gas buses. French public transport companies are also more innovative than many of their European counterparts for instance by taking part in the Praxitèle project that explored the combination of a train ride with the short-term rent of an electric vehicle.

4.5.2. EU Policies

The EU has a much more explicit inovation program than most of its member states. The European Commission recognises the need for a coherent approach to transport innovation that should produce results to be made widely available across Europe. (Melby 2001) A focus in these activities is provided by the so-called 'Common Transport Policy'.

Common Transport Policy

A common transport policy (CTP) has been the subject of several Commission proposals since the founding of the Union. Despite this, a CTP has proved an elusive goal for much of the EU's history. Initially, the EU was primarily seen as an economic endeavor and a key phrase was 'single market'. This was reflected in the EU's transport policy (or the lack thereof) that principally sought to liberalize and harmonise the transportation markets of member states. During the 1980s, reducing environmental impacts became a new priority. In 1992 the Commission published a paper, *The Future Development of the Common Transport Policy,* which introduced the concept "sustainable mobility". This shifted the focus of transport policy from liberalization and open market to social and environmental dimensions. (McGowan 1998, 461)

In a recent publication, the Commission specifies its objectives in the CTP. (European Commission 1998b) It starts by concluding that considerable progress has been made in the framework of the CTP: there has been a strengthening of the single market, development of more integrated transport systems, compatible traffic management systems, promotion of intermodality and best practices in local and regional passenger transport, improvement in safety and environmental protection and development of research activities. However, in certain areas, progress has been slower than expected, and a great deal of R&D remains to be done. The development of new transport technology is of particular importance, according to the Commission.

Transport innovation

The EU manages and supports an impressive amount of transport R&D projects which are briefly summarised below. There are three main programmes managed by DG TREN (the Directorate General for Energy and Transport):

- TENT (the trans-European networks for transport)
- PACT (Pilot Actions of Combined Transport)[23]

[23] http://Europa.eu.int/en/comm/dg07/pact/, 07.02.2000.

- Transport research and technical development programme[24]

The TENT programme (TEN for transport) is the coordinating programme for transport whilst building the Trans-European Networks (discussed briefly above).

PACT is a promotion of combined transport programme. It covers rail, inland waterways, several modes and maritime R&D. The more general Transport RTD Programme supports the development and implementation of the CTP, and the research will "contribute to the development, integration and management of a more efficient, safer and environmentally friendly transport system…"[25] PACT allows the Union to co-finance certain commercial risks taken by transport operators in the start-up phase of innovative combined transport actions. Maximum duration of financing under PACT is three years. The aim is to show that combined transport, if properly organised and if state of the art technology is used, can very well economically compete with road transport.

The transport research and technical development (RTD) programme falls under the general EU framework programmes. Under the fourth framework programme (FP4; 1994-98), transport RTD Programme was divided into seven areas, notably strategic research, rail transport, integrated transport, air transport, urban transport, waterborne transport and road transport. The areas in all covered several hundred different RTD projects covering a wide number of areas. Currently, the research activities conducted under the FP5 umbrella are organised under thematic- and horizontal programmes. Transport RTD may thus be conducted under any of these programmes (e.g. key actions such as "Sustainable mobility and intermodality", "Land transport and marine technologies" and "New methods of work and electronic commerce"). Many of the local initiatives described in earlier section are (co-) funded from these programmes.

4.6. Evaluation

4.6.1. Assessing different approaches

Public authorities play various roles in the innovation process, including

- stimulating innovation (e.g. by funding national laboratories or R&D by others);
- regulating the use of technologies for the 'public interest' (e.g. by enacting standards, taxes);
- supply large infrastructures and public services.

The role of public authorities is therefore very complex, also because it is not a single entity. We are dealing with governments at various levels (international, national, local) each of which have a variety of executive branches that attempt to realise very heterogeneous and not seldomly conflicting goals.

This heterogeneity leads to a variety of uncoordinated actions each of which can have definite influences on the innovation process but rarely achieving preset goals because there are so many factors operating in conjunction. This makes various analysts very sceptical about the influence public authorities can have on the innovation process which coincides with a political philosophy that this is not desirable anyway. All

[24] http://www.cordis.lu/transport/src/project.htm, 07.02.2000.
[25] http://www.cordis.lu/transport/src/outline.htm, 17.01.2000.

governments should do is to ensure that the conditions are fulfilled for the market to function in an optimal way. If this leads to societal problems, the costs of this should be 'fed-back' into the market development process on the basis of which suppliers will 'automatically' develop less problematic technologies.

This philosophy has gained strength internationally in the 1990s although at the same time various problematic consequences of this approach have become more manifest and more widely recognised. There are a number of reasons for this:

- many societal consequences cannot be expressed as economic costs in an unambiguous way (e.g. greenhouse effect, air quality, congested roads and cities); attempts to do so are fiercely opposed by various pressure and interest groups;
- some of these consequences are contested themselves like the (importance and effects of) the greenhouse effect;
- effects may not become visible until many years after the technology is introduced making room for strong differences of opinion on these effects in the early phases;
- many firms are internationally competing for a global market; attributing external costs to their products has a negative influence on their competitiveness which is at odds with (national or local) policy goals of economic growth and employment.

As a result, there is a feedback of societal costs on innovation processes but in many cases this works extremely slow. For instance, the bad environmental consequences of exhaust emissions have been recognised widely in the 1960s, the three-way catalyst technology was available in the 1970s but this technology did not become standard equipment on new cars in Europe until the 1990s. In the late 1990s there are still quite a number of vehicles that do not have this technology which, despite their relatively small numbers, make a large contribution to the total emissions of motor-vehicles because of their individual high levels.

Governments have a variety of instruments at their disposal to stimulate development and use of technologies that serve societal needs. These include, for instance, financial incentives (taxes, subsidies), voluntary agreements with industry and industry standards. Taxes are often motivated to be necessary to cofinance infrastructures (e.g. fuel tax to maintain and build roads) or to attribute a price-tag to societal cost (e.g. CO_2 tax). Subsidies are often used to stimulate initial market development of technologies that are (still) expensive because of low production volumes. Voluntary agreements are used to stimulate industry to develop new technologies and processes in cases where it is not clear what options seem best suited to gain better performance from the societal standpoint. Standards are typically used to force market introduction of technologies that have already been developed and demonstrated.

Enacting standards is clearest example of direct government influence on which technologies with which characteristics are (widely) used in society. Although theoretically this can be a powerful instrument, in practice much of its strength is lost. This is partly an effect of the political culture in which it is applied, partly because enacting standards is part of political and social processes in which strong interests clash. In Japan, for instance (political) culture implies that clashes of interests should be avoided by all means. The effect on standards is that these are not enacted until industry makes clear to the authorities that it is ready to fulfil those. In Europe, conflicts of interests are much more open especially with the advent of the European Union. The EU seeks to harmonise standards which in many cases have very different consequences for actors in the various member states thus triggering fierce opposition. The struggle

over the emission standards that mandate the use of the three-way catalyst are a clear case in point.

This process takes a very different shape in the US state of California. Because of specific geological and climatic circumstances air pollution in the southern part of the state (in the so-called Los Angeles Air Basin) is extremely poor. To try and remedy this the state has developed and obtained powerful tools for the enforcement of strict standards and, most importantly, has developed a culture of using these tools. As a result, catalysts were widely used in the state 15 years before they became common in Western Europe.

One of the most striking features of this policy process that it is not only used to force use of technologies that have been developed and demonstrated but also to force the development of technologies to meet standards (the zero-emission requirement) that cannot be attained with existing technology. This policy had interesting effects. The automakers initially fiercely opposed it. However, there appeared to be other relevant players such as the electric utilities and smaller technology developing companies (of components as well as vehicles) that reacted quite differently to the mandate. Whereas the automakers saw the ZEV as an enormous problem these actors saw it as in interesting opportunity to develop new technologies for new markets. Their dispersed and sometimes combined efforts demonstrated that electric vehicle technology had much more possibilities than had initially been assumed.

Although the California ZEV-mandate has some positive effects from the societal point of view, such mandates should not be seen as a panacea. The effects and circumstances under which mandates lead to desired effects have not been thoroughly investigated but some interesting lessons could be learned from the California experience, notably:

- The mandate directly targeted the major automakers. A major reason for its partial success, however, was that other actors started to react to it, notably the electric utilities and a variety of smaller companies. If they had not appeared on the stage the automakers could have upheld their resistance and on the EV-side little would have happened. As a result, the California legislature would have lost some of its credibility, weakening its role in other attempts to stimulate the use of technologies that would be considered beneficial to society but that industry would be reluctant to market.
- The mandate was enacted in a specific political culture in a situation that the companies affected were far away in Detroit and Japan. In Western Europe and Japan a much stronger political and societal battle should be reckoned with if national governments or the CEC should try to adopt this instrument. More insight would be needed into the strategies that could make this a viable option.
- Although the mandate has resulted into impressive progress on EV technology its societal consequences are still quite unclear. Take for instance the development of small one- or two-seater EVs. These can either be used for short-term rent services, in combination with various forms of public transport, or they can be used as the second (or third) family car that allows another family-member to move about more, and to find parking space and drive through places where larger vehicles cannot come. It is unclear how users are likely to react or whether and, if so, how it is possible to stimulate those developments that are most desirable from the societal standpoint. What is lacking here, although there are some noticeable exceptions, is the systematic involvement of users.

Mandates primarily work on the technological side. Enacting mandates can therefore be seen as an instrument of 'technology inducement', i.e. an instrument that induces technology developers to design technologies with specific characteristics. Mandates primarily have a 'stick' rather than a 'carrot' character which is one reason why industry strongly opposes them. Technology inducement can also be achieved using instruments that have a more carrot-like nature. An example is the Swedish so-called 'technology procurement program'. The procedure here is that the Swedish national board for technological development, Vinnova[26], brings together a group of potential users of a new technology that has positive societal attributes (e.g. energy saving, reduced emissions) and that is not available on the market. Jointly they draw up a number of specifications on the basis of which a 'request for proposals' goes out to industry. On the basis of the proposals submitted the users select the one that is considered to fit the requirements the closest, if needed after additional negotiations with one or some of them. As a prerequisite to start this process is that the technology is not available on the market this has a clear technology inducing effect.

A remarkable difference with mandates is that in this technology procurement program users play a prominent role by being directly involved in the process of defining the technological specifications. Defining the technology is much more a subject of negotiation between users, producers and government (in the form of Vinnova) as the representative of the wider societal interest.

At the European policy level, the need to increase the role of users in innovation processes (or RTD in the EU-vocabulary: research and technology development) is gaining importance. It is recognised that innovation is a process in which many factors have to play a role. To quote the *Green paper on Innovation*: "Innovation is not just an economic mechanism or a technical process. It is above all a social phenomenon. Through it, individuals and societies express their creativity, needs and desires. By its purpose, its effects or its methods, innovation is thus intimately involved in the social conditions in which it is produced. In the final analysis, the history, culture, education, political and institutional organisation and the economic structure of each society determine that society's capacity to generate and accept novelty." (European Commission 1995a, 11)

This quote also implies a recognition that market forces alone do not necessarily lead to the development and use of products that are most desirable for society as a whole. This means that in the system of science and technology both the 'market' and 'government' have a role to play. In general there appears to be agreement that *government intervention* is needed in cases of 'market (research) failure' in order to achieve economically as well as socially desirable results.

This attitude is reflected in the 5th Framework Programme where one of the central issues is how to link European RTD activities to social and economic needs and conditions in order to increase the social and economic rate of return on investments in RTD.[27] The same basic philosophy lies at the heart of the so-called 'Task Forces'[28] that

[26] Called KFB before 2001.
[27] In the past, economic needs were (implicitly) more or less taken to equal social needs in RTD. The fact that this definition has broadened implies we also have to broaden the processes analysed and purily economic models therefore are no longer sufficient.
[28] E.g. Task Forces "Car of Tomorrow", "Trains and Railway Systems of the Future" and "Transport Intermodality".

should "… define research priorities and any obstacles to innovation, in common with industry - including SMEs and the users". One main goal is to develop projects. Their methodology is not fully developed and needs further attention.

4.6.2. Conclusion

Governments have a clear role to play in innovation processes and orient these towards achieving societal needs. In the past, a variety of approaches have been followed to realise this but, looking at the traffic and transport sector, some problems appear to be rather elusive, especially the problems of congestion and emission of greenhouse gases. Also the problem of emission of pollutants, although there is some optimism, leaves a lot to be desired, especially in a variety of 'hot spots'.

In chapter 3 of this report we distinguished four main dimensions of technology related policies, notably infrastructure development, regulation, innovation and participation. The EU covers the full range of these dimensions while at the state level there is a strong emphasis on infrastructure development. It is doubtful whether this 'division of responsibilities' and the way it is shaped will lead to a sustainable traffic and transport regime. Activities in each of these domains have various weak points some of which may even lead away from sustainability. We can summarise these weaknesses for each of the dimensions as follows:

- *infrastructure developement*: Removing bottle-necks and creating missing links of course makes sensible policy but history has demonstrated that new and improved infrastructure attracts new traffic. Policies at the same time target achieving a modal shift but despite these policies again history shows that road traffic has grown much faster than other forms of traffic. The enormous emphasis on infrastructure in terms of funding by the EU as well as national states is likely to continue that trend. There is insufficient attention to how this emphasis might affect general traffic patterns and, hence, insufficient attention for its general sustainability impacts.
- *regulation*: The EU has been very slow in regulating vehicle exhaust emissions, both concerning pollutants and greenhouse gases. It appears there is a stronger emphasis on the interest of industry than on environmental or climatological concerns. Current and planned future standards for polluting emissions in effect protect the use of gasoline and diesel and create a barrier towards the market-uptake of alternatives that have demonstrated advantages. Concerning CO_2 emissions it is doubtful that the voluntary agreement with the car industry will actually reduce overall road traffic emissions let alone that it will help achieve the reductions the EU has committed to under the Kyoto agreement. This may point to the limits of regulation as an instrument and may call for other (complimentary) approaches geared at inducing innovation and achieving modal shift. Technology inducing forms of regulation (with either a 'stick' or a 'carrot' character) could hold some promise to achieve this. More subtle forms of regulation at the local level have demonstrated some promising local results concerning city liveability without sacrificing accessibility but there appear to be important barriers for the wider diffusion of such approaches. Public acceptance appears to be one of the major bottle-necks, also in case of more general regulatory approaches like road-pricing.
- *innovation*: Partly due to EU and national funding an enormous range of transport innovations has been demonstrated. A major problem, however, is to implement and diffuse them. This is a general flaw of the technology policies as they are pursued in many countries. The general point is that innovations do have little value in

themselves unless they are embedded in networks of relevant actors, i.e. that they are seen as valuable by producers as well as users. The problem is that many innovations are produced loose from such networks and that it appears difficult to fit them in later. Although this problem has been long recognised and policy makers try to address it no suitable approaches have yet been demonstrated.

- *participation*: The EU has started to co-operate more with industry in the process of setting standards for the emission of pollutants as well as on curbing CO_2 emissions. Whether this improved or speeded up the process of reducing emissions is doubtful, however. The reason is that this is a very narrow form of participation that does not include actors that have sustainability as there number one priority.

Especially the latter two points provide a strong argument that technology policy should be embedded in the networks of actors in which the technology should eventually function. To stimulate this, these actors should be involved in the early phases as well and, hence, calls for an 'Interactive Technology Policy' that will be presented in the final chapter of this report.

Chapter 5

INTRODUCTION TO THE EMPIRICAL STUDIES

5.1. The Case-Portfolio

This chapter discusses the various dimensions represented in the empirical studies from the INTEPOL project. The cases have been chosen from a *portfolio perspective*, i.e. we have not principally looked at individual success or failure stories for each case but we have sought to ensure that all the cases combined cover the range of aspects relevant to INTEPOL. Furthermore, since we seek to develop an Interactive Technology Policy (ITP) with Europe-wide (and potentially even wider) relevance we need a sufficient geographic distribution of cases. We have studied cases from the following countries:

- For practical reasons we have put an emphasis on cases from the home countries of the INTEPOL researchers, notably Denmark, the Netherlands and Norway;
- We have chosen cases from three additional European countries, notably France, Germany and Italy;
- For contrast, we have also analysed cases from two 'leading transport innovation' regions in other parts of the world, notably Japan and the US;
- We have also analysed supra-national policies, notably the process of setting and implementing EU emission standards and contrasted this with developments in the US.

In all, we have analysed 17 cases, each of which is briefly characterised in section 5.3.

5.2. Analytical and Empirical Interests

Our cases should allow us to analyse a variety of dimensions related to our analytical interests as well as to our domain of study, i.e. the traffic and transport (or passenger mobility) domain. Below we will give a brief specification of the main factors our cases should provide information on.

The INTEPOL project has an analytical interest to develop an ITP, implying our cases should tell us things relevant to technology policy. In chapter 3 we explained that we take technology policy to have a broad meaning, i.e. to include a broad range of policies and strategies that induce technical change, either intendedly or unintendedly. In this broader interpretation, to take an example, emission standards are also relevant because they affect what type of technologies are allowed on the road. Therefore, we will analyse a variety of policy initiatives in our empirical domain of traffic and transport that affect technical change, including change in the sense of what is usually called 'innovation' as well as change in the sense of what is usually called 'diffusion' of new technolgies.

Furthermore, we argued on the basis of insights from science and technology studies that technical change and social change (including behavioural change of a variety of actors involved) go hand-in-hand. Especially when looking at the passenger mobility domain, it is widely acknowledged that congestion and accessibility problems can only

be solved structurally if the car would loose its dominant position, implying that many actors would have to change their behaviour. Such a change would imply technical change (in connection with alternative modes of transport, facilities for easy and rapid change of vehicles or modes, information technologies to provide real-time info on options and schedules, etc.) as well as behavioural change. All of these factors are relevant for the type of ITP we seek to develop and therefore should be present and analysed in our empirical studies.

Chapter 3 of this report outlines the main contours of an ITP. The chapter argues that an ITP should cover a broad 'playing field', cornered by the following rectangle of concerns (the 'quadruple P' logic):

- Innovation (pushing logic);
- Regulation (policing logic);
- Infrastructure (provision logic).
- Interaction (participation logic).

This implies, that our cases should provide sufficient coverage of these concerns which leads to the following more specific requirements.

Concerning *innovation*, the field of 'science and technology studies' (STS) teaches us that it is important to recognise that innovation has technical as well as social dimensions. In fact, there is an enormous variety of dimensions relevant to innovation and we have sought to capture some of this 'richeness' in our spectrum of cases, looking at vehicle (propulsion) technologies, 'enabling' technologies (telematics), new public transport options, new pricing concepts (road pricing), etc.

Concerning *regulation*, there are important contrasts between the (cross-) national and the local dimensions which, in various cases, express deep underlying conflicts of interest. This is reflected in our portfolio of empirical studies where some cases deal with concerns and decision-making at a global level while other focus on the local level. Where useful, the conflicts of interests between these levels are analysed.

Infrastructure is one concrete domain where this local/global aspect is played out. To analyse this, some of our infrastructure cases look at the local (typically city) level while one deals with a national road construction project. Not only have we looked at (decision-making about) new infrastructures but also at ways to increase the effective usage and/or capacity of existing infrastructures.

Resistance to top-down policy making has led to an increasing recognition of the need for *interaction* with various stakeholders to increase commitment to policy objectives and enhance the chances that specific measures are accepted to realise these objectives. The number of stakeholders in such forms of 'participatory decisionmaking' and the way their views are taken into account varies widely. This variation is reflected in our portfolio of case studies.

The range of dimensions our cases need to cover are not only determined by our analytical interests be also by characteristics of our domain of study, the traffic and transport domain. One starting point are the problems in the current mobility regime that need to be solved to achieve what in the common vocabulary has become called 'sustainable mobility' and to which ITP should make a contribution. These problems include:

- Problems related to vehicle emissions;

- pollutants that deteriorate air quality and affect health and buildings (CO, NO_x, VOC, particulates);
- emissions of greenhouse gases (mostly CO_2 but also methane);

- Problems related to congestion;
  - poor accessibility of business, residential and other areas;
  - poor quality and liveability of residential areas, city centres, etc.;
  - extra emissions due to slow-moving and stand-still traffic.

Another relevant set of dimensions is related to the types of solutions intended to tackle these problems. At a general level, we can distinguish two routes for change, one involving 'optimisation' of the current mobility regime and the other involving 'renewal' of the mobility regime. (cf. chapter 9) The distinction is a matter of degree but, still, there are important differences in emphasis. The regime optimisation route focuses on optimising vehicles and extension of mostly existing infrastructures to tackle mobility problems. This implies a limited need of change of travel behaviour. Because past experience has shown that it is very difficult to change people's travel behaviour, especially to make them forgo using their private car, it is the route of 'least resistance' that is followed in most attempts to tackle mobility problems. It emphasises technical change with a minimal degree of behavioural change. For this reason, this route is also called the 'technical approach' to mobility problems.

Regime renewal, by contrast, emphasises behavioural change. It seeks so develop efficient and high-quality alternatives to car-use and subsequently minimise the role of the car as the common door-to-door means of transport. This route does not imply that technology would play a minor role as the development and tuning of alternatives would require a massive technical change, probably even more than for the optimisation route. On the other hand, it could also be achieved through the use quite conventional technologies by an appropriate regulation and incentive structure along with some additional technolgies to optimise ease of use. For instance, a radical ban of cars from parts of cities along with good P+R facilities and high frequency public transport connections would involve limited technical change but large behavioural change. Although it could be argued this route would be needed to achieve sustainability on all of the 'problem dimensions' listed above this is much more difficult to achieve in practice since so many things would need to change.

Looking at concrete attempts to tackle transportation problems these typically tend to follow the technological or optimisation route (cf. chapter 4). The vast majority of measures taken by local, national as well as EU authorities hardly affect people's travel behaviour. Policy plans from national ane EU authorities do stress the need for 'renewal' through behavioural change but concrete measures focus on 'optimisation' and a wide-spread sceptisim has developed whether renewal is possible at all.

There are noticeable exceptions to this, though, especially at the local level. Various cities are not prepared to take the dominance of car-use for granted and have taken concrete measures to try and change this. They come up with, compared to the optimisation route, 'radical solutions' on which they have achieved varying degrees of success. In term of our interest to develop an ITP these attempts are important, not in the first place because of the direct success or failure of the local scheme they sought to realise but because of the more detailed lessons they could teach us on what can change under which circumstances. The scepticism on the possibility of 'general measures' to achieve behavioural change might then be replaced by knowledge of what could

possibly change under which circumstances. This knowledge could then be used to design part of an ITP that would attempt to explore further this 'room for change' that several of these local initiatives suggest. The results of this part of the analysis are presented in Chapter 9.

As stated above, the distinction between 'optimisation' and 'renewal' is a matter of degree and perspective. For instance, people in a city trying to implement a P+R scheme with an inner-city limited access zone may feel they are just trying to realise a near term solution to a pressing problem rather than seeing this as a step in a longer term process of achieving a renewal of the mobility regime. In our empirical anaysis we have accounted for this by, on the one hand, analysing the views and expectations at the local level while, on the other hand, also assessing the potential wider relevance of the local findings for the longer term renewal potential.

The longer term perspective implied in regime renewal is usually not the perspective taken by the concrete cities that have sought to implement such 'radical solutions' to achieve near-term success. This points to a final relevant dimension in view of our analytical purposes notably the possible tension between local and global issues. At the local level, authorities and transport planners are interested in near term solutions and shape their efforts to achieve this. At the national or EU level, policy makers more explicitly stress the need for longer term change processes to achieve more radical change but such changes can only to a very limited extend be 'enforced from above'. They need the local level to actually implement radical alternatives to be able to assess their practical value. This leads to a number of possible tensions that we should be able to analyse in our cases.

5.3. Case-summaries

Initially, we selected over twenty cases that we had some knowledge of in the project team and collected 'raw data' on them. On the basis of a portfolio assessment of this selection, making sure that all aspects described in the previous section were represented, we eventually chose 17 to elaborate in detail, notably:

- Case 1: Getting Bicycles on Trains - Inter-modal transport developments in Denmark
- Case 2: The Metro - Infra structure and intra actor in Copenhagen
- Case 3: Wish You Were Here - Users, producers, politics and electric vehicles in Denmark
- Case 4: Agreed Discrimination - The Rotterdam approach to tackle highway congestion
- Case 5: Highway 1 - The development of a trunk road policy in Norway
- Case 6: A Slight Intervention - The production and application of knowledge in environmental impact assessment (EIA) in two urban development projects in Norway
- Case 7: Taxing Towards Future? - The discourse on road pricing in Norway
- Case 8: Th!nk Electric - A sustainable branding of sustainable mobility
- Case 9: A Touch of Technocracy? Technology policy and transport in the European Union exemplified by Trans-European Networks for Transport and road pricing
- Case 10: From Congestion to Urban Quality - The Strasbourg approach to tackle transport problems

- Case 11: V. Will Telematics Move in Concert? Social shaping of transport telematics: the case of Germany
- Case 12: Exit, Voice or Loyalty in the Italian Culture of Mobility - Electric transport as a vehicle of public space-making in Rome
- Case 13: Exhaust Emission Policies and the Technical Fix of Catalytic Converters
- Case 14: ITS in Japan - Stimulating the use of intelligent transport systems but to solve which problem?
- Case 15: California Dreaming - Sustaining American lifestyle and the car
- Case 16: Go Boulder - Public participation in transportation planning
- Case 17: The Living Laboratory - Introducing electric transit in Chattanooga

For the various cases, we started to collect written documents. The problem with these documents was that they typically contained little information on the interactions between the various players, their expectations, how they changed in the process, etc. In our approach, such information is crucial to be able to trace the 'socio-technical' dynamic rather than just the technical development. To fill this information gap, we selected some key players for the various cases whom we interviewed. Our final case descriptions thus are based on a combination of written sources and information provided by some of the actors involved.

Summaries from these cases are presented below. The full description can be found in an annex report to this report. These also contain references to the persons interviewed. (Elzen et al. 2001)

Case 1: Getting Bicycles on Trains - Inter-modal transport developments in Denmark

Bicycling has a long history in Denmark as in most other coutries. But in Denmark an e.g. Holland the use of bicycles has become a symbol in traffic asigned with a healthy and environmentally friendly transport system, despite the factual growth and dominance of car based transportation. After a decline in bicycling a period of renewed interest resulted from growing environmental awareness and movements in the 1970s, again requesting better facilities for bicyclists.

A special interest has been given to the facilities improving the combined use of trains and bicycles. When bicycles were the almost dominant means of transport in the early 20th century, bicycles could be taken on trains, but this has changed radically over time. The changing treatment of bicyclist in transport policies and the planning of the state railways (DSB) is the focus of this case study. Besides creating parking and service facilities at the train stations also the possibility of taking bicycles on trains has been adressed by the bicyclist movement and by politicians. After a shift in the perception of bicyclists from being just another user group asking for speciel treatment to become a customer group to take special care of, the state railways changed attitude and started changing the design of trains and stations to accomodate for bicycles.

Case 2: The Metro - Infra structure and intra actor in Copenhagen

Since the 1970s traffic planning in Copenhagen has been in a kind of crisis, as the traditional highway and road extensions and the overall planning concepts met substantial public critique. This has left the traffic planning of the Capital region behind, and improving the public transport system and creating new lines for e.g. the Copenhagen S-train has stagnated. With the planning of a new part of the city in the

centre of Copenhagen – the Ørestad – a 'new town' model for financing a Metro line has been created by government legislation. This Metro is supposed to both counteract the growth in private car traffic and to create such a rise in land prices in the Ørestad, that the costs of infrastructure and Metro can be covered. The Metro has become a separate actor, not controlled by any of the other involved actors, but at the same dependent of a co-ordination among users and other actors to fulfil its obligations.

Although great expectations are assigned to the Metro, both the strategic political support and the knowledge needed are lacking. Traffic models for the Capital region of Copenhagen are based tour matrices between segments of the town black boxing purpose and choice of trips and favouring public means of transportation in the future scenarios. The advantage of bypassing political decision processes and creating a completely new institution to maintain the building of the Ørestad, has at the same time not created the strategic responsibility to integrate transport policies concerning Copenhagen and supporting the Metro in becoming a successful agent of change.

Case 3: Wish You Were Here - Users, producers, politics and electric vehicles in Denmark

This study examines the role assigned to use and users in the design of electric vehicles. When transforming a technology from blueprint on a sketch board to a social institution, identifying and configuring users and use (localities, conditions, events) are critical. In the case of electric vehicles, the political engagement promising everyone benefit from using a technology, runs counter to the restricted behaviour inscribed in the technology. The case highlights three different user modes that have been at play, each of which have inscribed different benefits in the designed electric vehicles.

Examining the history of electric vehicles was challenging as claims have been made that Denmark is a country well suited for their use. But despite immense activities constructing physical as well as symbolic characteristics, a stable formation of users and user practices has ceased to emerge around the electric vehicle. Technical performance, user demands and the symbolic value of electric vehicles seems to have been mismatching considerably during most of the lifetime of this much desired technology, and these mismatches have contributed to obscuring the identity of the electric vehicle as a functional device inscribed in daily practices. A turn to the limited visions from the first user mode albeit in a new form, with political induced bounded territories may although give electric vehicles a stable identity.

Case 4: Agreed Discrimination - The Rotterdam approach to tackle highway congestion

The city of Rotterdam has the largest harbour in the world. Local as well as national policymakers consider the harbour as a 'chicken with golden eggs' for the Dutch economy. During the 1980s, congestion on the highways around Rotterdam became so congested that it became increasingly problematic to transport goods to and from the harbour. The chicken was in threat of being slaughtered.

To tackle the problem, Rotterdam used an innovative approach based on a general distinction between what was called 'necessary traffic' (i.e. vital to the economy) and 'non-necessary traffic' and developed concrete measures that prioritised necessary traffic. In its translation of this general philosophy into concrete measures (via hundreds of small projects) the approach was also innovative in that it involved interactions between all interested stakeholders from the very beginning.

The approach was successful in the sense that structural traffic jams on the Rotterdam highways decreased in a rather short time while overall traffic intensity increased and traffic jams in other parts of the Netherlands continued to grow. The success, however, was partly the result of using a rather narrow definition of traffic and transport problems. Additional measures will certainly be needed to develop solutions that will be sustainable.

Case 5: Highway 1 - The development of a trunk road policy in Norway

Norway, because of its topography and its small population compared with the size of the country, has to face large challenges when constructing a nation-wide high standard road system. The article discusses how trunk roads have become an important part of the Norwegian mobility strategy. The idea of constructing a network of trunk roads traces back to inspiration from the US Interstate Highway Act of 1956.

Norway has a tradition to interpret trunk roads, and roads in general, as a means to promote economic growth and prosperity. At the same time, road construction is looked upon as a human right and representing progress for civilisation. These interpretations are visible, for instance, in the development of a recent governmental trunk road policy where five major goals have been developed: the accessibility strategy, the environment strategy, the traffic safety strategy, and the regional/district development strategy.

By using a Norwegian road construction project, Krifast, the paper shows how a large road project not necessarily needs to be initiated by the national level, but can also be promoted by local initiatives and entrepreneurs. In this case it was very important to create “mental pictures” or “embedding” at the different administrative levels, which made the project beneficial for all parties.

Case 6: A Slight Intervention - The production and application of knowledge in environmental impact assessment (EIA) in two urban development projects in Norway

Environmental impact analysis is a widespread tool to evaluate transport-related projects. This case analyses the application of EIA in two Norwegian projects, one is a plan for a new highway in the city of Trondheim, the other is the construction of a new IKEA department store.

EIA may be interpreted as policy tool that facilitates the combination of regulation and participation, since in principle it invites public debates and even hearings. Thus it opens up a space for an interactive technology policy where construction actors have to negotiate with the involved public.

However, the results of our study suggest that EIA has less impact. The Norwegian EIA discourse allows construction actors to use the required EIA reports to argue for their construction plans in a rather partisan manner. Public debate emerges mainly in response to controversial plans, not because it is facilitated by the EIA procedures. To INTEPOL, it represents a non-traditional tool for technology policy that unfortunately seems to have been corrupted.

Case 7: Taxing Towards Future? - The discourse on road pricing in Norway

Road pricing is a radical socio-technical invention introduced to regulate the flow of traffic. The paper discusses the development of a road pricing technology and the

efforts to introduce road pricing in Norway since the early 1980s. The Norwegian case is discussed in relation to similar efforts in other countries.

The paper discusses the question why road pricing not has become more popular as a tool to regulate traffic in cities with large spatial and environmental problems in relation to the comprehensive use of cars. Two issues form an inroad to answering this question: (1) the definition problem (there is not a shared social and political understanding on what road pricing is) and (2) (different views on) efficient means to implement it.

The analysis of the innovation of the Q-free-piece (the payment technology) discusses how a small private enterprise, that developed a relevant technology at the right time, managed to mobilise political and public support for its innovation. The quality of the network building was tested when the first contract in Oslo was taken to GATT by a competing American company, Amtech.

Case 8: Th!nk Electric - A sustainable branding of sustainable mobility

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, but above all, EVs pose a challenge to the cultural definition of a car and the performance of mobility.

In this case, we 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 would narrate 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. In this respect, the Th!nk case is a reminder that the split between supply and demand is problematic in technology policy, since we need seamless efforts to combine them.

Case 9: A Touch of Technocracy? Technology policy and transport in the European Union exemplified by Trans-European Networks for Transport and road pricing

This case provides an analysis of technology policy in the European Union, with particular emphasis on transport. It starts out by making a number of general observations about aims and procedures of the EU. These observations are then pursued in brief studies of two examples of transport technology policy, Trans-European Networks for Transport and road pricing.

The EU represents a very interesting and particular example where technology policy mainly is motivated by regulation in order to facilitate the development of a common market and the exchange of goods and services across the regions. Many of the regulatory aims produce efforts to improve the transport infrastructure and the supply of

transport services, but we may also observe efforts of setting standards, e.g. in the area of emissions.

Particular efforts are related to the EU R&D efforts through the framework programmes and similar initiatives. These efforts have spurred development of new technologies in the transport area, which surpasses all previous initiatives undertaken by the member states themselves.

To INTEPOL, this case study provides important insights in the technocratic tendency of the EU technology policy in transport. We observe that some actors are allowed to construct ideas of a trans-European common good, without any substantial development of elected democratic bodies. Also, the productive role of regulatory aims is of great importance.

Case 10: From Congestion to Urban Quality - The Strasbourg approach to tackle transport problems

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 to define this as an 'urban quality' problem. The old city should be freed of noise and pollution and become a pleasant place for people to stay and stroll in.

To achieve this, the city developed a comprehensive plan, seeking on the one hand to discourage car use while, on the other hand, developing clean, attractive and efficient alternatives. Public participation was an important element in the decision-making process. Focus of attenttion 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 immportant elements were realised. The approach was successful in the sense that the tram and the P+R facilities became heavily used and the inhabitants of Strasbourg think the quality of their city has improved drastically. They wanted more and an extension of the tram network was planned and built.

Case 11: Will Telematics Move in Concert? Social shaping of transport telematics: the case of Germany

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 exellent 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 seem 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 may 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 thinking behind transport telematics as described it in this paper, is definitely supply side driven. Transport telematics is perceived as a technical fix, an application of technology to solve social problems related to transport. The interaction that was identified, 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.

Case 12: Exit, Voice or Loyalty in the Italian Culture of Mobility - Electric transport as a vehicle of public space-making in Rome

This paper explores transport technology policy in Italy through a particular focus on efforts to develop public electric transport in Rome. It starts out from the ambiguous observation that a few institutional and private actors dominate transport policy, while the sector of transport is highly segmented and lacking in central co-ordination. Definitely, Italy is facing serious challenges to practice transport technology policy.

The choice in Rome to focus on buses and trams rather than railway and metro systems may be interpreted as a result of lack of will to change the present system and/or the lack of a central actor with sufficient resources to implement large-scale infrastructural changes. However, the provision of a new type of electrical buses, suited to the particular demands of narrow historical city centres, appears to be an interesting response to a particular local situation. While the links to appropriate Italian industry are weak, Rome has nevertheless been able to influence the development of electrical buses to suit their demands. Moreover, these buses seem to represent a more friendly and communicative solution to the transport problem because they allow for the development of new communicative spaces for the public.

This case provides an important reminder that the cultural shaping of technology policy is not a banal issue. Of course, transport technology policy has to adapt to political structures and power relations. However, it may also be influenced by popular trends that define the relative attractiveness of available transport technologies. In fact, one of the inherent problems of public transport may be that it is the choice for those who have no choice. Transport technology policy should be sensitive to such sentiments and the requirements of becoming a trend.

Case 13: Exhaust Emission Policies and the Technical Fix of Catalytic Converters

This paper discusses two aspects of the introduction of three-way catalysts (TWC) in Europe which had implications for the effects of the political decisions taken. First, the

meanings assigned to the catalysts in national parliamentary debates on emission-standards differed from the meanings attributed to it in the expert discourse on the issue. Second, the meanings assigned to catalysts in the political debate also differed from the meanings attributed to it by the car-manufactures. On the basis of this variety of meanings, the question is raised whether TWC-technology and US-standards constituted a 'quick and clean' solution to a 'complex and dirty' problem and whether, contrary to all intentions, it allowed American mobility culture to sneak in through the backdoor.

The main trend in the US and the EU history of emission-standards and the differences in legislation are discussed. Further, the political debate in Norway is used to underline the meaning assigned to the standards and the catalyst in countries that strongly emphasise environmental concerns. This political debate is contrasted with the meaning of emission standards in the technical expert discourse and the position of the catalytic converters in the car manufacturers 'greening' strategies.

Case 14: ITS in Japan - Stimulating the use of intelligent transport systems but to solve which problem?

Japan is a country with one of the highest population densities in the world as a result of which it suffers heavily from congestion and vehicle emissions. ITS is seen as one of the crucial approaches to tackle these problems. ITS covers a heterogeneous range of concreate domains such as 'vechicle navigation systems', 'vehicle information and communication systems', 'electronic toll collection', and 'assistance for safe driving'.

The development and practical implication of ITS is heavily stimulated by the Japanese government wich makes it a clear example of technology policy in the transport domain. It appears difficult, however, to realise the various options in practice. Two important reasons for this are (1) that various different technolgies are supported by different agencies with (too) little co-operation and (2) that it is a top-down approach that insufficiently reflects the problems as they are experienced by other actors.

Some technologies like car navigation systems have started to become a reasonable market success but wether this has actually mitigated congestion and transportation problems is not known and not investigated. In the view of critics of the approach, the Japanes large ITS programs work more as a support measure for the electronics industry than as a strategy to solve transportation problems.

Case 15: California Dreaming - Sustaining American lifestyle and the car

In California the air pollution has been in focus in transport policies already for some time, and also the energy consumption of transportation is seen as a major problem. This has lead to the introduction of a rather radical governmental scheme demanding reductions in air pollution from traffic and especially focusing on this in combination with support measures for 'zero emission vehicles' and 'low emission vehicles'. This has been translated into innovations schemes, where California government authorities cooperate with car industries and transport researchers in shaping the new cars. The mandates have been translated into support for electric vehicles and hybrid vehicles combining fuels cells or otherwise fuelled engines with electric systems resulting in better energy efficiency.

The focus of the study is on the market potential as viewed in these schemes giving rise to understanding how American life style is taken for granted and mostly not challenged by the visions of car manufacturers and authorities. Although sometime radical visions of changes in transport demands are mentioned, none of major actors dare to question the growth and character of the car based transport regime in the US. Both US, Japanese and European car industries are active in the Californian schemes, as they are seen as challenging and creating potentials for markets for new types of cars. But especially the Japanese car manufacturers question the potential size of the American market, as the electric and hybrid cars still are supposed to be more costly, and transport policies in general do not imply other means to restrict the use of petrol cars in the US so far.

Case 16: Go Boulder - Public participation in transportation planning

The City of Boulder, in the US state Colorado, has a long history of progressive policies as a result of which other Coloradans tend to refer to Boulder as the 'nine square miles surrounded by reality'. When congestion problems became unbearable in the 1980s, the city developed a comprehensive plan to tackle these. Public participation was a crucial element in the implementation of this plan.

An important objective of the plan was to aim for a modal shift by introducing new and attractive bus services. In the US with its very strong car culture this can be considered a very risky approach but, surprisingly, it led to a considerable success. The public participation is likely to be an important success factor in this result.

To mitigate congestion further, Boulder also explored the option of road pricing. Part of the exploration would be an experiment in which the car moves of volunteers would be tracked and where they would receive a rebate if they would remain under a pre-established budget. Initial reactions to the plan were positive but as it approached implementation, many became extremely negative, in Boulder as well as in other parts of the US where the city's sanity was questioned. Clearly, roadpricing was a bridge too far in the US

Case 17: The Living Laboratory - Introducing electric transit in Chattanooga

In the 1980s, the city of Chattanooga in the US state of Tennessee was in severe economic and social decline. A huge and comprehensive effort was started to revitalise the city. In order to manage the traffic that would be generated by a revitalised downtown area, the city requested the local transit authority CARTA to develop a public transit shuttle system that would move people about town. In the early 1990s, the idea was developed to build park and ride garages at the edges of the downtown area and to use electric buses for a shuttle service to various downtown destinations.

The initiators were aware that the whole set-up was very risky: it used unproven (electric drive) technology and the concept of park and ride is not very common in the US, to put it euphemistically. To reflect the experimental nature of the set-up the phrase 'Living Laboratory' was used. The explicit emphasis on learning allowed flexibility to tackle a variety of upcoming problems. Concerning the effect on mobility patterns, effects are clearly positive but the modal share of the buses is still rather small compared to cars. Nonetheless, the Chattanooga example illustrates that even in the car country '*par excellence*' it is possible to attain some modal shift with properly and attractively designed alternatives. The challenge is to realise this in other locations as well and subsequently explore the conditions for upscaling.

5.4. A quick overview of main empirical findings

As was explained in chapter 1 we will carry out an analysis across the case studies under four headings in the chapters to follow, notably:

- Institutionalisation of mobility;
- The societal embedding of mobility;
- Technical approaches to tackle emission problems;
- Room for change in the mobility domain.

To facilitate this work we have identified an number of cross-cutting themes to be analysed in the cases. These themes emphasise that in technology policy it is very important to adress the 'social dimensions', i.e. actors, coalitions between actors, cultural factors, etc. The themes are:

- Mobility perception;
- Needs, rights, symbols;
- Transportation problem and solution;
- Actors and networks involved;
- Delegations and redistributions;
- Agency and institution building.

The table on the following pages gives an overview of the main findings from each case on these themes.

Table 5.1: Main findings from the INTPOL case studies

Theme: **Case Study:**	**Mobility perception**	**Needs, rights, symbols**	**Transport problem and solution**	**Actors and networks involved**	**Delegations and redistributions**	**Agency and institution building**
Wish you were here **- EV innovations in Denmark**	3 different modes: - stop-go and special design for work - alternative for short distances and city transport - conventional car, longer range, eventually the second car	in both the first and second mode, a symbolic value is attached to the very specific designs no question whatsoever about rights, and needs taken for granted Ellert a designed change!	many, different motivations: environment, energy saving, car dominance, job creation <> technical focus on EVs, little environmental impact, moves pollution from city to region	innovators, environmentalists, governments and unions users rather at distance	following the technical focus the EV is supposed to do the job no stable routines emerged, technical problems were left to users	follows the mode: - institutions in demand - enthusiastic users - environmentally concerned, modern life style
Taxing towards future **- Economic fees on road use**	road pricing either for finance of infrastructure or regulation (reduction) of traffic, efficient road use	attacks or at least questions the free use of roads opens for rights debate by questioning needs inequality vs. congestion and pollution	congestion and price of new infrastructure <> automatic billing of fee for use	road planners, cities, electronics companies	delegates regulation to the electronic registration of passing cars ? differentiated fees needed to influence mobility patterns - otherwise not documented reduction in traffic	producers and money collectors

Theme: **Case Study:**	**Mobility perception**	**Needs, rights, symbols**	**Transport problem and solution**	**Actors and networks involved**	**Delegations and redistributions**	**Agency and institution building**
Highway 1 **- Coastal trunk road**	roads for economic growth and interlinking in 3 phases: - linking centre and regions, linking cities - passing through cities, linking regions - creating road network	high quality, bypassing cities, need is taken for granted but problems are in focus: - car as a general problem - city and private car problem vs. public means - linking car into system including other means	economic role of transport and health and environment in the (early) modern version <> trunk roads, bridges and tunnels, radical change in infrastructure from Oslo-centred to distributed	from central highway engineers to local interests groups and cities linking the region to the city	trunk roads, leading around towns and making the highway system the core of infrastructure	highway engineers city planners and (commercial) interest groups organised and inter-acting infrastructure planning
Living Laboratory **- Chattanooga P&R and electric busses**	bad circle of economic downturn and congestion leads to new use of city making it attractive and avoid congestion from visitors and users	needs not the least for the city is taken for granted, a modal shift is expected but on voluntary basis	congestion and modern renewal of city centre <> Park & Ride in combination with electric busses	community activists especially bringing business and environmentalist together establishes committees and funds, including development firms: 'living laboratory	electric busses and parking facilities in close connections with new institutions	strong commercial and community interest in renewal of not only liveability but also economic bases for the city experiences from earlier actions on air pollution
Bicycles on trains **- Inter-modal transportation**	shifting from seeing means of transport as separate, the combination of bicycle and trains combines efficiency with comfort and health issues	basic transport not questioned, but by creating a diversified use of transport means, the car is less dominant and routine use determined bicycle use stagnating	difficult to combine means of transport <> building parking and service facilities and opening for bicycles to be taken on trains	bicycle activists, ministry and DSB (state railways)	parking facilities and new trains campaigns for using bicycles in combination with public transport hope for broader switch?	DSB has accepted a view of bicyclists as customers making it part of their commercial strategy

Theme: Case Study:	Mobility perception	Needs, rights, symbols	Transport problem and solution	Actors and networks involved	Delegations and redistributions	Agency and institution building
Negotiated discrimination **- Rotterdam select**	mobility is crucial to the economic status of harbour and city mobility is defined by economic means, with emphasis on speed - free flow of traffic	distinction between necessary and non-necessary traffic, where the first is defined as business traffic or traffic willing to pay national plans operate with selective access	congestion, air pollution and slow traffic <> selective access to priority lanes, payment for road use, public transport and bicycle lanes	national and regional planning board, traffic demand management centres, companies inter-active combination of short term and long term projects	dedicated fast lanes, road payment, provided alternatives by improved public transport and bicycle lanes, fines for misuse of priority lanes and entrances	especially the new co-ordinating regional level has promoted planning integrated and inter-modal solutions in combination with traffic management
Mini Metro **- high class transport**	mobility is crucial for the functioning of new towns, and a potential of guiding this in the direction of using public transport by creating infrastructure before city is supposed to reduce car traffic	high class, efficient, short waiting, symbolic value to attract new customers	growth in car traffic and new town planning focussing on concentrated growth, but attracting more traffic <> fast metro link to the city centre	privatised new town planning enterprise financed from the income from selling public owned land after having increased its value by providing infrastructure as a precondition	the Metro is supposed to attract personal transport of business people, avoid growth in the traffic load on the inner city, and raise the value of land	the Metro is a central supported by the public owned but privatised Ørestad company, but a lack of strategic coordination is the backdrop of this 'by-passing' operation
California dreaming **- sustaining American lifestyle**	the existing town structures and mobility patterns defines the future - this is the American way of life	a car is a car etc. defining the conditions for use as private and unlimited	air pollution <> EVs and hybrids (HEVs) solves the problem if the market can be created	government: CARB, transport researchers, car companies	new advance electric and hybrid cars are supposed to substitute traditional cars, not creating market niches, but putting new products on the existing market	CARB is the central strategic agent basing its policies on the interest of car industries in being able to deliver products for a new market segment
Telematics in Concert **- German Moves**	mobility can be regulated as it consists of different priorities	rather weak measures based on existing de-mands in Germany road pricing goes against liberal traffic regulation, and car dominance	urban congestion, environmental impact of traffic growth <> technical fix of transport telematics, optimise, regulate access, manage traffic taxes, support modal shift	company interest in promoting systems, public interests in regulating traffic	information and telematics is expected to move peoples choices and optimise use	cities in need for regulating traffic and strong support from EU for the technical fix

Theme: **Case Study:**	**Mobility perception**	**Needs, rights, symbols**	**Transport problem and solution**	**Actors and networks involved**	**Delegations and redistributions**	**Agency and institution building**
Urban Qualities **- Strasbourg trams**	mobility in city centre is important, but hampered by congestion and pollution from cars, 'urban quality' becomes the passage point	by increasing costs, and improving public transport, the means of transport is regulated, although no access is prohibited	city centre pollution and congestion <> P&R facilities, new tramway, high parking fees in the city centre	urban planners and citizen action groups, also including public transport authorities	market mechanisms: price for parking, in combination with the provision of alternatives: P&R and tramline	city planners establishing contacts to interest groups to identify options and recruit supporters
Th!nk Electric **- branding Norwegian EVs**	a change is supposed to be realistic in mobility patterns	urban transport is diffe-rent from other needs and can be translated into smart small vehicles, and shorter distance	congestion, pollution <> reduced emission, noise and space of EV based on radical redesign and new materials	the Pivco company, and later Ford Motor buying the concept of strategic renewal, not the electric car and mobility vision	the alternative car and massive marketing of an alternative vision was supposed to attract customer	innovation and entrepreneurship creating new industry, but no niche support
Go Boulder	high congestion of cars, a university community not questioning needs but heading for a modal shift - efficiency in focus: reducing miles travelled by 'single occupancy vehicles'	experiments with road pricing and rebates for reduced driving was not extended due to negative responses to reduced right to car usage	congestion <> new bus system established based on user consultation and creation of action plans	city support for experimenting institution, basing its initiatives on public campaigns and support	new bus system is supposed to tackle congestion problems	transport plans and advisory groups engaging in consulting the public
Italian Mobility **- Public Space-making**	Urban centre mobility is a problem but difficult to avoid, a modal shift may be achieved by offering public transport that also allow for new public spaces	small electric buses could get around in the old city centre of Rome, allowed for new forms of public space	congestion in city centre, threat to old buildings <> modal shift through small electric buses	city government, bus company, general public	small electrical buses are supposed to facilitate a modal shift	new users of public transport

Theme: Case Study:	Mobility perception	Needs, rights, symbols	Transport problem and solution	Actors and networks involved	Delegations and redistributions	Agency and institution building
Touch of Technocracy **- TENs and road pricing**	Mobility is important to economic grwoth and as a precondtion of an internal market.	a consolidated Europe needs efficient transport networks across member states, new transport technologies also creates new economic possibilities	lack of efficient flow, European industry potentially lagging behind <> new transport networks, R&D programmes to support development of new technologies	EU and national administrations, industry, highway authorities, railway authorities, politiicians, R&D communities	new transport technologies and transport networks are supposed to facilitate more efficient flow of transport as well as economic opportunities for European industry	trans-Euopean networks for transport, new or improved links between R&D and indudstry
A Slight Intervention **- EIA in urban development projects**	Mobility needs are taken for granted.	cars and highways represent environmental impacts that need to be kept in check. Highways and roads should be constructed with minimal environmental impact, but local needs may in the end be more important	construction of roads, highways and other mobility-related infrastrcuture may be enviromentallly harmful <> standardised environmental impact analysis should make constructurs more conscious about the need to reduce impacts	construction companies, local and antional planning authorities, in principle also local politicians and general public	the standardised tool of EIA is supposed to make environmental impacts more visible and more frontstage in planning	EIA specialists, new or improved planning institutions
Exhaust Emissions **- three way catalyst fixes**	not addressed, although indirect taken-for-granted	the polluting car has become a threat to people in cities and to car industry, and energy efficiency is e.g. not addressed	emissions from cars <> end-of-pipe solution based of standards and an obligatory demand to new cars	government, researcher and car industry	a three-way-catalyst is supposed to take care of pollution, instead of waiting for other improvements	negotiations about aligned standards have been at the centre, involving car industry and industrial policy
ITS in Japan **- solving which problem?**	Mobility crucial for society; share of public transport already high so car-driving should be facilitated	People have a right to efficient and safe car-driving.	road congestion and accidents <> ITS for car navigation, traffic monitoring, toll collection, driving assistance	Government bodies (national and big cities), (research) institutes and industry	efficiency and safety delegated to technology	government agencies attempt to enrol (research) institutes and industry

Chapter 6

INSTITUTIONALISATION OF MOBILITY

6.1. Introduction

Since Henry Ford began mass producing automobiles and selling them at affordable prices in 1908, the automobile has revolutionised not only the way we travel, but the way we work and live, as well. Urban planning has been designed to accommodate and complement the use of automobiles. This is made evident by the vast highway systems and high numbers of parking lots throughout the world's cities. This new mobility caused the cities to grow, and for suburbs, which are connected to the city through these roads, to develop. Highways brought cities together and made it easier for individuals both to separate from their families and friends, and to bring distant relatives and friends together.

Up to the late 1960s there was a large belief in public planning as a means to integrate and regulate the use of motor cars in urban areas and in to the everyday life of citizens (see 2.3.3. and 2.3.4.). Huge plans were made for most cities, regions and nations in the 1960s to "catch up with and "take control over" the development". But during the 1970s the existing planning rationale and the planning optimism came into a long lasting crisis, which is still present. First, it is an impression that the society has given up to make "master-plans" (multi-sectoral city, regional and national plans) for the whole society. Not mainly because of ideologically reasons, but because it has become too difficult. Second, the discussion on community development is not longer only a part of a more or less closed planning process, but has become much more attacked by organised public critique. At the same time these organised interests seem to have been integrated as a more or less "constructive" part in community development processes. Third, Instead of large plans containing political and ideological visions we now see much more of pragmatic planning at the local or micro-local level (single project planning as bridges or bits of roads).

This chapter will focus on changes in the institutionalisation of mobility, especially with relevance to the congestion problem. As a part of the view on planning until the 1970s the understanding of the most rational way to tackle the congestion problems was mainly to build new roads. This is more or less an important approach also today, but much more in combination with other means. Road building has also in many cases become more controversial and is in many urban areas not possible because of limited space.

This chapter will argue that technological and institutional innovations to deal with traffic problems more and more are initiated and developed by individuals and by private enterprises, at the same time as it has been significant reforms in public planning at the different administrative levels the last 2-3 decades. In many urban areas in the US, private sector leaders have formed umbrella organisations to study the future problems likely to be caused by regional growth. Members include leaders from private

firms, non-profite entities, civic groups, unions, universities, and public agencies. These organisations have little money and no governmental powers. But they can act as a forum for joint deliberations among their members about what regional problems will emerge and what they can do about them. Such organisations can adopt much more controversial stands on issues than their members could individually. They can therefore perform important functions in both designing regional policies and helping to get public support for such policies. Examples from the US are the Regional Planning Association in New York, the Bay Area Forum in the San Fransisco area, and Los Angeles 2000. Initiatives from such organisations is probably essential to getting innovative and controversial policies, i.e. Road Pricing, adopted in any area – not only in US but also in Europe. (Downs 1992) If we in the future will see a further growth of such individual and private organisations, the challenge of the future will probably be to develop new kinds of interaction and co-ordination between these more fragmented activities and planning authorities at different administrative levels. An obvious advantage of such a development is bringing to an end what Bruno Latour (1996) calls the isolation of engineers, technicians and technocrats.

It has been proposed that countries should stop developing so many highways. There are two schools of thought on this topic that consider the positive and negative aspects of such a solution. The first group supports the idea, as they believe that by limiting the amount of roadways, individual travel will naturally decrease or at least remain at the current level, rather than increase, as it now tends to do. The second group stands by the idea that increased roadways and even congestion itself represent an increase in a country's overall production and economy, and feel that discontinuing roadway construction would lead to results that are inconsistent with any country's desired outcomes from such a project. The increased number of cars were developed by automobile industries, the highways allow new business districts to develop, and even the highway crews themselves represent a form of industry that is made possible by our naturally increasing desire to travel. Neither of these schools of thought, however, could argue that all new expressways expand our cities and distribute our population over more terrain, thus forcing us to enter a spiralling equilibrium in which the use of cars becomes all the more necessary (Weinberg 1998).

Today, public authorities have begun to see mobility itself and the number of vehicle-kilometres travelled as the main problem. They have tried a variety of demand-side oriented policies aiming to stimulate the use of other forms of transport, e.g. to car-pool, or to reduce mobility. The policy instruments vary considerably due to different infrastructures and cultural differences. Some typical examples are:

- Communication strategies aimed at the general public.
- Pricing and taxation to discourage car-use (in general or at specific locations and during specific hours) and encourage use of public transport.
- Encourage or direct employers to develop transportation management plans for their employees.
- Policies to stimulate car-pooling.
- Parking regulations; etc.

Increasing levels of mobility have led to severe problems with congestion and air pollution on the highways and in urban areas.

The main causes of peak-hour traffic congestion in the western world are deeply rooted in cultural rooted desires and behaviour patterns. Some are even built into the basic physical and social structures of urban areas. Policymakers hoping to reduce congestion

therefore must persuade millions of citizens to change some of their most cherished social goals and comfortable personal conduct. Anthony Downs (1992) divides congestion into two basic categories: immediate and long term. With relevance to the American scene he identifies four immediate causes, each of which tends to reinforce the impact of the others and thereby heighten congestion:

- Rapid population and job growth.
- More intensive use of automotive vehicles.
- Failure to build new roads.[29]
- Failure to make drivers bear full costs they generate.

Urban traffic congestion in growing cities is also intensified by long-term causes:

- Concentration of work trips in time.
- Desire to choose where to live and work.
- Desire for low-density neighbourhoods.
- Preference for low-density workplaces.
- Desire to travel in private vehicles.

These causes are especially developed from an analysis of the American situation, but the case studies from the INTEPOL-project indicate that the same causes also are relevant for the European situation.

Its various how different countries deal with the congestion problems, but gradually work to improve accessibility and securing liveability seem to be a common feature. From the INTEPOL-cases several interesting approaches occurs:

- When the master-planning projects has crumbled away it seems to have developed a stronger interactive component in the sense that plans to attack the problems have become more discussed with interest groups and the public in general (Popkema and Elzen 2001a). It's a general impression that the democratic element in local planning to some degree has been strengthened. This is not a new development, but has gradually been enforced in local planning since the 1960s.
- It's an interesting feature that there are few examples of local or national policies that attempts to develop integrated approaches to, or balance the competition between different modes of transportation. The case study on Strasbourg exemplifies an approach consisted of a balanced combination of discouraging car-use along with the provision of new and attractive alternative modes of transportation (Popkema and Elzen 2001b).
- Very much of the dealing with traffic problems has not only to with improving transportation, or make a more efficient traffic system, but has also to do with improving the quality of life for a large number of citizens in the inner cities.
- Instead of make "master-plans" or large project plans, there is a tendency that large projects are developed by linking many small projects (Thomassen 2001).

6.2. A field of conflicting interests

The influence of the automobile on city development provides many opportunities for mobility, though the opportunities are distributed unequally. The automobile is both the most flexible modes of long distance transportation for multiple passengers, and one of

[29] Downs refers to the fact that the total highway mileage in America increased only with 0.6 percent between 1981 and 1989. The situation in Europe since 1980 is not investigated.

the most suited for recreational trips. However, in cities where the automobile is the main means for transportation, it degrades the overall quality of urban life, produces widespread pollution and contributes significantly to the understanding of the global environmental crisis.

The understanding of transport problems in cities has been a part of the history as long as cities has existed. Even horse drawn chariots caused congestion and safety problems in ancient Rome. Steam locomotives in the nineteenth century were both noisy and polluting, leading to the peripheral locations of railroad stations in most European cities. Tram accidents caused thousands of deaths in America and Europe during the early twentieth century. Transport problems are therefore not new, but they have to a large extent been increased by the automobile., which has caused much more serious and more extensive social and environmental problems than ever before: more noise, air and water pollution, accidents and injuries, congestion, urban sprawl, social segregation and inequity in mobility.

As transport technology has changed over the centuries, the speed and comfort of travel has increased, but the urban transport problem has never been never been solved – and will probably not be solved. Instead, it became more extensive and more complex. Mobility has greatly increased, but cities has have decentralised so much that accessibility has fallen for a large part of the population.

Congestion is one of the most obvious examples of how too much travel demand has concurred the level of transport supply. Mobility, once viewed as a goal itself, has become a major problem in modern cities. Technological improvements can help some of the side effects of car use, but will never solve the problem alone (Pucher and Lefèvre 1996, p.1-3).

The development of a policy to deal with the congestion problem has to cope with several conflicting interests. First, as mentioned above, the automobile is the most flexible mode for transportation at the same time as it degrades the overall quality of urban life, produces widespread pollution etc. Second, and a more direct policy relevant issue, do we want to build more roads to satisfy the demand for mobility or do we want to give priority to some kinds of traffic by restricting the access to existing roads. Restrictions can be both limited accesses to certain roads as discussed in the Rotterdam case or introduction of road-pricing systems. (Popkema and Elzen 2001a and Thomassen 2001b). The decision to build more roads can be viewed as a support for a more liberal traffic policy regime, when restricting access can be viewed as a support to a more regulative traffic policy regime.

The last decades, probably related to the fall of “master-planning”, more conflicts over traffic-issues have become more visible in the public. Nelkin (1992) has developed four types of controversies, which also more or less seems to be present in the INTEPOL-cases:

1. Disputes concerning the social, moral or religious implications of a scientific theory or research practice. Ethical issues as i.e. unequal social division of access to mobility or the moral aspects of calculating a number of deaths in traffic accidents each year represents these kind of disputes.
2. Tensions between environmental values and political or economic priorities. This kind of conflicts has regularly becomes focused in road building projects the last decades.

3. Controversies focussing on the health hazards associated with industrial and commercial practices, and the resulting clashes between economic interests and those people concerned about risk. This kind of controversy was i.e. present in the dispute on introducing the three-way-catalyst (TWC), where the car industry was reluctant to the new technology and health professionals and environmentalists pushed to make the TWC obligatory (Munch and and Thomassen 2001).
4. Controversies over technological applications reflecting the tension between individual expectations and social or community goals. So-called NIMBY's (Not in My Backyard Movements) protesting against road building projects, because the road is placed in *their own* neighbourhood, represents these kinds of conflicts.

Two general groups of problems can be distinguished, one in relation to the massive use of vehicles and the consequences on land-use, congestion and poor accessibility of various locations, and a second in relation to vehicle exhaust emissions. In this chapter the focus is on the first. The emission aspect will be discussed in chapter 8.

This chapter is based on an underlying assumption that from the 1970s, when the belief in "master-planning" as an overall method to solve urban problems was starting to decline, transportation policy began to be driven by two strong forces:

- Central city economic competitiveness with the suburbs and the wider surroundings
- Growing concern with energy and the environment.

Policymakers began to consider a variety of transportation and parking management devices: carpooling, park-and-ride, and controlling or "capping" downtown parking supply. By the end of the 1980s, however, it was becoming increasingly apparent to policymakers that these and other "transportation control measures" were not having a significant effect on automobile use in general and on pollution level in particular. Thus, policymakers began to consider additional means of affecting mode choice through "transportation demand management" (TDM) techniques that emphasised not only incentives for reducing auto travel, but disincentives for auto travel as well—including road and parking pricing (Rufolo and Biancho 1998).

6.3. Road construction to catch up with increased traffic

In his essay, The Autonomy of Technique, Jacques Ellul relates a concept rather befitting of the automobile:

> *Whenever technique collides with a natural obstacle, it tends to get around it either by replacing the living organism by a machine, or by modifying the organism so that it no longer presents any specifically organic reaction.*

The "technique" of transportation followed this trend. As there arose a greater desire for personal transportation, the horse and carriage was replaced by a machine, the automobile. The automobile required roads, with trillions of tons of stone, bricks, macadam, and concrete rendered. This is the most radical cultural change on the natural world. In US more than 60,000 square miles of land is paved for automobile use, or roughly 2 percent of the total area of the country. This is roughly equal to the landmass of the entire state of Georgia (Altman 1999).

The introduction of motorways or highways especially designed and developed to catch up for the growing road traffic after World War I came in the early 1920s. The first was the Italian "autostrade" between Milan, Como and the Swiss border, and the system was

extended to serve the industrial areas of the Po Valley. In the 1930s Germany followed by initiating construction of a nationwide system of "autobahnen" linking Berlin with the Ruhr, Hamburg and Bavaria (Tolley and Turton 1995, p.144).

At the mid-1950s the road system in Europe had changed little since pre-war days. During the war resources were diverted into the production of munitions and then, after the 1939-45 period, into reconstruction and flagging export industries and each nations industrial base. There was little to spare for transport infrastructure and for roads especially.

But from the mid-1950s this situation changed. Some countries in the Western world started to build motorways and highways and the following year's motorway and highway constructions were initiated all over Western Europe. Expectations were being changed by the knowledge that it was technically possible and needed, because of the rapidly increasing number of cars, to cater for modern motor-traffic.

The road transport sectors in Western Europe, Japan and US have received massive investments since the early 1950s. Expansion of highway networks increases in rates of car usage and ownership and in haulage of freight by road transport is common to all these countries.

The first long-distance highways in the US date from the 1940s. The most important single decisions to promote a large road construction project occurred in the US in 1956 when the Congress passed the Inter-State Highway legislation providing for the construction of a super-highway network to criss-cross the country.

Roosevelt first proposed the idea of a nation-wide highway network during the great depression. By the late 1930s, the pressure for construction of transcontinental superhighways was building. President Franklin D. Roosevelt repeatedly expressed interest in construction of a network of toll superhighways as a way of providing more jobs for people out of work. He thought three east west and three north south routes would be sufficient. Congress, too, decided to explore the concept. The Federal-Aid Highway Act of 1938 directed the chief of the Bureau of Public Roads (BPR) to study the feasibility of a six-route toll network. The resultant two-part report, Toll Roads and Free Roads were based on the state-wide highway planning surveys and analysis.

The approval of Roosevelt's ambitious proposal committed the federal government to construct 44 000 miles of toll-free express highways. The interstate highway system created from 1956 was the largest and most costly public works ever constructed (Nadis and MacKenzie 1993, p.8-9). The historian, James Flink, argues in his book: The Automobile Age, that the:

> *... passage of the 1956 Interstate Highway Act ensured the complete triumph of the automobile over mass-transit alternatives in the United States and killed off, except in a few large cities the vestiges of balanced public transportation systems that remained in 1950s America.* (Flink 1988).

In UK a high-speed road programme was initiated in 1959, with the opening of the first section of the Lancashire M6 motorway at Preston. The initiating of the US interstate highway-network and the UK high-speed programme was releasing similar programmes in all Western European countries. The common idea seems to have been to link together the major cities in each country.

The consequence of highway building, as Flink emphasised above, is not well documented, but it's reasonable to think that the planning of and construction of inner- and inter-city highways has had the same consequences all over the world (Volti 1996).

6.4. Many small projects becomes one large fulfilment

In Norway there has because of the small and scattered population compared with the size of the country and mountainous shape never been a policy to have a high-standard network of motor roads. Instead there has been a goal to develop a medium-standard network of trunk roads linking the country together.

The idea of trunk roads in Norway has its history back to an alternation of the transportation policy in Norway in the years 1956-58, combined with Norwegian road-construction engineers' inspirations from the US Interstate Highway Act of 1956.

The main actors in the trunk road policy in Norway are on the national level, in the Government and relevant ministries and directorates. This has mainly to do with the inter-regional character of the issue. Because of this regional background of an minister is often looked up on as more important than which party he or she is representing. Without documentation it has been said that several interregional (and local) roads has become realised because of the regional connection of the minister.

On the other hand there is many different actors at a sub-national (national economic interests, both public and private), and the regional and local level of administration. These interests are rarely represented as reluctant to road construction, bot mostly as promoting roads because of economic needs, as means to keep up the population etc. It seems to be a general impression that NGOs resistance against road construction is mainly connected to road projects in, or in the surroundings of, the larger cities. When roads in rural regions mainly is interpreted to be a "human right", this seems to be more twofold in the urban areas. On the one hand the individual "need" and feeling of higher welfare because of increased quality on roads. On the other hand the resistance against the individual experienced inconvenience because of air pollution, destruction of neighbourhood qualities or private property, so called "Not In My Backyard"-movements (NIMBYs) are often based on this kind of arguments.

In 1971 six explicit objectives for the inter-urban road programme were formulated as a part of the British inter-urban road system:

- To achieve environmental improvements by diverting long distance traffic, and particularly heavy goods vehicles, from a large number of towns and villages so as to relieve them from the noise, dirt and danger which they suffered.
- To complete by the early 1980's a comprehensive network of strategic trunk routes to promote economic growth.
- To link the more remote and less prosperous regions with this new national network.
- To ensure that every major city and town would be directly connected to the strategic network and that smaller cities would be within a reasonable distance of it.
- To design the network so that it served all major ports and airports.
- To relieve as many historic towns as possible of through trunk traffic.

To a smaller scale the same policy was implemented in Norwegian inter-urban transportation from the mid-1970s. The six objectives represented a kind of a closure of

the discourse on construction priorities in the road transportation sector. In a few objectives a wide range of interests became neutralised within the frame of improved means of determining the best alignment, standard of provision and timing of scheme, as well as of showing the economic value of the scheme. Neither in Britain nor Norway these objectives were used to determine the overall size of the inter-urban road structure or to give priority to specific road projects. This aspect remained a judgement for the Ministries (Starkie 1976, p.109-11).

Added to the objectives presented above it has been a prior intention with trunk roads in Norway to establish high standard transport routes, which link up the country and give access to foreign markets. The trunk roads are intended to have important international or national functions, while the lower classified highways are intended to have regional or local functions (Statens Vegvesen 1996, p.21). The international dimension of the trunk road policy seems to have been stronger in Norway than in the continental European countries and in the EU-area. A possible reason to this may be the fact that Norway on the one hand mainly exports raw materials, and on the other hand central Europe, which mainly need an infrastructure to domestic distribution.

The breakthrough for governmental priority of trunk roads came in the mid-1980s. One of the central issues became how to make a priority list of the trunk road projects. Detailed instructions about how to document improvements on accessibility, traffic safety and environment was presented in a guidelines, worked out by The Ministry for Transportation, to instruct the work with Norwegian Road Plan 1986-89.

The Ministry of Transport has in the 1990s developed further the basic strategies for accessibility, environment, traffic safety and regional policy in relation to trunk road construction. In addition to the four strategies was a fifth strategy: *recommended strategy*, which weighing factor between the four basic strategies with priority to the accessibility strategy. All the 16 trunk roads in Norway are ranked within each of the four basic strategies.

Several interests seem to meet each other in the realising of a coastal trunk road. First, local interests to get better access to the nearer surroundings and to direct through passing traffic outside the inner areas of cities and towns. Second, a regional interest concerned of getting access to distant markets and public services. Third, a national interest of getting better access to raw materials, especially fish and oil, and to promote efficient use of production capacity in this areas. As we will see in the two coming mini-cases, resistance from one of these levels to a road construction project seems to be of critical importance for the realising of these projects.

Norwegian cultural and political attitudes towards cars and roads in the 20th century have not established a united road-car regime in Norway. When building roads mainly has been seen as a carrier of (social-) democracy, freedom, mobility, equality, industrialisation, modernisation etc., the attitudes towards the car are more opposed. On the one hand in a historical perspective we find the same positive attitudes towards the car as we find towards roads. On the other hand, there have, especially on the policy and administrative arenas, been more restrictive attitudes towards buying, ownership and use of cars, especially private cars. Since the introduction of motor vehicles in the late 19th century this has e.g. been visible in a continuous debate over giving first priority to the "most favourable", but less competitive, mode of transport – the railroad, or to the most superior and most efficient mode of transport – cars and trucks (Thomassen 2001a).

6.5. Cities and the culture of traffic

As the urban traffic problem has developed so have ideals emerged from planners and scientists been incorporated in plans of the time. For example, Ebenezer Howard's garden cities of the early twentieth century were planned as settlements in which everyone could walk to work, while the US, with its higher levels of car ownership, was planning spatial arrangements that protected residents from the car by the 1920s. Clarence Stein and Clarence Wright's new town at Radburn, New Jersey was a pioneer idea when segregating groups of houses from surrounding traffic arteries and connected internally by walking routes (Krueckeberg 1997). These kind of walking routes became very popular in the post-war New Towns in UK and influenced the more advanced ideas of the segregation of different kinds of urban traffic developed by the British planner, Colin Buchanan, from the early 1960s.

Le Corbusier encouraged the use of cars in cities with his notion of "cities in the sky" - high rise developments connected by high-speed motorways, which became influential in the UK in the 160s and 1970s. The American architect Frank Lloyd Wright also emphasised the need for space for living, but envisaged it spread horizontally, with housing densities of two to the hectare, universal car ownership and a new city which would encompass the entire country, what he called the "Broadacre City of tomorrow" (Hall 1992). Jane Jacobs' book: *The death and life of great American cities* (1962), were an important starting point turn towards conservation, higher densities and resumption of urban living in compact communities connected by patterns of non-motorised movement.

Imagine a city without traffic jams or smog. A city with elevators and walkways powered by solar energy. One where residents live together in energy-efficient "Smart-houses", spaced closely enough so that everything people need is within walking distance. Around 1970 a visionary architect, Paolo Soleri, started building such a community in the Arizona desert, called Arcosanti. Soleri considered the project as an antidote to urban sprawl and pollution. Denser than New York City or Delhi in India the planned city would occupy only 2 percent of the land that normally occupied by typical suburban communities of the same population.

In the early 1970s students and pioneers in alternative lifestyles descended en masse to the desert to make the vision to a reality. Today only 60 full-time residents, mostly students, live in Arcosanti and less than 5 percent of the city is complete. Soleri has been forced to scale down the project dramatically and its most important role is as an tourist attraction. More than 50.000 people are visiting the site each year. The paradox is that even the dream of immobility has as tourism created even more need for mobility (Nadis and MacKenzie 1993, p.93-94).[30]

In the 1990s, most of the research and literature concerning cities and the problems of mobility argues that it is not realistic to propose eliminating cars. The idea instead, as it is made heavily visible in this report, is to create a host of attractive alternatives, concerning alternatives to car transportation, alternative use of the car and more environmental friendly technological modifications of the existing car concept. Perhaps the most important question at the moment, as it has been for decades, is to break the evil circle that the only alternative to the automobile is immobility.

[30] http://www.goodmoney.com/arcosanti.htm, 11.05.2001.

6.6. Master-planning, city traffic and the culture of planning

After the industrial revolution housing and industrial location were the main topics of town planning in Europe. After World War One followed by a rapid urbanisation of Europe it became more and more visible that the social problems and planning challenges in European cities were interrelated with the development of rural areas. As a part of the growing modernist movement increased influence on architecture and town planning the regional approach to planning was developed. At the same time transportation issues was put on the planning agenda.

Internationally the notion of regional planning was put on the agenda in the early 1920's. First time regional planning was discussed internationally among planners was at *The international town planning conference in Amsterdam* in 1924. The idea of regional planning had from the early beginning a strong character of anti-urbanism, promoting the idea of slowing down the growth of the largest cities. Instead the regional movement promoted the idea of satellite-cities connected with each other and the larger centres by well developed infrastructures.

It was at *The international town planning conference in Amsterdam* in 1924 car traffic for the first time was put on the agenda as a new "problem" in city planning. The coming decades traffic, together with housing, became the main issues in urban and regional planning in Europe. In the case of Norway the first regional plan was *The regional plan for large Oslo* of 1934, where the main issue was traffic and transportation.

US experienced the same growing focus on regional approaches to planning and transportation "problems". In the 1920's the traffic "problems" emerged clearly. The automobile contributed enormously to environmental and financial stress. It choked the streets of central business districts and residential areas, causing merchants and city officials to claim for major traffic plans showing proposed street widening, extensions and openings. At the end of the 1920's two American planners, Robert Whitten and Clarence Arthur Perry, made studies how residential areas could be planned so that they would be insulated from the noise, fumes and floods of automobiles. At the same time the City Housing Corporation, a firm of New York, built the city Radburn in New Jersey. A city especially designed "for the motor age" (Scott 1971, p.187-88).

In May 1929 the Regional Planning Committee of New York presented the first plan for the New York region. In fact it was the last document summing up what the committee had said about the future of New York in several sector survey volumes since 1927. The greater part of the first volume of the regional plan presented plans for a metropolitan loop highway, inner routes, radial routes, and outer circumferential routes, a metropolitan bypass and numerous minor highways, as well as proposals for new rail and waterway projects, airports, and a suburban rapid transit system. This was the first product of a "systems approach" to urban transportation planning in US (Krueckeberg 1997).

Later such plans were adapted all over the industrialised world. Well known is The Abercrombie plan for London in 1944, "The Finger Plan" for Copenhagen in 1947, and The regional plan for Greater Oslo in 1960. All cities, large and small, with respect for themselves and beliefs in their developing potential made a regional plan describing the wanted future. A study of Norwegian "general plans" from the mid-1960's show that the expected population in all plans together were higher than 10 millions in 1980. All

communities both in urban and rural regions who made plans, without exception, expected growth in local economy and population. In 1980 the population of the country was about 4 million (Thomassen 1997).

In the post WWII period viable and cost-efficient rail transportation has persisted in Europe and Japan, despite relatively high levels of automobile ownership and use. In Japan, world leadership in automobile production and a highly developed automobile culture coexist with very efficient mass-transit systems. These examples demonstrate that automobile cultures can be compatible with modern mass-transit systems. Why then have the growth of number of automobiles in US and Europe wiped out mass-transit systems in US and to a large extent in Europe?

One likely reason to the almost complete absence of mass-transit systems in US is the fact that the American automobile industry bought up and closed down mass-transit systems in American cities. James A. Dunn Jr. in a comparative analysis of European and American transportation policies suggest other reasons. He contrasts the European policy paradigm of centralised, authoritative planning with the American paradigm of relying on the invisible market. Rail transportation and mass transit in Europe historically have been viewed not as commodities exchanged for profit in a competitive marketplace but as social services to be provided by government on the basis of rational planning. This has meant that the development of highway transportation in Europe has been co-ordinated by the state to be complementary to rather than competitive with the railroads and the mass transit. And, in Europe, highways are not extended or improved beyond point's compatible with railroad networks and there has not been a great interest in building urban freeways.

Dunn argue that unlike the purchase of automobiles by individuals, which falls within the conception of transportation choice being determined in the marketplace, providing the infrastructure of highways and streets essential for automobile use requires centralised planning in US as well as in Europe. Unlike most European governments, the federal, state, and local governments in the US have consistently provided massive funds for building the best highway infrastructure in the world and excluded funds for the rail infrastructure. Dunn argues that the answer lies in the historic nondivertibility of highway revenues collected from gasoline and other special user taxes (Dunn 1981, p.100-17, Flink 1988, p.373-75).

6.7. Regulations or new roads

In general there seems to be no simple solutions to traffic congestion in inner cities. Two strategies have traditionally been most obvious among planners: Either a supply-oriented strategy to build new roads or a demand-oriented strategy to introduce restrictions on driving. To solve the inner city traffic problems by building more roads and constructing more parking houses is technically possible, but normally very costly. There is not available space in many cities to build more roads without extensive clearance of existing areas. Clearance of existing areas has been done most in the US and also to some extent in Europe, but is normally very controversial and the process is often very time consuming.

The US City Boston is an example of how expensive it is to solve the traffic problems by new road construction. At the moment the whole inner city highway system is being built in to underground tunnels. The construction period is 10 years and the cost is at the

moment expected to be about 12 billion dollars. This investment is done under the assumption that the traffic problems will be solved. The opponents of the project have called attention to the well-known fact in planning: there can never be enough roads and more roads generate new traffic.

In Europe the opposite solution has been tried by doing most of the inner cities car-free, either by heavy restrictions or by prohibition. This is the case both in Lyon and Barcelona. In Copenhagen the Danish drivers' organisations promote a car free inner city.

If a local authority wishes to make a inner city free of cars at the same time as they want the inner city to keep up its attractiveness the decision has to be followed up by additional decisions to reconfigure the traffic system of the city. Partly as a result of a social and technical opposition of mayor city plans the last decades, it is in the same period been a growing tendency to plan for smaller areas or more limited construction projects instead. The assumption has probably been that the social aspects are easier to handle in this kind of projects.

A decision of this kind was made in 1992 by the Danish Parliament, when they decided to build a new subway in Copenhagen. The aim of the project was to provide service for downtown Copenhagen and the southern part of greater Copenhagen. The main traffic expectations connected to the Metro is to improve:

- The efficiency of the public transportation system in Copenhagen, and
- The public transportation of the suburb Amager.

Added to these technical goals some further expectations are integrated to the Metro-concept:

- It must not increase construction expenses of the state or the city of Copenhagen.
- It must serve as the basis for the development of the new city district of Ørestad.

The most important lessons to learn from the Copenhagen-Metro case is that the consequences of a new transportation system is not a 'technical thing', which is the same as saying that technological consequences can not be produced rationally and that the effects do not always correspond to the intentions. The consequences of technologies, in this case the traffic consequences for Copenhagen of constructing a new subway, do not manifest themselves automatically on the basis of technical specifications and implementation. Technologies are not passive and automatic instruments for politicians and engineers. Technological consequences are produced when technologies function and technologies do not just 'function'; they must be "put in to" function. Behind this are active actions and strategies made by the network of actors involved in the case (Jørgensen and Munch 2001).

Other initiatives to promote alternative modes to car traffic have also been launched in Copenhagen. The City of Copenhagen has taken an active role in a City-Bike Project. City-Bikes is assumed to be very suitable as an extension of public transport. The "City-Bikes" scheme is an initiative according to which bicycles can be collected from the City-Bike racks throughout the city with the deposit of a 20 DKr coin in the lock, similar to collecting a luggage cart at the airport or supermarket.

The City-Bike project was originally developed in 1989 with the idea that the City-Bikes could help solve increasing problems with stolen bikes in Copenhagen. Insurance companies could sponsor the City-Bikes instead of paying out compensations for stolen

private bicycles. This original project was commercially based and went bankrupt in 1991 due to funding problems.

In the beginning of 1994, the project re-emerged with the establishment of a non-profit based foundation for City-Bikes in Copenhagen named "Fonden Bycyklen i København". The funding for the foundation was 300,000 DKr provided by the City of Copenhagen, The Ministry of Communication and Tourism, The Ministry of Culture, and the tourism organisation "Wonderful Copenhagen".

The project was realised in late 1994, when the organisation of green interests, "Den Grønne Fond" and The Ministry of Environment granted in 2.5 million Dkr. At the same time, two sponsors became interested in the project, ordering 300 City-Bikes each for three years. The additional funding was enough to order the bicycles and racks, and in summer 1995 the first 1000 City-Bikes were being used and seen in Copenhagen.

The Copenhagen City-Bikes seems to have overcome the problems of a pioneer project. The success and popularity of the project is evident in the interest of other cities in Europe, such as Sandnes, Trondheim, Hannover, Mannheim, Marburg, Munich, Amsterdam, Rotterdam, Helsingborg and Gävle. Another important factor is for the City-Bike system to become main component of an environmentally friendly system for urban living and a part of a Green Transport system in an urban area.[31]

Anyway, it seems not to be any co-ordination, or any ideas of an integrated system of car-alternative transportation modes, between the Copenhagen Metro project, the City-Bike project or other initiatives. The City-Bike seems not to have been promoted as a car-alternative at all. No adequate political forum exists for discussing and making decisions about city planning and traffic development in the Greater Copenhagen Area.

The traffic effect of the new Metro will depend on a complex of decisions by many uncoordinated actors – decisions both about the future development of the city, regional policy, economic policy, and traffic policy – i.e. the regulation of automobile traffic that can be expected very soon. One of the reasons most frequently given for why no radical measures have been taken in Copenhagen to regulate automobile traffic is a crucial lack of co-ordination of political initiatives. Co-ordination of the many different stakeholders appears to be an obvious necessity, but it is a task that is difficult to accomplish within the present political structures. The fragmented decision-making process and the many stakeholders make it difficult to develop a tenable transport policy strategy and establish stable alliances in relation to priorities and implementation of decisions (Jørgensen and Munch 2001).

6.8. From regulation to competition and from 'master planning' to local and private initiatives

After World War II planning of transport administration was seen as a logical extension of state intervention in European countries. The goals were to restructure railways to increase efficiency, to develop the structures and organisation of public transport in the big cities, and to see transport networks as a means of directing urban growth. Though different strategies were followed in Europe and US, Europe with a high degree of nationalisation and US with more regulation, the outcomes were very similar. As examples, the Urban Mass Transportation Act in US in 1964, when providing federal

[31] http://www.eltis.org/data/73e.htm, 13.01.2001.

grants for public transportation, had explicit social objectives, while the Transport Act of 1968 in UK brought about a major reorganisation of public transport management in an attempt to halt the disintegration of public transport services in the face of growth in car ownership.

In the first thirty years after World War II road issues were not regarded as a part of transport policy, but of traffic policy, neither in most European countries or US. A result of this was separate financial programmes and legislation and eventually autonomous bureaucracies dedicated to road building. The administrative planning approach to transport policy was on the retreat almost from the beginning. The balance between planning and restricted competition within a regulatory framework gradually shifted towards more competition. Examples on this is the taking of British road haulage out of public ownership in 1953, the removal of Norwegian regulations on competition between road transportation and railroads in 1957, and the abolition of the British Transport Commission in 1962.

The continuing pressure on the administrative planning approach was lead to an end in the late 1970s with the breakthrough of contestability as a main thought in transport policy, with deregulation and the goal of efficiency as main principles in transport policy. Instead of the state protecting what is understood as the public interest via planned competition and regulation, the role of the governments is redefined as one of creating conditions for efficient transport operations and allowing maximum competition. The ideologically related but distinct processes of achieving this are two: privatisation and deregulation. It is reasonable to judge the collapse of the idea of large "master plans" for cities all over Europe in the late 1960s as a result of the same shift in approach. Instead of making large overall city plans, planning all urban activities in relation to each other, there has in the thirty-year period from about 1970 been a tendency to break up larger projects to smaller and more administratively limited and locally embedded projects (Tolley and Turton 1995, p.334-39, Thomassen 1997, Østbye 1996).

At the same time as the regulations on the competition between different modes of transportation has been removed, new regulations on use of cars has been introduced. In parallel, at the same time as the large "master plans" for European cities from the first decades after World War has become less important for city development, planning knowledge has become increasingly important when judging the sustainability of local projects. Two examples showing this is the development of the road pricing concept and the concept of Environmental impact assessment.

6.9. From regulation of competition to regulation as a means to promote competition

The development of Road pricing systems is an effort which involves both governmental regulations and local or individual innovations of new technologies.

A part of the move towards more competition is the idea to introduce a price on road services to help regulating the flow of traffic. In a situation were there is lack of roads the market situation can help to decide a "correct" price on road services, helping to finance new roads or other adjacent activities. Road pricing is discussed in several countries over the world but has not been widely introduced. The Toll Rings in several

Norwegian cities since the mid-1980s are experiments which constitutes some of the first implemented “road pricing” projects in the world (Thomassen 2001b).

What makes these experiments even interesting is that they have been put into practice in urban areas. Electronic toll stations register the traffic when accessing roads to the city centre. Benefits in terms of traffic regulation and environmental advantages have been focused in addition to the financial returns of the projects. Furthermore, in some extent the projects seem to have stimulated other modes of transport.

On the one hand it can be argued that that toll stations have made living in the inner cities more attractive, with fewer negative impacts of traffic, including the control of atmospheric pollution and improvements in air quality. On the other hand it can be argued that road pricing systems has closed the inner cities from “outsiders” and reserved the entrance for the more well part of the citizens.

The discourse of Road pricing has been developing since the early 1960s. Perhaps out of interest, but still remarkable, this coincidences with the introducing of the first “electronic counting machines”, to count the amount of car traffic. Until the mid 1970s the discourse mainly was connected to a controversy about how to finance new roads, and from the late 1970s including a concept of how to regulate the use of roads, according the reduction of pollution, more efficient use of roads etc.

The Ministry of transport has emphasised that the environmental means has to be adjusted to the character of the problems. In general it is said that global and regional environmental problems has to be solved by governmental actions and local problems by local authorities. The result of these main principles seems to be that local authorities is given the possibility to decide themselves if they want to introduce toll rings, or road pricing, with the intention of financing new roads or regulate the traffic, and not for environmental reasons.

The experiences from Norwegian toll rings can not prove a reduction in the total traffic in the urban areas. Existing toll rings has until lately mainly had a one-price concept. Either a constant day and night price or a constant price during daytime and free passing during the night. An important difference between using road pricing for financing new roads and for traffic regulation, is the differentiation of passing charges, depending on when you are passing through the toll ring. The drivers will have to pay more during the rush ours than during the daytime or night.

As late as in 1994 the toll ring in Singapore, the first in the world in 1975, was the only one in the world which primary goal is to regulate the flow of traffic, not only to finance new roads. By using time-differentiated charges, the toll ring in Singapore rejected more than 70 percent of the car traffic during rush ours.

From a political point of view road pricing can be seen both as a new governmental regulation of public life, and a deregulation of the transportation market. This is perhaps an important source to the fact that the arguments resisting and favouring road pricing seems not to follow traditional social, cultural or political dividing lines in transportation and environmental issues.

On the one hand it can be argued that the free “traffic market” is not regulated by the demand and supply for traffic services, but it is the traffic engineers and traffic economists who influence the drivers behaviour; when they drive and where they drive. On the other hand road pricing can be looked up on as the introduction of economic

market mechanisms, according to a basic principle: The drivers has to pay the societies expenses of their driving.

6.10. Q-free: The Magic Piece – a local regulatory innovation

During the 1980s the largest Norwegian cities decided to build large road projects to solve the traffic problems in the cities. According to the assumed growth in traffic it was an understanding of an extensive need for new roads, to avoid pile ups of traffic and following environmental problems during peak hours. In a pamphlet from the municipality of city of Trondheim in 1993 the set up of a toll-ring system in 1985 was explained:

> *As a result of the big traffic and environmental problems, and the scary prospects for the future, the municipality opened up for o total development of the road system financed by a toll-ring.*

The alternative to toll-road financing, according to the presentation in the newspapers, was to wait fifty years for the fulfilment of a efficient road system (Thomassen 2001b).

The decision to introduce a toll ring in Trondheim was made in 1983, as a financing mean for the about 20 miles long highway from the city to the airport. The regional road authorities had the opinion that the running of traditional toll stations was too expensive and wanted to figure out new models for collecting money. Technology for automatically identifying of objects was well known from i.e. assembly line production in the car industries and systems for bus identification in London.

In the years 1983-86 the regional road authorities were in touch with several foreign contractors, but in the spring of 1986 a small local firm, Micro Design, was engaged to work through a preliminary project. The aim with the pre-project was to evaluate if it was realistic to carry through the idea of an electronic money collecting technology and if it was similar projects going on in other countries. The same year Micro Design presented their report: *The Simple System – Q-free*. The regional road authorities liked the idea and entered in to an agreement on a governmental R&D contract with Micro Design to develop an electronic paying system for vehicles (Bye 2000, p.38-39, Langmyhr 1997).

Five electrical engineers established Micro Design was established in 1984 when their mother company moved its activities to Oslo. From the beginning the purpose with Micro Design was to do research and development for other company's as contractors. Micro Design was virtually placed between science and industry and should be a kind of midwife for the electronic industry, as a translator of ideas in to profitable products. Previous to the Q-free contract Micro Design developed modules to the ERS-1 satellite, they developed a prototype of a supersonic radar lantern for the blind and they industrialised a version of wireless communication between keyboards and PC's for west Computer. In the early period the firm wanted to develop their skills on space research and military electronics (Evensen 1986).[32]

A fortunate coincidence for Micro design was a major shift in Norwegian industrial policy from the late 1970's an in the mid-1980's. The Government gave up the active economic policy to counter the problems in the traditional industries and wanted instead

[32] *Næring i Midt-Norge* 2/1986.

to promote the knowledge-based industrial production. Because of that technological based R&D was looked up on as the path to necessary structural changes in the economy. 1st of January 1987 a parliamentary statement introduced R&D-contracts as a strategic mean in the industrial policy (Bye 2000, p.43, Buland 1996).

One of the first critical choices in the early phase was selecting useable technology. The first idea was to use a so-called "smart solution" – a kind of a mini-computer installed inside the car. After a short time it turned out to be too expensive. In such a system the electronic piece in the car was the most expensive part. Instead so-called SAW-technology with passive pieces was preferred. The electronic pieces in this system do not need energy and they are able to contain large amount of information at the same time as no information is saved when the car passes a toll station. The idea of using SAW-technology (Surface Acoustic Waves) was a direct spin-off from the ERS-1 satellite. Professor Andreas Tonning developed the technology concept at the Norwegian University of Science and Technology in the early 1960's. The research on surface acoustic waves was based up on studying waves following the surface of earth after earthquakes. In 1970 the first reflector prototype which is the basic component in the Q-free was patented in US (Næss 2000).[33]

In the preliminary project Micro Design decided not to limit Q-free-technology narrowly to a certain purpose. The firm wanted to develop a flexible technology which could be used for different kinds of traffic regulation, not at least if road pricing where to be introduced sometimes in the future:

> *The solely aim of the system is to efficiently collect money for road building. It's not the purpose to limit the individual freedom or to use the road users time. Anyway, it's obvious that such a system may be used in several ways to better the traffic situation and to some extent regulate the flow of traffic.* (Bye 2000, p.48, Evensen 1986).

In addition to road pricing the Q-free system could also be used to collect parking fees, pay method at fuel stations and access piece to neighbourhoods closed for not admitted traffic. The aim with the visualisation of this multi-purpose seems to have been to crate a network of political and social support and potential buyers of the system in future.

It is not remarkable that Micro Design was interested in the political legitimisation of toll roads, which have been rare phenomena in Norway in the 20th century. On the other hand considerations on efficiency, both for the road authorities and the car users, was important when the firm promoted their technological solution:

> *The concept represent a new way of thinking, where the paying system represents the fastest way to get financial support without practical obstacles for the road user, at the same time as the system is environmental friendly and consume small areas.* (Evensen 1986).

The basic idea seems to have been the assumption that the only way the car users notice the use of a toll road was the withdrawal from his/her banking account. On the one hand Micro Design did not consider eventually legitimacy problems by placing a fee on a former free public service. On the other hand Micro Design was worried about the road users acceptance of what they had to pay for the electronic piece:

[33] *Gemini* nr.4 1991.

> *No matter the road users has to pay both the road and the paying system, but the price he/her has to pay for the electronic piece may be decisive for the acceptance of the system.* (Evensen 1986).

At the end, when the system was taken in to use, the electronic piece was distributed without costs as a part of subscription system. As remarked above, the road users paid both the road and the paying system anyway.

In the preliminary project Micro Design judged pros and cons of other international as a part of the final report. It was stated that the concept of Micro Design A/S was realisable and highly competitive compared with other similar technologies. The competitiveness and the flexibility of the technology became to important arguments, which were very important to enlist political and other actors in to the project.

The preliminary project ended with accepts from the county road administration on the technological solutions. Not only that, the county road administration also became enlisted in to the Q-free scenario at the same time as Micro Design became in to the toll road scenario of the county road administration. In late 1986 the Norwegian Road Directorate gave support and some financing to continue the project.

When the project went in to the second phase, the finishing of the Q-free system, it appeared that the county road administration or the national road directorate was not able to finance the project alone. For this reason it was decided to apply to the Ministry for industrial affairs for R&D support. The national road directorate wished that the ministry established a development contract with Micro Design to force the technological development so it was ready when other local toll ring projects was ready to implement the technology. The national road directorate argued that it was important to finance the project because:

> *It's important so the development of a good Norwegian technology with a large potential for export not will stop.*[34]

At this time it was crucial to the project to enlist the Ministry for industrial affairs. Micro Design A/S had at this time developed a versatile argumentation to promote the project:

- Safety: the technology avoids narrowing of the roadway.
- Flexibility: the technology can be used to several purposes, as i.e. parking.
- Economy: the system is inexpensive to obtain, to install and to maintain.
- Speed: the system can be adapted to all kinds of road standards.
- Easiness: the regular users will pay by bank account.
- Norwegian: the technology was Norwegian and could be an export product.

The use of "Norwegian" as an argument has to some extent a historic tradition as an important argument and symbol in favour of industrial development. In general not to the same extent as in the first decades after World War II, but still a relevant argument in the 1980's and –90's. Even if Q-free in 1987 became allied both with a national and a national industrial context, we will later see that this is relative argument, which can be negotiated. Micro Design A/S received grants from the Ministry for industrial affairs and the system was set up when the highway between Trondheim and Trondheim

34 The Norwegian Road Directorate: "Søknad om FoU-midler til utvikling av et norsk elektronisk bompengeinnkrevingssystem 'Køfri' hos Micro Design A/S i Selbu", letter to the Ministry of industrial affairs from The Planning Department, The Norwegian Road Directorate, 15th. September 1987, archive no. 231.

airport (Europe road 6) was opened for traffic in October 1986. Later the system has been extended and integrated in to the Q-free toll ring of surrounding Trondheim.

In the preliminary project Micro Design A/S had success both to develop a flexible understanding about the technology and to create a flexible system of supportive actors. Micro Design had success to open up others "black boxes" without opening their own "black box".

6.11. Environmental Impact Assessment - a governmental regulatory innovation

Environmental impact analysis was developed in the US from the late 1960s and can be viewed as an example of how planning has become more oriented towards pragmatic solving or surveying of specific local or spatial problems.

In Norway, which the two coming cases are referring to EIA was not mandated as a tool for environmental planning until 1989. The INTEPOL-study of EIA is based on a analysis of EIA guidelines provided by relevant government ministries and two case studies, one examining EIA in relation to a planned road development in Trondheim called Nordtangenten, and the other examining EIA in relation to plans for a new site for the Swedish furniture chain IKEA in Trondheim.

The procedure of doing impacts analyses, is clearly considered as a way of introducing environmental concern in the transport sector, and as such, called a tool or a policy instrument (Grande 2001).

The evident point of departure for the EIA study has been the rather understanding of the congestion of urban areas. The construction of new and better highways never seems to be up to par with the steady increase in traffic, resulting in traffic jams, increased pollution and what in many cases is characterised as a widespread degradation of the city environment and social life. When studying the general development of traffic and roads in this perspective, one could easily be struck by a bit of highly visible deterministic interpretation of the relation between number of cars and the need for new roads.

Most European countries have implemented legislation, which order specific procedures of environmental impact analysis (EIA) to be carried out, as a supplement to, or as a part of, the national planning system. These regulations usually require the developers of all large projects to assess the significant social and environmental impacts of their projects, and also to adapt relevant countermeasures, at this stage as modifications of the plans, when the proper authorities requires so. Such measures are required before any plans can be publicly approved. It is not an overstatement saying that doing and supervising EIA has become a trade or a profession in itself, during the last two decades, or so.

6.12. The Northern tangent in Trondheim

The idea of a tangent on the northern side of Trondheim, Nordtangenten, was developed in 1964, in the pre-laminar stage of the new Parliamentary Planning and Building Act of 1965 (Thomassen 1999). The act instructed all municipalities in Norway to develop general local plans. In this first stage, the planning deliberated on the track of the main road/highway, running south north in Norway, through the cities. The main objective at that time, apparently, was to guide the traffic through the city centres, along the

existing/old track, but of course, also thinking of improving the standard and capacity of the road (Grande 1999).

In the late 1960s there was a radical change of the city's pattern of traffic, as a diversion highway was built to the east of the city centre, guiding most of the thoroughfare by. This left the western, mostly residential, part of the city somewhat disconnected to the relatively large commercial and working areas to the east.

A decade later, the need for the "missing" highway created an alliance between the municipal authorities, politicians and the regional District of Trøndelag (DoT). At this time the local focus had been upgraded. It was not anymore solely the "passing-through"-approach, which was important. A new focus was also put on the traffic problems in the inner city. This problem was accentuated at the same time as the more environmental conscious/movements fought over the building of new roads.

The negotiations related to Trondheim's future transport policy was settled, at least partly, in 1988, when the so-called *Trondheim package* was wrapped. The *Nordtangenten* was a very important parts of this package, and probably also then recognised as one of the most expensive. To settle the disagreement of using toll stations, parts of this package also included funds for public transport, projects for reducing the environmental effects of transportation, and at last, on improving the security on the roads (the so called KMS-projects).

In 1992 there was submitted a notification of the Nordtangenten project document is a result of the implementation of the Norwegian EIA-regulations of August 1990. The notification is interesting mainly because it gives and understanding of what subjects which is assessed as relevant' The assessed impacts were divided into three topics; transport, environment and society.

- *Impacts on transport*: The new road was looked up on as an upgrading of, and more accommodated to, present traffic, reducing queuing, increasing the flow. This was said to be more economical and would reduce the pollution in the area.
- *Impacts on the environment*: The basis of evaluating these impacts was "extensive surveys of traffic". The District of Trøndelag had estimated the traffic volume in several roads of the inner city, both before and after the road was built. A considerable reduction of traffic in many of the main central streets was expected. The impact on the environment was furthermore sub-divided into seven sections: impacts on the safety of traffic, of noise, pollution, landscape, recreation, the cultural heritage, and finally, the impacts on climate.
- *Impacts on society*: Further divided into sub-topics; impacts on the development of the city centre, the development of commerce, residential areas/condensing, and public transport.
  - *Impacts on the development of the city centre*: The reduction of traffic in the city centre should give more room for pedestrians and bikers, larger parks, more parking space.
  - *Impacts on commerce*: Situating the road by the sea front should promote present and new cargo/freight businesses. It would develop and improve the present junction/combination of sea, rail and road transportation. Improving the connection from this area, to highways out of/into the city considerably.
  - *Impacts on residential areas*: a transfer of traffic from present residential areas would promote further development of these areas and condense the present structure.

- *Impacts on public transport*: Less traffic in the street of the city centre, should improve the situation for busses considerably.

The resolution of the city council in 1992 turned the thumb down for the Nordtangenten and ended the process for the time being. In the period 1999-2001 the question of Nordtangenten has been put on the agenda again. But the unsolved questions on the heavy expenses and the sprawling interests among the actors in the controversy seems not to promote a soon decision to build the new road.

6.13. Car-sharing – an example on private institutional innovations

Car-sharing is an example of how new institutional forms of mobility have been organised "from below", outside the

One of the earliest European experiences with car sharing can be traced to a co-operative, known as "Sefage," which originated in Zurich, Switzerland in 1948. Membership in "Sefage" was primarily motivated by economics. It attracted individuals who could not afford to purchase a car but who found sharing one appealing.

Car-sharing efforts mostly emerged from individuals who sought the benefits of cars but were ideologically opposed to widespread car use. The majority of the CSOs were initiated in the 1990s, especially in Europe and supported initially by government grants. Most involved shared usage of a few vehicles by a group of individuals. For many of them it was difficult to make the transition from former grassroots, neighbourhood-based programs into viable business ventures. They miscalculated the number of vehicles needed, placed too great an emphasis on advanced technology, and/or were ineffective in their marketing. Many failed organisations merged or were acquired by larger organisations.

Those that grew and thrived were more business-like, and integrated advanced information and communication technologies. But even at the end of the decade, their total presence was negligible in all but a handful of locations. The largest CSO had 1,400 cars spread across Switzerland, and the next largest about 500 in several cities of Germany. In total, fewer than 300 CSOs were operating several thousand vehicles.

Most car-sharing efforts remain small scale and concentrated in Europe. Until the late 1990s, virtually all CSOs start-ups were subsidised with public funding (and a few by corporate subsidies). The most usual way to organise car-sharing trips are roundtrips from a neighbourhood lot, with reservations made over the phone.[35]

Its relevant to ask if car sharing is interpreted mainly as an idealistic environmental friendly alternative to individual car ownership or if its other arguments which are focused to motivate car sharing. The internet-based car sharing company, LetsGoToWork.org.uk, represent an example of how car sharing is advertised and its interesting with respect to how the developers is trying to sell the concept:

- A way to save you money on petrol and wear of your vehicle.
- Give you a break from driving.
- Sharing provides alternative transport for the days your spouse needs the car or it must go in for a service.
- You will also value the social aspect of car sharing.

[35] http://www.calstart.org/resources/papers/car_sharing.html#HISTORY OF CARSHARING, 16.05.2001.

- For the environment there will be less traffic congestion and pollution.[36]

In general individual concerns seems to be are higher focused than societal concerns (environment). Four of these five marketing aspects are individually oriented. The most focused aspect in this advertisement is the individual financial advantages.

Car sharing can in two ways be interpreted as an innovation. First, Dutch governments' approach in relation to car sharing is new. Secondly, the building of a new social configuration around the car is a novelty. The Dutch government stimulates car sharing because it believes it would support the reduction of growth in mobility in the Netherlands. That's mainly the reason why the introduction of car sharing as a commercial activity is supported. The Dutch ministry of transportation stimulates various potentially involved actors to join the effort. Meetings were organised to which these actors were invited. After some time a certain degree of alignment developed between the actors. The ministry then decided to fund an association that would further the co-ordination between actors involved.

Car sharing is an interesting concept because it challenges the interpretation of the car based mobility concept. The link between car ownership and use is disconnected in the concept of car sharing. Car sharing can be seen as the bringing about of a new social configuration around the conventional car, nevertheless constructing a new socio-technical ensemble. These efforts result in a steady increase of shared car use in the Netherlands. In 1999, there were 75.000 people who took part in car sharing. As such, this has a visible reducing effect on total driven kilometres. The overall result on the growth of mobility is, however, rather slight. In the Netherlands, about 9 million people having a driver's license make use of 6 million cars.

Quantitative research has been done to see whether car sharing has an effect on the driving behaviour. Three groups were distinguished for this inquiry: former non-owners, former owners (substitutes) and former second car users. Behaviour is measured in kilometres driven by car per year. In the group of former non-owners, some people's mobility level is increasing. It depends, however, on the concept of car sharing that is used. In the research, several concepts were compared. Some of them lead to an increase in car use, and others lead to a reduction of car use. On basis on these inquiries, it is neither possible to conclude that car sharing leads to an increase in car use among former non-owners, nor to a decrease. In this group, however, the mobility level stayed low, much lower than the average. In the group of substitutes, the change in behaviour is substantial. The step from car ownership to participation in a car sharing project lead to a decrease of 55 percent in driven kilometres by car. For the group of second car users, car sharing replaces the use of a second car. In this group, there is no substantial change of the level of mobility. The overall conclusion of these inquiries is, however, that participants in car sharing show a reduction in the number of kilometres that is driven by them every year. The use of the car is replaced by other means of transportation, such as train, bicycle and city transportation (bus, tram and metro).

The concept of car sharing is an effort to change the understanding that the car user and the car owner are the same person. As such, this is to some extent changing the current mobility regime. During a period of three years, the efforts of the car sharing association led to a number of 25.000 people having a contract with a supplier and 50.000 people performing 'private' car sharing. On a total number of 6 million cars, this

[36] http://pages.unisonfree.net/hiwaycode/, 15.05.2001.

is rather slight. The main reason for consumers to participate in car sharing is the financial advantages that can be reached. Maybe this advantage does not weigh against the feeling of freedom that is associated with having the opportunity to leave the house with the car at any time it comes to mind.

Car sharing is an effort to secure accessibility and improve liveability, (which are the overarching goals of Dutch traffic and transport policy) via an increase in the efficiency of car use. It should result in a contribution to the reduction of the growth of the number of driven kilometres in the Netherlands and a reduced need for parking space. It is tried to reach this goal via an orchestration of developments in the marketplace. It is rather this orchestration effort that is new than the overall policy goals. The particular reconfiguration of the socio-technical ensemble as such is, on its turn, considerable innovative. It results that governments' problem definition is the general level of congestion and pollution of the environment. Car sharing suppliers often share this concern, at the same time as they get through with commercial goals. As indicated earlier, the Consumers seem to be partly interested in financial advantages and partly concerned about the environment (Harms and Truffer 1998).

6.14. Conclusion

The idea of "master-plans" to control the development of all factors that influence urban change was dominating in urban planning up to the late 1960s. This idea was based on the assumption that one policy could solve or harmonise the total number of problems or challenges in a city. With relevance to traffic the decline of the idea of "master-plans" was very much a result of the understanding that no one policy fully could remedy urban traffic congestion. It's easy to make visions, but its not realistic to suppose that all means suggested in a plan will be socially or technically possible to carry through at the same time. Most individual policies can even make a dent in such problems, especially in rapidly growing areas. That means various means have to be combined if we are hoping for a better situation.

The demand for mobility and the problems of traffic congestion is deeply rooted in cultural patterns that reflect certain cherished goals held by most people in the industrialised world. To reduce congestion it will therefore be necessary to change some of those cultural patterns, which also direct fundamental behaviour patterns. Most people living in modern cities are not even aware of the strong link between traffic congestion - which they hate, and the ingrained behaviour patterns - which they love.

One way to approach the tackling of the Congestion-problem is to promote supply-side or demand side strategies. The supply-side strategy encompasses efforts such as building more roads that increase the capacity of the traffic system. The demand-side strategy involves efforts, as encouraging more cars sharing among commuters that reduce the number of cars the system must handle during peak-hours.

Another way, lets call it the socio-technical way, to look at efforts to reduce congestion is to consider whether they rely primarily on national, regional or local planning or regulations or on innovations or initiatives by individuals or private enterprises. The INTEPOL project was based on an assumption that the main weakness of the traditional model of technology policy in transport was the tendency to make a clear-cut distinction between technological and social aspects and to pursue the one or the other. The findings discussed in this chapter goes even further than that. The socio-technical way

to approach and open up the congestion-problem, instead of using a traditional supply-/demand-side approach, adjust for an understanding which makes it visible that the cultural patterns and institutional innovations tends not to be sufficient covered in the supply-/demand-side approach (see ch.10.2.).

The INTEPOL case-studies shows that institutional and technological innovations are not limited to certain kinds of governmental, private, or individual actions or activities. Instead it has occurred a significant in change in governmental approach to planning since the 1970s, as i.e. both the Metro-case and the Highway 1-case indicates (Munch and Jørgensen 2001 and Thomassen 2001). At the same time as the idea of developing visionary multi-sectorial "master-plans" has become disavowed, sectorial planning with clear strategies and well defined road building projects seems to have been strengthened. The focus on large national road construction projects is not visible to the same degree as earlier either. Instead, it seems to develop a kind of organic understanding that many small projects over time will link together to a beneficial higher level network of roads.

Downs (1992) has shown how private interests have been organised in the US to influence urban traffic decisions. In the Rotterdam-case (Popkema and Elzen 2001a) the same phenomenon is discussed and indicates that it's contributing to a democratisation of local planning. This development can be interpreted as a social invention in the wake of the critique against "master planning" from the late 1960s. The recent orientation in public planning: planning for more specific and more limited goals (Grande 2001) and the influence of new social groups on urban development can be viewed as a major translation of societal interests, as Bruno Latour calls "inventing new goals" and "inventing new groups" (Latour 1987). If the European societies encourage this development it can probably be a potential strategy to mobilise citizens of congested European cities to support comprehensive efforts to deal with congestion problems.

Chapter 7

TINKERING WITH THE UNTOUCHABLE - Transforming Mobility Needs and Policy Instruments

7.1. Introduction

The topic of this chapter is the role of contemporary views of mobility, and how these views are expressed in discussions and studies about transport developments and transport policies. Especially the INTEPOL case studies[37] listed and introduced in chapter 5 have through their direct and indirect references to mobility informed the analysis in this chapter. Following the identification of views and expectations in relation to mobility, questions are raised about the possibilities for transforming mobility needs and influence how these are translated into transportation and taken up in transport policies.

Mobility is seen as a cornerstone for the functioning of a modern society and its cities most often being the nodes of their organisation. This links mobility closely to the concept of modernity, as shown in chapter 2, providing the individual with the needed access to situations, places, and institutions of importance for performing the diversified and distributed activities of modern living. To stay in touch with a number of different places may not only be part of the everyday institutionalised organisation of life, but also be an intrinsic part of satisfying the need for rest and maintaining personal identity. It can, although, be questioned how the social need for mobility as defined by access and connections is translated into needs for physical movement, where the borderline between the symbolic and potential versus the real and articulated becomes quite blurred. One solution is to establish a distinct difference between mobility needs and horizons and transport demands (Knie 1997) leading to a variety of possible translations of mobility into transport solutions, or to focus on the ambivalence in peoples' daily life and consumption concerning priorities between activities and the use of time (Læssøe 1999).

As argued in chapter 2 the particular understanding of mobility introduced by the development of cars for personal transportation has emphasised very individualistic elements like freedom, speed and flexibility to translation of mobility. This emphasise the importance not only of the understanding of mobility, but also how mobility can be performed and is translated into rather system bound, specific transport actions and choices of means of transport. It is also possible to identify how certain mobility visions and perceptions have been the result of a 'car-road' based regime in transportation. In the following a distinction is introduced by creating three stages of translation between mobility and traffic to support the analysis: mobility needs and expectations, socio-technical transport systems, and observable transport patterns (traffic). By creating these stages as an outset for the analysis, it is possible also to distinguish the different

[37] The INTEPOL case studies are published in a special volume (Elzen et al. 2001).

involved levels of specificity from each other, and to discuss a potential decoupling of the otherwise so intertwined problems.

The concepts of mobility as they can be identified explicit or implicit in the cases can easily turn out to be rather controversial and show the latent social and political dynamics and conflicts in transport developments and policies aiming at guiding or controlling these developments. In contrast to the often 'heroic' goals of transport policies and plans articulating 'strategies' facing the 'fundamental problems' in both national and European setting, the attempts to translate and implement these policies by practical means are often suffering from the conflicting views of the involved actors. Also contradictory measures promoted from other domains of policy influence the objects of transport policies and gives rise to confusing results.

The chapter will also include some preliminary discussions preparing for the concluding chapter of the report with special emphasis on the role of mobility and subsequent visions for renewing policy paradigms (concepts), as they can be subtracted from the cases.

7.2. Circling round mobility needs and rights

Mobility as a precondition for the functioning of the economic system and an untouchable aspect of a modern human need is most often taken for granted. The translation from mobility to actual requests for transportation on an individual basis – e.g. in private cars - is often questioned in discussions, but nevertheless not in practical terms prohibited or controlled outside certain restricted zones legitimated by either functional and historical arguments (ancient inner cities or living spaces with children) or environmental arguments (natural parks and reservations). The unlimited access provided by roads serving the car system is only in very few situations regulated beyond the obvious safety and congestion reasons.

Almost all the cases, we have been studying comply with this fact. Some even are part of the still continued extension of the road infrastructure that is the backbone and the precondition for the dominance of car based transportation. Others are involved in searching for alternative transport technologies and transportation system, either by focussing on innovations, by linking existing technologies together or by changing the conditions for use. These may eventually also have an explicit say on how mobility is perceived and may become changed by the transport innovations in question.

7.2.1. Mobility as performed in the case studies

A strong dependency of 'taken for granted' mobility 'rights' show in the cases in different ways, depending on how the process of development and the role of modernisation has been translated into different national and spatial settings. In the Norwegian case of 'Highway 1' (Thomassen 2001a) the extension of the road as the interlinking of regions and cities as the baseline for development in Norway is still dominant, even beyond what could be considered an economic rationale as discussed in the case. In the extreme this is shown with the example of the Krifast connection, analysed in the case.

But also the controversial nature of infrastructure developments and the extension of road (and bridges) can be identified in quite a number of cases, when played out e.g. in the local setting as in the 'Oslo Fjord' case (Thomassen 1997), where local opposition is

raised based on priorities not supporting mobility needs but promoting interests in keeping certain areas free from providing the physical space for satisfying others mobility. These conflicting interests fuel NIMBY (not-in-my-back-yard) responses in line with a large number of reactions that already surfaced in the late 1960s and 1970s as responses to the smooth, but often for the local community destructive highway planning visions of engineers in the 1960s. The responses especially in the 1970s were even strong enough to at least delay, but also in a number of cases change the dominant planning visions. This was the case with the opposition to local highway and ring road planning in Copenhagen, which created parts of the historical background for the change in planning visions for the Copenhagen metropolitan area, as illustrated in the Danish 'Copenhagen Metro' case (Munch & Jørgensen 2001). The complexity of local interest show the contradictions in transport planning when comparing the Krifast connection with the Oslo Fjord bridge, where the first was considered a means of getting connected with the flow of goods and person as part of the economic and cultural interlinking of Norway, while the latter is opposed for destroying natural qualities of the region.

The dominance of the 'car-road' regime over mobility show even more explicit in the case of 'California dreaming' (Jørgensen 2001), where almost all actors in the car industry and in government accept the 'American way of life' and the standard personal petrol car as the measure for the alternatives, both the electric cars (EVs and ZEVs) and hybrid cars (HEVs). In terms of both speed, size, and range the conventional car is explicitly viewed as the basic design, that meets the mobility needs of people, and these needs cannot in any way be changed, so the new products have to satisfy these needs by becoming just another type of car. And this is the case, even when transport studies show that for most commuters the performance of the standard car is consuming an excess of both materials and energy.

Contrary to the US situation the attempts to develop EVs in Denmark (see Munch 2001) and in the Norwegian 'Th!nk Electric' case (Undheim 2001b) have been implying a shift in mobility visions. The standard perception of a car with its speed, range, and size are explicitly challenged in the designs of EVs and especially in the 'Th!nk Electric' case a new mobility concept designed for urban people driving in urban areas is addressed, and the vehicle is presented as not just another car. In the Danish case both the 'Ellert' and the design idea of 'Whisper' deliberately focussed on city and uses for shorter distances, fewer persons, and less space for goods. But the involved innovative networks did not recognise or realise the importance of a supporting infrastructure and regulatory support for the new concept. Somehow not taking the new mobility visions serious enough or at least overlooking the strength and entrenchment of the car system to be overcome. At the same time, they experienced that the more likely use of the EVs was as a 'second' car supplementing the traditional family car, which made the design fit into the system, but that was against the whole concept and in most cases, as also in the US cases, too expensive to take off and create a mass market. Seeing EVs as providing the second car would also render the environmental expectations assigned to these cars obsolete weakening the support for these cars.

In the Danish 'Bicycle on trains' case the underlying idea is, that the choice of means of transportation is based on the types of obstacles that the given transportation will meet (Brix Pedersen & Jørgensen 2001). By making the use of bicycles easier in combination with trains, the combination of a rather widely distributed local means of transport: the bicycle, with a long range means of transportation in the form of trains and metros is

expected to turn the growth in car usage. Here the basic mobility assumption is, that the comfort and usability of the transport means plays an important part in how mobility needs are satisfied. Not basically questioning the need for certain transport actions, but on a broader level assuming, that a number of transport decisions are made, not in a simple link with unavoidable mobility needs, but are the result of the routine based access to a car. By extending the use of bicycles, this translation of mobility needs may be influenced, and comfort, privacy, and speed partly be substituted by health considerations, costs, and efficiency. Especially the problem of efficiency and comfort are in the centre of the intended modal shift, as it easily can be shown, that in many cases the combined use of bicycle and train is more time efficient than taking the car, but that especially the messy situation at train stations compromise the experience of users, and adding to this the comfortable private space of the car puts the efficiency to a second priority.

Also in the 'Copenhagen Metro' case (Munch & Jørgensen 2001) there are explicit references to the mobility needs and a strategy of changing both the image and the performance of public transport systems. The rather fast frequency of trains is supposed to cater for the time considerations assigned to transport by people, where waiting time is seen as much more tedious than travel time. Contrary to expectations made in many simplistic transport studies, the quality of collective transport systems is judged on this basis instead of focussing on the travel speed. Time valuation is one of the distinct means to translation of mobility as a cultural phenomenon intro transport investment decisions. Being able to moving is a matter of timely and spatial dislocation, and that waiting time is valued twice as problematic compared to transport time in studies made for the Copenhagen Metro hinge directly any investment in new transport technologies to the time-space matrix of the dominant regime. Transport policy is about physical dislocation, while mobility policy must be concerned with 'time quality'. The whole idea of the new design being to conquer back the business people and changing the image of public transport systems, which also is absolutely necessary to limit the car traffic to the 'new town' centre planned in the Ørestad, which is served by the Metro. For the Metro the same group of customers are in focus, that were addressed in the Th!nk development in Norway.

Not only time quality is an important and specific feature of mobility adding to the interpretation of access as social compared to physical contact or presence, but also the space and comfort of transportation is important

In many of the case studies, these mobility expectations are even not surfacing, but just form the backdrop for the actual case experiments. But even if the basic assignment of modernity, access, growth and personal freedom to the growing mobility needs, several cases illustrate the questions raised around the specific translations of the mobility need into transport actions. Although most cases - as mentioned - do not try to counter the transport needs head-on, they are involved in the translation of the mobility need into different directions by either introducing new mobility concepts or by regulating or simply restricting the access and use to certain means of transport in given local settings.

Similar concerns but rather different means are motivating the use of economic (dis)incentives to reduce or prioritise traffic as they can be identified in road pricing systems and in limiting access to fast lanes on major road. Initiatives like these do

normally[38] not restrict traffic, as it is seen as a fundamental provider of economic efficiency. But by prioritising traffic and adding extra costs for accessing certain zones transport is expected to consist of different parts, whereof some are unnecessary and will be given up, when it is no longer free of charge. This is the vision in the 'Trondheim toll ring' case (Thomassen 2001b) where road pricing and city access is used to induce priority changes in peoples transport choices. Similar visions are found in the German case of transport telematics (Bye & Næss 2001), where the measures although are primarily informative, and therefore can be expected to influence the overall load and eventual growth of transport less, than its distribution in time and among different routes. A distinct difference can, although, be identified between the situation in Norway and in Germany as none of the involved actors in Germany dare to introduce road pricing in fear of the responses from a liberalist view on car transportation and the rather large influence of German car industry.

In the Norwegian 'Road pricing' case, there is - besides potential revenue motives - an assumption of the extra cost to be able to motivate different transport solutions, e.g. that the number of trips using the toll roads or crossing the toll ring would be reduced in spite of the extra cost. That transport decisions are part of a personal set of economically optimised alternatives that can substitute each other. In this case mobility - at least in the extreme situation - is seen as just another act of consumption, and that the higher cost would either limit this type of consumption or if part of a combined 'package' of consumption would lead to restructuring of this package, e.g. combining more purposes for a single trip.

Also in the Dutch 'Rotterdam select' case (Popkema & Elzen 2001a) specific restrictions of car usage on certain lanes of the main roads has been introduced to regulate traffic. The specific mobility approach in this case is that the basic need for mobility for business purposes is not questioned at all. This need is considered more basic than private transportation for shopping or leisure, which is seen as at least not time dependent and even to be prioritised against costs and other forms of consumption. The cultural context seem here to be very important, as this idea of prioritising transport needs has to be supported by a broad public acceptance of these priorities. It therefore has to be supported by both local and national views and priorities. Also the creation of regional transport planning authorities has helped introducing more comprehensive transport policy measures in Holland than in most other European countries (Tengström 1999). The impact on traffic may not necessarily be an overall reduction in transport actions, but a more smooth distribution of these over the day and the week.

In this respect the German case show quite similar elements as the Dutch, but in road telematics the appeal is on rational decision making by the individual drivers instead of a general appeal to the acceptance of business needs being more important than private. As the German case show road pricing to be such a hot topic, as also illustrated in studies of transport policies around and in Munich (Hajer & Kesselring 1999), the only 'way out' has been to focus on traffic information systems, in an attempt to establish a decision basis for the rational driver not wanting to end up in queues day after day.

More radical solutions to the traffic load in city centres is taking in the case of the 'Strasbourg tramway' (Popkema & Elzen 2001b) the combination of a new tramway system with almost completely limiting access of cars to the inner city is introduced to

[38] A well known exemption is the limiting of access to the city centre in rush hours and the limiting of the number of cars in Singapore.

avoid congestion. Similar to this the US cases of 'Chattanooga's living laboratory' and 'Go Boulder' is about building new collective means of transport and supporting a park & ride concept for car users to reduce the load of the city centre (Popkema & Elzen 2001c; 2001d). But while the focus in the 'Strasbourg tramway' was on improving the liveability of the inner city for visitors and other users by substituting cars with collective means of transport more or less forcing people to combine means of transport, and having this as the motivation for a rather stringent type of regulation through high parking fees, the perspectives are quite different in the other cases of regulating access and time distribution, where the car use is not heavily priced, but systems installed to reduce congestion. The US cases use rather weak measures of regulation, and all three cases are based on three very different interpretations of mobility needs and how they can be satisfied and managed, completely embedded in the local setting and its cultural and economic history.

7.2.2. What kinds of mobility?

The relation between mobility, modernity, and social access raises a rather hard question for the analysis, as it tend to reinforce a determinist view of the growth and character of modern traffic. The linking of transport to the economic system as one of the basic functional preconditions for efficient economic growth and the speed of this growth is based on the assumption that the flexibility of the economic system is very dependent on low transport costs and an efficient infrastructure. In broad comparisons made between regions and cities of the world it is rather easy to point to the costs of inefficient infrastructures and transport systems. Two questions can although be raised around this rather obvious observation:

- is there a trade-off between the costs and other impacts of a continued extension to infrastructure to accommodate for the economic efficiency goal, and
- how does the use of private cars relate to the economic idea of efficiency.

The first question goes beyond the scope of this project focussing on personal transportation, but it is closely linked with it as the extensions to infrastructure is as well serving personal transportation and the commercial transportation of goods. The main problem is related to the limited space available and the growing land use becoming one of the external diseconomies of a continued growth in transportation. The other is related and is concerned with the problem of congestion often making road extensions and the building of new road system counter productive in trying to keep pace with concentrated localisation. The economic assumptions about transport as being an indirect cost to be reduced as far as possible is quite questionable, especially in a contemporary perspective of sustainable development. The consequence being that transportation costs have to be viewed as necessary costs and to be handled as a integrated part of regional planning and regulation for liveability and overall efficiency and not as a field where society both at a national and at a local level has to provide a cheap service to stay competitive.

Also the relation of personal transportation to the economic system argument is rather problematic, and the necessity of viewing personal transportation in liberal market terms no obvious. As personal transportation is one of the major loads on traffic both at a city and at a regional level, the need for a changed view on the competition between means of transportation enter into focus of the analysis. Like in the case of goods transportation there is a trade off between efficiency of the transport system and the idea of a free choice and the growth in traffic. Distinguishing between commercial and

private/leisure transport is not very common in the discussion of mobility. An exemption was found in the 'Rotterdam' case with its distinction between necessary and non-necessary traffic, implying that the needed transport was commercial and should not be questioned (Popkema & Elzen 2001a). Even if, the very specific economic priority may not be applicable in other cultures and settings, raising the issue show a change in the automatic translation from mobility to transport needs.

This points to a very basic distinction to be made between the role of transportation for business and in the economic system and the growing role of transportation as a consumer good and an indirect result of patterns in city growth. Just making every mobility need an argument for transport solutions is simply trying to solve the problem by providing more transport instead of looking for other ways to create integrated solutions of transport and infrastructure. This becomes even more important as building more roads seem to create more traffic and not just provide solutions for the existing (se Whitelegg 1997).

The path dependency and intertwined relations between transport system, localisation, and (economic) growth of cities is rather obvious. Although the car-road based transport system in many countries (besides the US) are not much older than 40 years, this system has already set very strong marks of path dependency on city and regional developments. On the other hand is the history of this system, despite its dominance, short. And following up on the economic rationale of transport growth and the rhetorical arguments often used for extending the road system, it is rather interesting to note, that further extensions of the road network is often not based on simple economic efficiency calculations. The interlinking of cities and regions and the continued extension of the road network has become as much a taken for granted policy issue, where infrastructure and interconnecting all parts of regions and countries has become a goal of its own, and not a means of specific political priorities or economic growth. This is illustrated in the changing visions of transport planning in the 'Highway 1' case of Norway, where the trunk roads have become a systemic enterprise of its own, eventually to be explained as a finalisation of the 'car-road' regime (Thomassen 2001a).

The structural development of modern cities create different perspectives for transport systems, where house prices and rents are important as they both limit mobility and provide the basis for new constructions and influence the localisation of people and businesses[39]. The entrenchment of the car system is not only the result of the car's success as a means of transportation, but as much the result of building a large system of roads and regulations. These have supported the use of cars, as have policies for localisation of housing areas and industry and the developments in the retail business. But even though this development is intertwined in such detail large differences have also developed between countries, regions and cities in how the car-road system has developed. These differences show in up to factor 7 in petrol consumption per inhabitant between the cities with lowest density in the US to the main group of cities in

[39] There are historically shaped, path dependent and rather basic differences between the developments in countries in Europe and most states in the US, which supports the view that several translations of mobility needs into the transportation and housing patterns are possible. In comparison to Europe US building codes support cheaper and short lived constructions which links to the mobility expectations of many Americans being prepared to move, if needed. This does not necessarily relate to a different mobility pattern in general and show in a quantitative comparison, but it has created a very special marginal culture of mobile homes and parks being the ultimate solution to stay mobile and ready to move.

Europe and South East Asia, who still also vary up to a factor 3 from the ones with most regulated traffic like Singapore to the least regulated and car dominated like Hamburg and Frankfurt (Skipper 1996). Such a large variation does provide the background for not just focussing on a general culture of car-based mobility and a general car-road regime. Although the US provides the alarm scenario in many European transport policy discussions, there still is a long way to go from the typical dense and public transport supported infrastructure of European cities, to the 'pan-cake' cities of the US.

The role of system lock-in therefore become important and makes the smooth exchange of means of transport more difficult. The time period accepted to be used for transport seem to be stable over long historical periods, so that improvements in speed open for the acceptance of longer distances in daily transportation (Læssøe 1999). This may be interpreted as a determinant of development, but instead it also can be seen as the specific feature of the locked-in development between city structures, localisations and car transportation, making it a temporal pattern open for change.

But even in the US these developments have – at least in some cities – come to an turning point, as economic reconstruction or liveability enters as more important goals than a further adjustment to the demand for car-space as it is illustrated in the 'Go Boulder' and 'Chattanooga' cases (Popkema & Elzen 2001c, 2001d). Alternate vision for city development have so far only surfaced in cases where cultural heritage and a threat to the tourist value of city centres have been threatened as it can be seen in the 'Rome' and in the 'Strasbourg' cases (Undheim 2001a; Popkema & Elzen 2001b), but it is obvious that there seem to be a growing public awareness around these issues. This could result in a broadening of the agenda for city transport renewal, bringing other arguments in front for modal shift strategies. Reconfiguring cities has been discussed in the last decades, but almost none of the cases studied included radical changes of this kind. This represents a change to the dominant vision of city growth as developed from the 1960s based on private homes in large suburban structures. Creating more density is one of the responses coming out of the discussions focussing on ways to make transportation more sustainable (Gilbert 1996). Being an element in the historic genesis of the 'Metro' this policy was included in the vision of a centred and dense city growth of Copenhagen. But while this vision for the future development of Copenhagen was important for the political decision-making, the consequence for balancing business and housing in the area served by the metro, and avoiding a large growth in commuting was not part of the implementation. Solving this problem was delegated to the metro – and left there (Munch & Jørgensen 2001).

But it is not simply the intertwined nature of the problem that creates the basis for a further growth in car traffic. Also the habits related to car usage is important, as the use of cars is not just the result of rational choice in relation to distance and time. The step to become a car owner turns out to be the crucial step to take – hereafter the tendency is that driving the car is becoming obligatory, the car is used for almost all purposes by routine. This underlines another side of the lock-in.

Just as it can be questioned whether road extensions today represents an economic rationale, the car as an efficient solution to mobility needs can be discussed. While growth may be related in some sense to the efficiency of transportation, there is no micro-logic making the car become the optimal economic solution translating peoples mobility needs into a transport demands. Even though simple correlations exist in most countries between household income and car ownership, this does not mean, that the relationship is determined either way (Skipper 1996). When studied in detail in families

and households the economic logic of growth and the overall pattern of the car as the solution does no exist. Instead rather different ways to cope with transportation and localisation can be identified opening for very different solution for future development of localisation patterns and transport systems (Godskesen 2001). Even the tendency to use the car in all situations can be questioned when opening the 'black box' of individual daily practices. This leads to a necessary critique of economic studies for not opening the black box but creating self-fulfilling determinants for development (se e.g. Polak & Heertje 2000).

The conclusion is that we are not only facing a lock-in of the car system, but also a behavioural lock-in where the individuals choice of means of transport for most car owners in most situations is not the result of a deliberate decision making process, where alternatives have been evaluated, but a simple repetition of the well known daily routines.

Mobility needs are as such the starting point for the analysis, where e.g. the symbolic role of providing and demonstrating access capabilities and readiness to move often are as important than the articulated demand for certain transport solutions. Not overlooking the problem of e.g. the demand for transportation under given locked situations, the mobility need can be solved by different means where transportation solutions often substitute for other ways of acting. In this respect e.g. more careful planning and the building of routines in daily life may be on the preconditions also being an obstacle for modal shift, but the articulated translation from a mobility need to a transport demand is not a determined process, although dependent on the quality of the alternatives offered (Godskesen 2001). This is illustrated in the 'Bicycle' case where the precondition for a modal change is dependent both on the actual presence of functioning alternative modes of transport combining different means, but also on an extended learning process for the involved users (commuters) (Brix Pedersen & Jørgensen 2001).
Also the transport action as such and how it is perceived as time use, and as space become important factors for the demand articulation. While transport time and space usage in economic terms is viewed as 'lost' time and space, a focus also on transport as a symbolic and possible useful time demands a different approach. It is important to observe that time in a social context is not considered a rational and linear thing. Time has to be understood as lived and perceived time, and not as measured time. Time to wait is conceived as much more tedious and 'longer' than the time used in the actual means of transportation. The conception of the space provided by the means of transport is important e.g. in the case of the private car, that most often is considered a private space in contrast to public means of transport and most public spaces considered to be either anonymous or exposing. Such a conception of space has been at least touched upon in modern train adaptation and also as an argument for redesign of the trains in the 'Metro' case (Munch & Jørgensen 2001) and in the 'Rome' similar phenomena can be observed in the creation of the public electric busses as an open forum for exchange (Undheim 2001a). Without going to the extreme of the situation in the US, where the car is considered part of the creation of privacy among youngsters, many studies in Europe bring about the privacy argument for the car as an intermediary between home and work. Another aspect of modern mobility that underlines the perspective raised here is the growing number of campers on the roads, where people take their private belongings along with them to far away places, and avoid the use of local facilities by bringing their own space.

Time, speed, and comfort are some of the crucial parameters to be analysed when means of transport are compared. But the significance of these parameters is often misunderstood in the repeated, but frozen controversy about public versus private transportation and more in general in looking for new ways of providing mobility solutions. It is more important to provide a smooth inter-linking of the transport elements than to improve the speed of travel (besides of cause avoiding queues and complete drop outs). This opens new avenues for delivering different ways of using the time and space that is provided by the means of transport, e.g. making it possible to do work and other activities on trains, and competing with the private car as a provider of private space.

7.2.3. Needs – rights – demands?

A basic problem for understanding the growth in transport demands is based on the fact illustrated hitherto: there is no logic leading to a determined translation of mobility needs (understood as the need for access and interaction and connectedness) into demands for certain and specific transport solutions. It can also be questioned whether all articulated needs that can be identified also have to be taken care of.

The problem can also be addressed by discussing the relevance and ethical aspects of what could be phrased as a 'human right to mobility'. By just linking mobility to the further development of a modern society and to economic growth, this issue is very difficult to address. It is also obvious that rather hard tensions and conflict have been fostered by attempt to close roads for traffic and by raising petrol prices and car taxation. In some countries like Germany even mentioning road pricing has become illegitimate in public policy for the time being (see Bye & Næss 2001). Also in the US case questioning the right to drive a car and the demand for car transportation is difficult to question leading to defence lines as basic as the reference made to the 'American way of life' in contemporary debates as mentioned in the 'California dreaming' case (see Jørgensen 2001).

The widespread 'acceptance' of the linking of cars with freedom and modernity is visible in the Copenhagen Declaration from the conference 'Car Free Cities': *Mobility is an expression of freedom and an integral part of modern society* (Car Free Cities 1996). So even in cases of quite outspoken policy goals, the assumption of mobility as intimately linked to modern society is propagated. To oppose this there is a need for policies that not only regulate and make car usage more efficient, but also a policy of car displacement partly utilising the impact of congestion on the experiences of car users and eventually leading to changing behaviour. This change is then dependent on the access to differentiated means of transport.

By taking a closer look and taking into account the existence of alternative ways of satisfying mobility needs, the expression of mobility as a right's issue is a rather superficial and unspecific response to more than articulated and actualised transport demands. The need for mobility is also articulating the ability of staying connected and being able to adjust to requirements as they may show in the future. People will also translate the feeling of unrest and the lack of confidence in what pressures future developments will expose them to into a need for unrestricted mobility. Such responses have as well historically lead to the definition of other human rights issues.

A critical understanding of this new 'human right' (for mobility) must be established as it goes hand in hand with the liberal request for free movement of capital and labour. In

this context demanding mobility rights is a general response to the need for adjustments in line with competition and market forces. In a different interpretation, the new 'human right' is adding new perspectives to other established human rights, like the individual's right to work, political participation, and freedom from oppression.

The rights' discussion relates to basic discussions in political philosophy and in ethics. While the first may be dominated by direction and advice given to maintain certain systemic conditions for a societies economic and social constitution, the latter is concerned with the understanding of particular phenomena in mobility and transport that produce questions about individual attitudes and responsibilities. In liberal political philosophy individual behaviour is seen as a component in the economic process demanding the right and the freedom to consume and the necessity of factors of production to be equally available and therefore mobile. In a political philosophy supporting a sustainability perspective freedom would be restricted by the responsibility for maintaining both the social and environmental reproduction. In contrast the ethical dilemma presenting itself to all humans would be to develop a responsibility for nature and other species including fellow humans in consuming resources and requesting transport solutions.

An ethical approach to the rights discussion introduces a similar view of mobility as it was introduced in the very beginning of this chapter underlines that the origin of mobility need is the dependency of humans with fellow humans and nature (Zeitler 1998). In an ethical context, mobility cannot be viewed as an individual right, but will be limited by the responsibility for the others (nature, species, humans, etc.). The individual's room for actions is bounded by the responsibility for giving others the same access and for sustaining the utilisation of social and natural resources. Historically both mobility and freedom have been interpreted differently. In the early concept of mobility the link to freedom was created through the committed learning process that was part of the elites' travels to other places. This is a distinct different view from the one provided by contemporary market logics. Here freedom is related to an indifference to content and choice, and mobility becomes a way to maintain this indifference.

In the view of daily experiences and in a context of ethics this market-based freedom translates into rather contradictory phenomena. By accepting the mobility needs is translated into rights to consume transportation, both congestion, safety problems in traffic, and environmental degradation enters the stage as ethical concerns where the individual consuming transportation has to face the responsibility for the limitations of others access and for the damage done to nature[40]. Consequently an ethical point of view would have severe trouble in accepting neither the market notion of freedom, nor the right to consume transportation as just another commodity.

Even when a basic freedom to move, and a freedom to choose and satisfy basic needs is accepted at the human rights level, this does not in a simple manner translate into a right to transportation or consumption in general and without restricting limits. Or in other

[40] In the study of Zeitler (1998) the introduction of certain technical means (fix'es) to solve problems with regards to the functioning of the transport system and its safety. The argument presented is: from an ethical point of view, and taking serious the safety problems of contemporary traffic, there is a high risk that traffic safety solutions will not improve the responsibility of traffic users, as the safety solution very often is based on a delegation to a technology. As shown with the improvements of cars with more powerful engines and automatic braking systems, the tendency among drivers is not to improve traffic behaviour and take more care for other traffic users, but to use the technology to the limits even resulting in deteriorated driving performance.

words *when speaking about mobility, we are not targeting a maximised amount of trips, but are concerned with the access to valued facilities of exchange, like shops, restaurants, friends and family, areas of recreational value, workplaces, etc.* (Zeitler 1998), again pointing to the need for a social concept of mobility interacting with the socio-technical transportation system offering both solutions and creating limiting views of mobility. Instead of accepting the 'human rights' definition of mobility the focus should be shifted to the services and efficiency of mobility offered in a given social and infrastructure context. This would move the issue from an ideal economic and abstract human philosophical level to a specific concern with access, time usage (efficiency) and quality of life because some forms of mobility for certain groups in their translation into transportation result in others immobility.

At a simpler level another rights problem may be raised, as mobility rights often also have been translated into the right to own a car and consume unlimited transportation. As ownership to a car is one of the important drivers sustaining car usage, there is a need to take the right to own a car up to critical evaluation and eventually reduce individual's rights to own cars (Gilbert 1996).

Because of this there is a need for taking some of the basic assumptions and taken for granted realities of mobility and transportation and the translations made between these two up to a close inspection before adding them further into simplified models of politics. Part of this is to uncover the assumptions made in the translations.

The point is to identify the social roots of the growing needs for transportation and how mobility seem to be an embedded social perspective in contemporary development and not an economic determinant ready to be quantified and related to structured and bounded markets and the related understandings of demand and supply. This is a problem as it raises some of the controversies of economic constructions, but it seem to be unavoidable, if we want to get close to an understanding of the mobility issue as an object of policy concerns.

7.3. Policies of lost hopes and nice dreams

In most of our case studies the reasons for not taking a radical intervention approach to transport policy is either based on the fact, that the issue of limiting transportation is not at all on the agenda in the policy promoted in the case, or due to some of the very basic policy problems being so visible in transport policies: the demands articulated in economic policy and the large number of private car owners guarding their vested interest in car based mobility. But despite the lack of radical interventions, there are rather large differences in how the involved countries tackle their transport policies. As shown in chapter 5 these differences do cater for both different traditions, and also for a difference in the dependency of car industry and other interest representations. In the Dutch case some more interventionist actions seem to be more in line with the general policy regime, than e.g. is the case for Denmark (Tengstrøm 1999). And from our experience in this study, we could add Norway to the list of countries facing difficulties in developing a coherent transport policy.

While infrastructure investments like the extension of road systems and the planning of public or collective means of transport still is based on large investments and a long term policy perspective, the growing use of private cars is the result of million of individual decisions and is only weakly regulated on a national and international level. In the expansion of the car system are almost every actor a 'free rider', who can only be

accessed indirectly or has to be addressed by rather radical types of interventions, that easily can made into a major political controversy. But the overall characteristic of transport policy in Europe is that the policy objectives have re-appraised, leading to genuine changes in direction from *more infrastructure to more efficient infrastructure and modal shift* (Powell-Ladret 2000). But in context of the discussion earlier in this chapter this change is also a change from an attempt to meet demands to instead meet the articulated and translated needs including the implementation of regulations of both flow and access.

At the same time the distance between policy goals and visions and the measures implemented seem to become larger. This has especially been the case after the climate demands for regulating traffic growth and the congestion resulting from the later years development have created a demand for more radical policy interventions, which have not been met in any of the studied countries. Instead of pointing towards more sustainable transport developments, current trends point away from sustainability in the sector (Gilbert 1996). A picture that has not changes in the later years.

A common denominator of all the policy settings that are involved in the rather diverse selection of cases, we have been studying, is the problem of not having created a stable and commonly accepted centre of translation and policing. Although every country has a ministry especially working with transport, and the EU has taken transport policies on the agenda, the number of agencies and actors is rather large. Also a large number of players are involved without having the responsibility for transport policies, but concentrating on economic policies and on city planning etc. This alone points to the need for a different approach to policy making in this field, as the number of involved actors will remain large and a coordinating centre is not likely established in the tradition hierarchical way. This also leaves aside the standard vision of policy making, as the lack of a single institutional and analytical framework to initiate policies become evident. There are as mentioned deviations to this pattern, as e.g. the Dutch transport policy has been improved by creating a regional level of planning responsibility and building of a longer tradition of coherent policy initiatives, and also in the EU attempt are made to create supra-national bodies based on the idea, that a new centre above national interest is needed and would be able to solve the problems (se e.g. Ross 1998).

One of the other policy measures that could have been influential in setting the stage for a sustainable transport policy has been the mandatory use of Environmental Impact Assessments of large construction and infrastructure investments and planning activities. This scheme, which has been translated from the national policy arenas, to become a commen European demand, does include both private and public activities and could therefore be expected to provide a common ground for setting environemental priorities. In reality this scheme seem to develop into a promotional activity instead of providing situations where a choice between different option are made available. This is shown in the Norwegian study of several EIA cases and in the Copenhagen ‘Metro’ case where the EIA was used to promote the metro solution instead of offering a complete insight into the new town development (Grande 2001; Munch & Jørgensen 2001).

The intertwined nature of transport developments resulting from the historic lock-in of transport systems gives rise to specific coordination of the means of transport, infrastructure, localisation patterns, and the routines of the users. It is therefore not feasible to reduce transport policies to improve the conditions for choosing between different means of transport referring to a market model of competition between different transport solutions. The competition between public, collective and private,

individual transportation that is often presented and discussed as one of the fundamental issues in transport developments is referring to such a market model. But the juxtaposing of public and private transportation does not encounter the basic incomprehensive nature of these two systems of transportation, and the problem is even extended when aligning walking, bicycling, bus-riding, train-riding and car-driving as comparable means of transport, as it is often seen in studies and policy reports.

But despite these fundamental problems and the scenarios of growing environment and congestion problems arising from the continued growth in transportation, transport policies still present rather radical goals and romantic visions for the future, as if either technical or regulatory fixes are in reach and able to solve the problems (OECD 1996). Transport policies can be categorised into a limited number of different concepts:

A. Optimising and innovating the mobile society – a technical solution building on improved fuel efficiency of vehicles, improved safety, and traffic optimisation by using transport guidance systems.

B. Searching for technologies offering a 'way out' - radical energy solutions getting rid of pollution and hereby catering for the growth in individual transportation although not for the resulting congestion problems.

C. Incremental regulation based on forced modal shift - an environmental friendly mobility in and around city centres through creating limitations and differentiating transport systems based on the combination of different means of transport (multi- and inter-modal solutions).

One could add also the idea of reducing traffic by improving conditions for tele-working and tele-shopping as a substitute for commuting and shipping trips, but although surveys have pointed to a marginal potential of reductions in overall transport growth coming from such changes, the few percent of transport trips, that would be substituted would not even match the contemporary growth in traffic (Kristensen 1996; Andersen 1998). This technological fix may turn out to be just another dead end, at least if considered a single solution to the problem.

A policy focussed at solving transport problems will have to make some fundamental choices to give rise to the pressures and priorities needed to change the actual car dominance in the transport system. On choice is to maintain the illusion of keeping a liberal agenda and letting cars move around freely, eventually adding some road pricing mechanisms and to exclude certain transport behaviours and choices as unacceptable and create mechanisms to rule these out, but still arguing that these restriction are elements of a liberal policy agenda taking responsibility for the common interest and good. A more radical mobility policy would include an account for the impact of life style developments and favour certain over others. In this case a broader set of policies will have to be influenced.

But no policies can identified that just leaves the development to the market place, especially because of the already existing lock-in in favour of private car transportation. Even road pricing and taxing petrol does have a social impact that will be rather important. This is seen in the taken for granted assumption in US politics, that higher petrol prices will lead to a middle class revolution – often phrased as the American way of life. Also in many developing countries are petrol prices an important part of development policies, and lead to very polluting and infrastructure demanding

solutions. This was also visible in the short uprising when petrol prices grew a few months ago in Germany and France.

After a first long phase where the EU primarily focussed its attention on technological innovations that could support the development of common European activities, the policies are changing and focussing more an more on a top-down approach of networks and decision making crossing country borders and regions. The change could be characterised as an initial technical fix (Bye & Næss 2001; Munch & Thomassen 2001) to a market fix and lately supplemented by a centralised policy fix as also illustrated in the case study of EU transport policies (Melby 2001). This latest strategy is based on the assumption that there is a need for coordinated efforts and policies that can establish priorities across country borders and even overrule national policies. The vision is building on the traditional view of policy based on a powerful centralised actor installing the goals and measures. Phrased as 'Europe's Incomplete Transport Revolution' this view is e.g. supported by *the creation of a truly level playing field for operators*, and *the coordination of fragmented political interests* (Ross 1998).

The case studies show that a central or regional planning still can do a lot by building infrastructures and establishing general policies for the transport sector. In this sense the traditional policy regime, that creates a more coherent policy and integrate economic policy measures with transport policy may be a part of the future landscape of policy innovations. But it is also evident, that despite radical goals articulated in transport policies, it is not evident that economic policies and private car interests would not end up in deconstructing the implementation of transport policies. This is underlined by the importance of the implementation and the adjustment of details often being responsible for the difference between a success and a failure. *The devil is in the detail*, as referred in the Dutch comparative study of European transport policies (Powell-Ladret 2000).

An inconsistency between traditional hopes for a better coordination based on centralised policy measures and the realities of experimentation on local and regional basis points to a need for different strategies in policy formation. Central plans and strategic goals are expected to be part of such a new policy, but the dismantling of lower levels of policy making and interest articulation can turn out to be quite problematic, as it seem to be at the local levels, that the alternative flourish and alternate learning processes can be established (Greaves 1997). The case studies also show that the contradictions of transport development still primarily become articulated in the local controversies, while overarching economic and other lobbied interests are quite strong at national and supra-national levels. Also the globalisation may give new significance to the local and regional strategies and will require a new way of articulating and developing policy measures.

7.4. New agendas: environment and congestion

Going back to the 1960s there was almost no discussion on the environmental impact of transportation. The growing number of cars was viewed as a problem for the narrow, older parts of towns, and was also criticised for creating a need for larger roads, that would cut cities apart. We have to move up till the 1990s to find a critique of the car system and the growth in transportation that took the growing environment and congestion problems serious. A quite thought provoking observation can also be made concerning the rather similar and parallel in time break-downs in the highway and ring road planning activities in the early 1970s. Not to say that highway or city planning

stopped, but the overall policies and priorities going beyond the expansion of roads, was left behind, without leaving proper new concepts to solve the problems (Thomassen 2001a; Munch & Jørgensen 2001).

Here the environment issues are often brought into the discussions as a problem that has to be addressed, but in factual terms the environmental degradation has hitherto not lead to any direct intervention in traffic or technology development. Besides the attempts to get rid of leaded petrol and the legislation on catalytic converters in cars as illustrated in the 'Emission Standards' case (Munch & Thomassen 2001), the environmental issue has been setting the agenda for support to technology developments in car fuel efficiency and the transformation of local emissions to regional emissions in the case of electrical cars (EVs) and more fuel efficient cars based on hybrid systems and in the future eventually fuel cells. This kind of technical fixes have been promoted as solutions to local environmental problems, but have in most cases not provided integrated solutions to deal with the advancing congestion problems (Munch 2001; Undheim 2001b). At the same time developments in car technology has lead to a situation where people buy heavier cars with larger engines (Skipper 1996) almost rendering the improvements in average fuel efficiency unimportant.

In Europe the vision of a 30 km per litre of petrol has been such an innovative goal, but no restrictions has been put on car efficiency or size to support these changes. Although the newest data on total energy efficiency do not promise more than 50-70% reductions, the expectations in official publications on the technological potentials are still kept high in solving the environmental impact of transportation. And as shown in the parallel development in car size, very often as in the 'Californian EV-mandate' case argued by safety issues and market conditions, is countering the efficiency gains (Jørgensen 2001).

Without doubt the emission policies concerning petrol additives and the focus on NOx emissions from cars has lead to environmental improvements. These improvements also work as a background for a continued focus on possibilities for further improvements through technical innovations, heavily supported by the car industry, and by its supporters in related businesses. In our case portfolio we have been studying attempt to solve problems through the introduction of more or less radical 'alternatives' to the standard car. The differences in approach to the mobility issues are very obvious when comparing the cases focussing on developing new electric or hybrid vehicles.

While the focus in most of the EV innovations are on making vehicles more energy efficient and moving the pollution impact from the local site - the city - to another place, where the production of electricity or fuel cells is taking place, the CO2 issue is only addressed through the general efficiency improvements and the congestion resulting from a continued growth in car transportation is not at all addressed. Very often, as in the Californian case, this element is not at all brought into consideration, or as in the Japanese case more through innovations focussing on the use of small EVs as part of inter-modal transport systems, or as in the Danish and Norwegian case by linking EVs with a broader change in mobility visions of the users, perspectives that have not shown to be successful as far as they have only been based on the choice of the car buyer and have not been supported by policy measures limiting access of traditional cars or similar actions.

7.5. Tinkering with the untouchable

In the previous discussion the attempts to tinker with the transport system and through different policy initiatives to try to modify on a short or a long-term basis how mobility need are translated into transport actions have been discussed. Also the limitations of existing transport policy configurations have been addressed. In this paragraph a structure is introduced to identify and discuss the differences in scope and approach identified in the studied cases leading to a discussion of the elements to be included in a renewal of transport policies.

7.5.1. Scope and reach of transport innovations

Not all the case studies made in this project contribute to the idea of redefining the transport, while all of them point to problems to be solved. Four different perspectives are directly addressed in some of cases, and they have to some extent also provided some experience with the needed changes in policy measures.

First and foremost we have been studying cases concerned with addressing and redefining the mobility rights issue. Although in some cases the local cultural heritage and even the economic interest of a city in sustaining a tourist business has been a 'helpe' in setting the agenda, the fact remains, that in both the 'Rotterdam' case and in the case of 'Rome' and 'Chattanooga', the unlimited access provision has been questioned and the quality, efficiency and sustainability of mobility has been used to establish a modal shift in transportation, which in some of the cases also has implied a shift in what is considered to be a human right.

The issue of mobility rights is addressed in many cities in different ways, but maybe the most general trend in this area is the growing use of reductions in parking space, higher parking fees, and the creation of dedicated bus and tram lines in combination with new means of transport has been the most influential way of addressing the mobility rights issue. In most cases these decisions have been taken with reference to congestion, safety and physical constraintts and not as a deliberate way of addressing the mobility issue, but newertheless both peoples often quite direct and sometimes negative responses tell that in fact there is a 'learning process' at play and that these policies raises the concern about the congestion problem and the unavoidable questioning of car usage in city transportation. By developing the city as a restricted and special zone the need for alternative means of transportation becomes evident and the need for modal shifts cannot be avoided by just continuing the unlimited use of cars having access to almost every corner of the urbanised and paved world. This opens also for an economy of scale for other means of transport, that otherwise were fighting the dominant position of the car regime.

Another way the mobility issue is adressed in policy is through the design of new means of transport and new ways of inter-modal coordination. From viewing the different means of transport as independent and competing socio-technical systems the changed views whether it directly addresses the quality of time and space or it focusses on specific customer needs. The impact of these changes is through the redefinition of concepts, norms, and symbolic values assigned to different means of transport and to the spaces they occupy. The other impact is the outcome of linking different modes of transportation and thereby providing af wider range of quality and efficiency to the

provided transport service. These cases include the creation of high-class means of transportation and the upgrades of the connection point between the different modes.

Also the differentiation of traditional regimes is considered an important way of modifying – tinkering – with the taken for granted coupling of mobility and transportation. Such examples are found e.g. in the cases studying the development of cars and alternatives to cars as electrical vehicles and hybrid vehicles. Although there is a risk, that these innovations are just translated to fit into the traditional regime, there is also the potential of creating new regimes based on both different forms of mobility services provided and new ways of constructing ownership and inter-connections with other means of transport. Also changing the ownership of the car provides new avenues of development, that may not directly restrict the car-road regime, but changes the habitual lock-ins resulting from the car as a commodity for private consumption.

In many of the cases core aspects of the change is delegated to a specific technology or systems to become the mediating instance, both carrying responsibility for e.g. the environmental performance or other qualities of the change and to be responsible for the enrolment of the actors, that in constitute the basis for the success or failure of the change. The role of delegation is twofold. It both serves in a conceptual understanding as delegating the complexity of a problem to a model based on theoretical assumptions and expectations and reducing this complexity and the elements of difference otherwise translated through stories to simple (essential) mechanisms. And it serves as a process in which certain solutions to problems defined are delegated to specific institutions and/or socio-technical systems, in the sense that they are supposed to be handled or solved through this delegation. But it is also evident that in most of the cases, the continued support and enrolment of actors in redefining and redesigning both scope and use of the technology or system in question is crucial for the success of the initial delegation. The delegation as such does not constitute a 'silver bullet' for transport policies.
Also the notion of configuration plays an important role in our study, as it can cover the process of defining and delimiting the policy that has be installed to deal with the problems of transport and mobility. This is based on the understanding that it is not enough to establish alternatives breaking away from the car dominated transport system. The 'rules of the game' have to be changed implying the combined efforts of developing alternatives and changing the focus of transport policies away from prioritising the efficiency of the car system, including eventually the rise of prices and use of telematics in making the system more lean and regulating congestion, and instead developing life and mobility friendly but car-hostile transport solutions. As mentioned several times in our discussion the omnipotent quality of the car-system and the tendency that car-ownership is followed by more and more car-usage also in situations where the car is not the best solution.

In terms of more traditional policy measures this points to the need for combining and involving four elements in tackling the policy renewal process:

1. Create markets: set up framing conditions and set the forces free using peoples priorities (willingness and ability to pay) and innovative creativity (competition and incentives to find new solutions).
2. Stage processes: by inviting and supporting actors to engage in experiments and finding solutions, and by continuously also identifying the need for redesigning the conditions for these experiments.

3. Setting strategic goals: putting the problems on the agenda by using the hierarchy in society to raise questions of basic nature to the needs and rights of mobility and how it can be translated in different ways into access and transport demands.
4. Building infrastructure: creating the technologies and material structures that constitute possibilities and boundary conditions for future developments.

Instead of focusing alone on the need for stronger policy measures and policy centres, as it e.g. can be seen in the EU attempts to create supra-national transport policies, the new agenda for an interactive policy formation, must focus on the ability to interact and support local learning processes and local experiments becoming the stepping stones for changes in the transport regime.

7.5.2. Performances on 'big' and 'small' arenas

The hereby for our pupose introduced frame of thinking both hints to the problems we are dealing with and gives some ideas to the ways out, but it does not in a radical way introduce new strategic policies or new institutional centres being able to take on the responsibility and carry the delegation of 'problem solving'. On the contrary this study in line with many other explicate the complex character of the mobility and transport problem. It points to a different policy conception, that in a deliberate way include what can be phrased as the 'small arenas' where the search for local solutions and the learning processes and experiences are created, like in our case stories. And at the same time include the need for setting policy goals and influencing the 'big arena' where the rephrasing of the frame of understanding transport and mobility e.g. provided by economic theory and the ideas of the unavoidable process of progress as provided in the visions of modernisation and globalisation are addressed.

A rather similar approach has been addressed in a discussion of new policy concepts building on distinction between the need for developing 'fine seized' policies as alternative to the traditional policy measures, that are focussed on a singular relationships between action and impact, which are characterises as 'strong seized' (Læssøe 1999). Instead of focussing on overall efficiency and complete solutions there is a need for more differentiated solutions and even a breaking down of existing regimes, so that other modes of transportation can enter the stage and become viable.

On a rather theoretical level the concept of interactivity in policy formation and development has been addressed in the policy literature about solving the problem of globalisation and the challenges of more heterogenious centres of power and policy making producing a much more complex set of interactions, than anticipated in traditional policy literature. To tackle the complexity of institutions and actors the need for an adaptive and actor involving approach is evident leading to new policy regimes and a shift from government of a hierarchy to governance of a complex set of interacting actors (Jessop 2000).

Involving both the 'small' and the 'big' arenas also the decisions about future infrastructure have to be addressed, and a deliberate development of policy perspectives. The interplay of has been illustrated in several cases, but most explicit in the Copenhagen 'Metro' case (Munch & Jørgensen 2001). This has implications both for the role of our cases as providers of input in this specific combination of the 'small' and the 'big' storyline, but it also has to be included in our understanding of the policy issue and the related vision for change processes.

Chapter 8

EMISSIONS AND OMISSIONS - Technocratic approaches to tackle pollution form motorvehicles

8.1. Introduction

EU has committed itself to achieve a sustainable transport system by the year 2020. The broad context to achieve these goals is the development of a Common Transport Policy and the development of Trans-European Networks. The broad objectives of the Common Transport Policy are to maintain competitiveness (efficiency), promote cohesion (regional development), while at the same time improving the quality of the environment. The overriding goal of transport policy is to facilitate accessibility, while at the same time fulfilling goals as sustainability, efficiency, equity and safety (Banister et.al. 2000, p.27-28).

Air pollution from motor vehicles is a major health problem and together with other environmental problems an important policy issue for cities of Europe. It is a challenging regulatory issue for policy making, public administration and political sciences, and it is a challenging technological issue for science and research. This chapter with deal junction between regulatory and technologically efforts to deal with the emission-problems.

The levels of toxic pollution from motor cars in European cities frequently exceed the EU and World Health Organisation (WHO) levels on materials as such carbon monoxide, nitrous oxides, formaldehyde, benzene, soot etc. At the same time as pollution from other sources is declining, particularly coal fires and industry, the pollution from motor vehicles is increasing (Whitelegg 1993, p.36).

Transport contributes seriously to climate change, acidification, summer smog and urban environmental problems. In EU the environmental impact of transport is increasing as technology and environmental policy are heavily challenged to keep up with the pace of growth. In Western Europe total mobility increased by about 3.6 per cent per year between 1985 and 1995. Fuel efficiency improved at only about 1 per cent a year. Partly because private car use is growing at the expense of public transport, cars are getting larger, and there are fewer people per car. The rapid growth in passenger and freight traffic is partly a consequence of rapid integration processes in EU, but the related growth of environmental pollution, noise and health problems makes a timely transition to more sustainable transportation and settlement patterns imperative.[41]

Trond Arne Undheim (2001) describes in his INTEPOL case-study how emissions are experienced in Rome, where day everyday traffic is immense. The emissions affect people and monuments alike, and citizens and tourists are “fed up with it”. Because of this Rome in principle, if not in practice, has a zone of limited vehicle access in the

[41] http://www-cger.nies.go.jp/geo2000/english/0074.htm, 01.11.2000.

historical centre. Tied in with this was national environmental policy changes introduced in 1999. The "benzene-decret" (law) provided soon coming deadlines for manual and automatic access control to the historical centre for non catalyst vehicles, economic incentives for the purchase of low emission vehicles, access permit renewed for non-residents of historical centre only if in possession of catalyst vehicle and no circulation in historical centre for emission vehicles (January 1th 2002).

The challenge of preserving the air quality in urban areas is hampered by the many obstacles created by the intrinsic complexity of the urban system. The issues involved are highly interdependent, they have intricate cause-effect relationships and depend very much on local characteristics. Their impact is also visible as regional and global phenomena. One of the main problems is the still ongoing growth of traffic that offsets the benefits of the introduction of cleaner technologies. Moreover, current urban trends indicate that the volume of car-based transport is likely to increase further in the future.

When approaching the emission problem it has been very much understood as partly a regulatory challenge and partly a technological challenge. This involves both policy institutions and the professional science community, and it involves governmental planning bodies and industry. There is also difficult to limit the emission problem to specific localities. Some of it has mainly local consequences, but other parts of it, as acid rain and CO_2, have regional, national and international consequences too.

Technologies developed to deal with the emission problem, as i.e. the three-way catalyst (TWC), are not purely technological. Instead we can say that they are heterogeneous artefacts embodied with trade-offs and compromises. In particular they embody social, political, psychological, economic and professional commitments, skills prejudices possibilities and constraints (Bijker & Law 1992, p.1-14). Because of this policies addressing emissions have to consider technological, social, economic, environmental, and cultural aspects at the same time as developing proposals for adequate solutions. The recent initiatives taken by European policy to improve urban air quality is a step in this direction. An example of this is the initiatives to integrate and harmonise air quality work into a single programme covering all sorts of pollution. Another example is the focus on improves knowledge transfer between cities.[42]

The notion "emission" is a word that covers a wide range of pollution from when related to traffic. It can be i.e. understood as dust, gasses or noise. In this chapter emissions will be limited to the discussion of particular gasses, which the TWC was introduced to minimise.

None of the other case studies in the INTEPOL-project explicitly discuss how governmental or international measures to regulate the production of cars gain superior societal goals, as i.e. environmental or social goals. The main reason behind this chapter is to catch up with that perspective. The TWC or emission standards does neither regulate the number of cars or the flow of traffic, but the dangerous output of the cars in use. As we will see the regulation of car emissions has had an important effect to motivate the car industry to develop a new and more environmental friendly technology.

[42] http://www.jrc.es/pages/iptsreport/vol47/english/EDI1E476.htm, 20.04.2001.

8.2. What are emission standards?

Tailpipe emission standards are usually implemented by government ministries responsible for the protection of environment, such as the EPA (Environmental Protection Agency) in the US. The duty to comply with these standards is on the equipment (engine) manufacturer. Typically all equipment have to be emission certified before it is released to the market.

"Tailpipe" emission standards specify the maximum amount of pollutants allowed in exhaust gasses discharged from a diesel engine. The tailpipe emission standards were first initiated in California in 1959 to control carbon monoxide and hydrocarbon emissions from gasoline engines. Today, emissions from internal combustion engines are regulated in tens of countries throughout the world. The regulated diesel in US and EU (Euremission) emissions include:

- Diesel particulate matter (PM) measured by gravimetric methods. Sometimes diesel smoke opacity measured by optical methods is also regulated.
- Nitrogen oxides (NOx), composed of nitric oxide (NO) and nitrogen dioxide (NO2). Other oxides of nitrogen, which may be present in exhaust gases, such as N2O, are not regulated.
- Hydrocarbons (HC), regulated either as total hydrocarbon emissions (THC) or as non-methane hydrocarbons (NMHC). One combined limit for HC + NOx is sometimes used instead of two separate limits.
- Carbon monoxide (CO).

Emissions are measured over an engine or vehicle test cycle, which is an important part of every emission standard. Regulatory test procedures are necessary to verify and ensure compliance with the various standards. These test cycles are supposed to create repeatable emission measurement conditions and, at the same time, simulate a real driving condition of a given application. Analytical methods that are used to measure particular emissions are also regulated by the standard.[43]

In view of the global responsibility to protect the environment, the Euroemission Standards were introduced in Europe to progressively reduce the amount of harmful pollutants, such as carbon monoxide, hydrocarbons, nitrogen oxides and particulates, found in engine exhaust.

"Euro0" limits came into effect on 1 October 1990 in Germany, whereby only low-emission commercial vehicles were allowed to register for road use. As the plan was to gradually reduce pollutants, 'Euro1' and 'Euro2' limits came into effect on 1 Oct 93 & 1 Oct 96 respectively, lowering the amount of pollutants allowed in each limit.

In December 98, the European Council of Environment Ministers reached an agreement on the final Euro3 standard and also adopted Euro4/5 for the year 2005/2008. Euro3, expected to take effect around 2000, will cut harmful emission by approximately a third. Under the agreement, heavy-duty diesel engines will have to be equipped with an on-board system for monitoring emissions. The 15 EU governments are planning to continue to provide tax incentives for emission-compliant vehicles.

The Council have also set specific, stricter values for extra low emission vehicles ("enhanced environmentally friendly vehicles" or EEVs) in view of their contribution to

[43] http://www.dieselnet.com/standards/intro.html, 27.05.2001.

reducing atmospheric pollution in cities. The Euroemission expects that the emission limit value set for 2005 & 2008 will require all new diesel-powered heavy duty vehicles to be fitted with exhaust gas after-treatment devices, such as particulate traps & DeNOx catalysts. The main goal with Euro4 is to bring down harmful emission to around half of present level in the year 2005.

European manufacturers have been successful in reducing harmful emissions partly due to turbocharged engines. With the development of better combustion, the level of harmful pollutants produced has been reduced. As the emission standard gets stricter, more sophisticated turbos with variable geometry or wastage controls, are required in order to minimise black smoke during sudden acceleration.[44]

8.3. Air quality guidelines

The development of air quality guidelines has been helpful to give focus to environmental objectives that have been poorly developed in transport. John Whitelegg has described several unsolved problems with air quality guidelines:

- They are muddled in the sense that they are not linked to clear policies for improving air quality over specified time scales. In particular there is no direct link to the EC institutions or in national governments between transport policies and urban air quality. One major view that Whitelegg argues, is the conservative character of the guidelines and the limit values. This gives plenty of scope to the polluter and is not based on long term epidemiological work, which would establish the degree of damage to health from living and working in polluted urban environments.
- The air quality guidelines do not carry with them the obligation to make detailed measurements.
- Models of transport planning that can cope with environmental objectives, especially air quality do not exist in Europe.
- The air quality guidelines take only a partial view of the problem of urban pollution.

The last problem Whitelegg describe is a definitional one. When gaseous, evaporative and particulate emissions from engines, exhausts and fuel systems are normally identified, particulate emissions which are not fuel derived are not. These particulates, many of which will be of respirable size, largely arise from tire abrasion and from braking systems (Banister 1993, p.42-48).

8.4. Regulation and liberalisation: Incompatible goals?

It seems to be a general phenomenon in most of the developed countries that market liberalisation within appropriate regulatory and competition frameworks is essential for sustained economic growth. This seems to be the case at least in the infrastructure sectors.

Regulatory reform is widely viewed as part of the larger picture of good governance, which is essential for strengthening pluralistic democracy, promoting economic prosperity and social cohesion. It looks like that these issues go to the heart of the

[44] http://www.dieseltech.com.sg/Euroemsn.htm, 29.05.2001.

changing relationships between government, the market and civil society that are transforming the whole nature of the policy-making process.

It has been acknowledged among developed countries in the post-war period that regulations have been helpful to protect the environment, improve the safety of products and maintain fair competition in markets. On the one hand it apparently seems to have been a general political pressure against any form for governmental regulation in any sector of the society the recent decades. On the other hand, a paradox to this observation, is the increasing number of governmental regulations all over the world at the same time as there have been an internationally trend towards liberalisation of production and trade.

In 1997, the OECD submitted a major multidisciplinary study on regulatory reforms to the OECD ministers. The report found that many regulations are unsuited to today's markets and social needs. They slow innovation and job creation, unnecessarily reduce competition, or are too complex and burdensome to be effective. Such regulatory problems substantially reduce the prosperity and well being of citizens. Almost all OECD countries have launched programmes of regulatory reform to address these kinds of problems.

The OECD report made clear that regulatory reform includes both deregulation and better regulation. Deregulation, the complete or partial elimination of regulations in a sector, is necessary in many cases. But deregulation itself does not necessarily assure market competition or policy effectiveness. In many cases, governments must continue to regulate to safeguard competition, and to protect public interests in areas such as environmental quality, safety and health, and consumer protection. Here, there is a need to develop instruments that are less costly, more effective, and which use and shape market forces to achieve public policy goals. The challenge is to find the right mix of market forces and government intervention to achieve policy objectives efficiently in changing economic and social conditions (Kondo 1993).

It seems that deregulation to achieve societal economic goals often involve new regulations of sectors which have not been heavily regulated before. Several examples show that deregulation of production, transportation and other economic activities on the one hand develop the need for new environmental and social regulations on the other hand.

The TWC, perhaps more than anything else, is an example of an invention by regulation. The interpretation of air quality problems leads to a professional discussion of what is "clean air" which next leads to the development of what is understood as appropriate standards. At the end the industry has to adjust their production to these standards, which in this case lead to the invention of the TWC.

8.5. Regulation and the manufacturers: Conflicting interests?

Under the pressure of government mandates, car manufacturers have been required to produce safer, quieter and less polluting vehicles. Most of these manufacturing standards have been less stringent in the US and were introduced later. Nevertheless, cars in the Western Europe have been certainly improved since the 1970s.

Environmental policy had during the 1980s turned from a focus on industrial policy towards focussing technology policy, but political ambitions had so far mostly been to

regulate 'backwards'; i.e. to set a standard which should prevent things from developing the wrong way. Now political ambitions changed and regulations had to be pro-active; i.e. regulations should induce 'green innovations' – new technologies aiming at improving environmental conditions. The innovative effect of regulations is central if green and democratic technologies are to be developed in the long run. From this position must be considered relevant to assess the efficiency of the whole socio-technical system of regulations with regard to promote innovative behaviour. The American emissions-standards has a reputation of promoting technological innovation and that the strict emissions standards produced the TWC's during the 1970s, but many producers questions if this is a correct assumption. Most European car-manufacturers questioned if the TWC's and the US-emission-standards - contrary to intentions - didn't promote but hamper green innovations in car design (Munch & Thomassen 2001). When the West Germany in the mid-1980s made pressure on EU to introduce new standards on car-emissions the auto-industry played an active role to postpone this development. Some of the main arguments put forward were:

- It would slow down the development of a lean burn engine – the TWC was interpreted as a "dead-end technology".
- It would disturb the international competition and open up the European market especially for Japanese cars.
- The TWC would lead to poorer fuel consumption, lower performance, and have a high failure rate.

We will come back to the West German efforts to introduce new standards, but a general observation from the contemporary debate is the national Governments willingness to protect/defend the views of their domestic auto manufacturers. During the attempts to develop an EU-level compromise on car emissions in the mid 1980s UK, Italy and France accepted that the catalyst would be necessary on the most-polluting cars, those over two litres, but they did not accept the Commission's proposals for cars under two litres. Their concern reflected the nature of respective motor industries, which were heavily reliant on medium and small cars.[45]

Legislation on emission control steadily has evolved since the 1980s. The car industry response in the early stage was to explore a range of technological solutions to reduce the different types of emissions. While earlier controls had been met by incremental technological advance, as i.e. the introduction of engines running on lead free patrol and other engineering refinements created the expectancy that increasingly lower acceptable emission levels would require more drastic measures.

The compulsory fitting of catalytic converters meant that all car manufacturers operating in Europe had to adopt and develop this technology, after, in some cases, pursuing alternative technological solutions. Efforts were concentrated on the development of different approaches to its refinement, such as the reduction of cold start emissions.
From the point of view of the automotive industry, it was strategic dilemma. On the one hand, there was increased emphasis on electronic systems for engine management, which represented a significant step in the evolution of a technological paradigm towards a kind of integrated system. On the other hand, the more incremental technological solutions working within the existing technological paradigm, as the use

[45] "Compromise on car emissions", *Financial Times* 21 June 1985.

of alternative fuels and engine improvements did not radically alter, or challenge, the fundamental principles of the car.

Mark Boden argues that the need to comply with catalytic converter legislation has meant that resources had to be devoted to the refinement of the existing technology and the ongoing adjustments that it required. The legislation has according to Boden (1993), had the effect of promoting the incremental approach with firms devoting resources to develop the catalytic converter. From his view it has not precluded consideration on longer term more radical change.

8.6. The early regulation of automobile emissions in US

By the Mid-1950s it was quite clear that automobile emissions were linked to photochemical smog in major metropolitan areas, particularly those prone to atmospheric inversion layers. By the early 1960s California began to consider requiring emissions control devices on new cars. In 1963 the California Motor Vehicle Pollution Control Act was enacted (White 1982, p.14). Exhaust control devices to reduce emissions of CO, HC and lead compounds became mandatory in 1966. US federal emission control laws concerning CO and HC were introduced in 1970, and concerning NOx in 1973 (Almås 1992). Car-manufacturers have been sensitive towards regulation, but not always co-operative. Members of the Automobile Manufacturers Association signed the 1954 agreement on pollution control devices, but the manufactures were reluctant to add devices that would raise costs 'without adding elsewhere to the design or sales appeal'.

As late as the mid-1960s evidence on the health and welfare effects of air pollution created by automobiles remained unclear. Photochemical smog, or its components, was believed to be an important source of reduced pulmonary (lung) function and to contribute to asthma, chronic bronchitis, and emphysema (Schottlin & Landau 1961, p.545-49). In addition, there was evidence that carbon monoxide might cause increased cardiovascular problems by reducing the ability of the blood to carry oxygen.

The US federal authorities first initiated governmental regulation of automobile emissions in the late 1960s. Federal regulation of automobile emissions began approximately at the same time as federal automobile safety regulation, in 1968. The US Department of Health, Education, and Welfare set light-duty vehicle standards for carbon monoxide and hydrocarbons for the 1968 model year. These standards were supplemented with legislated standards in the Clean Air Act Amendments of 1970, which also set nitrogen oxide emissions standards for automobiles in the 1973 model year. Mainly because emissions controls in the 1970s and –80s had serious effects upon fuel economy and operating performance in some model years and were quite expensive to carry through, they have been much more controversial than most safety standards (Crandall et.al. 1986, p.85-86).

Before the Clean Air Act was adopted in US in 1970, industry leaders lobbied furiously against the new emission limits, claiming that pollution reductions would be technically impossible to achieve as well as economically ruinous. In 1970 Lee Iacocca, then vice president of Ford Motor Company, claimed that the bill "is a threat to the entire American economy and to every person in America." Despite these protests the motor manufacturers in Detroit did help cut pollution dramatically and later told the world that

these improvements was an evidence of what car manufacturers "can do" (Nadis & MacKenzie 1993, p.21-25).

Catalytic converters became mandatory in California from model year 1975. General Motors, who is given the credit for having perfected the catalyst technology, had chosen to develop TWC already in the beginning of the 70s and when the Clean Air Act Amendment was signed by President Nixon, GM immediately choose to install catalysts in all cars. The California standard was in 1977 approved as US-Federal standard, without explicitly making installation of catalyst mandatory, but the new emission standard was taken to equal TWC, as soon as Ford and Chrysler decided to follow GM and install catalytic converters in all vehicles (Flink 1988, p388).[46]

The public all over the Western world became increasingly concerned about air pollution problems in the late 1960s and the 1970s. This concern was based upon more than the health issues relating photochemical oxidants and carbon monoxide to respiratory and cardiovascular problems. Visibility and other aesthetic values provided additional motivation for the original clean air movement. Following the inception of emission controls, evidence that photochemical oxidants damaged historic buildings, ornamental shrubbery and reduced agricultural yields helped sustain backing the program. Finally, the problem of acid rain increased concern over nitrogen oxide emissions from both mobile and stationary sources, since these emissions are precursors of the nitric acid component of acid rain (Crandall et.al. 1986, p.85-86).

8.7. The regulation of automobile emissions in EU

It was mentioned in the introduction that EU and WHO have developed air quality standards, which is something else than emission standards. Air quality standards and emission standards have mainly been developed for public health reasons. In the case of EU they are standards and mandatory. In practice both sets of standards are based on the same technical information. WHO guidelines for Europe was published as Air Quality Guidelines for Europe by the WHO Regional Office for Europe in Copenhagen in 1987. The EU was for the first time defining guidelines for air qualities in August 1980 as the directive 80/779/EEC, and the first directive on air pollution from petrol engines was released in 1970 as the directive 79/220/EEC.

Since the mid-1980s the EU has introduced increasingly strict emission standards for new cars. They roughly correspond to those in the US, imposing maximum permitted levels for CO, HC and NO_x. To achieve those emission reductions all cars were equipped with three-way catalysts (TWCs).[47] To achieve reductions the market also

[46]GM is mostly credited for developing the TWC, but Volvo introduced in 1976 a TWC with sensor and electronically controlled fuel injection, which seems to be the 'mother' of all TWC's as it was subsequently taken up by all other automobile manufacturers.

[47]A catalytic converter is a device that uses a chemical catalyst to convert three harmful compounds into harmless compounds.
- Hydrocarbons (HC), in the form of unburned gasoline, produces smog.
- Carbon monoxide (CO), formed by the combustion of gasoline, is a poison for any air-breathing animal.
- Nitrogen oxides (NOx), is created when the heat in the engine forces nitrogen in the air to combine with oxygen, lead to smog and acid rain.
Basically, the harmful gases enter a kind of stainless steel container, coated with platinum, palladium or aluminium oxide, spread out over a great surface area. These chemicals cause the carbon monoxide and hydrocarbons to change into water vapour and carbon dioxide. A third lining of chemicals, platinum and rhodium, that reduce nitrogen oxides into nitrogen and oxygen. This is called a three-way catalytic

became supplied with unleaded petrol from the mid-1980s. The use of unleaded petrol was absolutely essential for the proper functioning of TWCs, and dramatically reduced airborne lead emissions the next years.

Generally EU regulations on motorcars has increased since the mid-1970s. This implies norms for construction, noise and emission, but emission regulation was a relatively insignificant part of European policies until the controversy in the mid-1980s. European car manufacturers were reluctant as all regulation was seen as a disturbance of the free competition. Instead political focus in Europe had been on regulation of *driver behaviour*; i.e. licensing requirement, vehicle inspections, drink-driving regulations, seat belts use, parking restrictions, urban speed limits, etc. (Pucher & Lefevre 1996:58).

At first, the West German federal government tried to encourage installation of TWCs through various tax incentives such as reduced tax rates for cars with TWCs and for unleaded petrol. It was not able to require absolute emission standards, however, without co-ordinating them with all other EU member countries.

The issue of exhaust emission policies in Europe was heavily stimulated by a West German proposal in 1983 to introduce the new US-emission standards. In 1980 United States passed a federal law enforcing stricter emission standards which required all new automobiles to have installed TWC from 1983. The German proposal produced serious controversies between EU member countries about exhaust emission-standards and TWC-technology. The EU-policy at that time was to postpone the decision until lean burn engines were available and reduce noxious emissions in the 1990s. The technological reason why the Germans made pressure on the EU was mainly the lack of progress in the development of lean burn engines. This divergence between the German and the EU time schedule for introducing new emission-standards were an important reason why the especially German car-industry became worried of a "split in the EEC motor market."[48]

From our point of view the case of the TWC's illustrates some of the problems of designing functional policies crossing resorts. It illustrates the ambiguities of political expectations to a 'technical fix' and the non-linear relations between intentions and consequences (Munch & Thomassen 2001).

Because of high concern for its dying forests, West Germany pushed hard to uniform European standards, which were adopted in 1985 and revised in 1991 and 1992. Different types and sizes of motor vehicles were subject to different deadlines and different standards, but in general emission standards for all motor vehicles throughout the EU became much stricter than earlier. As in the US, the reduced emissions per kilometre driven helped offset the increase in air pollution which would otherwise probably had been the result from the enormous growth in car travel (Pucher & Lefevre 1996:58-59).

The TWC entered the political scene as a player in the intersection of environmental policies, industrial policy and transport policy. The political debate in the EU about introduction of TWC was closely related to a debate about shifting exhaust emission standards from EU standard to US-standard. The negotiation of a new EU-standard

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converter (TWC). Catalysts require lead-free gasoline. The lead coats the chemicals in the converter, and makes them unable to do the job anymore, since the chemical lining can't come in contact with the pollutants.

[48] "The war of the car exhausts", *Financial Times* October 16th 1984.

came step by step and the positions of the involved actors changed significantly during the long process. From an environmental point of view it seems immediately intelligible to support the US-standard against the prevailing EU-standard; it seems like an unquestionable choice of 'best practice'. TWCs was a mean to achieve better standards for car exhaust emissions and it became a kind of a short cut to improve air-quality. Catalyst technology had the big advantage that it was not only applicable for *new* vehicles, but they could also be installed in *old* cars. One benefit of choosing catalysts was that they were a mean to reduce total exhaust emissions without having to reduce the number of vehicles on the roads.

The new emission standards inscribed a specific interpretation of how to solve problems of air pollution. A number of questions regarding the efficiency of this decision in view of environmental policy can be addressed when examining the broader socio-technical complex coupling TWC-technology, environmental policy, and mobility policy and technology policy. The meaning assigned to the catalysts differs considerably between involved cultures related to their varying definitions of efficiency, best performance, technological possibilities and desires. In environmental policy TWC is a short cut to emission reduction - a 'technical fix' which will make it possible to reduce total exhaust emissions. In the mobility policy TWC can be seen as an escape route, making it possible to avoid the reduction of mobility in terms of numbers of cars, speed limits or kilometres driven. In car design TWC is but only one trend - and maybe not the best one - towards greening of cars. The EU implementation of the TWC and emission standards, by learning from the US, can very much be seen as what Bruno Latour calls one of his "translation processes": I want what you want (Latour 1987, p.108-11). In this particular case it can be added: - but I want it in my own way. In the translation - process from one culture to another, significant agency tends to be lost (Munch & Thomassen 2001).
The US federal law contained new and stricter exhaust emission standards. At the time of the approval of the US-law the comparable EU-emission standard (ECE R-15 (03)) was followed by all EU-member countries and some EU outsiders: Italy, France, Germany, Belgium, Holland, Denmark, UK, Austria, Finland, Switzerland and Norway. Pushed by the German initiative, EU was from 1984 preparing a profound revision of R-15. The new EU-standard implicated extensive negotiations between the EU-member countries as their positions to a revision of standard were diverging radically. The revised standards, R-15 (04), were agreed at the Luxembourg meeting 1985, without being legally binding. The standard was revised - restricted - in 1987, where the EU Ministry Council decided it. Before the new EU-standard was implemented it was revised- again as restricted versions. First time in 1991, next time in 1993.

In 1976 did Volvo invent the TWC with sensor and electronically controlled fuel injection, a technology that all car manufacturers later on had used. In 1978 had Japan introduced the world's strictest emission regulation so far which enforced catalytic converters - much comparable to the latter US-standard. Following the US federal decision West Germany announced in 1983 that they would introduce the US-standard from 1988. Most EU-member countries reacted negatively upon the German decision and their action was criticised heavily from economical, technical and political positions. West Germany acted upon a fierce green pressure and pushed hardly for new emission standards believing that reduced NOx exhaust from cars could prevent their forests dying from acid rain. So the German government wanted the fastest possible reduction of exhaust emission, which they found would be reached by the fastest possible introduction of TWCs for all cars. The German decision created a sharp

difference between Germany and the other car-manufacturing EU-countries, but without EU-co-ordination Germany would not be able to reach its goal and maintain a general reduction of car exhaust emissions, which would help the forest.

The EU controversy profiled an environmentalist view against an industrialist view, but the actual demarcation line is muddled and the question of 'who is the true environmentalists' was part of the controversy. The reason for the German actions was a concern for the dying forests, but their appropriateness of their actions was criticised as having relatively small effect and being a choice of a long road to protect the environment. Various scientific actors pointed out, that the role of car exhaust in the production of acid rain was not proven. No one had a clear picture of whether car pollutant was a minor or major contributor in comparison to emissions from power stations and other industrial sources. If fast action is required it can reasonable be questioned if a change of exhaust norms is the best option. First, there seems to be easier and faster and probably more effective means to reduce car exhaust - as Financial Times wrote:

> *…Bonn could demonstrate its concern for the woods by limiting speeds permissible on the autobahns. .. A speed limit would fall immediately on all cars, instead of being phased in slowly as people replace their old cars with models carrying a converter.* (FT, 16.4.1984)

But one important reason to chose the emission standard strategy could exactly be, that it didn't bring the German parliament - or other national parliaments - in serious conflicts with car users, as could have been expected if policies like speed limits, or other restrictions on car use was introduced.

Second, it can be argued that hat the best way to clean up exhaust emission is not to pick the available 'technological fix', but to set industry a tight - but realistic - deadline for developing alternative 'green cars'. During the first part of the 1980s the positions of the various European nations spoke for the strategies their respective national manufacturers had chosen, but late 1980s the environmental movement seems to push national considerations to aside and persuade the governments to overrule their interest as car manufactures.

The fiercest opposition against introducing US-standards came from UK, Italy and France. These were furious at the prospect that the community might be 'blackmailed' into following the German lead. All kinds of arguments opposing TWC-enforcing standards were made. Two major issues was raised in the debate: First, you can do it 'the fast way' and immediately have all cars equipped with catalytic converters; or you can do it the 'gradual way' and make time to develop other technologies to fulfil the same goal. Really, this was also a false contrast, as the catalysts did not hold out for a 'instant' solution. Catalysts require lead-free gasoline that was not generally available on the European market, only Germany was in the beginning of developing outlets for lead-free fuel, and the time horizon for an European-wide infrastructure was 4-5 years. The introduction of lead-free gasoline was itself an environmental improvement, and UK had - even if they favoured the lean burn strategy - decided that all new cars would have to run on lead free gasoline from 1990. Despite this the lead free gasoline counted as one of the benefits from introducing TWC's. The Luxembourg agreement required leaded free gasoline to be available in EU from 1989.

Second, you can apply the same standards for all vehicles and then support the introduction of technological innovation, or you can differentiate between cars and let the development of a variety of technical solutions be possible. In contrast to the US-standard, the Luxembourg agreement differentiated exhaust limits according to type and size of engine: The EU-norms for large cars above 2 litre would require installation of TWC, making the agreed EU-standards for large cars equal to the US-standards with regard environmental effects. Medium sized cars (up to 1.41) and small cars (below 1.41) could meet the EU-norm using other technologies; either 'lean burn technology',[49] or minor conventional adjustments.

The economic situation and the future of the European car industry were a major concern within the EU negotiations. A most worrying prospect in the early EU-negotiations was that the Germans would erect a 'non-tariff barrier' within EU, and split the sensitive balance between the EU-motor market vis-à-vis US and Japan. Germany had previous experiences with TWC's from their engagement in the US, which was not the case for France and Italy, but the German car manufacturers did not prefer the catalyst strategy for lean burn technologies and they wasn't unified in their support to the policy of the German government. VW, who had a major part of their production in small and medium sized cars, tended to support the catalyst, but after the Luxembourg agreement and lined up with the non-German industry arguing for a differentiated standard. This argument was based upon the - biased - impression that German manufactures had a more advanced use of catalysts than the rest of EU already. It also reflects the nervousness of the EU car manufacturers that the norms would disturb the balance of car manufacturing in favour of Japan and the US. It could be expected that the Japanese would reap the benefit out of the German decision, as they was the main producer of small and medium-sized car with catalysts for their home market, and had a long and broad experience in 'green car design'.

The strategies of the Governments of UK, Italy and France reflected concerns for their respective automobile industries producing small and medium sized cars. Italy was ready to compromise, but France and UK was implacably opposed, but feared a political solution from the EU. UK government had chosen an exclusive lean burn strategy for the catalytic converters.

Denmark had supported Germany and was going the 'fast road' to environmental protection. In 1987 they voted against the EU-standard agreement on the ground that the time schedule for implementation was to slow. The Netherlands tried in 1985 to introduce its own strict standards for imported cars, but the EU wanted a trial against the Netherlands for breaking ranks. Generally the political debates in non-manufacturing EU-countries (Denmark, Netherlands and Greece, a.o.) - and Norway - concentrated solely upon the environmental impacts, while the effects of regulations on long term technological development were not an issue, and also the actual implementation of the standards was absent.

The Luxembourg agreement in 1985 was a two step proposal. Up to 1989-91 manufacturers would have to reduce emissions by 80% below pre-70 level, and HC and NOx to 64% below pre-70 level. Manufacturers agreed on this, but opposed that in 1995

[49] 'Lean burn' technology means that the combustion processes have a lower air/fuel composition than the theoretical necessary to achieve a complete combustion. A lean burn process will reduce NOx but increase HC and CO if not additional technical developments are installed. These additions are installed in a lean burn engine

should the EU-cars match the US and Japan standards. The 1987 binding agreement had stricter values and was interpreted as a pure victory for the environmentalists. The position of UK, France and Italy was sweep away by an overwhelming vote by the EU-parliament. Switzerland and Austria introduced US-emission standards in 1986, Norway and Sweden in 1989 and Finland in 1990.

8.8. Standardising mobility cultures: The difference in European and American understanding of 'the problem'

The European policy debate was highly influenced by the problem of the dying forests in Germany, and had then concentrated upon the environmental benefits to be gained from changing to US-standards, while the practical implications of (changing) a standard more or less was neglected. Relating to the Norwegian debate, the US-standard looks very nicely 'on paper' and inscribes a vision of high environmental protection, but how should it be implemented to be effective; i.e. to reduce total exhaust emission more efficient than according to the EU-standards?

It is not necessarily the nominal level of emission norms, which makes the significant difference between the two standards. The testing procedure is an important condition for the working of a standard, which there hasn't been paid much attention to in the long political controversy. An agreed test cycle is a precondition for the possibility to meet and control norms. The political debate didn't take seriously if it was socio-technically possible to implement a new standard with sufficient efficiency. How to control and sanction the new standard? And in what way is the US-standard 'better' and more 'efficient'?

A significant technical difference between the two standards was their differing units of measurement, meaning that they are not directly comparable by figures.[50] The EU exhaust emission standards state norms in grams per test, while the US-standards state norms in grams per kilometres. The various standards in 1980:

	Exhaust emission standards			
Components	ECE R-15(02)	ECE R-15 (03)	Sweden[51]	US 1977
CO	80-176 g/test	65-143 g/test	2.1 g/Km	9.3 g/Km
HC	6.8-10.9 g/test	6-9.6 g/test	2.1 g/Km	0.9 g/Km
NO_x	10-16 g/test	8.5-13.6 g/test	1.9 g/Km	1.2 g/Km

Table from Fiat (1981)

A crucial point is, that when putting at table like the above together, the figures will tend to 'cheat'. The political intention – the US-standard is best - seems to be confirmed by the figures, but the actual exhaust emissions norms are not comparable and the relation between them is at all not clear. The outcome of the tests are not unidirectional: the experts experience that if the same vehicle was tested according to both standards it would in some cases fail to meet the EU-standard but would meet the US-standard –

[50] In 1989 the EU-technical staff decided to change EU-standards to be measured in grams per kilometre.
[51] Sweden introduced in late 70s a national standard, which was comparable with the US-standard but differed according to test methodology, and some equipment, which reduce fuel consumption.

depending upon actual testing, methodology and object. The Norwegian technical committee concluded:

> *Choice of test methodology is crucial for the rigour of the emission norms. Different test methodologies are today used in US and in Europe. A comparison of exhaust-tests or exhaust-norms performed by ECE-methodology and US-methodology is not possible. A vehicle which produces a certain amount of exhaust tested due to the ECE-methodology can, depending upon the construction of the vehicle, made higher or lower values if tested due to the US-methodology.* (Statens Forureningstilsyn 1986, p.26)

A statement like this doesn't seem to have exerted any influence upon the political debate and choice of standard. Likewise would the argument that ECE-norms can be designed also to enforce TWC installation not have any impact. But this was the actual conclusion after years of EU negotiations. According to the technical experts, the main advantage from switching to US-standard is to be able to compare performance; - i.e. having the same standard is a goal in itself, disregarding actual norms.

In 1980 most European car-manufacturers produced vehicles according to a number of different standards. They were manufacturing to the European marked according to the European ECE (R-15) standard, for the Swedish market according to a special Swedish standard, and for the American and Canadian markets, according to US-standards.[52] FIAT compared the time required and the size of documentation needed to fulfil the three standards:

ECE R-15:	3 months	8 pages
Sweden:	7 months	60 pages
US:	12 months	460 pages

Time required and size of documentation needed to fulfil the three standards.[53]

From FIATs points of view, the much more comprehensive and complex Swedish and US lab-testing procedures would *not in themselves* produce a 'greening' of motoring, as 'controlling vehicles on the road is certainly more productive and economically valid' (FIAT 1981:3). FIAT supports their argument by a reference to a change in US-procedures (1981) which introduced more elaborate 'on the road' testing to support the lab testing procedures. FIAT estimates that US-emission test and equipment costs 13% of the price of the vehicle, which they find 'out of proportions' in relation to the possible benefits achieved by using the test. The advantage of the ECE R-15 - FIAT argues - is that it's less costly, more exact and being accepted by a nationally wider group of users.

During the EU-debate the problem was raised that the US-standard was only appropriate for US driving conditions; the standard was - so to speak - evaluating the driver performance according to US-standard for 'good behaviour'. The point made was that not only testing but also the conditions for *producing* exhaust exert a significant difference between EU and US. Exhaust emission from cars varies substantially

[52] The models equipped according to the Swedish standard did not have to reduce NOx emission in every case.
[53] Melhus 1981.

according to driving patterns and the US and European driving-patterns differ. Driving patterns are influences by speed, road material, elevation, accelerations, temperatures (inside and outside the engine), etc. – and all factor makes' significant difference upon the amount of exhaust emission.

The existing testing procedures inscribe different driving patterns between EU and US, as well as various cultural differences relating to cars. US seems to prefer large cars with large engines being driven relatively slowly, while the Europeans have a tradition for highly tunes small cars being driven relatively fast. Also, US citizens' drives on average longer than the Europeans and they shift their cars faster.[54] The US driving cycles are developed from 'real time' driving patterns. It includes a speed-peak at 52 km/hour and a 10 minutes break in the test corresponding to the typical American lifestyle, that you a stop at the shopping mall on your way home from work.[55] The US-standard inscribes the Americans preference for cars with automatic gearshifts, by not including a procedure for gearshifts in the cycles. Automatic gearshifts mean a surplus of fuel use on approximately 15% compared to cars with manual gearshifts. It is estimated that US-drivers could save approximately 20% fuel by using a smaller car with a manual gearbox and smaller acceleration (Elzen et. al. 1993).

The EU-test - UTC - is a tightly controlled test procedure, which is repeated four times. EU test driving patterns are made up by a collection of driving patterns from a number of European cities, which are transformed into a unified 'synthetic driving pattern'. The 'synthetic' EU-driving pattern is represented by a curve describing the significant steps of a typical European city-trip: a sequence of speed, acceleration and de-acceleration, speed peaking at 50 km/hour, and a detailed descriptions of gearshifts and tolerances.

The two standards have different qualities: EU procedures can be hard to follow as it is very detailed and tolerances are very small. The US standard is 'easier' and tends to give larger variations, as the lack of details in instructions means that output from the test typically will vary with the person performing the test. The US testing procedure takes 1876 sec. (including the 10-min. break). The EU testing procedure takes 780 sec. Both are for one vehicle on a test stand.

It was criticised that both tests were only simulating city-driving patterns, and in EU as well as the US the extension of the test to also include motorway driving, was an issue among the technical experts. A European version - called EUDC - which peaked at 120 km/hour was developed during the late 1980s, after introducing a complete new test cycle the EU-staff had to determine the exhaust norms allowed for this faster test cycle.[56]

The revised EU-norms were intended to be equivalent to US-norms regarding environmental impacts, after adjusting for driving test cycles. The EU-standard differentiated the norms to be met according to the size of the vehicles. For cars above 2 litres it became a problem to find a methodology to match both the US standard and the EU-

[54] The average lifetime for a car in Japan and US is 8-10 years. In Denmark it is 15 years.
[55] US-testing standards are UDDS 'The Urban Dynamometer Driving Schedule', HDDS 'The Highway Dynamometer Driving Schedule' and SHED, 'Sealed Housing Evaporative Emission Determination'.
[56] As mentioned by FIAT, US had changed their testing procedure in the early 80s to include a road test and a long-term test. In addition to the lab-test cycles models were selected from the manufacturers and submitted to more protracted testing on an annual basis. The car is driven continuously for 80.000 kilometres on a mechanical rolling track, which takes between four and five months. After the full 80.000 kilometre cycle the car must still perform within emission norms.

standard. Italy, France and UK were argued - opposing Germany - that the US-standards had been translated wrongly into EU-norms so 25% of the cars, which currently passed the test, now would fail. It was complained that Jaguar, for example, would have to re-engineer its current models.
A decision to change standard without a corresponding and substantiation testing procedure seems meaningless. The Luxembourg agreement was not legally binding, but the revised - and restricted - standard from 1988 was binding. Still, the car manufacturers, importers, the national authorities and the users were by mid 1989 not provided with clear guidelines for the evaluation of their performance. There was still not agreed upon a test driving cycle by which the level of emission by cars seeking legislative approval could be measured. The EU-staff was in the beginning of 1989 still wrestling with the issues:

- Whether testing should be performed only on new cars, or being a lifetime issue.
- Whether EU-member states could use existing emission tests or develop completely new test cycles.

The EU chose to go along with the US-standards on both issues. Cars had to be tested, through lifetime and daily use and a completely new lab test cycle including high-speed performance was designed. The driving cycles, the test procedures and the emission norms, had to be fixed and corresponding before it is possible to evaluate the efficiency of changing the standard. The effects of strict emission standards on acid rain, dying forests and city-smog, must be related to other political means to reduce environmental damages.

8.9. Emissions on the Norwegian agenda

Around 1980 the Norwegian political agenda for environmental issues changed. During the 70's most environmental legislation was end-of-line regulations setting standards for the acceptable outcome from industrial productions sites. But things got more complicated. Not all sources of environmental damage could be effectively regulated this way and among the more problematic was mobile sources like road and marine traffic. Also the political focus changed from environmental problems caused by production to the problems caused by increasing diffusion, use and decomposition of industrial products. The car is a good example on a product where the main problems are cause not during manufacture, but during use.

In 1981 the Ministry for transportation appointed a committee to evaluate different aspects concerning use and ownership of automobiles. In February 1984 the committee published a report (NOU 1984:6) which judged pollution from car traffic partly as function of number of cars and (emissions) from each car. Relevant means to reduce pollution was divided into two categories:

- Reduction of (emissions) from each car, and/or
- Reduction of car traffic in vulnerable areas.

The car-commission suggested to use economic and technological regulations; i.e. reducing fees and taxes on new cars approved by new environmental and safety standards., and by introducing US-standards the producers was forced to use the catalysts. The committee promoted the TWC as a long-term priority because Norway from their point of view had to meet the same environment standards as US and Japan had approved. The introduction of the TWC did also have another effect on

environmental issues: the TWC promoted the introduction of gas without lead. (NOU 1984/6:60-64).

In December 1984 the Norwegian Government made a principle statement about introducing the same emission standards on personal cars as in the US. It was an assumption that similar standards were introduced in Sweden, Denmark and Western Germany (*NOU 1983:40*, *NOU 1984:6*). About a year later Norwegian Pollution Control Authority (SFT) issued a report where it was argued why the new standards should include the entire country and they should be obligatory, why the US standards was the prototype. The report also used a cost-benefit analysis to evaluate the consequences of the new standards (SFT 1986).

SFT assessed the EU goal about only emission-free cars in 1994 not to be a realistic scenario for Norway and because of the total increase in traffic would the available means not be sufficient to fulfil this goal. Only for CO_2-emissions did SFT judge it realistic to get some major effect. If the emission standards should have some major effect in Norway SFT asked for supplementary financial means, i.e. a differentiated tax on purchase of new cars. This was a controversial issue which according to SFT "at the time was not accepted by a political majority in Norway". (SFT 1986:12). Despite changing governments in Norway in the 1980s and 90s has it become more and more politically acceptable to tax use of cars instead of taxing purchase of new cars.

What cannot be read out of the table, but was argued by SFT, was the fact that most of the reductions in CO would be counteracted by the increase in the total number of cars. US-standards were anyway so restrictive that they would imply a reduction of the total exhaust emission even with the expected increase in numbers of cars.

Components	Emission reductions per car	
	EU-standards	US-standards
CO	50%	70%
HC	0	75%
NO_x	30%	70%
Particles	0-30%	85%
Materials causing cancer	0-30%	80%

Reductions of emissions for an average car by the EU- and US-standards at the year 1986.

With the expected increase in number of cars could only very restrictive emission standards entail a larger reduction of the total emissions. SFT expected the number of cars to increase by about 40 percent from 1986 to 2000. Based on this SFT calculated the changes in different emission components according to the two standards.

	Emission level in year 2000			
Components	Emission level 1986	Requirements 1986	EU-standard	US-standard
CO	100%	100%	50%	30%
HC	100%	115%	115%	30%
NO_x	100%	150%	105%	45%

Emission from private cars in Norway in 2000, related to different requirements in 1986 (SFT 1986:14).

In relation to the last table SFT argued that the US-standards should be a model for the Norwegian standards. Added to this SFT argued that concerns for environmental issues supported to adapt to the primarily to the US-standards.
In 1989 was maximum emission levels decided based on the US-standards. The Norwegian decision on car exhaust emission-standards was accentuated by international negotiations in 1987-88 about NOx reductions.[57] The decision did not content any requirements to install TWCs in existing cars, but it was emphasised that installing TWCs only could fulfil the standards. The Parliamentary message previous to the decision had no commands on TWCs, but using TWC could de facto – only fulfil the demands. The emission standards did also include already registered cars, because it was assumed that reduction in total emissions would occur very slowly if it should depend on the replacement of all cars. Because of this it was recommended to give the new regulation retroactive status on the existing cars.

> *It's assumed that about 20 percent of the existing cars can install three-way catalysts. This effort will reduce NOx-emissions with estimated 60 percent per car. This effort is interesting because maximum effect can be achieved at once. The sooner the initiative is taken, the larger is the effect.* [trans. by author][58]

The problem with the speed achieving maximum effect becomes visible when we relate it to the slower renewal of the total amount of cars in Scandinavia compared with most other Western European countries and US. But this is also a political problem related to the symbolic value of being world leader in environmental protection (Stortingsforhandlinger, June 8th 1988). But in Norway there is no tradition to give new laws or regulations retroactive status, so did not happen with this regulation either.

The Norwegian decision was founded on the assessment that the US-standards were better than the EUs because the American was related to a specific technological device, as the US-standards could only be meet by using catalysts. When Scandinavia, and especially Norway, has an international profile emphasising environmental protection as a high priority, it would seem unnatural not to vote for the most restrictive standard; i.e. the US-standard. EU-standards kept being held as an alternative in the Norwegian political debate despite the fact that Norway is not a EU-member, and therefore at that time could not be forced to accept the EU-standards. This implicates that the choice of the standards is maybe not as clear-cut as presented. The technical analysis and preparations for the Norwegian legislation took more than 3 years, and despite the intentional statement from 1984, it was not developed any parliamentary decision and regulations in Norway before in 1989. And despite all; the EU-standard would also mean enforced use of TWC, but then not for all cars.

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[57] The NOx-agreement would reduce NOx by 30 pct. before 1995. Norway did not want to regulate NOx in the same way, because its mobile sources – the car traffic, especially sea transport, which is the main source to the NOx problem. Mobile sources are more difficult to regulate than stationary installations. Instead Norway decided that the total emissions of the country at the end of 1994 should not exceed the emission level of 1887. It was different attitudes about how this reduction should be achieved in different countries. Germany and England wanted to join the proposal, Sweden wanted to reduce the emissions level of 1980 with 30 percent before 1995, Denmark a 30 percent reduction of the 1987-level before 1998, and Finland wanted to stabilise the emission level of 1987 before the end of 1994. Stortingsforhandlinger [Norwegian Parliamentary discussions], June 8th 1988, om Nitrogenoksidutslippene i Norg**e.**

[58] Stortingsforhandlinnger [Norwegian Parliamentary discussions], June 8th 1988, about *NOx-emissions* in Norway.

8.10. Political confusion and the role of industry

When turning from the expert culture of testing car exhaust to the expert culture of manufacturing cars, significant dimensions of the standard-catalysts controversy change. From the position of car manufactures implementation of a strict standard in mid 1980s is controversial because it forces to use a designated technology - not in itself because its environmental ambitions. In the wider innovation perspective catalysts were viewed as a 'dead-end' technology. They do a very good job on cleaning emission, but in the nature of their operation they militate against progress upon other important fronts, such as fuel energy. Lean burn technology can contribute both to reducing exhaust emission and to improve fuel economy. At the time of the 1985 decision there was no evidence that the catalyst technology would not soon be taken over by lean burn technology, and that fast and strict norms would hamper alternative developments.[59]

Earlier had US National Academy of Sciences declared that catalyst was *the least promising way in the long run* to control exhaust emission, and Chrysler, had argued for meeting the US-standards of 1977 with lean burn technology (Flink 1988, p.388). Catalysts were an end-of-line regulation, which did not solve the basic engine design problems or opened for radical new solutions. Despite this, there is a number of technical problems with catalysts: They tends to increase fuel-consumption with 5-10%; they do not work properly when cold, i.e. during starts where 40% of the exhaust is produced. Beside, for the catalysts to be optimal the fuel-air mixture has to be controlled by computerisation (which itself improves the effectiveness of the combustion process), but a major technical challenge is that the optimal mix for the catalyst generally doesn't equals the optimal mix for the engine. NOx presents a tricky problem in it self; as reduction of exhaust emissions improves the efficiency of the combustion, but the amount of NOx is increasing as combustion gets more effective (temperature increases). Improvement in combustion efficiency will then most likely produce more Nox (Høyer 1990, p.33).

A major argument in favour of the strict standards was that the catalytic converter technology was a reliable technology that was ready 'on the shelf' and could be implemented immediately. This is not a 'best technology' argument, but a 'less bad and ready' argument. The 'readiness' of the TWC's clashed with the preferred strategies of the European car manufacturers who - with only a few exeptions - favoured lean-burn technologies. This made the time-schedule for implementing the new standard became an issue of controversy, as time determined the possibility for manufacturers to develop a better solution. The EU-agreement left open the possibility to make - at least - small and medium sized cars meet the norms by using other technologies; either oxidising catalysts /unregulated catalysts, or lean-burn technology. The TWC was originally invented for large engines and was - in the eyes of the manufacturers of small and medium sized vehicles - too costly a technology for small and medium sized cars. It was crucial for Italy, France and UK to be able to meet the emission standard with technologies, which would produce larger reductions for lower price and with lower fuel consume. They accepted that catalysts would be necessary for cars over 2 litre, but at not time did they accept that there were not any alternatives for cars under 2 litre. Introducing strict standards enforcing general use of TWC's would implicate that the

[59] Chrysler was under pressure from GM who had invented the catalysts, and the enforcing the emission standards was further weakening Chrysler's position in US Automobile industry. Equipping a converter into a vehicle costs GM $200, but Chrysler more than $400.

balance of markets in Europe would change, as Italy, France and UK would face hard competition from US, Japan and West Germany (Statens Forureningstilsyn 1986).

Various sources argues that the present engine technology can be made considerably more efficient and less fuel consuming without major innovative work has to be done, and that the major obstacle to achieve this efficiency is (pure) reluctance from the manufacturers. Greenpeace - as the strongest voice - argues that cars already in the mid 1980s could run on average 23 kilometres on 1 litre of fuel, which was in deep contrast to the prevailing EU-norm of 11.5 litre per kilometre (Elzen et.al. 1993). Also it is a well-known fact that most innovations are used to increase performance instead of increasing engine efficiency. The point is that this general reluctance towards the strict standards reflects that the sensitive balance between manufacturers will be disturbed by the new norms. Every car manufacturer in Europe wanted to avoid that the position of the European car manufacturers on the world market is weakened compared to Japan and US - this is also reflected in the last minute German change of position.

In the view of the Italian, French and British car manufacturers a differentiation of emission norms would be better for the consumers: They'd have more choices, lower prices and – in the long run – a better technology for the environment. European manufactures have a historical favour for product variety (which in some cases are on major reason for it poor performance) in contrast to US manufacturers, who has a tradition for preferring a few standardised products, low costs and increased production volume. The strategies of the EU car manufacturers interacts with the images of EU as a union of independent nations with large cultural varieties and strong local preferences regarding (automobile) design and use. The large European differences in culture, income, vehicle taxes, geography, symbolic values, design traditions, etc. are reflected in the strategies of the car-manufacturers. If the variations are interpreted as large or small depends upon the eyes of the viewer. Users assign values and characteristics to cars like macho, family, dull, down to earth, smart, etc. and in term of engines, characteristics like top-speed and acceleration are important. European consumers have been quite loyal to their national products, and only latterly has environmental characteristics begun to play an increasing importance in users choice of vehicle. It seems in general that the user's sophistication in taste of cars are increasing, being an argument both for variation and for 'green cars', 'intelligent cars', etc.

The role of industry in the negotiation of the standards differs significantly between EU and US. The American way was not a model for EU-policies, not the least because industrial points of view was already inscribed in the various national policies as main parts of the European automobile industry is nationalised or have heavy state involvement. Renault (F), British-Leyland (UK) and Alfa-Romeo (I) was in 1980 entirely owned by the state. Volkswagen was owned 20% by German Federal Republic and 20% owned by the regional government (Flink 1988, p298). Meeting a new standard means that the manufacturers must regard it as realistic and if the standard is too restrictive, it will fail its pro-active purpose. Experiences from US show that too restrictive standards can produce evasive behaviour from the automobile manufacturers. In 1973 Environmental Protection Agency (EPA) demonstrated that actually the vast majority of vehicles produced between 1968 and 1971 failed to meet the emission standards. US car manufacturers insisted that they could not meet the standards for 1975-76, and they were granted a two-year extension.

The EU-manufacturers continued to question if the political ambitions of gaining best environmental protection in the long run were achieved by changing standards and enforcing TWC.

8.11. Conclusion

Air pollution caused by the motor car has been viewed as a major problem in large cities all over the world since the 1960s. Originally it was formulated as a human health problem. Later has other effects on social life and nature has been added to the health approach.

The TWC became mandatory in California from the model year of 1975 and in Europe from the mid 1980s. Previous to these decisions there had been 10-20 years of development of emission standards. The first tailpipe standards were first introduced in California in 1959.

The US case on the introduction of emission standards is an example of how standard setting can promote technological innovation. This happened in opposition to the auto-industry that opposed the new standards. The industry in Europe argued that strict standards would hamper the development of new engine technologies, as i.e. the lean burn engine. Today it is difficult to argue that this has been the situation. Instead it is relevant to argue that the emission standards has partly been important to open up several new tracks of technological development.

Regulation can be viewed as a representation, or a mirror, of how the society understands car driving and the culture of driving. With respect to this way of viewing regulation, setting technical standards and regulation becomes more complex than only being a neutral technical standard. Emission standards are not eliminating emissions, but represent a professional judgement, or a social contract or compromise between social groups or/and professional groups about what is acceptable. When we tend to understand some kind of regulations, especially technical standards and norms, as neutral, it reflects a kind of acceptance of what is acceptable or not. The critique by John Whitelegg about the lack of clear policies for improving air quality in connection to air quality guidelines, is an example of how an attempt to open up the “black box” these kind of standards can be.

Another example of how regulation can be viewed as representation is the difference in European and American understanding of “the problem”. When the US air quality problem from the beginning mainly was understood as a urban problem, the European way of approaching the need for emission standards was the experience of dying forests, especially in Germany. At last we have the example of how different cultures of driving and differences in car technology (manual vs. automatic gearing) was important when deciding the development of testing methods.

Because the car industry the recent 2-3 decades has been met with more strict national and supra-national regulations on emissions, they have been forced to become more innovative when dealing with the less environmental friendly effects of the use of the motor car. When i.e. the discussion on introducing road pricing mainly involves a series of outspoken arguments connected to the social and political effects of it, the use of the TWC seems not to have such effects. Beside the car industry’ early resistance to implement the TWC, there has not been any important social or political controversy over the use of the TWC.

Most of national or supra-national regulations, whether it is economic regulations or regulations of technical or other standards, are objects for democratic evaluation and discussion. But there are different traditions among the European countries. Some countries have a stronger democratic tradition at some areas of regulation, where others have a more technocratic tradition. Compared with the discussion on road pricing, the development of the TWC and the emission standards seems to be much more of a technocratic developed regulation both in Europe and in the US. One important reason for this is obviously that it is very difficult for non-professionals to rationally discuss what is a "safe" level of emissions from car traffic. An another area where the same problem is more visible, because the "experts" are not agree, is over the international discussion on global warming and CO_2-emissions.

This is corresponding with the impression given in chapter 3, where it was argued that in the literature on the economics of innovation very important activities related to the development of infrastructure and regulation of technology are placed backstage or even made invisible (See chapter 3.2.). It is also corresponding with Line Melby's case-study on technology policy and transport in the EU shows that a common attitude is that innovation policy aims are stimulating new technologies, when regulation is reducing the space for development of technology. The TWC and the exhaust emission standards are examples of how the setting of standards, by specifying requirements regarding maximum or minimum characteristics, technology is reconfigured (Melby 2001).

Chapter 9

EXPLORING THE ROOM FOR CHANGE

9.1. Introduction

Few actors question that the traffic and transport regime causes major societal problems and that there is a need for considerable change. Ironically, there is not a lack of ideas nor of technical knowledge to improve the situation drastically. The main problem is to implement these ideas and technologies in practice.

By only using technologies that have been demonstrated it would not be difficult to design a traffic and transport regime with extremely low emissions and that would also be much more efficient (far less congestion) than the present one. There are two major problems, though, to realise this in practice, notably:

1. Different actors have different views and different expectations on what is most promising and what would be worthwhile to make large investments in. This creates a general uncertainty on the basis of which various actors try to minimise the risk of lost investments or prestige by only taking very small steps at the time.
2. The alternatives have to compete with an existing situation that is deeply rooted in society in a variety of ways. Alternatives have to compete with existing infrastructures (e.g. for refuelling), existing modes of production, existing consumer preferences, existing legislation tailored to the current situation that works as barrier for certain alternatives, etc.

On the basis of various empirical studies we will analyse a number of 'promising new developments' in the traffic and transport domain. Promising in this case means that they have certain characteristics that, when fully exploited, would offer a far more sustainable solution to (some of) our traffic and transport problems than current 'main stream developments'.

We will structure this analysis using a specific framework. This existing situation is denoted using the notion of a *regime*, in our case the traffic and transport regime. (Rip and Kemp 1998) Regimes are not static but inherently dynamic with continuous innovation.[60] However, this innovation tends to be 'conservative', with small changes at the time because radical changes are likely to be problematic as they would challenge various existing interdependencies making various actors resist such changes.

The latter point reflects a general characteristic of innovation processes, referred to by the concept of 'path dependency'. Innovation then typically leads to what is called *regime optimisation* which means that problems and challenges encountered are dealt with by optimising the regime in specific directions. A possible alternative is called *regime renewal* which refers to much more profound changes. Focusing on the traffic and transport sector, regime renewal has much more promise to solve the problems at

[60] This is why we prefer this notion over that of a 'system' which has more static connotations.

hand but is also much more difficult to realise. Still, history shows that regime renewal does take place at times via specific processes in which so-called *technological niches* play an important role.

Despite a variety of barriers, radical change may take place because new technologies are initially developed and experimented with in 'protected spaces' when they are not (yet) ready or able to compete with existing technologies. Such protected spaces are called *technological niches* or just *niches*. In these niches, a new technology is protected by various actors who believe in its long-term prospects and who are willing to invest time, money, and effort in 'making it work', both in the technological and in the social sense. (Hoogma 2000)

In a niche, an attempt is made on a small scale to tune the technical and social characteristics of an innovation[61] to one another. An innovation, if 'successful', eventually has to become embedded in the activities of a wide variety of actors. This is a far from trivial tuning process that can be 'smoothened' by ensuring that a sufficiently wide spectrum of actors is involved in this process early on. In such a process, both the technical characteristics of the innovation as well as its social embedding become articulated. This process is interactive in a dual sense: there are interactions between the participating actors in relation to the innovation and they are all interacting with the innovation at the same time.

Such a process acknowledges that (subsets of) actors cannot decide upfront which technology works best because what may be attractive from the perspective of one actor may be completely unacceptable to another. In an interactive process they then try to *experience* (rather than think out behind their desk) what 'works' in practice. It can be characterised also as a process of 'learning by doing'. To be able to use such an analytical scheme to tackle the problems of mobility important questions then become wheter and, if so, how such processes can be 'guided' by strategic or policy action.

9.2. Learning from case studies - assessing 'problemsolving'

9.2.1. Conflicting problemdefinitions

The problems of traffic and transport tend to increase with increasing population density. As a result, they are felt most strongly in big cities. People travel to and in cities for a variety of reasons but increasingly, the functions of the cities become threatened by the negative effects of traffic. Vehicle emissions threaten human health and ancient buildings; extensive use of cars and other vehicles makes the streets dangerous for pedestrians and cyclists; poor air quality and noise make parts of cities unpleasant to live or stroll in; congestion makes parts of the city hard to reach which is a nuisance and has negative effects on the economy.

At the centre of attention is the private car, used for some 80% of all passenger-kilometres, along with a variety of vehicles used for freight transport. The massive use of these vehicles on the one hand is highly valued by their users and important for the economy while on the other hand this creates enormous societal problems. Because of

[61] Innovation not necessarily means some 'fancy new technology'. Any innovation has social as well as technical dimensions where the emphasis may vary across cases.

this, different actors tend to have very conflicting visions of the car: for some of them its the symbol of freedom and prosperity; for others its a major source of trouble.

Attempts to tackle the problems of traffic and transport often are an attempt to juggle conflicting interests and visions. The outcome of this process varies widely depending on how strongly actors experiencing problems are able to push their view and on local (political) culture that reflects what is considered of prime importance in the broader sense. Strassbourg and Rotterdam may serve as nice examples to demonstrate this variety.

Strassbourg is one of the political centres of Europe and has a high esteem of itself as a beautiful city with a long history. It is a nice city to live in and has a very attactive city centre with ancient buildings, including a majestic cathedral. The city centre is an island, about 15 minutes to walk across. The major problems as percieved in the late 1980s were that due to congestion the city became more difficult to reach, it became less pleasant to stay in and the damaging of the cultural heritage via pollution became more and more recognised. The approach chosen prioritised the aspect of 'quality of the city centre'. Through a variety of measures the use of cars in the centre had to be greatly reduced and alternatives were made more attractive through new bicyling infrastructure and a new tramline. Concerning the tram, quality aspects were given priority, in terms of functionality as well as design. (Popkema and Elzen 2001b)

Rotterdam sees itself more like a working town, as the economic heart of the Netherlands. Especially the Rotterdam harbour, in terms of annual transhipment volume the largest in the world, is considered vital for the Dutch economy. Estimates are that every guilder earned in Rotterdam yields 3.5 more guilders elsewhere in the Netherlands and that every job in the harbour yields 4.4 other jobs in the rest of the country.
Rotterdam is surrounded by a square of highways that connect the harbour to the rest of the country and the German hinterland. When congestion on this square increased this was seen as a major threat for the economy because it made transport to and from the harbour less reliable. Congestion, however, is not the only serious problem in the Rotterdam area. The harbour region also has large industries, especially oil refineries, that emit large amounts of pollutants. In summer, especially after a series of consecutive hot days, these emissions, along with traffic emissions, can generate heavy smog which creates a serious health hazard.

Looking at the way Rotterdam tackles these problems it is clear that the accessibility of the harbour is seen as priority #1. Very explicitly, through the concept of selective supply, Rotterdam seeks to prioritise freight traffic over other traffic. At the same time, attempts are made to provide alternatives for the other traffic but clearly, freight traffic gains most. In the Dutch national long term traffic and transport policy two of the major concerns are accessibility and liveability but in the Rotterdam case the emphasis is clearly on the former. Approaches to stimulate modal shift meet with scepticism or opposition in case it creates a burdon to the free use of cars. Company level transport management schemes have been developed but expectations of their effects are not high. As in many other cities, it is not believed that a major shift in people's travel behaviour is possible. (Popkema and Elzen 2001a)

Although this general vison on options to tackle mobility problems is widespread, the Strasbourg example illustrates that there are important differences in emphasis in various cities. In Strassbourg, a systematic attempt was made to push back the role of the car in the city centre and achieve a modal shift. At the overall city level, the

achieved shift has not been impressive, but people do feel the quality of the city centre has substantially improved.

Next to congestion, many cities consider pollution a serious problem. In principle, a modal shift could make a substantial contribution to lessen this problem especially since congested traffic with a lot of stop-and-go worsens tailpipe emissions. But, as was argued above, many cities are quite sceptical about the possibilities of realising a modal shift. As a result, the general feeling is that this problem should be tackled by making vehicles cleaner but this is outside the policy range of local authorities. This responsibility is shifted to the national state or EU level that has to stimulate industry to develop and sell cleaner vehicles. The best cities can do, once such vehicles are on offer, is to demonstrate them and provide certain incentives to stimulate use of the cleanest vehicles available.

There is considerable controversy over what 'cleaner' entails and, by implication, which developments should be supported. Diesel vehicles emit more carcinogenic particulates and nitrous oxides than gasoline vehicles but they are more fuel-efficient and emit less CO_2. Proponents of electric vehicles point to the zero emissions they produce upon driving while adversaries stress the powerplant emissions to produce electricity. Other alternatives like natural gas or liquified petroleum gas have no unambiguous advantages either. Traffic planners in cities have difficulty evaluating the contradictory claims by a host of experts on the potential of various options.

As a result, every city chooses it's own solutions on the basis of varying considerations. Problemdefinitions may vary due to local circumstances or the strength of local lobby groups; certain solutions may may have strong local proponents while others have not; there may be earmarked financial opportunities for some approaches rather than others; there may be incidental political support for certain solutions that may, however, disappear again with the next elections; etc. Because of the strong local focus, there is little co-ordination and learning across local experiences.

9.2.2. Interactivity in problemsolving

Tackling the problems requires an interplay between a range of different actors. The way these actors interact to a large extent determines how attempted solutions work in practice. In a rough approximation we can distinguish three broad categories of actors, viz. public authorities (at different levels), industry (producers of vehicles, fuels, etc.) and users. Furthermore, there are intermediary actors like (public) transport operators. The way these actors interact and the respective roles they play varies widely. This is reflected in strategies to tackle the problems of traffic and transport and the effects of these attempts.

Concerning vehicle emissions, an extreme case where an actor tries to force others in a specific direction is the state of California in the US (Jørgensen 2001) The California Air Resources Board (CARB), the state agency with legislative power concerning vehicle emission standards, has mandated the auto industry to offer 10% 'zero-emission vehicles' (ZEVs) by 2003. Ever since the first adoption of this requirement in 1990 industry has strongly lobbied against it, thus far to no avail. In the past years, CARB has changed details of the requirement but the 10% mandate has thus far been upheld and was reaffirmed at the latest bi-annual review of the mandate in September 2000. Furthermore, industry has to offer increasing percentages of vehicles with 'ultra low emissions' (ULEVs) and 'super ultra low emissions' (SULEVs),

In Europe, the vehicle emission standardisation process is much more an interplay between industry and the European Commission. (Munch and Thomassen 2001) Furthermore, differences of interests between European nations complicate the decission making proces. One striking result is that European emission standards requiring the use of the three way catalyst came in force more than decade after the US More recently, the Commission has co-operated with industry in the so-called auto-oil program to try an reach agreement on bringing emissions down further. A voluntary agreement has been reached to bring back CO_2 emissions. Concerning local pollutants, new standards will come into force in 2001 while tighter standards have been defined for later years. These standards go somwhat further than what industry would have liked to see, although not much. They are not as tight, though, as in California.

In Europe, where there is no differentiation in the emission levels of vehicles, users only play a passive role. They can only buy vehicles that adhere to the standards. Things get more complicated with differentiated standards as in California. Customers have a choice between conventional vehicles, ULEVs, SULEVs and ZEVs. Costs of vehicles tend to increase with decreasing emissions. This is especially the case with ZEVs which in current practice are battery electric vehicles (EVs). The large batteries make these vehicles very expensive, 50-100% more than conventional vehicles. Users thus face the question of how much they are willing to pay for lower emissions. As cost usually is a primary motive public authorities try to make users choose for cleaner vehicle types by providing additional incentives like free parking or cheap electricity for ZEVs.

The fate of attempts to tackle congestion and stimulate a modal shift critically depends upon user choices. In contrast to the situation in relation to emissions, curbing congestion is more a play between public authorities and users where producers play a secondary role. Typically, public authorities take the lead by offering new travel options and/or discourage the use of private vehicles. Across Europe, during the past decade or two, numerous attempts have been made to improve public transport but it appears that most travellers so much prefer using their private vehicle that they are willing to pay extra for it if needed. In Italy, it is even a widespread feature that people massively break rules and regulations to continue driving themselves. (Undheim 2001a) Making people change their travel behaviour appears to be far from easy.

During the 1990s, attempts have been made to enrol users and the public more directly in decision making on transport issues. In Strasbourg, France, extensive consultations of the public helped to shape the new tramway. In Boulder, US, the public was also consulted on possibilities to restrict car-use and make more use of public transport which helped to shape new bus-routes and some other measures. Although Boulder is not the most typical American town, sometimes referred to as the ‘nine square miles surrounded by reality’, it is significant that even in the car nation *par excellence* there are possibilities to achieve some modal shift. (Popkema and Elzen 2001c)

This discussion illustrates that different types of actors need to co-ordinate their actions to change the traffic and transport regime. Some actors may try to force others to go in specific directions but this may trigger serious resistance with uncertain outcomes. More interactive approaches may lead to better consensus on certain measures but in the negotiations some of their effectiveness may have been lost. What is or is not possible may largely depend on national and local culture but in general it seems that the way the interactions between the various actors are shaped is an important success factor in tackling the problems of mobility.

9.2.3. Tackling the problems - Breaking away from conventional strategies

Two general groups of problems of mobility can be distinguished, one in relation to vehicle exhaust emissions and one related to the massive use of vehicles, leading to congestion and poor accessibility of various locations. Concerning emissions, across the world the conventional strategy has been to tighten emission standards and thus force industry to market cleaner vehicles. These approches are analysed in chapter 6 of this report.

These approaches have been quite successful in the sense that, on average, exhaust emissions have gone down considerably over the past decades. Nonetheless, especially several large cities feel these are still too high and make local air quality a hazard to the health of citizens and a threat to ancient buildings. They are very interested in the 'promise' of electric vehicles (EVs) to improve this situation drastically. As EVs do not fit the current mobility regime smoothly, new approaches seem to be needed to stimulate their further development and their introduction into practical use. This will be briefly discussed below.

Also the attack of congestion problems seems to be in need of new approaches. Especially since the mid-1980s, various ministries and local transport planners have had these problems high on their agenda's but the overall results have not been very satisfactory. There have been local successes in achieving some modal shift but although in many occasions public transport use has grown, car-use has grown even faster. Below we will also discuss attempts to reach more sustainable results.

The quest for the zero emission vehicle

In the late 1980s, the strive to bring back the emissions of cars further caused an upsurge in the interest for electric vehicles. As such vehicles emit no pollutants during driving they became referred to as 'zero emission vehicles' (ZEVs). Electric (road) vehicles have been around for a long time and in the initial decades of the 'horseless carriage', until about 1915, there were more electric vehicles (EVs) than internal combustion engine vehicles (ICEVs).[62] After the latter had gained the upper hand, however, EVs disappeared from the public scene. In the 1960s, when a general conception of the 'all electric society' started to develop, the interest in EVs rose again. In the mid-1960s, General Motors announced that it would take another decade before EVs would hit the road again. In the 1970s, a series of bi-annual industrial conferences was initiated under the name of 'Electric Vehicle Symposium'.[63]

In the next decades, presentations at these symposia reported progress in many domains but one problem refused to go away: the enormous weight and limited capacity of batteries along with their high cost. A typical battery weighed of the order of 500 kilograms, gave a vehicle a range of 100 km or less and would cost of the order of 5000 euro. On top, the battery would have to be replaced several times during the lifetime of the vehicle. A typical joke among sceptics was that 'EVs have been, are, and always will be the technology of the future'.

Despite the regained interest in the 1970s and 1980s EVs were not taken serious until the US state of California enacted new emission standards in 1989. Partly because the

[62] In those days there was also a third competitor, the steam-powered car. Jamison 1970, chapter 3.
[63] For an overview of EV history see Kirsch 2000.

air quality in several parts of the state have traditionally been among the worst in the US, California has a long history of enforcing tight emission standards for stationary (industry) as well as mobile (vehicle) sources. In the late 1980s the agency responsible for air quality in the state, CARB (the California Air Resources Board) felt that the regulations for stationary sources could not be tightened much further and started to look more critically towards mobile sources. In 1989, after interaction with many experts and consultation with industry, CARB enacted new 'low emission vehicle regulations'. It defined new categories of vehicles with the name of LEV (low emission vehicle), ULEV (ultra low emission vehicle) and ZEV (zero emission vehicle). Large automakers were mandated to produce and offer increasing percentages of these types of vehicles in the years to come. Part of the requirement was to sell 2% ZEVs as of 1998, increasing to 10% in 2003.

Worldwide, the California ZEV-mandate spurred an enormous interest in EVs, encouraging those who believed in EVs. The automakers, however, were and remained very sceptical. As time progressed and the 1998 date approached they more-and-more forcefully argued that it would be impossible to make a commercially viable electric vehicle. With this they meant a vehicle that could attract a mass market implying, in their view, it needed a range of a hundred miles at least.

Proponents of EVs, however, argued that EVs needed a more differentiated approach. EVs would have to target markets where vehicles would not need a long daily range. Many of such markets were identified and many entrepreneurs and technology developers started to develop vehicles intented to serve these markets. Such entrepreneurs can be found in many countries, also in non traditional car manufacturing countries like Denmark and Norway. It is illuminating to look briefly at these examples.

In the early 1990s several Norwegian companies created a joint venture with the name of Pivco. Pivco set out to make a small two-seater electric vehicle. Such a vehicle would be ideal to drive around town, as it was clean and needed only limited parking space. Pivco's first product, the City Bee, was very much a prototype. Some 40 of them were used in California in a demonstration project. These experiences helped Pivco to develop a follow-on, named the Th!nk which would be more commercially oriented. Th!nk not only involved an innovative design for a car but also innovative production techniques to be able to produce annual series of several thousands on a commercial basis. Conventional vehicles are typically produced in series of tens or hundreds of thousands.

Pivco, however, was not very successful in its marketing efforts and was unable to sell sufficient numbers of the Th!nk. The company was virtually bankrupt when it was bought by Ford in 1998. Interestingly, the Ford buyout is not just to secure a vehicle or a vehicle technology although the Th!nk might help to fulfill Ford's obligation to sell 10% EVs in California in 2003. Ford is also interested in the production technology as there seems to be a broader tendency of customer interest in small, customised city vehicles. Furthermore, Ford uses Th!nk as a broader concept of sustainable mobility. It is a clear indication that the automakers feel the mobility markets are changing. Like everybody else, they are not sure where it is going and they try to familiarise themselves with new ideas and concepts they think might become important. (Undheim 2001b)

Denmark provides another example of attempts to build EVs for specific market segments. A first EV was produced by a mechanical factory as a new product in the early 1980s. It had a 50 km/h top-speed and a 60 km range per battery-load and was

sold primarily for closed areas in large factories. Several hundred were sold to users who were quite satisfied with the vehicle. For sustainable production, however, the market would have to increase by being able to sell it for use it on public roads. The authorities, however, did not consider the vehicle roadworthy after which the manufacturer gave up production.

In the mid-1980s, a new attempt was made by an entrepreneurial businessman who attempted to 'sell' this as a novel Danisch business endeavor that could become an international symbol of Denmark. The vehicle was a small city-car with an 80 km/h top-speed and 60-100 km range. There was a substantial interest in the concept but after a prototype crashed at a car-fair, watched by a large number of journalists, interest quickly waned. More successful, around the same time, was the Ellert, also a small city car, a three-wheeler. The entrepreneur behind the vehicle saw this as a new means of transport suited specifically for short distances. Until the mid-1990s, over 4000 were sold but the company was regularly in financial trouble, even went bankrupt several times. Although the users seemed to be quite satisfied, it never received wide acclaim, partially because its safety was regularly contested.

Over the past decades, the Danish authorities have not followed a consistent policy in connection with EVs, partly due to shifting in the reasons why EVs were considered attractive and partly because these advantages were controversial. In the late 1970s, early 1980s, energy diversification was an important reason to support EVs. In the late 1980s, industrial development and environmental polution became more important. On the basis of this the government provided tax-incentives for EVs but there was also serious doubts about their advantages. It was argued that even an unlikely high number of EVs (150,000) would hardly reduce energy consumption although there would be a noticeable effect on CO_2 and NO_x emissions. But it was also argued that vehicles like the Ellert were competitors to cycling and walking which were considered much more sustainable alternatives. (Munch 2001)

At the turn of the 21st century, in Denmark as well as in other countries, most EVs driving around are conversions from conventional vehicle designs, manufactured by the traditional automakers. The largest producer has been the French PSA (Peugeot-Citroën) with about 6000 EVs sold by mid-2000, or two-thirds of the EVs in the European market. (Calstart News Notes 19 May 2000) This exemplifies that, although the strongest legislation is in California, the strongest believe in EVs is in France. Many French cities with medieval buildings that suffer visibly from pollution see the zero emission vehicle as the ultimate answer to their air quality problems. The French national government agrees and has set up various programs to stimulate French industry to fulfill this need.

Of course, an EV is not a zero emission vehicle in the strict sense as there are still significant emissions at the powerplant that generates the electricity. In the early 1990s, automakers tried to fight the ZEV mandate arguing that these powerplant emissions made the ZEV even more polluting than certain categories of conventional vehicles. This, of course, largely depends on the fuel used to produce electricity and the cleanliness of the plant. In Germany, with a high share of relatively dirty coal-fired plans, there is considerable opposition against EVs on this basis. In France, where most electricity comes from hydro and nuclear plants that produce no atmospheric emissions, there is a lot of support.

From the city perspective, however, emissions at a single powerplant are less of a problem and easier to control than emissions from hundred thousands of tailpipes which deteriorate the air quality in town at the ground level. Furthermore, various developments in the 1990s have led to a more widely shared consensus that EVs are a promising means to curb emissions overall, partly due to technical developments, partly due to the more differentiated view on EV markets. Given that the range of EVs is limited, proponents and EV developers target applications where a limited daily range is needed which often are inner-city applications with a considerable amount of stop-and-go. In such applications, the emissions of conventional vehicles are the highest and an EV can be 2-5 times cleaner, even with coal fired powerplants.[64] The advantage gets bigger with a cleaner burning fuel like natural gas. The largest air-quality benefit, of course, is achieved with emission free generation as in the case of hydro-electric plants.[65]

Despite the numerous activities in the EV arena in the 1990s there are still virtually no stabilised markets. Most vehicles produced are used in demonstration projects and programs that show a wide variety in types of applications and types of vehicles. It is clear that there is a considerable interest on the side of city authorities who provide all kinds of incentives to help develop a market. The demonstration projects indicate there is also a considerable interest on the side of a wide variety of users. These users, however, are very heterogeneous and require various types of vehicles. As there is little learning across projects this does not add up to more precise definitions of vehicle types for which there might be a market large enough to legitimise series production.

Making vehicles is one thing but marketing them is at least as difficult. Small EV producers in Norway and Denmark had the skills to make vehicles but lacked the marketing skills to attract a sufficient number of customers. An alternative interpretation is that there is no market for such types of small 'city vehicles' but there is also evidence to the contrary. For instance, Mercedes, after having put in a lot of effort in marketing a new small car called Smart (also referred to as 'baby-Benz'), succeeded in selling hundreds of thousands of them. In the centre of Rome, with huge congestion and parking problems, several thousand of them were sold within a month after its market launch. (Undheim 2001b)

Rome provides also an example of a more successful use of electric vehicles, notably electric mini-buses (up to 27 passengers). Over the past years, ATAC (the Rome public transport company) has introduced 40 such vehicles. The centre of Rome is so extremely congested that there is wide agreement that something should change. On the other hand nobody seems to be prepared to change his/her behaviour and Romans are extremely inventive in finding ways to break new regulations. Still, there is a sense of

[64] On the technical side, the drawback of the low storage capacity of the batteries has made many developers of EVs concentrate on the efficiency of electric drivtrains in order to reduce the energy consumption of EVs. State-of-the-art EVs in 2000 are close to 50% more efficient than those of the early 1990s and powerplant emissions, including CO_2, go down in direct proportion to this. More importantly, the comparison with conventional vehicles is made on the basis of the emission data that are gathered on a standard test cycle on a test bench. In actual road driving, especially within cities, emissions from gasoline and diesel vehicles are typically 2-4 times as high due to cold start emissions (when the catalyst does not yet work), hot soak emissions after stopping the engine and frequent stop-and-go. Furthermore these emissions tend to increase with the age of the vehicle.

[65] The same is true for nuclear plants but there is considerable controversy over the sustainability of this power source in connection with radioactive waste. Because of these concerns, an increasing number of countries has started to move in the direction of phasing out nuclear power.

urgency in which new initiatives spring up and can get support. The electric buses are one example; another example is the initiative by the Rome shopowners association to let 400 electric scooters for use in the centre.

Concerning the buses, these not only simply replace conventional buses but they also create a 'new experience'. People sit and stand opposite one another in a very silent bus in seats too tall for most people's feet to touch the ground. In this 'lego-like' reality riding the bus becomes a playground in which travel-time becomes fun-time stimulating people to interact with one another. These buses have created a new public space that people obviously value. This has stimulated ATAC to start a new service, the Satuday night version of the electric bus line with a particular itinerary servicing all major theatres in Rome, leaving from large parking lots outside the historical center. It is another attempt to reflect the aspect of quality of city life in the type of transport service provided. (Undheim 2001b)

This discussion illustrates that there are various barriers that make it difficult to make EVs that could find a sizeable market. The vehicles require new behaviour from their users, which some users are prepared to but many others are not. Public authorities have not been very consistent in their strategies or even desires to stimulate electric vehicles. Small producers can make new types of EVs for new types of applications but do not have the marketing skills. The big automoakers do have the marketing skills but concentrate on re-engined conventional vehicles for which they claim there are no markets. Still, certain types of EVs do have attributes that could help solve certain problems making it worthwile to explore to what extent their promises can be realised in practice.

Improve accessibility (reduce congestion)

Over the past decade, congestion has become the most heavily debated problem in relation to mobility. It became recognised as a problem in the 1960s and 70s with the rapid growth of ownership and use of private cars. Initially the answer was to build more roads and related infrastructures. During the 1980s, however, it appeared this approach became less and less effective. New roads only gave temporary relief and also became congested after a while; within cities it became more and more problematic to find space to increase the capacity of the road infrastructure.

An alternative approach was to increase the capacity and quality of public transport and to stimulate travellers to use it more rather than their private cars (modal shift). Many were very sceptical about the effects of such attempts and saw it as a waste of public funds. For a variety of reasons, it was believed, public transport could never match the ease and flexibility of the private car. Because this expectation was widely shared it became a self-fulfilling prophecy and at the turn of the 21st century attempts to achieve a modal shifts are widely seen as failures. Increasingly, traffic planners came to believe that general solutions do not work and that more differentiated and local approaches are needed to tackle congestion problems. The Rotterdam case provides a good example. (Popkema and Elzen 2001a)

In the late 1980s the Dutch national government developed a long term traffic and transport policy plan by the name of SVV-II (a Dutch acronymn for 'Structureplan Traffic and Transport'). In connection with congestion problems it defined two major objectives, notably accessibility and liveability. This framework policy had to be implemented at the local and regional level such as the Rotterdam area.

The city of Rotterdam lies about 30 kilometers inland from the North Sea. The City is connected to the sea by a huge waterway and the space to the sea along the banks is filled with harbours and industries. This area has road connections with the hinterland, partly in the shape of a square of highways around the city of Rotterdam that cross the grounds of several other municipalities surrounding Rotterdam. When these highways got more and more congested this was seen a major problem for a vital part of the Dutch economy.

In 1995 a regional body with representatives from the various municipalities presented a comprehensive plan to tackle these problems called the 'Regional Traffic and Transport Plan'. In accordance with SVV-II it stressed accessibility and liveability. These issues were treated rather a-symmetrically, though. Liveability was considered a long-term concern to be approached through a variety of measures in the next 10-15 years. Accessibility, however, had to be tackled immediately through a comprehensive plan called the 'Congestion Relief Program' (CRP).

Economic concerns are the basis of the CRP which is clearly illustrated by the development of a novel approach called the 'select system' which makes a distinction between between 'necessary' and 'non-necessary' traffic. The former group includes freight transport and other traffic that is considered economically relevant. Dedicated infrastructure will be made available to necessary traffic and various mechanisms will be used to control access, like pay-schemes, vehicle license plate recognition, dedicated lanes, freight traffic priority at access ramps, etc.

The select system is an integrated program of projects and measures with the following main ingredients:

- stimulation of the maximal use of rail and inland shipping for transportation of goods, which includes an improvement of infrastructure and measures that have an influence on modal split;
- selective extension of the road network, in order to increase the road capacity for necessary traffic;
- development of a high-quality public transport network for the city as well as for the region;
- a broad range of other car-mobility reducing measures.

The select system not only seeks to prioritise 'necessary traffic' but also attempts to develop alternatives by improving public transport and facilities for cycling. An extension of the metro system is under construction and a network of dedicated bicycle lanes is created.

The CRP follows the overall select system philosophy and consists of over a hundred small projects grouped under three headings: traffic control, 'area specific approach' and 'chain mobility'. In the group of traffic control, projects are carried out that aim at a better guidance of flows of traffic. The introduction of Dynamic Route Information Panels (DRIPs) and ramp access control installations are part of this group. In the 'area specific approach', eleven zones are defined that all are approached separately with dedicated sets of measures including company level transport management. 'Chain mobility' aims to improve the weak links of the 'mobility chain', either by enhancing infrastructure for a specific mobility mode (like the improvement of the infrastructure for bicycles), or by developing sites where a transfer to another mode is facilitated (like changing from bicycle to metro).

Improving public transport and cycling facilities is not expected to relief congestion in the short term which is considered necessary for economic reasons. A variety of short term measures that explicitly prioritise 'necessary traffic' should help to give some immediate relief. An interesting example concerns an exit ramp that, because of local liveability concerns, was only allowed to be used by buses. Traffic to a nearby business area in some cases had to make a 15 km detour. With increasing congestion, these businesses more and more saw opening up of this ramp for other traffic as a relief to their accessibility problems. Their concerns were honoured after negotiations with various involved parties in which a scheme was developed that allowed specific vehicles (identified automatically through their license plates) to use the ramp.

Giving out these permits in a sense was not a surprising outcome as their was a coalescence of interests from local businesses and traffic planners that sought an alleviation of congestion on the main highways. Interestingly, though, these traffic planners attempted to embed their decisionmaking in a wider range of concerns under the CRP. One of the approaches used was 'company level traffic management'. In this approach companies with more than 50 employees should develop traffic plans for their employees that would alleviate congestion (e.g. by stimulating employees to carpool, use bicycles, use public transport, etc). In the interactions between the various parties over permitting to use the exit ramp it was agreed that only businesses with approved traffic management plans would be given permits.

This Rotterdam example illustrates some interesting points. The measures taken reflect a clear priority of economic (accessibility) concerns over liveability concerns. Although the latter are also addressed in the long term plans, the short term focus was on accessibility and the effects of the longer term intentions and plans still needs to be seen.

A second interesting feature is that the Rotterdam approach consists of a comprehensive plan that is subdivided into a variety of individual projects. This is not uncommon in itself but less common that an attempt is made to keep the link between the various projects in the execution phase as was illustrated in linking up exit ramp permits with company level traffic management plans. The way this was realised is also not very common, notably by specifying the exact measures in close interaction with all relevant stakeholders and stressing the importance of sticking to the overall vision in defining the local measures.

Whether the overall outcome of the approach can be considered a step forward towards sustainable transport remains to be seen. Indeed, in the short term the traffic jams on the highway around Rotterdam have been reduced significantly which has increased the accessibility of the harbour which was the first objective. However, given the trend of a continued increase in mobility and the plans to increase transhipment in the harbour and to develop the surrounding business areas further, new problems are likely to emerge in the future. Furthermore, prioritising 'necessary traffic' over 'non-necessary', creates a more problematic situation for the latter that should be addressed. Rotterdam has developed plans to tackle this as well with an improved bicycle infrastructure and improved public transport. These plans, however, closely resemble the approaches that have been followed elsewhere with limited results in most cases. It seems that a more comprehensive approach will be needed to develop solutions that are sustainable in the longer term.

Improve liveability and quality of the city

There is widespread agreement that the large numbers of cars running through cities reduce the quality of the city by leaving little public space where it is safe to stay and stroll and by worsening the air quality which creates health hazards and threatens the cultural heritage, especially in cities with medieval structures. By implication, improvement of liveability and quality of city life requires a significant reduction of car use. Traffic planners in various cities across the world have tried to reach this objective. The typical approach is to improve or extend public transport services along with discouraging car-use in parts of the city. The French city of Strasbourg provides a good example. (Popkema and Elzen 2001b)

The Strasbourg City centre is an island, about fifteen minutes walk across. It has many ancient buildings, including a cathedral. In the 1980s, it became more-and-more recognised that the large numbers of cars traversing the island decreased the quality of the centre. The centre was heavily congested and polluted with CO-levels twice the WHO standard. The extensive presence of cars caused discomfort and insecurity to pedestrians and cyclists, as well as damage to the historic heritage of Strasbourg.

To tackle the problems, it was felt that a drastic improvement of the public transport service was needed. Throughout the 1980s there was preperative work on a rail based system, either light-rail (with tracks separate from the road) or a tram with tracks in the regular road. The knot was cut in mid-1989 by a newly elected mayor who had made a reorganisation of the Strasbourg transport system a heavy issue in the election campaign. The city council approved the plans for the first tramline later that year.

The new tram was part of an encompassing plan to improve the quality of the city along with improving the quality of transport. The plans focussing on transport included better facilities for cycling, park and ride facilities in connection with the tram, improved bus services, eliminating through traffic on the centre island, extensive pedestrian zones, etc. To improve the quality of the city in the broader sense, landscape architects were hired to redesign parts of the city and integrate the new facilities into the city landscape. A special effort was made on the tram design as a recognisable and valued element of the ‘new Strasbourg’.

The public and shopowners initially were sceptical and in some cases opposed to the plans. In preparation of the implementation, extensive consultations of the public took place to understand their concerns and to attempt to take them into account. This gradually increased support and most fears seemed to be allayed in November 1993, when a full-scale model of the tram went on public view. As work progressed and the new urban landscape began to take shape, reactions became more positive. Resistance from shopkeepers was overcome once the work was finished and the inconvenience over and the tram came into service.

To improve access to the city centre by combining complementary modes of transport, three park-and-ride car parks were built to serve the first tramline. For FF 15 (about 2 euro) drivers can leave their cars in the car parks for an unlimited period and they and their passengers each receive a tram return ticket for the city centre. At the same time, through traffic in the centre was banned. Four access roads lead into the centre, each to a car park with high parking rates. In addition, a few thousand parking spaces for residents were created that can be used at lower cost. Parts of the centre were made into pedestrian zones.

In 1994, the first tramline was introduced, a 12.6 kilometre long route that connects the north-west of the city to the south, servicing the train station and the city centre. The service operates from 4.30 AM to 0.30 AM, with an initial rush hour frequency of one tram every four minutes. The tram has a low-slung floor along the entire length which makes the tram easy accessible, also by people in wheelchairs, parents with a baby buggy and people with walking problems. The large windows give an open and wide view. The tram has round shapes and a metal paint coachwork in an attempt to integrate the tram into the city background. In 1998, when it appeared that the tram was more popular than anticipated the frequency was doubled to one tram per two minutes on the busiest part of the line.

These measures had a large effect to reduce car use in the centre. Ninety percent of the users of the P+R facility used to park their car in the centre before. The tram carries close to 70,000 passengers per day, about half of whom use the P+R system on weekdays and 15% on Sundays. Most people in Strasbourg feel that the quality of the city has been improved significantly and that it can be accessesed at least as easily as in the old days.

The Strasbourg example of tackling congestion has met with wide acclaim. Since the mid-1990s, the city has received three to four delegations a week to learn more about the details.

Another interesting example of an attempt to combine ‘city quality’ aspects with transportation issues comes from the US In the early 1980s the city of Chattanooga (Tennessee) suffered from a serious economic downturn and the downtown area was very much in decline. Seeking a way out the city authorities started a process of open debate with the citizens to develop plans. (Popkema and Elzen 2001b) This process, called ‘Vision 2000’, rendered a series of broadly supported recommendations called a ‘commitment portfolio’, covering areas such as health care, housing, education, community relations, economic development, environmental issues, recreation and quality of life, transportation, government services and historic preservation.

One of the priorities was to restore the waterfront at the Tennessee river and make it an attractive area to stay and stroll. In connection with this a need was also felt to set up a new transportation system that would give some relief from congestion. Though the project’s main focus was on the waterfront, some parts of the revitalisation plan were in other areas of the city. It was felt that there was a need that these areas were connected by a high-quality transport service which the local prublic transport company CARTA was asked to develop.

CARTA was provided with a set of criteria by the local authorities through the downtown planning process. The service had to match the quality of the developments in the downtown area and be something more than just a ride. It should be an experience in and of itself. The service should not only connect the various new developments but it should also use distinctive passenger boarding areas, distinctive graphics, and an effective information system. The system design had to anticipate future extensions and modifications. Finally, it had to be environmentally benign. This was a strong issue in Chattanooga that had had one of the poorest air qualities in the US in the 1960s and it had put in a lot of effort to meet the federal standards in the 1970s.

The concept developed was to have a series of P+R car parks at the periphery of the downtown area and install a high-quality, high-frequency public transit system that

would connect the parking garages with downtown destinations. This system would permit local workers and out-of-town visitors to leave their automobiles at one location and use the transportation system to move about town. The revenues from the parking facilities should provide the funding for the operation of the transit system.

Concerning the vehicles, based on positive experience in a specific service in California in the early 1990s, CARTA chose for electric buses. Such vehicles, however, were not for regular sale and mostly prototypes. CARTA realised this was a risky choice and thereupon explicitly defined the whole set-up as a learning situation, calling it a 'living laboratory'. A local entrepreneur set up a new firm, AVS, to produce the buses locally. This reduced technical risks as AVS had an interest to quickly deal with any upcoming problems to gain knowledge on a reliable design that could be marketed more widely. AVS worked closely with CARTA to get the necessary feedback.

The first locally produced buses came into operation in 1993. In the course of time, the frequency of the service was adjusted according to demand. Initially, the buses were in service from 10 AM to 6 PM. As of 1994, after the opening of the first P+R garage, the service was extended to range from 6 AM to 10 PM. When the second garage was opened, the service had to be adjusted to changing flows of passengers. With the first garage, there was an uneven distribution with many passengers going downtown during morning hours and most of them coming back at the end of the day. This changed when the second garage was opened and flows became more evenly spread.

In summer, the garages are mainly full, mostly due to tourists who find it convenient to park their car in one of the garages and move about in the city on the shuttle. In this period, ridership on the buses is also higher. An increase of 30-40 percent occurs during the summer months, mostly in weekends. In winter, shuttles are used more often on weekdays. In March 2000, about 1900 passengers per day were registered on the shuttles, with peaks on Friday and Saturday up to 3300. Its use on Sundays during this month was generally low: 1000 passengers per day. In 1999, close to one million passengers used the shuttle. With this level of use, about two-third of the costs of operation is received from the parking revenues. The City of Chattanooga pays the remaining share. CARTA expects to be able to pay all costs when a third garage is built.

Contrasting the Chattanooga with the Strassbourg example can render some interesting insights. Transport planners in Chattanooga see the electric buses as a positive development although, at least until now, they have had no serious impact on the overall transportation patterns. In Strasbourg, by contrast, the changes have been significant, especially in the city centre. This is widely recognised as is exemplified by the many visiting delegations. The difference, of course, was already reflected in the initial objectives. Chattanooga chose for a modest scale, even calling it an experimental situation while Strasbourg very explicitly set out to change the overal tranportation pattern. It developed a high capacity public transport service along with taking measures to make car use less attractive. This worked which is in a sense surprising given the widspread scepticism on the possibility to get people out of their car. How could this happen?

Probably a combination of things. In the 1980s there was a wide recognition among the population that there was a serious problem. A new mayor, who had stressed the need for a tram in the election campaign, forcefully tried to implement the plans. There was intitial scepticism among considerable parts of the population and shopowners but the public consultation process did much to create an open attitude. When the system

gradually came into operation many of them experienced it had attractive features and much of the scepticism turned into enthusiasm. Many initial opponents feel that the inner city has become a much more attractive place and that the opportunities to reach the city have not gotten worse, maybe even better. The public even asked for a second tram line.

In general, one of the largest barriers to change in the traffic and transport system is the (perceived) unwillingness of people not to use their car. The Strasbourg example indicates that substantial changes are nonetheless possible. These people changed their perceptions, not on the basis of paper plans but after experiencing the new system had attractive features to them as well. They started to experience that travelling downtown is part of something more encompassing and that the 'quality of life in the city' in the wider sense has improved (although they might still prefer sitting in the private space of their car over sitting with others in a tram). It is a clear example of what may be called 'learning by experience'.

Although the results in Chattanooga are much more modest the same phenomenon can also be observed there. What complicated things there was the use of an unproven technology (electric buses) against the scepticism of the vast majority of transport operators at the time. In their view, electric propulsion would be cumbersome, problematic because of short range and expensive. In Chattanooga, all of these problems were indeed encountered but by focussing on learning and having people in the team to quicly tackle upcoming problems the 'living laboratory' demonstrated it could develop an operating system 'against the odds'. This is not to say that it is clear that electric buses are the future but the opposite can no longer be taken for granted either (which still seems to be a widely shared view).

Clearly, both cases illustrate that there is more room for change in the current system than many transport planners assume.

9.3. Signposts en route to sustainable mobility

9.3.1. Critical evaluation of successes and failures

Policies to curb vehicle emissions are generally seen as quite successful. Although, especially in Europe, the decision making process on emission standards has been a whimsical one, the vehicles sold nowadays on average are much cleaner than the ones sold ten years ago. In the coming decade, these emissions will go further down significantly when most old cars without catalysts will disappear from the road and the tighter Euro 4 and Euro 5 standards come into force later this decade. Of course, it would be better to have zero emissions but, it is often argued, experiences with EVs have demonstrated this is an elusive Utopia: EVs produce emissions elsewhere (at the powerplant) and it is virtually impossible to produce a vehicle with a reasonably driving range at a acceptable cost. Most traffic and traffic planners see fuel cell vehicles as a better candidate to lower emissions in a decade our so. Whether this will be realised or not, there is widespread optimism that technical innovations on vehicles will solve the problem of emission of pollutants.

This is certainly not the case for greenhouse gas emissions. The vast majority of vehicles run on fossil fuels and produce CO_2 emissions through combustion. Over the past decades, engines have become considerably more efficient. At the same time,

however, more-and-more cars are equipped with features like power steering, ABS, air conditioning, all of which increase fuel consumption while numbers of vehicles have also continued to grow. The overall result is that CO_2 emissions from road transport have been on a continuous increase. This is a serious problem that has been internationally recognised in the Kyoto agreements that call for a reduction of CO_2 emissions to 5% or more below the 1990 level by 2012.

In the US, in the early 1970s, fuel consumption per vehicle tended to be twice as high as in Europe and Japan, partly because fuel prices in the latter regions were 4-5 times as high. After the 1973 oil crisis, the US goverment enacted the so-called CAFE (corporate average fuel economy) regulations that forced industry to manufacture increasingly fuel efficient vehicles. From the beginning of the 1980s, however, these standards have not been tightened further. The worldwide discussion on the greenhouse effect did not put this issue back on the agenda either.

It did so in Europe, however, and the European Commission has been looking for ways to develop standards for vehicle fuel consumption. These met with strong opposition from industry that very skillfully played out national differences thus effectively blocking action from the European authorities until 1998. That year, when the EU environment ministers at last threatened industry to develop binding legislation, the European automaker's organisation ACEA, which also includes major US automakers, offered to voluntarily cut carbon dioxide emissions from automobiles by 25 percent over the next 10 years. This was accepted by the ministers and confirmed in a voluntary agreement. Under the agreement, the automakers must cut average automobile fuel consumption to 5.8 liters per 100 kilometers. That should cut CO_2 emissions from new cars to 140 grams per kilometer (g/km) compared to the 1998 average of 186 g/km. Although the cut in CO_2 emissions would save 85 million tons of CO_2 emissions per year by 2010 , the amount represents just 15 percent of the cuts the European Union has committed to as part of its Kyoto commitments. It can even be doubted whether this commitment will lead to a lowering of overall CO_2 emissions from transport as there is no such commitment for other vehicles and numbers of cars are continuously increasing.
Congestion seems to be an even more elusive problem. Most traffic and transport people have come to the conclusion that it will never be possible to play down the role of the private car. Despite local successes (e.g. a reduction of traffic jams on specific stretches of highways or improved parts of cities with limited car access) many think massive car use and the related congestion problems cannot be curbed. This widespread view is reflected, for instance, in the draft of a new long term 'National Traffic and Transport Policy Plan' that was published by the Dutch government in October 2000. (Ministerie van Verkeer en Waterstaat 2000) Car mobility is taken as a given and the way to cope with congestion is to extend and improve the road infrastructure to remove bottlenecks, to increase the capacity of existing infrastucture (e.g. by increasing the number of driving lanes) and to spread traffic more through road pricing schemes. The emphasis on reducing mobility growth and stimulating modal shift from the earlier long term plan from the late 1980s has been downplayed considerably.

This sceptical view on the possibility to change people's mobility behaviour seems to be supported by experiences from the past decade. Campaigns to stimulate people to drive less or use public transport did not change patterns significantly; despite a decade of development and demonstration electric vehicles are rare to be seen; mobility in terms of passenger kilometers travelled has continued to increase as has the number of cars per household.

In this section, however, we want to challenge this sceptical view. We will take a closer look at some of the 'successes' from our empirical studies as well as some of the failures and argue that there two biases that feed the scepticism. The first is that new developments or demonstration projects are evaluated too much in black-and-white terms, seeing them either as a success or a failure. The second is that such projects are evaluated primarily in terms of their short term effects and not in terms of their long term effects or potential.

The congestion relief plan in Rotterdam is considered a considerable success as the structural queues of traffic on the square of highways around the city decreased by 10%. People in other parts of the Netherlands, were the traffic jams only seem to get worse, look at this result with envy. Indeed, this is a good near-term result but whether it is sustainable can be seriously doubted. There is no significant increase in infrastructure capacity nor a reduction of mobility in terms of number of vehicle trips which implies that there has been primarily a displacement of traffic. Given the trend of a continued increase in mobility and the plans to increase transhipment in the harbour and develop the surrounding business area further new problems are likely to emerge in the future unless other measures are taken

Rotterdam is aware of this and tries to counter this by its long term approach on the basis of the 'select system' philosophy. A category of what is called 'necessary traffic' (i.e. freight transport along with people who are willing to pay for infrastructure use) will be prioritised over other traffic. Public transport will be improved as will facilities for bicyling. Experiences in the past, however, suggest that this will not help to reduce congestion. New infrastructure primarily seems to attract new traffic or invite people to 'upgrade', i.e. to go cycling instead of walking or to take public transport instead of cycling.

Nonetheless, there are also examples where people have started to use alternatives next to their own car. Strasbourg provides a good example. Here, a combination of measures seems to do the trick to discourage people to use their car in the city centre. These measures are:

- Part of the centre is made into a pedestrian zone where it is forbidden to use the car.
- It has been made impossible to cross the city centre with a car; people can only drive in and out.
- Parking tariffs in the centre are much higher than in the rest of the city.
- A new, high quality alternative has been offered in the form of a tram. Good P+R facilities with cheap parking and a free tram ride help to make a combination of modes attractive.

This raises the question why Strasbourg has been successful in this respect while various other cities have not. An important characteristic seems to be that Strasbourg has made huge investments in this combination of measures against the expectations of many that this would not work. Shopowners as well as many inhabitants were sceptical or even outright opposed but according to the people involved it was the strong determination of the new major that made it possible to carry out the whole plan as a package. Interestingly, now that it is implemented, virtually everybody thinks the transport situation as well as the quality of the city has improved.

Thus, it appears, the situation is not that there are no alternatives that work. Representatives from many cities realise this which is exemplified by the large number of delegations that visit Strasbourg. Why hasn't this approach been copied widely

elsewhere, then? The main reason is probably that the approach requires huge investments in a situation that there are many important actors sceptical. It is difficult for these cities to get the necessary (political) support. This raises the question whether it is possible to follow a more gradual approach than has been followed in Strasbourg. A strategy with more limited investments that could gradually convince more actors and create a better climate for larger investments is more easy to carry out. We will get back to this issue in chapter 10.

A closer look at the vicissitudes of electric vehicles also reveals that a priori scepticism may not be justified. Indeed, all of the small scale undertakings to produce EVs in Denmark failed. In Norway, Pivco and its Th!nk electric vehicle were saved just in time by the Ford buyout. It seems that it is very difficult if not impossible to sell a small, purpose built rather light weight electric vehicle. Most EVs currently in use are heavy conversions from conventional production line vehicles produced by the major automakers. But ten years after the rapid increase in interest caused by the California ZEV mandate these vehicles are still basically seen as prototypes and demonstration vehicles rather than regular products. Does this mean that there is no future for electric vehicles?

A closer looks reveals that it is too soon for such a conclusion. Let us make a number of other observations on the bases of recent developments and electric vehicle projects:

- Many users of small EVs produced in Denmark were quite satisfied with their vehicles, despite their short ranges.
- The Th!nk predecessor, the City Bee, was highly valued in a project in Oakland were 40 of them were used by employees of several companies as part of their commute journey, the other part of which they made by train. (Elzen et al. 1998, 107-109) At the time of writing, a follow-on to the project ran using the City Bee's successor, the Th!nk, supplied by Ford.[66]
- Near Paris, the Praxitèle project has just been cloncluded in which Electric Vehicles (heavy conversions from conventional vehicles) were used as part of a mobility chain also including a train ride. Users very much valued this combination of services. (Elzen 2000)
- In the centre of Rome, a conventional small city car, the Mercedes Smart, became very popular soon after its market launch.

Over the past decade, the automakers have stressed that EVs can never match conventional vehicles in performance, that they are more heavy, more costly, have a much shorter driving range, and take hours to refill. They have produced quite a number of these vehicles to prove they are right. The observations above, however, suggest that there may be a much more interesting types of applications of a different type of electric vehicle notably a relatively small vehicle that is used for specific applications rather than as an all purpose car. They might either be used as a city car by users that only drive limited daily distances or as part of a mobility chain as in the Oakland or Praxitèle demonstrations.

In such an application, small EVs have considerable advantages over conventional vehicles. Scaling down conventional vehicles in engine size hardly brings emissions further down. Electric drivelines of EVs, however, are much more easy to downsize and emissions go doen in direct proportion to their energy use. Furthermore, such EVs

[66] http://www.stncar.com/

would be used primarily for short trips where conventional vehicles perform bad on emissions because a relatively large part is run with a cold engine when the catalytic converter does not work.

Would this be a step towards a sustainable mobility system? Not in and by itself. But it can be argued that in sustainable mobility system people would less use their private car from door-to-door and, by implication, use a combination of services. In some of these combinations or mobility chains a small self-driven EV could be an important link. The argument that EVs should not be supported because it is more sustainable to use a bicycle bypasses the complexity of people's mobility choices. Whatever the exact vehicles used, a sustainable mobility system should offer people more options to match their travel needs than the current situation does. Bicycles certainly have a place in such a system but so could small EVs. [67]

European traffic and transport policy as well as various national policies stress intermodality as an important objective in tackling traffic and transport problems. Intermodality implies that the supply of travel services and associated vehicles should broaden. By combining findings from different projects it can be concluded that small electric vehicles have an interesting potential as part of such a broadened supply. The issue then becomes to explore the usefulness of such a match in practice.

9.3.2. Refininig Learning

Sustainable mobility implies that the existing mobility regime will have to be transformed substantially. New mobility options will be required that, by definition, do not fit the current regime. The question then becomes how such options can be identified and how their development can be stimulated and supported.

Learning from past projects

Part of the answer is to try and learn more from past attempts to change people's travel behaviour, e.g. to achieve a modal shift. Across the world, people responsible for traffic and transport have tried to create 'missing links' in order to stimulate intermodality. They have tried to implement new solutions or carried out experiments to learn whether new solutions could work in practice. Typically, such attempts were not carried out with the vision of transforming the existing regime but to find out whether new options could be made to fit the regime. The results of such attempts are usually judged in terms of a single dichotomy: success or failure. Success means the new option can be fitted in, failure means a misfit.

Taking a closer look at many of such attempts will result in a more nuanced picture. In virtually all cases we can observe that some aspects worked well while others did not. Let us take a differentiated look at user behaviour, for instance. To take and example, a new P+R option is often evaluated primarily in terms of the number of people that use the facility. As these numbers hardly ever are a significant fraction of the overall number of car users the typical reaction is that these facilities do not really solve any problem. In view of long term sustainability, however, it is more informative to try and understand the reasons why certain people do use the option as well as why certain

[67] It might also be objected that EVs remain costly, whatever their size. Such an assessment, however, is based on the current small volume production of EVs. When mass produced, a small EV with a limited size battery (app. 100-150 kg) would cost only a fraction of what a conventional vehicle costs.

potential users do not. This information may be useful for the design of future facilities to make them attractive to larger groups of users.

This may seem trivial but it is not very common to make a detailed evaluation of such projects. This is despite the people directly responsible who often do have a differentiated view of what happenened which might even be found in the reports they write on the project. This more nuanced learning, however, does not filter through to higher levels. Projects have often originated in a situation of controversy and different actors tend to stress either their good or bad aspects to prove they were right.

To take an example, in the 1990s several large Dutch cities have created so-called transferia at the periphery where people can leave their car and then take a bus or tram to go to the centre. Although the experiences are mixed, the general image has become that transferia hardly affect overall traffic patterns and that they are not a very effective way to fight congestion. Transferia, however, are never *the* answer to tackle congestion and realise a modal shift but they can only be part of an answer. There are several missing links to create an effective mobility chain for many. No wonder that a tranferium only does not make the masses change their travel habits. A closer analysis of what happened, however, might give some valuable information on how transferia might function as part of a more varied set of mobility services. Such type of analysis, however, is hardly ever carried out. To make such an analysis we need to take a more differentiated approach towards learning from attempts to change the mobility regime.

In contrast to the P+R projects discussed above, which are attempts to change travel habits in the short term, some projects are primarily defined as a learning situation to render knowledge on the potential of longer term changes. These are usually called pilot or demonstration projects or practice experiments. This is very common, for instance, for projects with alternative fuel vehicles like natural gas vehicles, electric vehicles, fuel cell buses, etc. In most cases the emphasis in such projects is on technical evaluation and/or user acceptance. Again, evaluation tends to focus on a limited set of issues like judging whether the option is ready for the market. On the basis of such a limited evaluation it is often heard, for instance, that electric vehicles are not very interesting because the heavy battery makes them expensive while their performance is worse than that of conventional vehicles.

In view of the discussion in the introduction to this chapter, such projects can be seen as socio-technical experiments within a range of techological niches. The general objective of such experiments is to learn how new technologies and their societal embedding can be tuned towards each other. This societal embedding is not fixed if we accept that considerable changes are needed to realise sustainable mobility. These experiments should give information on pieces of a puzzle while the overall image of the puzzle is still far from clear. This implies that the necessary learning processes have to be rather open, much more open than is common practice.

In current practice, ‘pilot’ and ‘demonstration’ projects are usually defined more narrowly. In such projects a specific technology is typically taken as a starting point and the objective is to explore its fitting into the existing regime, i.e. the general strategy targets regime optimisation. To stress the need for more open learning processes that are needed when targetting regime renewal, however, we will use the more appropriate phrase of experimentation rather than demonstration or pilot project. Experiments are crucial elements of a niche development strategy with the objective to explore the potential of new pieces of a sustainable mobility puzzle in practice.

Identifying 'promises'

A next question then becomes which options (vehicle technologies, transport concepts) to explore. A more detailed and nuanced evaluation of many past projects can increase knowledge in terms of lessons learned about the potential and feasibility of various technologies, the world in which they have to function and the measures that need to be taken to mutually adjust the technologies and the social environment in which they have to be produced and used.

Targetting long-term regime renewal towards sustainable mobilility requires broad learning, in dedicated experiments as well as from more market oriented projects. Especially the demand side deserves more attention as one of the most 'wasteful' characteristics of the current regime is the habit of the individual use of a single 'oversized' vehicle from door-to-door. Counter examples in specific situations, however, illustrate that this habit is not a law of nature and it would be a challenge for a variety of experiments to explore in detail under what circumstances and to what extent this habit seems changeable.

User behaviour, however, is only one aspect to characterise mobility. The general question on what aspects and in connection with which technologies and arrangements learning needs to take place to obtain useful knowledge en route to a sustainable tranport regime. It cannot be decided upfront what such a regime looks like. The requirements are likely to vary considerably across different locations. Looking at the problems of the current regime, however, it is clear that it will need to fulfill objectives like:

- Mobility supply should be more tuned to mobility demand and be less 'wastefull' (e.g. vehicles being used only 5% of the time; vehicles only being used to 25% of their capacity). This will require more intermodality in which people use a chain of vehicles and services that they share with others. Vehicles and services should be tuned to the requirements of a particular stage of a trip to minimise the negative societal effects. This will require more variation in services as well as vehicles.
- To make chain mobility efficient and attractive there is a wide and varied need of transfer points and a need for quick and reliable information services on the optimal combination of services and vehicles to make a specific trip. This information should be dynamic to account for delays or to suit changing requirements of the user.
- More efficient use of vehicles. On average, cars are now used about 1 hour per day. The rest of the time they just use space, in many cases public space which is scarce in urban areas.
- Fewer emissions of all criteria pollutants, i.e. VOC,[68] CO, NO_x, particulates (also ultrafine particulates the health hazards of which have only been realised recently).
- Fewer emissions of greenhouse gases, principally CO_2 but also methane.

In such a system the car will be much less used as the all-purpose vehicle for any trip from door-to-door. It may still have that role in areas that are not densily populated with dispersed origins and destinations because it is not economical to provide a public service there. In such areas car-use is also less problematic because the lower density of car travel causes less nuisance to society. In densily populated areas, however, the car

[68] Or, to be more precise, non-methane hydrocarbons (NM-HC). The problem of methane is that it is a greenhouse gas rather than a contributor to local pollution.

will become less common because a well tuned combination of services can provide the same mobility efficiency or even better in places where there is now heavy congestion.

In many cases, there now is a negative spiral. For a variety of reason, many travellers do not see public trasport services as a serious alternative to their car use. These reasons include:

- not readily available;
- lack of knowledge on how, where and when the service can be used;
- no easy way to get to and from a stop or station;
- expensive;
- slow; and
- habit and affection to their private vehicle.

Especially in the climate of deregulation that swept Europe in the past decade, there is more strain on public transport operators to balance the budget. Amongst others, this has resulted in a breakdown of peripheral, dispersed services and a concentration on services that are often used. This seems to make sense but many trips stil originate or go to the dispersed locations and for those trips the quality of the overall chain of sevices has gone down. Many travellers leave their home by car and once in it, by far the most of them do not leave it at the nearest P+R facility but continue driving until they have reached their final destination. Thus, although in many cases it can be argued that the quality of public services in the city is of a good quality, many people do not see that as an anwer to their needs.

On average, public transport use has grown in many European cities but car use has grown even faster. Many of the public transport services use the same infrastructure (roads) as cars and suffer from the same congestion. In the public image, this further worsens the quality of the service and the negative spiral continues. This also has a negative effect on emissions as increased congestion means increased stop-and-go or slow moving traffic which increases vehicle emissions and fuel consumption per unit of distance.

We could, however, also imagine a spiral going the other way. In a situation where there is a ‘reasonably’ good service from door-to-door (with good links to dispersed locations as well) it is likely that more people will use the service. Because there is an alternative, public authorities are in a better position to discourage or forbid car-use for specific locations like city centres. This can be strengthened by increasing the variable costs of car use, a trend that is already developing across Europe. This will make the public service attractive to a larger group, thus creating a self-reinforcing dynamic.

Initially, many of these users will still have a private car but some of them may find they hardly ever use it anymore. For many, a car is not only a means of travel but also a status symbol that they will not easily forgo. With a trend as sketched, however, more-and-more people will face the question whether they are willing to pay a lot of money for a status symbol that loses much of its functionality. Increasing numbers are likely to say no. Thus we have a spiral in which cars are used less and car ownership may start to go down as well.

The latter may seem unlikely and many transport planners are probably sceptical about this option. This scepticism, however, is largely based on a vision of the current regime in which cars are both a status symbol and a functional tool while public transport services are not seen as a serious alternative by the large majority. In a different vision,

however, the balance between the efficiency of the services and the efficiency of using the private car will also be different. This could trigger and stimulate new processes that are difficult to imagine in the current situation but more likely in another situation.

Let us carry our speculation on such a new regime a bit further. Intermodility, we argued above, requires the devolpment of a variety of services and a large number of transfer points where people can switch between services. Let us coin a new concept, the 'neighbourhood mobility centre' (NMC). Most residential areas with a high enough population density would have such a centre and, on average, people would live less than a kilometre from the nearest NMC. At the NMC, they can either use a high frequency public transport service (tram, train, subway) or rent a range of vehicles, including cars, vans, lorries, etc. In such a situation, especially when car use is discouraged through the proper financial incentives and various impediments, most people will have relatively little use for a private car. They do have use for a vehicle from their home to the NMC with which they are only alowed to drive 50 km/h or less. In some countries, many people will use a bicycle while in others this may create a market for a new type of vehicle, a relatively small, low power neighborhood vehicle for one or two people. They could be electric since range is no limitation for such an application. Such vehicles, when mass produced, are likely to be considerably cheaper than conventional vehicles. In return, the residents get more flexibility in case they do want to self-drive a vehicle to go out of town. In the current situation, most households still have only one car to choose from. At an NMC, however, they can choose from a range of vehicles at, e.g. a car to make a trip with the family, a van to make a trip with a larger group or a cargo vehicle if they want to transport something big.

The point to be made here is not that NMCs are the solution to mobility problems. We simply don't know. The point is, that new technologies and new arrangements trigger new processes that can take us away from the present dilemma in which massive car-use is the source of various problems but at the same time seems unchangeable.

The issue then becomes whether we can start such new spirals going the other way and whether we can speed them up. How can we stimulate the innovation processes in which the various needed elements are developed and which are the crucial elements we should invest in? There are no straightforward answers to these questions, especially since different actors involved will give different answers.

One of the problems is that many of the expectations of different actors are based on gut feelings and theoritical grounds rather than on experience. This makes it very difficult to get any sort of agreement on which way to go. As has been argued above, however, there is a lot of practice based experience with new mobility options that has not been properly evaluated. That is at least a useful place to start to provide some more empirical ground to expectations and thus raise their quality.

Learning more from past projects raises the question what to look at and which aspects to evaluate. The main general point to be made is that, whereas projects are usually evaluated against the background of the current mobility regime, from the standpoint of sustainable mobility it is more meaningful to evaluate them against the background of a renewed regime. Although we don't know the details of such a regime there is wide consensus that such a regime should emphasise intermodality and chain mobility. This at least points to various mobility characteristics to focus on, such as:

- user (and other stakeholder) behaviour, preferences; different behaviour of large numbers of travellers; leading edge versus average users;

- new types of mobility services; a greater variety of services;
- customised vehicles; this implies a need for a larger variety of vehicles for different applications. The optimal propulsion system for such a variety could also vary and include conventional, electric, natural gas, hybrid, fuel cell propulsion, etc.;
- transfer points; easy combination of different types of services and private vehicles;
- user friendly mobility information services;
- reduction of emission of pollutants; more energy efficient; lower CO_2 emissions; and
- multiple use of vehicles (less emphasis on car ownership);

Various projects in the past have sought to address these characteristics, either market oriented projects seeking direct results or more experimental projects. These characteristics we call *promises* en route to sustainable mobility. An interactive technology policy should then attempt to explore whether these promises can be realised in practice and, when combined appropriately, render a sustainable mobility regime.

A first step would be to look more precisely at past projects as many lessons are hidden in them. One of the important issues is that from the perspective of regime renewal projects dealing with these characteristics should not be judged in terms of whether they are a good or poor alternative in the current situation. They should be evaluated on a range of dimensions against the background of chain mobility and intermodality. Thus, many projects are likely to render promising lessons as well as point to barriers. These promises and barriers should be related to the findings from other projects.

In the current situation, the local people responsible for a project often do have a nuanced view towards its findings. At more aggregate levels, however, typically only a simple message filters through: an option either works or it doesn't. To explore more radical changes, however, it is important to relate the more detailed findings of various projects to each other. For instance, can we trace general patterns in the type of people who use P+R (i.e. intermodal) options in different European cities; can we trace general patterns in the type of users using small vehicles (conventional as well as electric), etc. There are hundreds or even thousands of projects across Europe that could serve as the empirical basis that could render valuable practice based findings on pieces of a sustainable mobility puzzle.

Evaluating projects against a regime renewal background renders different conclusions than in current practice. For instance, in 1998 a finding in connection with the Ellert EV in Denmark was that most users also had a car. The Ellerts were substituting car-trips as well as other transports modes: 45% car-trips, 25% bicycling, 5% moped, and public transport 25%. The avarage trip was 20 km, and an avarage Ellert drove 3.700 km/year. The overall evaluation was that Ellerts were obviously used as a second car and that 50% of their trips were substitutes for bicycling and public transport. Therefore, they were no sustainable alternatives. (Munch 2001)

Looking at the potential for regime renewal, however, it can be concluded that the Ellert, for some users at least, fills a space between car-use and bicycling. Results, also from a variety of European research projects, show users are happier with their EVs than they expected themselves. They feel the electric vehicle is secure and that they have become more careful and attentive drivers. In fact, even the problems attached to recharging batteries are balanced by a "positive feeling of belonging to a pioneering group of urban innovators". (Gjøen and Hård 1998, 4)

It could then be well-imaginable that in a situation where there would be a very functional public transport system some users would not need a car anymore. The interesting follow-on question then becomes to explore under what circumstances Ellert users (and others in comparable projects across Europe) would sell their car (e.g. by surveys among Ellert users) and subsequently to try and realise such a situation in a project in Denmark or elsewhere. The lessons from a concrete project are thus used to define follow-on steps. Thus, practice based information on a somwhat larger piece of a sustainable mobility puzzle could be gathered.

Carsharing projects can also be evaluated in the same vein. There are many carsharing projects across Europe that attract growing numbers of users. (Harms and Truffer 1998) The general image, though, is that carsharing is hardly relevant from the sustainability perspective because it doesn't curb the overall trend of increasing car-ownership and car use. However, the relative success of carsharing illustrates that a specific category of users sees advantages in using this service. And carsharing does have the promise of decoupling car-use from car-ownership. This, firstly, has the advantage that less space is needed to park cars. Secondly, and potentially more importantly, the users take a more functional view towards these vehicles thus opening up the space for also using and combining other mobility services. *En route* to sustainability it would then be necessary to try and understand what differentiates the 'car-sharers' from others that do not make the transition and, subsequently, whether there are any follow-on steps possible that could influence the situation.

These examples illustrates that learning and evaluation need to get a broader meaning than in current practice. On the one hand, learning should be more precise and be described as specifically as possible. A general conclusion like "Electric vans cannot replace diesel vans" (which is a conclusion from various EV projects) does not mean a lot because it will be based on a variety of assumptions concerning present habits and preferences. The whole idea behind an interactive technology policy is to seek new ways to 'question' these habits and preferences and 'open them up'. The small nitty-gritty lessons from various projects in themselves may not seem to lead to straight-forward conclusions but combining lessons across projects may reveal the 'contours of a promising new direction'.

Learning needs to be specific but it also needs to be 'open'. This type of learning is qualitatively different from learning in the situation where objectives are rather specific and fixed. This, we call *first order learning* which can be part of a regime optimisation strategy. If the learning also takes place in relation to the definition of the objectives themselves, implying that various actors become reflexive in relation to their own starting points and assumptions, we call this *second order learning*. This second order learning seems essential if the overall target is to renew (parts of) the traffic and transport regime. So many things will have to change that it is not possible to assess upfront which directions seem most promising. To be critical of one's own assumptions and preferences is essential to find out what may have practical value, especially since it is required to create a minimal degree of consensus between actors in a situation that a large degree of dissensus is the starting point.

Building further on the portfolio

The portfolio of promises can function as an instrument to co-ordinate and further these learning efforts. Learning from past projects and the promises thus identified can be

used to define new projects. At the local level, actors can consult the portfolio to try and learn from experiences elsewhere in situations comparable to their own. On the basis of this they can either attempt to implement a specific solution in case there are good reasons to assume this will solve their problem. In case that there are too many uncertainties they can design a project of their own to explore certain issues further.

At the national and EU level, the portfolio can be used to judge projects that ask for support by prioritising projects that are likely to render knowledge on weak parts of the portfolio. The portfolio can also be used in a pro-active manner by inviting projects to explore the 'options for change' further, e.g. by combining lessons from several smaller projects into a larger one.

9.4. Conclusion

The problems of traffic and transport are large and multivaried. Usually, two groups of problems are distinguished, one relating to tailpipe emissions (contributing to air pollution and global warming) and one related to the massive use of vehicles (leading to congestion, poor accessibility and poor city and neigbourhood quality).

Concerning emissions, new technologies should help remedy the situation and there is widespread optimism they will. Indeed, despite a growing number of vehicles, the overall emissions from traffic have gone steadily down over the past decades and can be expected to go further down in the decades to come. This process, however, is far from efficient with the result that emissions are far higher and for a much longer time than would be possible with the best available technology, not to mention with innovations proven in demonstration projects.

The motor vehicle industry has a long history of opposing tighter emissions as this makes vehicles more expensive which may make sales numbers go down. Governments have been extremely sensitive to this opposition with the effect that the tightening of emission standards has been a very slow process. Especially in the EU, industry has been very successful in playing out national differences to slow down the process although it seems that the EU authorities have started to stand firmer in the late 1990s with the definition of the Euro 3, 4 and 5 standards.

Emission standards have been the strongest and most effective instrument to bring vehicle emissions down. The way they are defined, however, does not necessarily favour the cleanest vehicles. The vehicle industry has the bulk of its expertise in diesel and gasoline engine technology and the standards in effect protect these fuels. Diesel vehicles, for instance, are allowed to emit more NO_x and particulates making it difficult for cleaner alternatives (e.g. gaseous fuels) to compete. If the standards should stimulate the development and use of the cleanest technolgies this protection should disappear. Standards should be based on the cleanest possible technology for a given type of vehicle and then leave it up to industry to pick the technology to satisfy the standard, taking into account necessary requirements for a transition of fuels, if necessary.

For CO_2 emissions the situation is not very encouraging. Although engines have become considerably more efficient over the past decades, fuel consumption by vehicles has hardly changed or sometimes even increased due to new features like power steering, ABS, air conditioning. The overall CO_2 emissions from traffic have grown continuously which constitutes a real challenge in view of the Kyoto agreements. There is now a voluntary agreement with the European car industry to limit emissions per

vehicle for passenger cars this decade but it is doubtful whether this will lead to a lowering of overall CO_2 emissions from transport as there is no such commitment for other vehicles and numbers of cars are continuously increasing.

The drawback of standards is that they legitimise a certain level of emissions and they provide no incentive to the customer to buy cleaner vehicles which are more expensive than the ones that just adhere to the standards. Financial incentives, e.g. in the form of differential taxes, could provide such incentives. For a variety of reasons, (e.g. because it would create unfair competition) such measures have met with strong opposition in the EU although the attitude seems to become more favourable. Indeed, there are considerable practical and legal problems but these options could be much more exploited.

Interestingly, although it seems that reducing emissions is primarily a technical issue, the discussion above illustrates that the main challenges are not technological. Very clean vehicles and very energy-efficient vehicles have been demonstrated and one important issue is to stimulate the wider use of such technologies. Industry is likely to argue that the main barriers are primarily economical but this is also a very limited view. The use of clean technologies is an economical issue only within limits set by government regulation. The main barrier thus is that governments are not able or not prepared to tighten the standards even to the best available technology. Reducing emissions further is first of all a political issue.

A technology policy seeking to reduce emissions should not bypass economic issues but they should not be exaggerated either. Industry's expressed fear that tighter standards will increase cost and thus decrease sales is hardly supported by past experience. The mandatory use of the three-way catalyst did not lead to a noticeable drop in sales.

The tightest possible emission standards (taking into account lead time to adjust production) do have a strong innovative effect, especially when combined with differentiated price incentives for consumers to buy the cleanest vehicle. Especially the latter would turn 'cleanliness' into an element of competition between industries that is likely to bring overall emissions down quicker than in the current situation where reducing emissions is principally seen as a cost item. That could also lower the barriers for 'alternative' vehicle technologies which, subsequently, would increase the pressure on diesel and gasoline technologies to be cleaned up further.

Creating the right incentives through standards and differentiated taxation may be effective to tackle emissions, it will not solve congestion and related problems. Here the problem is more complex because sustainable solutions would imply a more drastic change of behaviour of travellers and many others. The general attitude is that 'experience has shown' that this is unrealistic and that the answer has to be to increase the capacity of the infrastructure for road vehicles by removing bottlenecks and by increasing capacity.

There are also other experiences, though, where considerable changes took place on the scale of limited size projects. The main challenge is to try and learn more from these projects and not directly judge them in quantitative terms but in qualitative terms. The challenge is to try and understand what made some participants change their behaviour and some potential or targetted others not. By combining that sort of knowledge from projects across Europe a much more differentiated and experienced based view can emerge on possibilities and barriers for more radical changes. These can either be used

as a starting point for projects to learn on further issues or to start larger-scale implementation in cases where the necessary preconditions seem to be fulfilled.

The number of past projects that can provide useful information is enormous which calls for some focusing mechanisms. From the standpoint of sutainability an important guiding heuristic could be to focus on 'chain mobility' and, by implication, on intermodality. This can then be translated into several more concrete areas of exploration, notably:

- facilitate better tuning of supply and demand ('customised mobility') by stimulating variation of vehicles and services;
- transfer points and mobility information services;
- efficient use of vehicles;
- low emission of pollutants; and
- low greenhouse gas emissions.

In such an approach, technology policy initially becomes a matter of 'interactive learning' on parts of new mobility chains that not necessarily directly have to fit into the current regime. They are evaluated on their 'long-term promise' to become a clean, energy efficient and functional element of a modal chain. Thus, detailed knowledge would be developed on a 'portfolio of promises' that can be combined as elements in larger projects to explore systemic relations at a higher level. Care should be taken that a sufficient variety of actors (travellers, producers, service providers, industry, public authorities) is involved in such processes to get the best possible information on the practical value of the various options.

Currently, there are a limited number of successful attempts to tackle congestion problems, at the same time increasing the quality of urban life and maintaining (or even improving) accessibility. However, because of a variety of local factors, such solutions cannot be easily transferred to other locations. To stimulate this, we need a more detailed understanding and identification of the potential of various combinations of solutions in circumstances still to be identified. An interactive technology policy should help to guide such an exploration process.

In view of the above, an interactive technology policy for the traffic and transport domain needs to include the following elements:

- An exploratory part: try to learn in detail on the basis of concrete experience how promising new elements of a new mobility regime can work in practice. This exploration can be carried out retrospectively (on the basis of past projects) or as a pro-active strategy by setting up projects designed to explore specific issues.
- A part to stimulate the development and market uptake of clean and energy-efficient vehicles through a combination of standards and financial incentives.

This will be further elaborated in the next chapter.

Chapter 10

TOWARDS AN INTERACTIVE TECHNOLOGY POLICY IN TRANSPORT

10.1. Technology for a sustainable mobility

The INTEPOL project started out from the assumption that there are socio-technical options to provide the basis of a reform of modern mobility, for example to achieve a greater sustainability. However, the nature of these options is by no means clear, nor is the possibility to exploit them. The idea behind the INTEPOL project was to study this situation by looking into a set of concrete instances where efforts were made to find new ways of coping with the challenges of modern mobility. We thought that this would help us identify strategies and tools that could serve as guideposts to improve the knowledge base of sustainable mobility.

Thus, we started out from the following initial premises and goals for INTEPOL:

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

We came also to emphasise 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.

In chapter 2, we identified three main challenges that were put forward in the existing research literature on transport and mobility. The first we 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.

In chapter 3, we outlined a framework for analysing technology policy that was based on four concepts or dimensions: providing infrastructure, policing or regulating transport, pushing new technology by supporting transport-relevant innovations, and public participation in the transport discourse or in decision-making. We know that these dimensions are important, but we do not know how nor how they interplay. This is an important challenge.

In our analysis, we are interested in alternative ways of performing technology policy that transcends traditional approaches. Our analysis starts from the critique of the common tendency to assume that it is easy to distinguish between technological concerns and social concerns about the way that the technology will (or will not) developed. More concretely, the analysis will be pursued by looking for the way that the challenges related to the performance of providing, pushing, policing and public participation are catered for in concrete projects.

However, as is evident from the previous chapters 6, 7, 8 and 9, 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 only one or two of the four dimensions.

Thus, our analysis in this chapter will in particular be concerned with the challenge of characterising concrete efforts of implementing or reshaping technology policy, with an emphasis on transport. This means that we should study the performance of technology policy emerging from efforts to think about technology in relation to transport: the transport problem, the land use problem and the car problem. Thus, our most important task is to analyse 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 chapter 3.

Our ability to fulfil our aims of developing a different approach to technology policy through the analysis of the case material provided by the INTEPOL cases, is of course restricted by the above-mentioned limitations. However, the analysis will pursue as far as possible the potential of thinking in terms of interaction between supply and demand side policy measures. This means an effort to conceptualise the challenges as either problems of delegation (technical fixes) or problems of (re)distribution (social fixes related to advantages and disadvantages, or to the distribution of action). In this respect, our approach supposedly will be a kind of synthesis of delegation and distribution concepts. Moreover, there is a need to be concerned about the possibility of development of new centres of performing policy, e.g. local, regional or supra-national centres as alternatives or supplements to national centres. Thus, the analysis should also be sensitive to the possibility of emergence of new actors or new ways of structuring actors.

The emphasis put on the four dimensions of technology policy, providing, policing, pushing and participation, implies that the dominant innovation policy model is transcended and extended. While of course new technology is still very important, we will expect that shaping processes related to technology policy in transport will be concerned with infrastructure, regulation and democracy as much as with innovation. An important example is the learning processes taking place in transport planning. In principle, the transport sector should contain a kind of a learning economy, the efficiency of which depends on the ability to communicate experience across different

groups of actors and thus facilitate social learning between actors, rather than just individual learning.

Social learning related to technology policy in the transport sector could be expected to imply the concerns of infrastructure, regulation, innovation and democracy. Moreover, presumably, it is a kind of window to the architecture of technology policy itself. Observing different processes of social learning may also allow analysis of the extent to which technology policy has interactive features. Efficient procedures of social learning should be interpreted as indications of interactivity, because social learning is by definition an interactive process. Similarly, lack of social learning will indicate lack of interactivity.

In a somewhat different mode of thought, the analysis will be concerned with the socio-spatial aspects of the performance of technology policy. That means that it will focus on the characteristics of the locality in which technology policy is performed and in particular the construction of the boundaries of the activity. To us, there are in particular two different strategies that may be made use of. The first is a localisation strategy where one tries to link plans and projects to local authorities, rather than regional, national or supra-national. This means that plans and projects becomes a municipal affair, with well-defined political and administrative relations, but without any clearly defined idea about diffusion of results outside the locality. The second is a niche strategy where the main consideration is to provide a protected space where new technologies may develop. Plans and projects may be embedded in a particular locality, but above all, they will be related to national or supra-national aims of transforming inventions into profitable business products. Thus, localisation strategies and niche strategies are two different ways of doing interactive technology policy.

10.2. The traditional model

The INTEPOL cases were generally selected to provide information about non-traditional efforts of utilising technology in transport. The “Highway 1”-case (Thomassen 2001a) is to some extent an exception that invites a few remarks about the architecture of traditional technology policy in transport. Many of the other cases also provide similar insights, supporting the conclusions from the Highway 1 case.

As noted in chapter 6, the traditional approach to transport planning has substantially been shaped by the way of thinking that have been labelled master plans. Master plans express a way of thinking where transport would be analysed from an overarching national perspective and highway projects would be proposed and evaluated on the basis of the belief that a national system of transport could be optimised “from above” and through government management. Chapter 6 shows that this way of thinking has gradually lost terrain, to be replaced by an ideology of deregulation and decentralisation. However, there are still strong national institutions of highway planning in most countries.

An interesting paradox of the master plan approach is evident from the fact that highway projects throughout the whole period has been related to local initiatives and shaped by a particular political logic. This logic has made highway projects a very potent form of political currency. The standing of members of Parliament has been substantially shaped by their ability to get support for highway projects relevant to their political constituency. The masterplan ideology could never circumvent this currency

character of highway projects, making the resulting master plans into negotiated results of national and local concerns. Even when the master plan ideology has been officially dismissed, the same peculiar interaction of the local and national remain a strong influence.

This is very clearly exemplified by the Highway 1-case, in particular in the account that Thomassen (2001a) provides of the long history of the establishment of the so-called Krifast connection. This was supposed to provide the island city of Kristiansund in Norway with a mainland road connection. Throughout the whole period, which lasts from mid-fifties to the 1990s, the Krifast project has been a political commodity that local entrepreneurs have tried to sell to national actors. Only when they succeeded in getting sufficient support to make Krifast a part of the national highway plans, there would be some hope that the connection would be built.

This relationship between local and national actors should of course be understood on the basis of the economy of highway construction. The construction of highways is too expensive to be paid by local authorities or communities, which makes them dependent on national funding. One might say that local and national transport interests are negotiated in a context where local political support is offered in return for national funding. This is a very important feature of the architecture of traditional technology policy in transport.

There are more lessons to be learned from the Highway 1-case. To begin with, we should note that the case basically describes efforts to extend and improve infrastructure. Many people in Kristiansund wanted a road connection to become independent of ferries as a way of transporting the cars to the mainland. In the early stages of the project, the building of such a mainland connection is perceived as a challenging task, technologically, although no real efforts are made to prepare for the solution of the technological problems. However, as time goes by, the technological challenges become more trivial. The demanding part of the project is, as noted above, to get it funded, which means talking national authorities into funding the connection.

The assertion of technological triviality should be interpreted with considerable care because large-scale projects like Krifast always involve technological challenges. The important aspect is really in the perception of the challenges and the way technological problems are managed. Basically, the Highway 1 case finds that the construction of highways is perceived in terms of infrastructure and planning of infrastructure. There is no particular identification of technological challenges that demand innovation or R&D. In the political process of highway planning, R&D and innovation become backstage phenomena. As a consequence, the technological component is subdued and there appears to be no need to look at transport policy as technology policy. Thus, technology policy aspects of transport planning tend to be rendered invisible.

Arguably, this is also related to the way the construction industry operates, with small emphasis on R&D and innovation. In fact, this industry to a considerable extent seems to work from a kind of craft model where technological problems are solved so-to-speak on site. This would also explain the particular epic interpretation of the success of highway projects, which tend to romanticise risk, skill and effort rather than knowledge and new technology.

The above observations about highway projects as political currency may invite cynical remarks. However, in a fundamental sense, this points to a strong democratic aspect of highway construction. Highways are a real popular concern. They are thus frequently

also objects of considerable political interest and even controversy. The Highway 1 case, however, reminds us that this democratic aspect is also – and above all - present in the construction of mobility as a publicly accepted «human right» and thus an opaque aspect of the present transport paradigm - the taken-for-grantedness, untouchable and invisible property of mobility. The Highway 1 case illustrates clearly the importance of this understanding of mobility as a human right because it indicates that it is this perception of mobility that guides the kind of demands put forward. This means, for example, that environmental concerns are set aside to provide an argumentative space for the mainland connection.

This should of course not make us overlook the fact that the transport sector has been thoroughly regulated, and that regulations have a long history. One need only to think about traffic rules. Highway engineering authorities have spent much time and resources in the development of standards for highway construction and various technologies for directing traffic, including accident prevention. In the INTEPOL project, we have focussed most explicitly on the issue of emissions, which has emerged from the late 1960s as a central topic for technology policy in transport.

Chapter 8 provides an extensive discussion about various regulatory actions related to emissions, with a particular focus on the history of the mandating of the three-way catalyst. Surprisingly, it turns out that such regulatory actions are highly embedded in a cultural interpretation of existing mobility practises, which in turns shape the emission standards and the testing procedures for emissions. Of course, this confirms our point about the taken-for-grantedness of mobility. It also indicates that regulations as a concern for technology policy commands less interest than infrastructure, even if emissions become an important issue in much local discussion about transport.

The last point also suggests that concerns about emission levels play a more critical role in the transport discourse. Thus, it may provide an important impetus to think differently about the practise of transport. This is evident from a great number of our cases, not just the ones concerned with electrical vehicles or the three-way catalyst (Undheim 2001b, Munch 2001, Munch & Thomassen 2001).

Nevertheless, the taken-for-grantedness of mobility seems to be the most important issue also with respect to regulation. A striking example is found in the case about the use of environmental impact assessment (EIA) transport-related projects in Norway (Grande 2001). In principle, EIA invites a critical assessment of infrastructural projects as well as potential regulatory activities. However, the way EIA seems to be practised, mobility needs or the factors that shape mobility needs are not critically assessed. In fact, mobility needs are taken as the point of departure. Regulatory action is at best limited to reducing the impact of increased levels of mobility.

Our observations about of the architecture of traditional technology policy in transport may be summarised in the following points:

- 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. The observation of technological challenges seems only in a limited way to lead to an interest in R&D and innovation. In fact,

we are tempted to make the more general argument that explicit technology policy is difficult to find in relation to transport. This may also be due to a singular focus on innovation in the common perception of technology policy, but we believe that this is also an expression of the knowledge culture of the transport sector. One could also noted that innovation efforts support by the EU as well as individual nations tend to be focussed on development of marketable products, rather than construction work or reforms of the transport sector.

- 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 INTEPOL point of departure was the assumption that the main weakness of the traditional model of technology policy in transport was the tendency to make a clear-cut distinction between technological and social aspects and to pursue either the one or the other. So far, we can observe a more complicated picture where the subdued role of technology policy raises new questions about the relevance of a technology policy perspective to the analysis of transport. These questions are related to the paradox of, on the one hand, the obvious importance of technology as a tool to facilitate transport, and on the other hand, the lack of reflection of the meaning of technology in transport.

However, this paradox may be related to some peculiarities of the Highway 1 case. Thus, we will proceed by investigating if other INTEPOL case material opens different analytical options.

10.3. Challenges to the traditional model

In chapter 9, we analysed cases where non-traditional strategies for change were pursued. These strategies included new technologies but also different modes of exploiting available technological options. Clearly, there are indications that under certain circumstances, socio-technical strategies emerge to transcend the traditional approaches to the problems of organising transport. To understand such efforts of transformation, it is important to analyse they manner in which they challenge the traditional model. As indicated above, concerns about too high levels of toxic emissions from cars and other vehicles have played a very important role in motivating such challenges.

However, it is important not to overestimate the force of these efforts of transformation. Thus, it is tempting to begin by noting the stability of problem definitions in the transport area. In particular, the perception of the transport problem as being characterised by inefficiency and inability to provide sufficient transport capacity is striking across all INTEPOL cases. Just as striking is the lack of critical engagement with mobility as a basic modern value and with the car as the dominant mode of transport. Thus, we have not observed any clear effort to reduce mobility. Instead, what we find are efforts to perform mobility with reduced environmental costs. Generally, problems tend to be defined in terms of lack of flow (or congestion), emissions and land use, including the protection of city centres.

This should be understood on the basis of the findings of chapter 7, namely the way that mobility has become an integrated part of the modern projects. The idea of a

continuously increasing mobility has become so-to-speak naturalised, an entrenched mode of thought that is never really questioned.

It would be naive to discuss technology policy in transport without any reference to the economic and political strength of the car manufacturing industry and the car constituencies in general, a strength that is without parallel in modern society. The INTEPOL project has not particularly focussed on this aspect and none of our cases explore directly the role of the car industry. However, we observe the importance of the industry in some of the cases. In the Th!nk case we learn that Ford acquired the small innovative company Pivco that produced this electrical vehicle Th!nk (Undheim 2001b). This was no accident, but a result of careful planning. Ford has the resources to acquire a lot of small companies, and they have a potential need to get such innovations under control. We have also seen how the interests of the car industry have an important impact on the development of transport telematics. For example, they have yet succeded in making road pricing into a, politically speaking, problematic options in most European countries (Bye & Næss 2001).

In chapter 8 and 9, we see the importance of the car industry in two different ways. The history of the regulatory efforts to support the three-way catalyst, detailed in chapter 8, shows how the car industry and its allies for a long time were able to stall the mandating of the use of catalysts on cars. In the end, the industry also played a decisive role in the shaping of the regulations that were introduced across the EU.

Chapter 9 gives a slightly different impression. While there is no doubt that the car industry dominates the efforts to innovate in the transport sector, there are serious limitations in their ability to provide new options. The innovations of the car industry are mostly related to vehicles, and even so, their innovations tend to be related to the dominant design of cars, with traditional diesel or gas fuelled engines. The car industry seems not very capable of developing radically different vehicles, like EVs. This is probably also one of the reasons why Ford acquired Pivco.

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

- 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 and the majority of resources available for innovation is focused on the traditional car and its needs, rather than at developing new forms of transport.

On the basis of the above observations, it is quite understandable that there is considerable and widespread pessimism with regard to being able to solve the problems created by modern mobility. For example, this is evident from the demise of master plans (see chapter 6). Deregulation and decentralisation, to facilitate local initiatives, are ambiguous features of the alternatives to master plans. They signal a willingness to let go of the overly technocratic belief in the possibility of expert-based optimisation of a total national system in order to produce links between the local nature of problems and the local conditions of solutions and to provide greater freedom for a larger number of actors. At the same time, they indicate less willingness on the side of central authorities to take the responsibility for finding solution to the transport problems.

However, the increasing emphasis on local action should not be interpreted as an expression that the role of central authorities has been completely eroded. Rather, as noted in chapter 6 and in the previous section, local and central actions and initiatives co-exist and co-develop. Still, there seems to be an important division of labour between the levels. At least, judging from our case studies, development of new practices in the transport sector is mainly taking place as local experiments or projects. We will now turn to a closer look at some of these to see how they may be seen to challenge the traditional model.

As a point of departure, we should note that the mainly local efforts to perform experiments to provide new socio-technical solutions to the transport problem, analysed in the majority of the INTEPOL cases, has substantial autonomy from the car industry. 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.

It has been a tenet of the INTEPOL project that it is mainly local experiments or project that provide alternatives or challenges to the traditional model. In many ways, this is supported by the case studies. 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. As we have previously noted, 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 (see Rotterdam case) 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, like “urban sustainable transport” – the Th!nk case – or “the businessmen’s metro” – the Copenhagen metro case
- use of heterodox planning procedures that tries to tackle transport problems more broadly, rather than to try to fix problems gradually and individually (Strasbourg case).

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 bricoulage, 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 some 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? Our 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. This points to challenges like niche management and social learning.

10.4. Niches and learning in mobility experiments and projects

Chapter 3.4 introduced the concept of socio-technological regimes (Kemp et al. 1998) in order to characterise the potential stability of relationships between technologies and the way they are appropriated. The present transport system is clearly characterised by a regime of private cars, a regime that is deeply entrenched and difficult to change.

On a general level, change may be seen as facilitated by the emergence of new technologies that, potentially, may function as catalysts to help weaken or even transform a given socio-technical regime. Thus, to achieve change one needs to support the development of new socio-technical arrangements that may supplement or even

replace the dominant one. A major challenge to technology policy is to stimulate and cater for such new developments.

In chapter 3.4 we mentioned one basic strategy of such stimulation as technology inducement. Technology inducement implies that expectations of a certain class of technologies, for example cars, are changed through political measures. A prime example is the so-called ZEV decision by the state of California, (Jørgensen 2001) the demand that car companies at a given date should sell a certain amount of zero emission vehicles to be allowed to market their cars in the state.

Arguably, most European countries are engaged in some forms of technology inducement, but in a rather careful manner. The main form of technology inducement is suggestions to introduce so-called green taxes, which means that some aspects of or practices related to mobility are taxed more heavily than others. Road pricing (Thomassen 2001b, Bye & Næss 2001, Hoogma 2001) is an example, which also highlights some weaknesses. This form of tax is meant to induce less use of private cars or at least to change the temporal distribution of driving patterns to reduce traffic peaks during rush hours. In order to achieve the aims, a modal shift in the choice of transport has to occur. That means above all a strengthening of public transport in order to make this into a viable alternative.

However, there is no direct link between road pricing and public transport to provide a technology inducement to the actors that could be developing new solutions or even improving the existing ones. Green taxes are mainly directed towards consumers, which means that they are supposed to be the ones providing technology inducement. We cannot yet claim to be able to observe that this mechanism works, but to be fair, the instrument of green taxes has been employed quite mildly – if at all.

Chapter 3.4 also introduced the idea of niches as a kind of protected spaces of development of new (socio-)technologies. Three major processes are taking place in the development of niches and their relations with existing regimes; 1. coupling and changing of expectations, 2. articulation (or learning) processes, and 3. network formation. Some of our case studies describe situations that could have been made into strategic niches, for example Th!nk (Undheim 2001b) or road telematics (Thomassen 2001b, Bye & Næss 2001). However, strategic niche management does not appear to have been on the agenda of the related policy-makers.

Still, it is possible to look for the kind of processes that are supposed to take place in the formation of niches. We have already made some remarks about the issue of expectations, linking this to green taxes. However, our cases include several efforts to change expectations through cultural redefinitions, above all Th!nk and the Copenhagen metro. This also implies a kind of coupling of expectations. Changed expectations about the practice of mobility (urban driving, businessmen's metro) are coupled to changed expectations about the mode of mobility (EVs, metro).

Learning processes is a more complicated issue. First, our case study based approach limits our information about the transport system as such. Second, learning processes tend to be tacit, which means that they are difficult to observe. Still, the predominantly local nature of experiments and projects that challenge the traditional model makes it very important to provide for learning across localities. How is this achieved?

The most explicit strategy that addresses issues of learning is found in the transport telematics case (Bye & Næss 2001). The experiment in Hanover was a part of a

European research project, involving a number of European cities. This means that experiences are accounted and made available through research reports and similar dissemination mechanisms.

However, by far the most common situation seems to be that dissemination and learning is given little or no explicit attention. Plans are made and put in action, and that is it. This does not mean that dissemination and learning does not occur. For example, in the case of Strasbourg where the city has achieved a successful modal shift from private cars to the use of tramcars, the success has been quite widely accounted, even in newspapers and magazines.

Given the fact that learning and dissemination is given little attention, the critical issue is whether the transport sector already has established a kind of learning economy where learning and dissemination of experience are institutionalised and thus flow without particular attention. Our case material indicates that some aspects of such a learning economy is in place, but it does not seem to be well developed. Arguably, the transport sector is ambivalent towards the strong role of local actors in the development of new practices related to transport. Thus, there is a lack of acknowledgement of the importance of the local. Or, rather, that local actors are fairly well linked to central actors, but not to other local actors. Our case material is limited with respect to information about this, but we suspect that the learning economy of the transport sector basically is oriented in a vertical/hierarchical fashion with links between the local and the central. This means that it is lacking in horizontal links that would facilitate local actors learning more from each other.

In this section, we have tried to assess practices in the transport sector from the perspective of two potentially important instruments of technology policy, niche management and learning economy. We have seen that niche management seems absent, even if some aspects of it are found. Also with respect to a learning economy, we find considerable room for improvement. Thus, both in terms of thinking and practising technology policy, the transport sector has some way to go. The question then is how to get further?

One type of argument would be to emphasise a need for a change of perspectives or mindshifts. By mindshift we mean a change of perception of the transport problem as well as a different technology policy practice. The discussion in this chapter so far suggests that we need at least two such mindshifts. First, as argued in section 10.3, it is necessary to start to question mobility in order to counter the strong tendency that mobility and mobility growth is just taken for granted. Second, as we have seen in section 10.3 as well as 10.4, there is a need for the development of combined socio-technical strategies that covers broader aspects of transport reform as well as extend beyond local circumstances.

In the following, we will discuss content of these two mindshifts in greater, in order to assess their potential and implications in the light of our case studies.

10.5. Mindshift I: Questioning mobility

A main conclusion that we could draw from the INTEPOL work is that when mobility needs are taken for granted and as the basis for planning, this reduces the space for action. In particular, we have seen how this leads to:

- A strong tendency to think about mobility in terms of access, flow and optimation

- A sectorial focus on transport, which means that mobility tends to be understood as a autonomous factor without critical reflection about how it is produced by other sectors and activities in society. Moreover, other sectors do not become partners in efforts to cope with the transport problem
- When mobility needs are taken as granted, this limits the development of radical solutions basically to be about the facilitation of modal shifts, above all to public transport.

This suggests that we in a sense need to reinvent mobility in order to perceive mobility not as a goal in itself, but rather as means to other ends. In institutional terms, the radical solution would of course be to abolish the transport sector as a sector as a sector in itself. However, that might be to attach greater importance to formal institutions than is merited.

In chapter 7, the embeddedness of mobility in modern society has been analysed in great detail. We will not repeat that exercise, but rather look at some of the cases where dominant understanding of mobility becomes challenged. This allows an identification of some strategies to challenge mobility as well as an assessment of their impact.

However, as a point of departure, it should be noted that none of our cases describes an effort to curb mobility. To the extent that there is critical engagement with mobility, this is primarily focussed at shifting the mode of mobility or to reduce the social and environmental impact of mobility.

The classical strategy of changing the mode of mobility is to try to persuade people to use public transport instead of their private cars. The main successful example of this among our cases is the Strasbourg case (Popkema & Elzen 2001b). However, we do have other instances, like the Rome case (Undheim 2001a), the Go Boulder case (Popkema & Elzen 2001c), the bicycle-on-train case (Pedersen & Jørgensen 2001) and the Copenhagen metro case (Jørgensen & Munch 2001).

The common feature of these cases is that the strategy to achieve a modal shift in favour of public transport is heterogeneous and combines several technological and social elements. On the one hand, the supply of accessible, reasonably comfortable, frequent and affordable public transport. On the other, the use of social measures like access restrictions to city areas, rebranding of public transport (the businessmen's metro (Copenhagen), a new social space (Rome)) or the facilitation of combined solutions, like park-and-ride or bicycles-on-trains.

It is important to emphasise that these measures are much less efficient when applied singularly. Access restrictions without improved public transport invites rule bending or breaking. Improved public transport without supporting measures, positive or negative, seems to have difficulties in attracting the number of customers needed.

Modal change is not just about public transport. It may also concern a shift from one type of vehicle to another. Currently, the most important example here is electrical vehicles. It is debatable whether EVs are sustainable in a strict sense, and their environmental impact depends on the source of electrical power. Still, the use of EVs reduces local emissions, including noise, and they may also demand less energy due to the smallness and lightness of most EVs. Thus, most actors perceive a shift from traditional diesel or gas fuelled cars to EVs as a positive one.

The two INTEPOL case studies of EVs provide some interesting observations about the problems encountered in making such a shift and some of the strategies that have been applied to achieve it. Clearly, the shift has been difficult to get. EVs have been available for a long time, and they have been marketed as a sustainable alternative since the 1970s. Still, the number of EVs on the streets is very low. EVs are definitely a marginal phenomenon.

The renewed efforts to market EVs in the late 1990s provides important clues to why the shift has been difficult to achieve. For example, Munch (2001) shows how it has become necessary to redefine the EV from being an alternative technology to become advanced technology. EVs as an alternative technology connotates to a critique of modern mobility that is accepted only by a small number of people. Moreover, many features of the EV are unattractive to the majority of people buying cars because they think of the car as an instrument that should cover all their mobility needs, including the need for long-distance travel. A high-tech image could be helpful to counter this negative perception.

This sort of strategy has been taken further in the case of the Norwegian EV Th!nk (Undheim 2001b). The marketing of Th!nk has been linked explicitly to an effort to redefine mobility in late modern urban terms, to be about short distances, easy parking with a small vehicle, trendy and sustainable. If such a redefintion of mobility could not be achieved, Th!nk would not stand a chance in the competition with ordinary cars.

The shift towards branding EVs as advanced, trendy and urban has not been very successful yet. Mobility does not lend itself to redefinition that easily, it seems. In fact, the entrenchment of the dominant definition of mobility as an unquestionable human right, with a very strong element of individual freedom, appears to be very hard to change indeed. A clear proof of this is the great resistance towards road pricing, which would be an acknowledgement of the environmental costs of unfettered mobility. Even if road pricing is suggested from many quarters as a viable instrument to reduce the environmental impact of transport (Thomassen 2001b, Melby 2001, Bye & Næss 2001), implementation is very slow indeed. You do not tax a human right.

Thus, the pessimistic conclusion is that modern mobility bas become too strongly entrenched to allow for easy changes. Basically, the dominant perception of mobility seems resistant to the kind of strategies we encounter in the INTEPOL case studies. However, we should not underestimate the fact that questions are asked about it. Moreover, when we look at the analysed efforts to achieve modal shifts, we see that mobility needs to be considered in order to for efforts to succeed. Of course, one does not question the need to be transported. Rather, one questions in what way mobility may be achieved. Thus, there is an effort to achieve some erosion of the dominance of the private motorcar as the basic vehicle of mobility.

We should also – again - observe the success of combined socio-technical efforts. Clearly, as is evident from the EV cases, new technology is not on its own able to help redefine the issues. On the other hand, modal shifts seem to be difficult to achieve without technological improvements. This underlines the importance to think about mobility in terms of the kind of technology policy that has been outlined by the INTEPOL project.

Do we need continued growth of mobility? When this question is never asked, the transport problem will never be solved. In fact, to cope with the transport problem, we

need a more critical debate about modern mobility. This issue is too frequently side-stepped, even when we would expect it to emerge, for example in the discussions about road pricing.

10.6. Mindshift 2: Developing combined socio-technical strategies that extend beyond local circumstances

In this and previous chapters, we have frequently noted the productive potential of applying combined socio-technical strategies to cope with the transport problem. How may one facilitate a consolidated move in this direction?

One response to this could be to provide more arguments to support the gains that might be achieved from such a move. For example, we may observe the challenge explicit in the promotion of electrical vehicles, namely that without a mindshift about mobility, EVs may reinforce environmental problems. This is because electric energy often is produced from fossil fuels and because EVs may be attractive as a second or third car of affluent households, supplementing rather than replacing the dominant motorcars. It is clear that EVs cannot in themselves produce such a mindshift, but they may contribute. In fact, the existence of a technological alternative to the dominant motorcar facilitates critical questions about the features of the motorcar and the related form of mobility.

Similarly, we may observe what we may call the road pricing puzzle. On the one hand, this is an innovation that aims to regulate traffic, either by reducing it, changing its temporal distribution or stimulating modal shifts. However, the impact is debatable and highly dependent on the taxation level, since many people may prefer to pay rather than changing their mobility habits. On the other hand, it is also an innovation in collecting taxes, for example for the construction of new roads (Thomassen 2001b). Which is the dominant feature?

More generally, this exemplifies some of the problems with so-called green taxes. They provide increased financial provenues for governments, how should this be used? They are supposed to influence demand, but at what levels should taxes be set in order to achieve the supposed impact? The shaping of green taxes is not an exercise in abstract economics, as is evident from the protests against fossil fuel taxes across Europe during the year 2000.

A more productive response could be to analyse examples of challenges where combined socio-technical strategies seem to be appropriate. The INTEPOL cases contain several interesting examples. Here, we will focus on two of them.

The first and probably most important one is the need for *concerted action* that is evident from many cases, in particular those who study efforts to achieve modal shifts. The establishment of new tramlines in Strasbourg is perhaps the most successful of these. Concerted action means that one utilises several combinations of policy measures to achieve goals, usually by considering a local transport problem in a broad context. It should be noted that concerted action does not mean a kind of all-out attempt to optimise a local system, a kind of local master plan. Rather, what we are taking about is finding a kind of compromise between master plan thinking on the one hand, and small scale tinkering on the other. In this respect, concerted action means an effort to carefully evaluate the combined socio-technical challenges at hand and develop measures to cope with both technical and social ordeals. There is no simple recipe for doing this, either than to reason from knowledge about the local practice of mobility.

This lead to the second example, which is related to the need to assess critically implied or explicit *configurations of users* in transport experiments or projects. Configuration of users refers to the images among designers or policy-makers of the potential customers of a particular transport offering and the way this image shape the offering: What kind of people will use it, what are their demands, how do they react to particular aspects like comfort, price, accessibility, frequency, visual design, etc. We have several times commented on the Th!nk and Copenhagen metro cases as instances of such assessments, leading to efforts of reconfigurations. The perspective is above all developed in the Danish EV case (Munch 2001).

Probably, the importance of configuration is underestimated by many transport planners. For example, if one plans for "the general public", one may end up by planning for a subset that are difficult to enrol or by mixing features to the extent that one gets a result that fits nobody. If public transport is configured to meet the needs of the people without cars, one should not wonder if the demand for public transport is reduced as car ownership increases. Again, the success of the Strasbourg efforts probably also depended on the fact the that the configuration of the users of the new tramlines included car owners that wanted to use their cars to get to the public transport facilities.

Doing policy is about measures and instruments, but it is also about process. In the technocratic dreamworld, policy makers just have to decide what measures and instruments that are appropriate and then implement the resulting strategy. In the real world, there is an important role for local as well as national politics. On occasion, even the supranational level of the EU may be activised.

The INTEPOL project has not aimed to provide any detailed insights into policy processes. Clearly, there are substantial variations here. Even if there are a surprising number of similarities in the organisation of the transport sectors across the eight countries we have studied, many of these similarities are probably more of a formal nature than real in terms of everyday operation. Comparing, e.g. the Rome case (Undheim 2001) with the Copenhagen metro (Jørgensen & Munch 2001), we encounter rather different political systems as well as practices.

It is nevertheless tempting to return to a previous observation, namely that a lot of transport planning that aims to solve the kind of problems with which the INTEPOL project has been concerned, seems quite dependent on local action. Of course, the building of a trunk road like the one analysed in the Highway 1 case (Thomassen 2001a) is planned on a national level. But still in a case like that, we see quite manifest local initiatives that are taken into consideration in the national plan. To some extent, one might argue that the national planning is dependent on local interest, not to say local acceptance.

From the discourse on sustainable development has emerged the slogan "Think globally, act locally". From the perspective of traditional transport planning, the slogan might appropriately be changed to "Plan nationally, construct locally". However, that would be to accept uncritically traditional hierarchical notions about the role of the national and the local level.

The case that describes the use of environmental impact assessment in transport related projects in Norway suggest that there is in fact a much more limited horizon: Think locally, act locally. Local concerns are very much frontstage in environmental impact

assessments. This seems to be in line with the main impression from all of the INTEPOL cases that have a focus on local developments.

Local does not necessarily mean democratic, but a strong role for local actors in the development of technology policy for transport means a kind of interactivity that at least facilitates participation, relative to national projects. EU initiatives are worst in this respect (Melby 2001). Participation does need to mean direct public involvement. It may be local discussions, mediated by local newspapers, or it might just be the execution of normal activities in the city council.

We will argue, on the basis of our case studies, that this interactivity is productive. Local participation of some sort seems to be instrumental to provide the kind of positive interest that is critical to the success of transformative projects. We see this in the Strasbourg case, but also in the Rome case, the Go Boulder case and arguably even in the road pricing experiment in Trondheim. In the latter case, road pricing is quietly accepted as an instrument to achieve some enviromental goals at the same time as funding is acquired to improve the standard of important parts of the local road network (Thomassen 2001b).

The Trondheim road pricing case may in fact be seen to exemplify many of the points we have tried to make in this section. To begin with, we should note that the road pricing experiment depended on the availability of reliable electronic technology that could collect taxes and supervise entry of vehicles into the city area. Interestingly, such a technology was initially developed in Trondheim by a start-up company (Q-free) in collaboration with local highway authorities. Through intervention from national actors, the development received economic as well as political support needed for the technology to be implemented in other areas, first in Oslo, later in Singapore and the Netherlands.

Initially, the system was put in place as a toll road system. The development into a system of road pricing was gradual, and the basic legitimacy came from a strong need to find funding for local road projects. The system represents an interesting combination of the concerns that we have highlighted in the INTEPOL project: infrastructure, innovation, regulation and participation. It provides funding for infrastructure, it was developed as an innovation, it represents a regulatory activity and it is dependent on some sort of local political representation. The system is definitively an example of a socio-technical combine, constructed through a technology policy sensitive to the need for some sort of such combinations.

But does this represent a new architecture of technology policy?- This rhetorical question should be understood in a context where one is facing multi-facetted challenges. As emphasised in section 10.4, when new approaches or ideas are tried out locally – in the city, municipality or small region – there remains the challenge to get experiences and results communicated out of the locality. In addition, one is facing the need to respond to a broader scope of issues, which we have tried to catch by the use of the formula “socio-technical”. However, a change of mindset is only possible if there are alternatives around. This means that we need to consider the idea of an interactive technology policy as a theoretical idea, not just an empirical concern.

10.7. Deductive versus empirical analysis in the outlining of an Interactive Technology Policy

In chapter 3, we discussed technology policy as a theoretical concern. We criticised the most common approaches for being too focused on innovation. The chapter concluded that technology policy studies need in addition to emphasise infrastructure, regulation and participation. Moreover, we argued repeatedly that social and technological dimensions should be integrated.

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 closer to our rather abstract ideas about an interactive technology policy. In turn, this should help us spell out these abstract ideas more clearly and more concretely.

Initially, 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 INTEPOL, 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.

Interactivity could then, as already suggested in chapter 3, be made more concrete by reference to the concepts of niche management and learning economy. Niche management suggests that interactivity may be performed as a way of managing the context of a new technology or practise, to allow growth and maturing. Learning economy highlights interaction as a way of providing for learning between actors. A social learning perspective also reminds us that socio-technical developments may remain dynamic over a long timeframe, which means the outcomes may change or be reconfigured even if the strictly technological components or principles remain the same.

A new technology policy paradigm, the paradigm of 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 socio-technical arrangements and thus a long-term engagement in the management of the resulting social learning process
- 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.

Most, if not all of these points, could have been deducted from the kind of theory we presented in chapter 3. The above outline of a paradigm of an interactive technology policy is in this respect theoretical and idealised. Thus, it is vulnerable for dismissal on precisely this ground – it is just a theoretical ideal without practical value.

The idea behind the INTEPOL case studies was that they should provide the idea of interactive technology policy with an empirical grounding, allowing us to counter the possible charges that this was just a theoretical construct. The reader will of course have to assess whether the cases and our analysis of them support our claims about the possibility and productivity of the new technology policy paradigm. Do the above outline of an ITP make sense in relation to our case material, pragmatically speaking?

From the arguments made in this and previous chapter, there is clearly considerable support in our case studies for the basic soundness of the above outline of the interactive technology policy paradigm. However, we also have to admit that none of the stories narrated in the case studies come close to the ideal ITP that we have tried to construct. For example, the relatively successful construction of new tramlines in Strasbourg (Popkema & Elzen 2001b) is in line with quite a few of the above points, but also this case miss out on a number of others, like broadness in perception and the dynamics of the implementation process.

On the other hand, we should not assume the validity of the kind of thinking that is behind our ITP paradigm to be dependent on a kind of total realisation. Few if any currently used mindsets would survive such a test. Thus we have to decide what criteria should be considered critical.

The initial conception of ITP was based on the optimistic idea that it would be commonplace to find the sort of reflective activity as technology policy when one utilises technology as an element of political projects or efforts of reform. Our case material raises in fact the issue whether technology policy in transport is just another fancy name for good old-fashioned transport planning. When we nevertheless transform our findings by using the vocabulary of technology policy, this represents an effort to show the relevance of this vocabulary rather than to show that this vocabulary would be a reasonable representation of the efforts.

Still, we think that technology policy is a good concept to push because it facilitates the task of asking critical questions about the way transport planning usually is performed. Clearly, technology 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. Thus, the first boundary criteria of ITP has to be that one can identify conscious efforts to plan and discuss in terms of technology policy.

Throughout this chapter and in the whole of the report we have repeatedly emphasised the need to combine technological and social options or measures into combined soci-technical strategies. This has to be the second boundary criteria - 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 (1992) concepts of delegation and programme/anti-programme. 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.

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 spatial distribution may be countered by an increased willingness to pay the taxes demanded by the road pricing system. Efforts of restricting access to city areas like in the centre of Rome may be met by acts of disobedience or circumvention (Undheim 2001a).

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 emphasises 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 indentified.
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.

10.8. Interactive technology policy as a general approach to technology policy

All INTEPOL cases have been drawn from the domain of transport and mobility. This means that the arguments we have made in support of 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.

The first concern has been addressed in chapter 3 and also discussed in this chapter. The main point is our claim that technology policy studies are basically descriptive and that the field is not very well developed. The two main exceptions are evolutionary economics, with its emphasis on innovation and learning through interaction of participating actors, and strategic niche management, which focusses on the strategies needed to establish protected spaces for development of new technologies or rather new socio-technical arrangements.

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. This basis is primarily coming from the field of science and technology studies (STS). We have particularly underlined some of the conceptual strengths of evolutionary economics and strategic niche management, which we have tried to integrate in ITP. Thus, we claim ITP to represent a synthesis of these two approaches, informed by general STS theory.

But ITP also extends beyond evolutionary economics and strategic niche management. The most obvious reason for this is in the extension of scope resulting from the inclusion of other concerns than just innovation, conceptualised by reference to infrastructure, regulation and participation. In addition, we have chosen to address more intimately the issues related to policy translation, the dynamics of acts of delegation and the configurational aspects of technologies. We think this makes ITP an improvement, without making claims that ITP under all circumstances should replace evolutionary economics or strategic niche management.

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 on 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. We believe that the INTEPOL case material supports these observations.

We could add a couple of features that arguably provide additional differences between the transport sector and other sectors. One such feature that has been extensively commented upon in this chapter is the strong role of local actors and the tendency to organise projects and experiments within a local context of for example a municipality or a city. The other is the elusive character of mobility and its taken-for-grantedness. There should be little doubt that the transport sector offers difficult challenges to technology policy thinking as well as practice.

An alternative to the "hard case" argument is to underline the fact that a number of the INTEPOL cases are cross-sectorial. For example, the EV cases as well as the telematics case and the road pricing case are concerned with relationships between industry and the transport sector. This means that the case base of INTEPOL transcends the transport domain. In this respect, the development of ITP has been drawing on material from the industrial sector as well.

The main potential reason why case material from the transport domain should not be relevant to other sectors, would be that the transport sector is more hierarchically organised and with stricter central control. However, as we have frequently observed, the INTEPOL case material shows that local initiatives and action play a very important role. Thus, this point does not seem to be that important either.

In fact, 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. Here, 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.

The arguments supporting our claim that the ITP paradigm may have general value, also outside the transport domain, should also be judged on the basis of the impact of national-comparative differences in the INTEPOL material. Our cases and other information has been collected from eight different countries: Denmark, France, Germany, Italy, Japan, the Netherlands, Norway and the US, in addition to the EU. Of course, as indicated from our national-level studies, there is ample evidence of national styles of performing technology policy, generally as well as in the transport domain. These differences include political culture, political and administrative institutions as well as the conduct of traffic.

However, in our analysis of the cases, these differences have remained backstage. The "Frenchness" of the Strasbourg case is not its most prominant quality, neither is the Dutchness of the Rotterdam case or the Danishness of the Copenhagen metro case. The way we have developed the features of the ITP paradigm also make these national differences less important to the relevance of the features. The impact of national and local particularities becomes important above all in the transformation of ITP as an abstract mindset into a concrete policy-making exercise, and that is something else.

10.9. Final remarks: The dual quality of the INTEPOL results

As should be evident from this report, the INTEPOL project has worked with a kind of dual purpose. On the one hand, we wanted to study the practice of technology policy in the transport domain in order to use this as the basis for developing a new paradigm for an interactive technology policy. On the other, we have studied rather intimately the challenges of the transport sector, challenges emerging from the late modern practice of mobility dominated by the private car. This means that the project has provided a dual set of results, one concerning ITP, the other about mobility and transport.

Of course, the results are relevant to each other. We could not have developed the ITP paradigm without detailed case studies about transport challenges. And we do believe that transport challenges will be managed more efficiently by using ITP ideas. Still, we think we should be credited by having two sets of findings.

There may be a more general insight to be teased out here. Perhaps the study of technology policy needs to be performed in such a dual fashion, focussing on the architecture of technology policy as well as the specifics of the sector under scrutiny. For example, technology policy studies in the form of innovation studies have mainly been undertaken in industry. When these models are transferred to other sectors that manufacturing, for example to private or public services, this creates problems. An important one is that the concept of innovation may take on a different meaning in services than in manufacturing.

What other lessons to draw from the INTEPOL project? An obvious but somewhat simplistic and boring conclusion could be that we need more interactivity in technology policy. In a more concrete manner, we have identified some main candidates that would contribute to increased interactivity. In addition to the improvements that, from our perspective "obviously" will follow from an implementation of the ITP mindset, we will point to the following:

- Improving «the learning economy» of transport planning by developing institutions for communicating experience across projects, experiments and localities. This would also facilitate the transfer of innovative socio-technical arrangements.
- Creating protective spaces to facilitate innovation and stabilisation of new solutions. A related strategic difficulty is how to facilitate take-over of new solutions when old and entrenched arrangements are difficult to get rid of. The so-called sailing ship effect, frequently observed when new and old technologies compete, means that the threat of new technologies leads to considerable improvements in the old ones. However, when there are great sunk costs in infrastructure, institutions and skills, new technologies may not stand a change unless some sort of retirement strategy is put in place for existing solutions. This is relevant, e.g., for the competition between fossil fuel engines and EVs or fuel cell vehicles.
- Extending and bending criteria of design of transport technologies to improve their configurational qualities, in particular their userfriendliness and their cultural compatibility with major audiences of users.
- Improving relations between transport constituencies and between the transport sector and other sectors could bring about critical reflection about the way other sectors influence mobility needs and broaden the scope of available ways of coping with and managing transport problems.

The ideology of the INTEPOL project may be read as an exercise in Gramscian strategy: “Pessimism of the mind, optimism of the will”. Clearly, the challenges facing the transport sector are formidable. To reform the present system, by replacing the traditional car and/or stimulate modal shifts, seem like utopian perspectives when we consider the dominance of the private car-based mode of mobility, economically, institutionally and culturally. Still, our case studies show that there is “optimism of the will”, a willingness or great pressure to continue to search for new, more efficient solutions. Thus, potentially, there is a transformative dynamic, a room for change, even if it seems difficult to put in motion.

The spirit of the present period supports deregulation and decentralisation and provides a sceptical outlook on most efforts to manage social problems by central authorities. Master plans are definitely out, local initiatives appear to be in.

It is tempting to argue in support of a restructuring of transport planning that above all implies a new structuring of the local space of transport policy. Transport problems are perceived through local lenses, they are defined in local terms and invite local action. The role of central authorities is reduced to that of supporters of local action, or maybe rather to the orchestrator of a host of local actions. Orchestration means loss of control but access to supporting initiatives and to developing structures that facilitate learning across localities, including the respective role of imitation and inspiration. However, some important problems cannot be solved at the local level. They include the perception of mobility as a human right and the competition between new and old technologies. The construction of protected spaces for growth of new solution as well as retirement schemes for the entrenched practices may very well imply a more active role still for central authorities.

REFERENCES

Allen, F.R. (1957), "The automobile", in F.R. Allen, ed., *Technology and social change*, New York: Appleton-Century Crofts.

Almås, Terje (1992), "Drivstoff, forbrenning og forurensning fra forbrenningsmotorer", Inst. for Marine maschinery, Norwegian University of Technology and Science.

Andersen, E. S. and B-Å. Lundwall (1988), "Small national systems of innovation facing technological revolutions: an analytical framework", in C Freeman and B-Å Lundwall, eds., *Small countries facing the technological revolution*, London: Pinter, p. 9-36.

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

Andersen, Hans K. (1998), *Distancearbejde - et case studie (Distance working - a case study)*, Notat nr. 98-04. Copenhagen: The Danish Transport Council.

Anthony M. Rufolo and Martha J. Bianco (1998), "The Impact of Congestion Pricing and Parking Taxes on Spatial Competition", http://www.upa.pdx.edu/MB/ Trb1998h.htm, 20.07.2001.

Arrow, K. (1962), "The economic implications of learning by doing", *Review of economic studies*, 29, 155-173.

Aune, M. (1998),*"Nøktern" eller "nytende"? Energiforbruk og hverdagsliv i norske husholdninger*, report 34, Trondheim: Centre for technology and society.

Banister, D. (1996), "Energy, quality of life and the environment: The role of transport", *Transport reviews*, 16 (1), 23-35.

Banister, D. (1997), "Reducing the need to travel", *Environment and planning B - Planning and design*, 24, p 437-449.

Banister, D., S. Watson and C. Wood (1997), "Sustainable cities: Transport, energy, and urban form", *Environment and planning B - Planning and design*, 24 (1), p 125-143.

Banister, David et.al. (2000), "Transport Policy Scenarios for the EU: 2020 Images of the Future", *Innovation,* Vol.13, No.1 2000.

Bartholomew, K.A. (1995), "A tale of two cities", *Transportation*, 22, 273-293.

Baudrillard, J. (1988), *America*, London: Verso.

Bayley, S. (1986), *Sex, drinks and fast cars: The creation and consumption of images*, London: Faber and Faber.

Beckmann, Jörg ed. (1999), *Speed – A workshop on space, time and mobility,* Notat nr. 99-54, Copenhagen: The Danish Transport Council.

Belesco, W.J. (1979), *Americans on the road. From autocamp to motel*, Cambridge, MA: MIT press.

Berman, M. (1983), *All that is solid melts into air. The experience of modernity*, London: Verso.

Bieber, A., M-H. Massot and J-P. Orfeuil (1994), "Prospects for daily urban mobility", *Transport reviews*, 14 (4), 321-339.

Bijker, W. and J. Law, eds. (1992), *Shaping technology/building society*, Cambridge, MA: MIT Press.

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

Bijker, Wiebe E. and Law, John (1992), *Shaping Technology/Building Society*, Cambridge and London: The MIT Press.

Bjørnland, D. (1997), *Determinants to mobility. Introduction to transport economics with examples from Denmark, Norway and Sweden*, Copenhagen: Institute for Logistics and Transport, Copenhagen Business School.

Boden, Mark (1993), "Shifting the Strategic Paradigm: the Case of the Catalytic Converter", paper presented at the workshop *The Car and its Environment*, Trondheim: May 1993.

Bottles, S.L. (1987), *Los Angeles and the automobile. The making of the modern city*, Berkeley: University of California Press.

Branscomb, L.M., ed. (1993), *Empowering technology. Implementing a US strategy*, Cambridge, MA: MIT press.

Bratzel, S. (1999), "Conditions of success in sustainable urban transport policy. Policy changes in 'relatively successful' European cities", *Transport review*s, 19 (2), 177-190.

Brix Pedersen, Bjørn and Ulrik Jørgensen, "Getting Bycicles on Trains - Inter-modal transport developments in Denmark", in Elzen et al. (2001).

Brooks, H. (1986), "National Science Policy and Technological Innovation", in R. Landau and N. Rosenberg, eds. *The Positive Sum Strategy*, Washington DC: National Academy Press, pp. 119-167.

Buland, Trond (1996), "Den store planen. Norges satsning på informasjonsteknologi 1987-1990", *STS-report* 27/96.

Burkart, G. (1994), "Individuelle Mobilität und sozial Integration. Zur Soziologie des Automobilismus", *Soziale Welt*, 45 (2), 216-241.

Button, K.J. (1993), *Transport economics* (2 ed.), Aldershot: Edward Elgar.

Bye, Robert (2000), "Fra køfri til problemfri", *STS-report* no.47, Trondheim: Norwegian University of Science and Technology.

Bye, Robert and Robert Næss (2001), "Will Telematics Move in Concert? Social shaping of transport telematics: The case of Germany", in Elzen et al. (2001).

Calstart News Notes (19 May 2000), "French Automaker's Plant Builds its 5,000th EV". http://gaea.calstart.org/newsSearch/selDis.html?cmd=98083160

Calstart News Notes (26 March 2001), "Toyota Sells 50,000 'Prius' Hybrid EVs, 8,000 in US". http://gaea.calstart.org/newsSearch/selDis.html?cmd=98083719

Car free cities (1996) *The Copenhagen Declaration*. Annual general meeting of 'Car free cities' in Copenhagen, 8 May. http://www.edc.eu.int/cfc/copenhagen.html.

Carter, A. (2001), "Intelligent transport systems", *Journal of navigation*, 54 (1), 57-64.

Cole, S. (1998), *Applied transport economics - Policy, management and decision making*, London: Kogan Page.

Cowan, R.S. (1982), *More work for mother*, New York: Basic books.

Cowan, R.S. (1997), *A social history of American technology*, New York: Oxford University Press.

Crandall, Robert W. et.al.(1986), *Regulating the Automobile*, Washington, D.C.: The Brookings Institution.

Crang, M., P. Crang and J. May, eds. (1999), *Virtual geographies. Bodies, space and relations*, London: Routledge.

Cronberg, T. and K.H. Sørensen, eds. (1995), *Similar concerns, different styles? Technology studies in Western Europe*, COST social science, Brüssel: DG XII, 1995.

de Rus, G. and C. Nash, eds. (1997), *Recent developments in transport economics*, Aldershot: Ashgate.

Dettelbach, C.G. (1976), *In the driver's seat. The automobile in American literature and popular culture*, Westport, Connecticut: Greenwood press.

Dimendberg, E. (1995), "The will to motorization: Cinema, highways, and modernity", *October*, no 73, 90-137.

Dinan, Desmond (1994), *Ever Closer union? An Introduction to the European Community,* Basingstoke: Macmillan.

Dosi, G. (1982), "Technological paradigms and technological trajectories: A suggested interpretation of the determinants and directions of technical change", *Research policy* 11, 147-162.

Downs, Anthony (1992), *Stuck in Traffic: Coping with Peak-hour traffic congestion,* Washington, D.C. and Cambridge (MA), The Brookings Institution and The Lincoln Institute of Land Policy.

Dunn, James A. (1981), *Miles to go: European and American Transportation Policies*, Cambridge, Mass.: MIT Press.

Dunn, J.A. (1998), *Driving forces. The automobile, its enemies, and the politics of mobility*, Washington DC: Brookings Institution Press.

Edquist, C., ed. (1997), *Systems of innovation*, London: Pinter.

Ellul, J. (1964), *The technological society*, New York: Random house.

Elzen, Boelie, Schot, Johan and Hoogma, Remco (1993), "Strategies for influencing the Car System" in: Sørensen, Knut H., Ed. (1993).

Elzen, Boelie, Bert Enserink en Wim A. Smit (1996), "Socio-Technical Networks: How a technology studies approach may help to solve problems related to technical change", *Social Studies of Science*, Vol.26, no.1 (February 1996), 95-141.

Elzen, Boelie, Frank Geels, Remco Hoogma, Johan Schot en Robbin te Velde (1998) *Strategieën voor Innovatie*, (Strategies for Innovation), Arnhem: NV Samenwerkende Elektriciteitsproductiebedrijven (Study for the joint Dutch electric utilities)

Elzen, Boelie et al. (1999a), *Dimensions of an Interactive Technology Policy and Country Overviews of Technology Policies*, Deliverable 1 from the INTEPOL Project (EU project nr. SOE1-CT97-1057), Enschede: University of Twente.

Elzen, Boelie (1999b), "Country overview – USA.", in Elzen et al. 1999a, pp.187-216.

Elzen, Boelie (1999c), *Inventory of Market Acceptance Factors*, Enschede: University of Twente. Deliverable 5 of EU-Project UTOPIA (Contract No. UR-97-SC-2076).

Elzen, Boelie (2000), "Socio-technical learning from experimentation", in Peter Zwaneveld et.al., *Analysis of demonstration projects with new transport and propulsion systems*, Delft: TNO-INRO. Deliverable 6 of EU-Project UTOPIA (Contract No. UR-97-SC-2076), pp.43-79.

Elzen, Boelie, Ulrik Jørgensen, Knut H. Sørensen and Øyvind Thomassen (2001), *Tackling Tranportation Problems around the World - Case-studies used in the INTEPOL project*, Annex report to final report from the INTEPOL project, Enschede: University of Twente.

Elzinga, A. and A. Jamison (1995), "Changing policy agendas in science and technology", in S. Jasanoff et al., eds.: *Handbook of science and technology studies*, Thousand Oaks, CA: Sage, pp. 572-597.

Encel, S. and J. Ronayne, eds. (1979), *Science, Technology and Public Policy. An International Perspective*, Oxford: Pergamon Press.

European Commission (1990), *Communication: Industrial policy in an open and competitive environment: Guidelines for a Community approach*, COM (90) 556. Brussels.

European Commission (1992), *Communication: The future development of the Common Transport Policy. A global approach to the construction of a Community framework for sustainable mobility,* COM (92) 494. Brussels.

European Commission (1993), *White Paper: Growth, Competitiveness, Employment: The Challenges and Ways Forward into the 21st Century*, COM 93 (700). Brussels.

European Commission (1995a), *Green Paper on Innovation*, COM (95) 688. Brussels.

European Commission (1995b), *Green Paper: Towards fair and efficient pricing in transport*. COM (95) 691 final. Brussels.

European Commission (1998a), *Communication on developing a Community apprach to CO_2 etc.*, COM (98) 204. Brussels.

European Commission (1998b), *Communication on the Common Transport Policy Sustainable Mobility: Perspectives for the Future,* COM (98) 716. Brussels.

EU (1990), *Transport in a fast changing Europe*, a report from the Group Transport 2000+, Brussels.

Evensen, Jan (1986), "Et elektronisk betalingssytem for biler", *Rapport 1/86*, Micro Design.

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

Financial Times (1984), "The war of the car exhausts", October 16th.

Financial Times (1985), "Compromise on car emissions", June 21th.

Flink, James (1988), *The Automobile Age*, Cambridge MA: MIT Press.

Freeman, C. (1974), *The economics of industrial innovation*, Penguin: Harmondsworth.

Freeman, C. and B-Å. Lundwall, eds. (1988), *Small countries facing the technological revolution*, London: Pinter Publishers.

Freeman, C. et al., eds. (1991), *Technology and the future of Europe. Global competition and the environment in the 1990s*, London: Pinter Publishers.

Giddens, A. (1990), *Consequences of modernity*, Cambridge: Polity Press.

Gilbert, Richard (1996), *Towards Sustainable Transportation – Conference Highlights and Overview of Issues*, Report on Vancouver conference, March 24-27, Paris: OECD.

Gjøen, H. and M. Hård, (1998), "Cultural Politics in Action: developing user scripts in relation to the electric vehicle", paper presented at the workshop *Cultural Politics of Technology*, Trondheim.

Gjøen, H. (2001), *Gasstanker. En sosiologisk studie av visjoner og virkelighetskonstruksjoner knyttet til bruk av naturgass i Norge*, unpublished PhD-dissertation, Trondheim: NTNU.

Godskesen, Mirjam (2001), *Rutiner og brud i hverdagens transport (Routine and ruptures in every day transportation)*, Ph.D. thesis, Copenhagen: IPL / Technology and Environment Studies, Technical University of Denmark.

Grande, Jan and Sørensen, Knut H. (2000), "Det standardiserte miljøet. Kunnskapsteoretiske perspektiver på konsekvensutredninger", *Tidsskrift for samfunnsforskning,* nr.3-2000, Oslo.

Grande, Jan (2001), "A Slight Intervention - The production and application of knowledge in environmental impact assessment (EIA) in two urban development projects in Norway", in Elzen et al. (2001).

Greaves, Celia (1997), "A Transition to Sustainable Mobility", *IPTS Report*, No. 11, pp.29-34, Seville: Institute for Prospective Technological Studies / ESTO.

Gudmundsson, Henrik (2000), *Mobilitet og bæredygtighed – strategier, mål og institutioner i reguleringen af persontransporten (Mobility and sustainability – strategies, goals and institutions in the regulation of personal transportation)*. Ph.D. thesis, Faculty of Economics, Copenhagen Business School.

Hajer, Maarten and Sven Kesselring (1999), "Democracy in the Risk Society? Learning from the New Politics of Mobility in Munich", Article to appear in *Environmental Politics*.

Hall, P. (1994), "Squaring the circle - Can we resolve the Clarkian paradox?", *Environment and planning B - Planning and design*, 21, p 79-94.

Handy, S. L. (1996), "Understanding the link between urban form and nonwork travel behavior", *Journal of planning education and research*, 15, 183-198.

Hård, M. and A. Jamison (1997), "Alternative cars: The contrasting stories of steam and diesel automotive engines", *Technology in society*, 19 (2), 145-160.

Harms, Sylvia and Bernhard Truffer (1998), *The Emergence of a Nation-wide Carsharing Co-operative in Switzerland*, Dübenborf: EAWAG (case study for EU-funded 'Strategic Niche Management' project).

Hau, Timothy D. (1998), "Congestion pricing and road investment", in Kenneth J. Button and Erik T. Verhoef (eds.), *Road Pricing, Traffic Congestion and the Environment,* Cheltenham: Edward Elgar.

Hensher, D. A. (1993), "Socially and environmentally appropriate urban futures for the motor car", *Transportation*, 20, 1-19.

Hepworth, M. and K. Ducatel (1992), *Transport in the information age. Wheels and wires*, London: Belhaven Press.

Hirschman, A. (1970), *Exit, voice, loyalty*, Cambridge, MA: Harvard University Press.

Hjorthol, R. (1998), *Hverdagslivets reiser: en analyse av kvinners og menns daglige reiser i Oslo*, report 391/1998, Oslo: Institute for transport economics.

Hoogma (2000), *Exploiting Technological Niches*, Dissertation University of twente, Enschede: Twente University Press.

Hoogma, Remco (2001), "ITS in Japan - Stimulating the use of Intelligent Transport Systems but to solve which problem?", in Elzen et al. (2001).

Høyer, Karl G. (1990), "Miljøvenlige biler i Norge. Er det muligt?", Project-report 8/1990, Molde: Vestlandsforskning.

Hubak, M. (1996), "The car as a cultural statement: Car advertising as gendered socio-technical scripts", in Lie and Sørensen, eds., p. 171-200.

Jacobs, J. (1961), *The death and life of great American cities*, New York: Random House.

Jamison, Andrew (1970), *The Steam-Powered Automobile - An answer to air pollution*, Bloomington: Indiana University Press.

Jansen, G.R.M., P. Nijkamp and C.J. Ruigrok, eds. (1985), *Transportation and mobility in an era of transition*, Amsterdam: North-Holland.

Jasanoff, S. (1990), *The fifth branch. Science advicers as policy makers*, Cambridge, MA: Harvard University Press.

Jessop, Bob (2000), *Globalisering og interaktiv styring (Globalisation and interactive governance)*, Roskilde University Press.

Johnson, Debra and Colin Turner (1997), *Trans-European Networks. The Political Economy of Integrating Europe's Infrastructure*, London: Macmillan press Ltd.

Jones, P. and A. Hervik (1992), "Restraining car traffic in European cities: An emerging role for road pricing", *Transportation research*, 26 A (2), 133-145.

Jones, Peter (1998), "Urban road pricing: public acceptability and barriers to implementation", in Kenneth J. Button and Erik T. Verhoef (eds.), *Road Pricing, Traffic Congestion and the Environment,* Cheltenham: Edward Elgar.

Jørgensen, Ulrik (2001), "California Dreaming - Sustaining American Lifestyle and the Car", in Elzen et al. (2001).

Jørgensen, Ulrik and Birgitte Munch (1999), "Country overview - Denmark", in Elzen et al. 1999a, pp.19-49.

Juhlin, O. (1997), *Prometheus at the wheel. Representations of road transport telematics*, Linköping: Linköping University.

Kay, J.H. (1997), *Asphalt nation: How the automobile took over America, and how we can take it back*, Los Angeles: University of California Press.

Kemp, R., J. Schot, and R. Hoogma (1998), "Regime shifts through processes of niche formation: the approach of strategic niche management", *Technology Analysis and Strategic Management*, Vol. 10, pp. 175-196.

Kenworthy, J.R. and F.B. Laube (1996), "Automobile dependence in cities: An international comparison of urban transport and land use patterns with implications for sustainability", *Environmental impact assessment review*, 16 (4-6), p. 279-308.

Kirsch, David (2000), *The Electric Vehicle and the Burdon of History*, New Brunswick: Rutgers University Press.

Kline, S.J. and N. Rosenberg (1986), "An overview of innovation", in R Landau and N Rosenberg, eds. *The Positive Sum Strategy*, Washington DC: National Academy Press, pp. 275-305.

Knie, A. (1997), "Eigenzeit und Eigenraum: Zur Dialektik von Mobilität und Verkehr", *Soziale Welt*, 47 (1), 39-54.

Kondo, Seiichi (1993), "Liberalisation, Regulation and Growth -- the OECD Experience", http://interdev.oecd.org/media/release/kondoroma23nov99.htm, 20.01. 2001.

Kristensen, Jens Peter et al. (1996), *Distancearbejde og teleindkøb – konsekvenser for transporten (Transport consequenses of telecommuting and teleshopping)*, Notat nr. 96-09, Copenhagen: The Danish Transport Council.

Læssøe, Jeppe (1999), *Mobilitetsbehov – kulturelle læreprocesser og bæredygtighed (Mobility needs – cultural learning and sustainability)*, Notat nr. 99-03. Copenhagen: The Danish Transport Council.

Lamvik, G. (1996), "A fairytale on wheels: The car as a vehicle for meaning within a Norwegian subculture", in Lie and Sørensen, eds., p. 151-170.

Langmyhr, Tore (1996), *Managing equity: the case of road pricing*, Paper presented at the ACSP-AESOP Joint International Congress, Toronto, Canada 1996.

Langmyhr, Tore (1997,) "Vegprising som planleggingsutfordring", Trondheim: Norwegian University of Science and Technology.

Latour, Bruno (1987), *Science in Action*, Milton Keynes: Open University Press.

Latour, B. (1995), *ARAMIS or the love of technology*, Cambridge, MA: Harvard University Press.

Law, J. ed. (1991), *A sociology of monsters. Essays on power, technology and domination*, London: Routledge.

Le Corbusier (1987 [1929]), *The city of tomorrow*, New York: Dover publications.

Lefebvre, Henri (1971 [1968]), *Everyday Life in the Modern World*. London: Allen Lane.

Lewis, D.L. and L. Goldstein (1983), *The automobile and American car culture*, Ann Arbor: The University of Michigan Press.

Lie, M. and K.H. Sørensen, eds. (1996), *Making technology our own? Domesticating technology into everyday life*, Oslo: Scandinavian University Press.

Ling, P.J. (1990), *America and the automobile. Technology, reform and social change 1893-1923*, Manchester: Manchester University Press.

Lowe, M.D. (1990), *Alternatives to the automobile: Transport for livable cities*, Worldwatch paper no 98.

Luukkonen, Terttu (1998), "The difficulties in assessing the impact of EU framework programmes", in *Research Policy*. Vol. 27, no. 6, pp. 599-610.

Lynd, Robert S. and Helen Merrell Lynd (1937), *Middletown in transition*, New York: Harcourt .

Marshall, S. (2000), "The potential contribution of land use policies towards sustainable mobility through activation of travel reduction mechanisms", *Innovation*, 13 (1), 63-79.

Marvin, Simon and Simon Slater (1997), "Urban Infrastructure: The Contemporary Conflict Between Roads and Utilities", in *Progress in Planning*, Vol. 48, part 4, pp.247-318.

McGowan, Francis (1998), "Transport Policy", in Desmond Dinan (ed.), *Encyclopedia of The European Union*, London: Macmillan.

McShane, C. (1994), *Down the asphalt path. The automobile and the American city*, New York: Columbia University Press.

Melby, L. (2001), "A Touch of Technocracy? - Technology policy and transport in the European Union exemplified by 'Trans-European Networks for Transport' and roadpricing", in Elzen et al. (2001).

Melhus, Øyvin (1981), *Notes from a visit at FIAT*, Inst. for Marine Machinery, Norwegian University of Science and Technology.

Miller, D., ed. (2001), *Car cultures*, Oxford: Berg.

Ministerie van Verkeer en Waterstaat (Dutch Ministry of Transport, Watermanagement and Public Works) (2000), *Van A naar Beter: Nationaal Verkeers- en Vervoersplan 2001-2020 - Beleidsvoornemen*, (From A to Better - National Traffic and Transport Policy Plan), The Hague.

Mumford, L. (1961), *The city in history*, Harmondsworth, UK: Penguin.

Mumford, L. (1963), *The highway and the city*, New York: Mentor Books.

Munch, Birgitte and Thomassen, Øyvind (2000), "Exhaust Emission and the Technical Fix of Catalytic Converters", INTEPOL working-paper.

Munch, Birgitte (2001), "Wish You Were Here - Users, Producers, Politics and Electric Vehicles in Denmark", in Elzen et al. (2001).

Munch, Birgitte and Øyvind Thomassen (2001), "Technological Fixes Towards Sustainability - Controversies over the reduction of vehicle emissions", in Elzen et al. (2001).

Munch, Birgitte and Ulrik Jørgensen (2001), "The Metro - Infra Structure and Intra Actors in Copenhagen", in Elzen et al. (2001).

Nader, R. (1965), *Unsafe at any speed*, New York: Grossman.

Nadis, Steve and James J. MacKenzie, (1993), *Car Troubble*, Boston MA: Beacon Press.

Næring i Midt-Norge (1986), nr.2.

Næss, P. (1995), *Urban form and energy use for transport. A Nordic experience*, dr. ing. dissertations 1995:20, Trondheim: Norwegian University of Science and Technology.

Næss, P., S.L. Sandberg and P.G. Røe (1996), "Energy use for transportation in 22 Nordic towns", *Scandinavian housing and planning research*, 13 (2), p. 79-97.

Nelson, R.R., ed. (1993), *National innovation systems. A comparative analysis*, New York: Oxford University Press.

Newman, P.W.G. and J.R. Kenworthy (1989), *Cities and automobile dependence*, Aldershot: Gower.

Newman, P., J. Kenworthy and P. Vintila (1995), "Can we overcome automobile dependence? Physical planning in an age of urbn cynicism", *Cities*, 12 (1), 53-65.

Newman, P. (1996), "Reducing automobile dependence", *Environment and urbanization*, 8 (1), 67-92.

Newman, P.W.G. and J.R. Kenworthy (1996), "The land use - transport connection. An overview", *Land use policy*, 13 (1), p 1-22.

Nijkamp, P., S. Reichman and M. Wegener, eds (1990), *Euromobile: Transport, communications and mobility in Europe. A cross-national overview*, Aldershot: Averbury.

Nijkamp, Peter, Sytze A. Rienstra and Jaap M. Vleugel (1998), "Design and Assessment of Long Term Sustainable Transport System Scenarios", in Kenneth Button, Peter Nijkamp and Hugo Priemus (eds.), *Transport Networks in Europe,* Cheltenham: Edward Elgar Publishing Ltd.

Nugent, Neill (1999), *The Government and Politics of the European Union*, Basingstoke: The Macmillan Press (4th ed.).

OECD (1996), *Culture, Choice and Technology – Final Report*, second OECD workshop on individual travel behaviour, University of Sussex, July 17-19, Paris: OECD, OCDE/GD(97).1

OECD (1997), *Reforming energy and transport subsidies. Environmental and economic implications*, Paris .

OECD (1997), *Transport and environment. Background report and survey of OECD, IEA and ECMT work,* OECD working papers vol. 5, no. 94, Paris: OECD.

Østby, P. (1995), *Flukten fra Detroit : bilens integrasjon i det norske samfunnet*, report 24, Trondheim: Centre for technology and society.

Oum T.H. et al., eds. (1997), *Transport economics. Selected readings*, Amsterdam: Harwood Academic Publishers.

Peterson, John (1996), "European Union Industrial Policy", in Philippe Barbour (ed.), *The European Union Handbook*, Chicago: Fitzroy Dearborn Publishers.

Peterson, John and Margaret Sharp (1998), *Technology Policy in the European Union*, New York: St. Martin's Press.

Popkema, Marcus (1999), “Country overview - The Netherlands”, in Elzen et al. 1999a, pp.51-76.

Popkema, Marcus and Boelie Elzen (2001a), “Agreed Discrimination - The Rotterdam approach to tackle highway congestion”, in Elzen et al. (2001).

Popkema, Marcus and Boelie Elzen (2001b), “From Congestion to Urban Quality - The Strasbourg apporach to tackle transport problems”, in Elzen et al. (2001).

Popkema, Marcus and Boelie Elzen (2001c), “Go Boulder - Public Participation in Transportation Planning”, in Elzen et al. (2001).

Popkema, Marcus and Boelie Elzen (2001d), “The Living Laboratory - Introducing electric transit in Chattanooga”, in Elzen et al. (2001).

Potter, Stephen and Marcus Enoch (1997), “Regulating transport’s environmental impacts in a deregulating world”, in *Transportation Research, part D*. Vol. 2, no. 4, pp. 271-282.

Powell-Ladret, Roxanne et al. (2000), *A Thematic Comparison of Transport Policy Approaches in Europe – Final Report,* Rotterdam: Transport Research Centre of the Ministry of Transport, Public Works and Water Management.

Prettentaler, F.E. and K.W. Steininger (1999), “From ownership to service use lifestyle: the potential of car sharing”, *Ecological economics*, 28 (3), 443-453.

Pucher, J. (1998), “Urban transport in Germany: Providing feasible alternatives to the car”, *Transport reviews*, 18 (4), p. 285-310.

Pucher, John and Lefèvre, Christian (1996), *The Urban Transport Crisis in Europe and North America*, London: Macmillan Press Ltd.

Pucher, John and Lefèvre, Christian (1996), *The Urban Transport Crisis in Europe and North America*, London: MacMillan.

Renner, M. (1988), *Rethinking the role of the automobile*, Worldwatch paper no 84.

Rienstra, Sytze A., Jaap M. Vleugel and Peter Nijkamp (1996), “Options for sustainable passenger transport: An assessment of policy choices”, in *Transportation Planning and Technology*, Vol. 19, pp. 221-233.

Rip, A., T. Misa and J. Schot, eds (1995), *Managing technology in society. The approach of constructive technology assessment*, London: Pinter.

Rip, Arie and René Kemp 1998), “Technological Change”, in S. Rayner and E.L. Malone (eds.), Human Choice and Climate Change, Columbus Ohio: Batelle Press (1998). Vol.2, Ch.6, pp.327-399.

Rosenberg, N. (1982), *Inside the black box: Technology and economics*, Cambridge: Cambridge University Press.

Rosengren, A. (1994), “Some notes on the male motoring world in a Swedish community”, in Sørensen, K.H., ed,. p. 115-136.

Ross, John F.L. (1998), *Linking Europe – Transport Policies and Politics in the European Union*, Praeger Publisher.

Sachs, W. (1992), *For the love of the automobile. Looking back into the history of our desires*, Berkeley: University of California Press.

Scharff, V. (1991), *Taking the wheel. Women and the coming of the motor age*, New York: The Free Press.

Schneider, K.R. (1971), *Autokind vs. Mankind*, New York: W W Norton.

Schot, J., R. Hoogma and B. Elzen (1994), "Strategies for shifting technological systems - the case of the automobile system", *Futures*, 26 (10), 1060-1076.

Schottlin, Charles E. and Landau, Emanuel (1961), "Air Pollution and Asthmatic Attacs in the Los Angeles Area", *Public Health Reports,* vol. 76 (June).

Scott, Mel (1971), *American City Planning since 1890*, Berkeley, Los Angeles, London: University of California Press.

Seely, B. (1987), *Building the American highway system - engineers as policy makers*, Philadelphia: Temple University Press.

Skipper, Lee (1996), *Sustainable Transportation – Elements of a Dialogue*, Presentation made at the Transport Conference in Aalborg, Proceedings Supplement, pp.19-39, Aalborg: The Transport Research Group.

Sørensen, K.H. (1991), "The Norwegian car", in K. H. Sørensen and A-J. Berg, eds., *Technology and everyday life - Trajectories and transformations*, report no 5, Oslo: NAVF-NTNF-NORAS.

Sørensen, K.H. (1992), "Bilen og det moderne Norge. En sosioteknisk transformasjon", *Tidsskrift for samfunnsforskning*, 33 (1), p 27-48.

Sørensen, Knut H., Ed. (1993) *The car and its Environment. The past, present and future of the motorcar in Europe*, EU-COST A4.

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

Sørensen, K.H., ed. (1994), *The car and its environments. The past, present and future of the motorcar in Europe*, COST Social sciences vol 2, Brussel: Directorate general science, research and development.

Sørensen, K.H. and J. Sørgaard (1994), "Mobility and modernity. Towards a sociology of cars", in Sørensen, ed, p 1-32.

Sørensen, K.H. (1996), "Learning technology, constructing culture. Socio-technical change as social learning", *STS working paper* no 18/96, Trondheim: Centre for technology and society.

Sørensen, K.H. (1998), *The spectre of participation. Technology and work in a welfare state*, Oslo: Scandinavian University Press.

Sørensen, Knut H. (1999), *Rush-hour Blues or the Whistle of Freedom? Understanding modern mobility*, Deliverable 2 from the INTEPOL Project (EU project nr. SOE1-CT97-1057), Trondheim: Norwegian University of Science and Technology.

Sørensen, K.H. (2001), "Social shaping on the move, On the policy relevance of the social shaping of technology perspective", in K.H. Sørensen and R. Williams, eds. (2001), *Guiding Policy, Shaping Technology: Concepts, Spaces and Tools*, London: Edward Elgar (forthcoming).

Sørensen, K.H. and R. Williams, eds. (2001), *Guiding Policy, Shaping Technology: Concepts, Spaces and Tools*, London: Edward Elgar (forthcoming).

Starkie, D.N.M. (1976), *Transportation Planning, Policy and Analysis*, Oxford: Pergamon Press.

Statens Forureningstilsyn (1986), "Avgassbestemmelser for personbiler", Oslo.

Statens vegvesen (Vegdirektoratet), *Norsk veg- og trafikkplan 1998-2007: Forslag til strategier for strekningsvis utbygging av stamvegnettet, Oslo februar 1996.*

Stortingsforhandlinnger [Norwegian Parliamentary discussions], June 8th 1988, about *NOx-emissions* in Norway.

Tarr, Joel A. (1988 [1973]), "From City to Suburb: the 'Moral' Influence of Transportation Technology", in Colin Chant, ed., *Sources for the Study of Science, Technology and Everyday Life 1870-1950*, vol. 2, London: Hodder and Stoughton.

Tedlow, R.S. (1990), *New and improved. The history of mass marketing in America*, New York: Basic Books.

Tengström, E. (1992), *The use of the automobile. Its implications for man, society and the environment*, TFB report 1992:14, Stockholm: Swedish Transport Research Board.

Tengstrøm, Emin (1999), *På vej mod en miljømæssig bæredygtighed? - En sammenligning af dansk, hollandsk og svensk trafikpolitik i en europæisk sammenhæng* (Towards environmental sustainability? - A comparison of Danish, Dutch, and Swedish transport policy in an European context), Working paper no. 99-02, Copenhagen: The Danish Transport Council.

Thomassen, Øyvind (1991), "Bil i by", *STS-report* 14/91, Trondheim: University of Trondheim, Center for Technology and Society.

Thomassen, Øyvind (1997) *Bridge over troubled Water: Oslofjordforbindelsen – miljø eller mobilitet*, STS arbejdsnotat 1/97, Trondheim: Centre for Technology and Society, Norwegian University of Science and Technology.

Thomassen, Øyvind (1997), *Herlege tider: Norsk fysisk planlegging ca.1930-1965*, Trondheim; Norwegian University of Science and Technology.

Thomassen, Øyvind (1999), "Country overview – Norway", in Elzen et al. 1999a, pp.77-94.

Thomassen, Øyvind (2001a), "Highway 1 - The development of a trunk road policy in Norway" in Elzen et al. (2001).

Thomassen, Øyvind (2001b), "Taxing Towards Future? The discourse on road pricing in Norway", in Elzen et al. (2001).

Tolley, Rodney and Turton, Brian (1995), *Transport Systems, Policy and Planning*, Essex; Longman Scientific and Technical.

Truffer, B. and G. Dürrenberger (1997), "Outsider initiatives in the reconstruction of the car: The case of lightweight vehicle milieus in Switzerland", *Science, Technology and Human Values*, 22 (2), 207-234.

Undheim, Trond Arne (2001a), "Exit, Voice or Loyalty in the Italian Culture of Mobility - Electric transport as a vehicle of public space-making in Rome", in Elzen et al. (2001).

Undheim, Trond Arne (2001b), "TH!NK Electric - A successful branding of sustainable mobility?", in Elzen et al. (2001).

Verhoef, E. (1996), *The economics of regulating road transport*, Cheltenham, UK: Edward Elgar.

Volti, Rudi (1996), "A centuri of Automobility", *Technology and Culture* vol.37 no.4.

Weber, M., R. Hoogma, B. Lane and J. Schot (1999), *Experimenting with sustianable transport innovations. A workbook for strategic niche management*, Seville: Institute for prospective technological studies.

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

White, Lawrence J. (1982), *The Regulation of Air Pollutant Emissions from Motor Vehicles*, Washington, D.C.; American Enterprise Institute.

Whitelegg, John (1993), *Transport for a Sustainable Future*, Chichester etc.; John Wiley and Sons.

Whitelegg, John (1997), "Finding and Exit from the Mobility Maze: Non-conventional Approaches to Mobility in Urban Areas", *IPTS Report*, No. 11, pp.23-28, Seville: Institute for Prospective Technological Studies / ESTO.

Whyte, W.H. (1988), *City. Rediscovering the centre*, New York: Doubleday.

Williams, R. and D. Edge (1996), "The social shaping of technology", *Research policy*, 25, 865-899.

Wolf, W. (1996), *Car mania. A critical history of transport*, London: Pluto Press.

Wootton, J. (1999), "Replacing the private car", *Transport reviews*, 19 (2), 157-175.

Zeitler, Ulli (1998), *Mobilitet og moral – aspekter af en transportpolitik (Mobility and morality – aspects of a transport policy)*, Notat nr. 98-05, Copenhagen: The Danish Transport Council.

Zuckerman, W. (1991), *End of the road. The world car crisis and how we can solve it*, Cambridge: The Lutterworth press.

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