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**STRATEGIC NICHE MANAGEMENT
AS A TOOL FOR TRANSITION TO A
SUSTAINABLE TRANSPORTATION SYSTEM
(SNMT)
SUMMARY FINAL REPORT
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I. OBJECTIVES

The focus of this research was the under-utilisation of more sustainable transport technologies. The transport system is still dominated by internal combustion engine vehicles for private transport that give rise to adverse health effects, road accidents, traffic jams and environmental degradation, including photochemical smog, acid rain and climate change.

The project developed and applied the concept of strategic niche development as a way to *unlock* society from presently unsustainable transport technologies and practices. Strategic niche management (SNM) is the creation and management of niches for radically new technologies and concepts. The primary aim of SNM is to articulate user needs, indicate options for technological development, and assess the advances in technology, infrastructure, and the social and institutional context that are critical to the wider use of alternative transport technologies.

The general goal of the project was thus to examine how niches for alternative transport technologies are created and managed by various actors, and how public policy can contribute to the wider diffusion and development of new transport technologies and systems by building upon these niches. The central idea of the project was that if such experiments are given the right support by private and public policy makers, they could develop into economically and socially feasible options and be the starting point for more sustainable types of development in transport.

The specific objectives of the project were:

1. to examine and describe 12 initiatives and experiments with alternative transport technologies and concepts that are under way in various European countries, such as electric vehicles and the integration of public and private transport;
2. to examine how public policy can contribute to the wider diffusion of promising transport technologies and systems by building upon the results of experiments initiated by business, government, users and social movements alike;
3. to assess the impact of these alternative transport technologies with respect to environmental effect, the competitiveness of the industries and nations involved and the employment possibilities that are connected with the growth of alternative transport systems;
4. to organise a conference in which the project results will be presented and discussed with a group of experts from business and academia;
5. to produce a workbook for 500 users in which barriers and facilitating factors to the diffusion of promising transport technologies and systems are identified, with guidelines as to how to promote the wider diffusion and development of more sustainable ways of transport.

II. METHODOLOGY

The research applied the quasi-evolutionary theory of technological change, a combination of evolutionary and sociological theories of technical change and strategic management theory, to the problem of making a long-term shift towards a sustainable transport system. On this basis it developed and correlated the concept of *strategic niche management* to the problem of a technological regime shift in transport.

Technological regimes and regime shifts

Economists, historians and sociologists have studied patterns in technological change and have proposed concepts to account for ordering and structuring of technology, among others the concept of technological regime. The definition of technological regime used in the project was: "the whole complex of scientific knowledges, engineering practices, production process technologies, product characteristics, skills and procedures, and institutions and infrastructures that make up the totality of a technology." The idea behind the technological regime is that the existing complex of technology extended to social life imposes a grammar or logic for socio-technical change, the same way as the tax regime or the regulatory regime impose a logic on economic activities and social behaviour. This notion of technological regime helps to explain why most change is of an incremental nature rather than a radical nature. Radically new technologies require changes in the selection environment (in regulation, consumer preferences, infrastructure, price structure), which usually take time and meet resistance even within the organisation that promotes the innovation.

Regime shifts and the role of niches

Regime shifts, i.e. structural change in technology, is a gradual process in which technological niches are important. These are specific “spaces” which are created by particular actors wanting to promote the technology. The central hypothesis of the project was that niches are important because they facilitate learning and societal embedding, that are necessary for the further development of a new technology. Experiences with a new technology in the niche help to change established views, inform action and private and public policies, help to achieve cost economies, the development of complementary assets, and the building of a constituency behind a product. This constituency exercises political influence and is engaged in collective action like the programming and pooling of research, or the introduction of quality assurance schemes. The real use of a new technology is crucial, as some things one can only learn from experience.

Technological niches are created as a conscious effort by actors who apply some sort of “protection measures” in order to support the new technology. Protection measures may consist of temporary resources being invested for the development and testing of the technology from the usual decision calculus of managers, users and regulators.

Technological niches are important because they create space for discovering new technological development paths. It is in the niches that the dominance of the existing regime may be called into question and first beginnings of a new regime may begin to flourish. In the literature on innovation two key processes have been identified which play a major role:

- *learning processes*: A new technology will confront more or less difficulty in its further development, depending on how the new technology fit into the prevailing sociotechnical environment, how the policy and regulatory framework is suited to its future development, how cultural and psychological factors influence the demand of potential users and how production, infrastructure and maintenance systems have to be set up. Technology promoters have to learn about all these aspects of a new technology by trying out the technology in practice and monitor and evaluate what happens. Also central presuppositions of the current technology should be called into question in order to have an outlook on changes to the existing regime. The former, more restricted type of learning is referred to as first order learning; the latter, more open type of learning is referred as second order learning.
- *institutional embedding*: A new technology has to “create” its own specific institutional environment, i.e. it has to be institutionally embedded. There are three aspects to this: first, the social aspect of creating appropriate contact networks between suppliers, regulators, users and the impacted public; second, the cognitive aspect of aligning expectations of involved actors and society at large and third, the embedding of a new technology in an existing socio-technical infrastructure.

Strategic niche management

Building on the insights on how technological regime shifts occur and the role of niches and key processes in innovation in these regime shifts, the conceptual approach of Strategic Niche Management has been developed. SNM is a new approach and perspective on how to facilitate the uptake of new transport technologies and mobility concepts and at the same time manage the transition process to a new regime. It gives emphasis to a combination of technological and social learning processes during the early introduction phase of new transport technologies by means of experiments or demonstration projects, and the establishment of supporting networks of partners and stakeholders. Strategic niche management can be defined as: “the creation, development and controlled phase-out of protected spaces for the development and use of promising technologies by means of experimentation, with the aim of 1) learning more about the desirability of the technology, and 2) enhancing the development and rate of application of the new technology.”

Many ideas exist about ways to make transport more sustainable. Some of the ideas are selected for further development by private companies with the help of public research programmes. Once developed into prototypes, they remain on the shelf; the costs of commercialising the technology are deemed too high for the innovating company. SNM aims at taking the new technologies to the market place and to test them in selected settings by real users. The actual use of a new technology is important for articulation processes to take place, learn about the viability of the new technology and build a network around the product. Experiences in the technological niche are used to inform decisions about technical improvement and niche policies. The protected space, in which the technology is temporarily protected from the full force of selection pressures, acts as a social test-bed and incubator for the new technology which gives it a chance to develop from an idea or showpiece on an exhibition into a technology that is actually used.

More specifically, the aims of strategic niche management are:

- to articulate the changes in technology and in the institutional framework that are necessary for the economic success of the new technology;
- to learn more about the technical and economical feasibility and environmental gains of different technology options -- i.e. to learn more about the social desirability of the options;
- to stimulate the further development of these technologies, to achieve cost efficiencies in mass production, promote the development of complementary technologies and skills, and stimulate changes in social organisation that are important to the wider diffusion of the new technology;
- to build a constituency behind a product -- of firms, researchers, public authorities -- whose semi-coordinated actions are necessary to bring about a substantial shift in interconnected technologies and practices.

Experiments are a central element of the SNM approach, as they can help develop niches. Experiments may fulfil four functions: they can act as a test-bed, a demonstrator, an incubator, and a simulator. They can act as a test-bed or laboratory by helping the new technology go through a series of articulation processes and to learn about specific aspects. They can act as a demonstrator by demonstrating the viability of the new technology, which causes people to change their outlooks, expectations, and mindsets. They can act as an incubator by protecting a fledgling technology against the myopia of market forces. And they act as a simulator by making visible possible patterns of interaction of technology and the social environment. The extent to which experiments contribute to niche formation and ultimately to regime shifts depends on their actual set-up, the stated goals and the quality of the network which supports the particular experiment.

Strategic niche development is a bottom-up approach. It differs from the 'technology-push' approach that underlies most of today's transport policies, by bringing in knowledge and expertise of users and other actors into the technology development process and to generate interactive learning processes and institutional adaptation. It differs from technology control policies by being aimed at the development of new technologies. The management of niches can be done by firms, governments and other social actors, although not necessarily in a systematic and co-ordinated way. The actors have different interests, technological capabilities, powers, belief systems and expectations. SNM offers a structured way of thinking about how to design real-use experiments with new technologies and mobility concepts, in ways that help to generate learning processes and co-ordination of resources and policies.

III. MAIN RESULTS

Conclusions

The SNMT project has shown that experiments can contribute to niche formation and ultimately to regime shifts. The degree to which they do depends on the way the experiments are designed, organised and managed. Experiments that are focused on first order learning and are carried by rigidly managed restrictive networks may be expected to contribute only marginally to a regime shift. Experiments which intend to optimise the potential for second order learning and establish diversified support networks will have better chances to deliver insights into fundamentally new technology development paths. Strategic Niche Management should be seen as an approach which aims at better understanding and improving experiments of the second kind.

The scope or depth of learning and institutional embedding in a particular experiment depends on the extent to which the existing regime is taken as a reference point. The evaluation of the case studies has shown that experiments can be distinguished along two dimensions: the technology dimension and the user dimension. With regard to technology, we may distinguish between an artefact perspective or a technology systems perspective. In the first, the socio-technical environment of the artefact is taken for granted and the question is how a specific design may be optimised without altering the context in which the artefact is introduced. In the second view, interaction between the technical artefact and its socio-technical environment are in the centre of analysis. The user dimension may be distinguished along similar lines: if users needs, preferences and use patterns are taken for granted, learning may be restricted to assessing acceptance behaviour of prospective users. If, however, users are seen as being able to develop new needs, sort their preferences and establish new use patterns, second order learning becomes more important and the chances for gaining insight into potential regime shifts are improved.

With these two dimensions, a four-way table has been constructed which identifies four kind of experiments with different scope and depth of learning and institutional embedding. If both characteristics of technology and users are taken for granted, experiments may test the functionality of a given design of an artefact and its acceptance by the users. The function of *test bed* or a *demonstrator* will then be in the foreground. If users are taken for granted but a systems perspective is taken with regard to technology, experiments will provide results for optimising the existing system. The function of an experiment of this kind may then be more strongly the one of an *incubator*. The same function prevails if users' behaviour is allowed to vary but an artefact focus for the technology is taken. This case could be called "ecological product differentiation". Here a market has first to be developed and consumers have to learn about the benefits of this product and have to integrate it into their lifestyles by developing new use contexts. The case with the strongest potential for contributing to niche development and regime shift is where a systems orientation is combined with a relative openness towards the future preferences and use patterns of users. Here a true co-evolution of technology and use patterns may be expected. In these kind of experiments the function of a *simulator* will be most important. Figure 1 below summarises this classification of experiments with regard to the scope and depth of learning and institutional embedding.

| | | |
|--------------------------------|-----------------------------------------------------------------|----------------------------------------------------------------|
| <i>User</i> | conventional use patterns are taken for granted | new use patterns and preferences may emerge |
| <i>Technology</i> | | |
| artefact orientation | substitution of components in the design of the artefact | ecological product differentiation |
| technology systems orientation | optimization of performance of the technological system | co-evolution of use patterns, products and technologies |

Figure 1: Classification of experiments according to their scope and focus.

Depending on the degree of learning and institutional embedding that may be achieved in a single experiment, technological niches will be transformed and will ultimately contribute more or less to a regime shift. Figure 2 shows how the four possibilities of niche development paths can be related to the classification of experiments in Figure 1. This attribution is not as clear-cut as the table suggests: in principle every kind of experiment may lead to each kind of niche development, but the attribution does indicate the most probable niche development process which is achieved if a specific set-up of an experiment is chosen.

| | | |
|--------------------------------|-------------------------------------------------|---------------------------------------------|
| <i>User</i> | conventional use patterns are taken for granted | new use patterns and preferences may emerge |
| <i>Technology</i> | | |
| artefact orientation | stays technological niche | becomes a market niche |
| technology systems orientation | becomes an integrated part of a regime | becomes an element of a new regime |

Figure 2: potential niche development processes and their connection to regime shifts.

The research has shown that the relationship between experiment, niche and regime is very intricate. SNM operates at the level of experiments, at which level it can improve the contribution to niche formation and development. When a range of niche developments come together they may create synergy at the regime level, which may result in a regime shift and system transformation. This is contingent on various other factors, such as the potential for further development of the existing regime, geo-political events influencing fuel and materials prices, etc. Also, carrying out experiments is subject to fundamentally different logic, time frames

and uncertainties than changing technological regimes. There is, by principle, no theory which could overcome this dilemma and which could identify the experiments which will ultimately transform a regime. SNM is thus much of a probe and learn strategy and not a technology push device. Having said this, the research has led to a framework for analysing the quality of experiments and their potential contribution to niche development and regime shifts. These evaluation criteria are featured in the workbook for strategic niche management, which is available separately from the co-ordinator.

The research has also shown that the linkage between experiments and regimes is too indirect and involves too many uncertainties. The case study research has also weakened the expectation that SNM may be applied to stimulate regional development, creating employment and economic growth. In none of the cases studied did the experiments have any substantial effects on employment. An experiment does give jobs to the project management team, including public relations people, monitoring staff and maintenance staff, but often these people just spend part of their time on the project in question. The interest created in experiments may also draw study groups from other cities and countries whose presence supports the local hotels. More employment may be created later on in the development of the technology when production will start and the necessary infrastructure will be created, but in the early experimental phase of technology development that we have focused on, the effects are marginal. In a similar vein, the environmental effects of experiments are generally negligible due to their relatively small size.

Recommendations

The research resulted in a workbook (available, on request from the co-ordinator) with recommendations on how to design, organise and manage experiments with new transport technologies and mobility concepts in such a way that the experiment's contributions to niche development and regime shift are optimised. It is meant for people involved in the design and implementation of transport experiments as well as for those dealing with longer-term transformations of our transport systems. They can work in various contexts and organisations. Moreover, any person who discusses the use of sustainable technologies, investment and set-up of experiments, either in government departments, in manufacturing companies, in transport operating companies, or in research organisations will profit from appropriating the idea of SNM. As a reflexive tool, it should help the reader to identify potential pitfalls and dilemmas in transport innovation management. The following general recommendations, taken from the SNM workbook, can be made to public policy makers to contribute to wider diffusion of new technologies tried in experiments.

When approaching the end of a single experiment, the problem needs to be addressed of how to develop an – often isolated – experiment into a niche. This can be done by interconnecting similar experiments, or by expanding an experiment to a size which makes it relevant beyond the local level. In large experiments an increase in scale may already be anticipated from the start, but usually it is not planned. Changing scales and circumstances requires reconsidering and changing a number of the features of the original experiment (such as organisation, location, user characteristics, etc.), and introducing new aspects which were not relevant before.

Up-scaling also means making the step from the level of an experiment to the level of the technological niche. In other words, scaling up concerns integrating an experiment into the context of similar activities going on elsewhere and establishing its technology on a larger scale. Typical means for expanding an experiment into a niche are the dissemination of information, the extension of the network of actors and stakeholders, the involvement of competing parties into the network, the setting up of partner experiments, or a modification of the regulatory and political framework which facilitate the establishment of new, similar experiments.

The initial experiment should incorporate some thoughts about its follow-up even if the details of such a follow-up obviously depend on the results of the experiment. Three important issues that public policy can address are discussed in the following:

Changes in the carrying network

Both grassroots movements and professional networks have advantages which are brought to bear in different phases of an experiment or niche development process. Once the transition to a more extended network supporting a technology is made, usually a move towards a more professional organisation is required, and thus also a different structure of the carrying network. Public policy makers can aid in this process. Also, new requirements which have been brought about by the learning processes during the initial experiment or by a growth in size may make it necessary to integrate new partners with complementary competencies into the network. Public policy can stimulate this. The management of an experiment differs also from the management

of a niche in terms of the tightness of control. An individual experiment may have to be run in many respects like a co-operation project in which somebody has to take the lead. Niche management is more about interconnecting activities, facilitating exchange of information and bringing the debate about the framework conditions for the niche technology to a higher, political level. Niches affect the transport context at national or even European level, and the debates about their further development under unprotected conditions inevitably raise issues of adjustment of regulatory and political frameworks.

Complementary policies

The scaling-up process depends in many cases on fitting a new technology into the wider policy context and the implementation of complementary policies. This may entail the establishment of a preferential treatment for environmentally benign policies (such as a favourable tax regime) which apply not only to the experiment as such but to the transport area as a whole. It may apply to the modification or extension of the existing legal framework, for instance with regard to safety and environmental regulations. It also may entail policies to discourage the use of the existing technology if it is too competitive for the new technology. In other cases, an experiment may be planned right from the beginning as an element of a broader initiative, e.g. of a programme to reduce urban emissions. The synergies and complementarities with other initiatives can be used to mutually reinforce the possibilities for learning and successful implementation. Actors beyond the local level, especially government institutions, may have to become involved in order to create more widespread support for scaling up an experiment. This gives the new technology legitimacy and improves its reputation. Recognition at the national or European level may be more important for the scaling up process than massive financial support.

Transfer of the experiment to other places

The most important issue for niche development is the creation of a store of knowledge accumulated during the implementation phase of an experiment in order to facilitate the learning process throughout the experiment as well as for a follow-up. This obtains even more so for any attempt to transfer the results to other experiments or to follow-up activities. By monitoring the improvements made, the acceptance, the patterns of use and the effects of an experiment, it is possible to retain much of experience accumulated and to redesign the structure and policies for a follow-up.

Further work

The research work on Strategic Niche Management has until now focused on the application of this new perspective to real world case-studies, i.e. SNM as a tool for analysing past experiences. Strategic Niche Management represents a new perspective and “lens” for studying and analysing experiences made in experiments with new technology. This has allowed to distil crucial issues which ought to be taken into account when planning an experiment with new transport technology, and to identify criteria for assessing the success potential of an experiment at different levels. In other words, it has helped to sharpen our thinking about experimental situations and how their management could be improved.

Beyond this first type of application, it appears to be promising to explore also three other opportunities for applying SNM in a more “constructive” way, i.e. whether SNM has the potential to be used as a “tool” to support decision making, planning and forward-looking analysis. For the moment, these constructive types of application have only been explored to a very limited extent. It would be highly interesting to test them under real-world conditions in experiments which are currently planned or in an early phase of design.

SNM as a support tool for experiment planning

For practitioners in the field of transport, the perspective of SNM and the understanding of key issues, dilemmas and trade-offs can help to improve the actual planning of new experiments. They help to identify aspects of crucial importance to technological introduction processes which go beyond standard management practices, but ought to be reflected upon. Obviously, these aspects are not a ready-to-use toolbox, but require a good understanding of processes of niche formation.

Some first attempts to explore the use of SNM as a guidance for the planning of concrete experiments right from the beginning have been started but it is still too early to draw conclusions on the added value it has had. In order to provide clearer evidence of the constructive contribution that Strategic Niche Management can make to planning, it would have to be used and tested explicitly in the design and implementation of a series of experiments with new transport technology.

SNM as an evaluation tool for policy making

Demonstration projects are an important element of transport technology policy, but in fact many of these projects are not followed up once funding is stopped. The criteria to assess the success of an experiment as developed in this workbook concentrate exactly on two aspects of major interest to policy-making, namely the potential for wider diffusion after the end of the demonstration phase and the contribution which a technology would make in the longer term to the establishment of a sustainable transport system (i.e. to a regime shift). The criteria could be used in principle before, during or after an experiment, and would thus allow to inform choices between promising or less promising projects, or possibly even between proposals for further funding.

SNM as a prospective analytical tool

SNM opens up several opportunities for analysis in a forward-looking perspective, but it needs to be pointed out that this should not be misunderstood in the sense of a linear planning process. The numerous uncertainties and risks inherent to processes of technological and social change in transport would have to be addressed inevitably within a scenario framework. Inside such a framework, SNM provides the tools to model qualitatively different pathways of experiment and niche development processes. In other words, Strategic Niche Management could be used to construct technological niche development pathways within the settings of wider transport scenarios.

IV. SCIENTIFIC INTEREST AND NOVELTY

The notion of path-dependency in economic development and technological change is widely shared among social researchers. Also economists have come to recognise that there is something historical about economic life, its dynamics and equilibria. According to historians of technology and growth economists the 'patternedness' of technological change follows from the cumulative aspects of knowledge and problem-solving activities, whereas according to micro-economists and sociologists it stems from network externalities of system technologies and the development of interests and social networks in particular paths of development. The phenomenon of path-dependency thus introduces a historical element and the notion of irreversibility into economic analysis and bridges the gap with sociological analysis.

The SNMT project was less interested in causes of path dependency than in the possibility of intentionally constructing a desirable path. There are different ways to do this. One can try to construct a path by brute force, that is, by planning a system and working to overcome the barriers to its realisation by eliminating them. This is often done in the case of physical infrastructures and complex technical systems like the grid-based electrical system. One can also try to bend the development process by judiciously applying economic (or social, for that matter) incentives and disincentives, so as to make some possible paths more, and others less interesting and feasible. Thirdly, one can float with the co-evolution process and modulate it. Depending on circumstances and on the position of the actor who takes the lead (government, public-private consortium, firms, NGOs and societal groups), one or the other approach will appear more suitable and/or more advantageous.

To change the pattern, policies that rely on the use of economic (dis)incentives or the planned construction of a new technological system have been shown not to be successful in the past. The third approach is important in modern societies, but it is underdeveloped as yet. Strategic niche management has been articulated as a method for constructing paths. Originally, the method was positioned as making the introduction of new technology more successful. The exposition of the method in this project showed the same orientation, for example when specifying 'enhancing the rate of application of the new technology' as the aim of SNM. But the method is now part of a broader framework: the build-up of new technological regimes and the possibility of working towards desired regime change intentionally.

V. POLICY RELEVANCE

The project has drawn interest from policy makers at different levels and from various countries. The practitioners' group formed to support project development through an interactive process between researchers and practitioners included representatives from Commission DG's VII and XII, the public transport authorities of Bologna and Göteborg, the regional planning authority of Greater Braunschweig, the Swiss lightweight vehicles project management, the Amsterdam energy company, the Dutch automobile association and Daimler-Benz Forschung und Technik. It has turned out to be difficult to keep the members of the participants' group

actively involved in the project, especially those whose work bore little relationship with the transport experiments being studied. Some of the contacts with practitioners have remained strong, however, especially with Daimler-Benz, ATC Bologna and DG VII.

Some of the project partners have developed new strong links with policy makers who became interested in the SNM approach through the case study research, such as University of Twente and the Energy Saving Trust (UK), and JRC/IPTS and Austrian Mobility Research (AMOR).

Policy makers from several national governments as well as Commission Directorates (VII, XII, XVII, JRC) attended the conference on "Strategic Management for Clean, Innovative Transport Technology and Sustainable Mobility", held in Seville from 7-10 June 1998, and/or commented on the workbook. Their positive reactions support our belief that the SNM approach is relevant for innovation and technology policy, because the Strategic Niche Management approach forms an alternative to both R&D-based policy and technology control policy. Strategic Niche Management is not just a useful addition to a spectrum of policy instruments but perhaps one of few practicable ways to transform regimes.

The experience we could gather through the empirical case studies and the progress which was made in the understanding of the role of experiments for the development of new technologies signal that there is considerable potential for applying a broad, socio-technical perspective on technology dynamics. In this respect, SNM proved to be a fruitful perspective which deserves further attention and development. In order to be transformed into concrete practical tools, however, much more work would be needed. The interaction with practitioners in the field throughout all the stages of the project proved to be of invaluable importance to this end. Future developments of the approach would have to concentrate even more thoroughly on this interaction between researchers and practitioners.

VI. LIST OF PUBLICATIONS

i) In preparation

Remco Hoogma, Final report of the project 'Strategic Niche Management as a Tool for Transition to a Sustainable Transportation System' (ENV4 - CT960275), January 1999.

Final book on strategic niche management, co-authored by Remco Hoogma, Bernhard Truffer, René Kemp and Johan Schot. The provisional title is: *Experimenting with New Technologies. Strategic Niche Management for Sustainable Transport*.

ii) In press

Black, Colin and Potter, Stephen: Portsmouth Bikeabout: an automated smart-card operated bike pool scheme, in: Proceedings of Velo-city, Graz (forthcoming 1999).

Gerhard Prätorius: 'reson - a development coalition within a regional innovation network'; in: Richard Ennals / Björn Gustavsen (eds.), *Work organisation and Europe as a development coalition*, John Benjamins (forthcoming 1999)

Gerhard Prätorius: 'Die soziale Situierung ökonomisch-technischer Innovationen'; in Bernd Rebe (Hrsg.), *Humanität - Wandel - Utopie*. 9. Cloppenburg Wirtschaftsgespräche, Hildesheim (forthcoming 1999).

Matthias Weber and Andreas Dorda, 'Facilitating the uptake of urban mobility innovations: Learning about technological niches and social needs', Proceedings of the Euro-Mediterranean Conference, 21-23 January 1999 (forthcoming).

René Kemp, Bernhard Truffer and Sylvia Harms, 'Strategic Niche Management for Sustainable Mobility', provisional title of chapter in the book "Social Costs and Sustainable Mobility - Strategies and Experiences in Europe and the United States", Springer Verlag (forthcoming).

iii) Published

Remco Hoogma, Boelie Elzen and Johan Schot, 'Improving the Design of EV Experiments', in: Proceedings of the 15th *Electric Vehicle Symposium*, Brussels, 1-3 October, 1998.

René Kemp, Johan W. Schot and Remco Hoogma, 'Regime Shifts to Sustainability Through Processes of Niche Formation: The Approach of Strategic Niche Management', *Technology Analysis & Strategic Management*, Vol.10, No.2, 1998.

Kanehira Maruo: Strategic Alliances for the Development of Fuel Cell Vehicles, KFB-Rapport 1998:37, Stockholm, December 1998.

Gerhard Prätorius: 'Mobility and regional development - guiding concepts, strategies and projects. The example of Southeast Lower Saxony'; in: VDI (ed.), *Gesamtverkehrsforum* 1998; VDI reports 1372, Düsseldorf 1998.

Matthias Weber and Remco Hoogma, 'Beyond National and Technological Styles of Innovation Diffusion, A Dynamic Perspective on Cases from the Energy and Transport Sectors', *Technology Analysis & Strategic Management*, Vol.10, No.4, 1998.

Matthias Weber and Andreas Dorda, 'Strategisches Nischenmanagement von neuen Transporttechnologie und -Konzepten. Zur Rolle der Beteiligung von Nutzern und Interessengruppen in nachhaltigen Mobilitätskonzepten', Proceedings of the international conference Europäisches Forum für Sanfte Mobilität im Tourismus. Innovative Modellvorhaben und Pilotprojekte, Bad Gastein, 9-11 December 1998.

Matthias Weber, Remco Hoogma, Ben Lane and Johan Schot, Experimenting with sustainable transport innovations. A workbook for Strategic Niche Management, Enschede: University of Twente (1999), ISBN: 9036512751.