

# Experimenting with sustainable transport innovations : a workbook for strategic niche management

**Citation for published version (APA):**

Weber, M., Hoogma, R., Lane, B., & Schot, J. W. (1999). *Experimenting with sustainable transport innovations : a workbook for strategic niche management*. Universiteit Twente.

**Document status and date:**

Published: 01/01/1999

**Document Version:**

Publisher's PDF, also known as Version of Record (includes final page, issue and volume numbers)

**Please check the document version of this publication:**

- A submitted manuscript is the version of the article upon submission and before peer-review. There can be important differences between the submitted version and the official published version of record. People interested in the research are advised to contact the author for the final version of the publication, or visit the DOI to the publisher's website.
- The final author version and the galley proof are versions of the publication after peer review.
- The final published version features the final layout of the paper including the volume, issue and page numbers.

[Link to publication](#)

**General rights**

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal.

If the publication is distributed under the terms of Article 25fa of the Dutch Copyright Act, indicated by the "Taverne" license above, please follow below link for the End User Agreement:

[www.tue.nl/taverne](http://www.tue.nl/taverne)

**Take down policy**

If you believe that this document breaches copyright please contact us at:

[openaccess@tue.nl](mailto:openaccess@tue.nl)

providing details and we will investigate your claim.

# **Experimenting with Sustainable Transport Innovations. A workbook for Strategic Niche Management**

Matthias Weber, Remco Hoogma, Ben Lane and Johan Schot

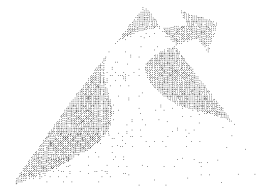
**IPTS Library**



Class No. 2711

Acq. No. bk2999

Date: 19 octobre 00



# Colophon:

Experimenting with Sustainable Transport Innovations.  
A workbook for Strategic Niche Management

Matthias Weber, Remco Hoogma, Ben Lane and Johan Schot

with contributions from: Bernhard Truffer, Stephen Potter, Alex Grablowitz,  
Matthieu Craye, René Kemp and Richard Rogers

Cartoons by Paul Hoogma

Seville/Enschede January 1999

Design and Lay-out: MultiMediaLab / Universiteit Twente  
Paul Hoebee & Bertil Roerink  
Printing: Promotieel Drukwerk Service, Wierden  
ISBN 9036512751  
Printed on chlorine free paper  
600 copies printed

Copies of this document are available from: Institute for Prospective Technological Studies,  
Joint Research Centre, W.T.C., Isla de la Cartuja s/n, E-41092 Seville, Spain.

# Preface

This workbook has been developed as part of the DG XII project on "Strategic Niche Management as a Tool for Transition to a Sustainable Transport System". It will be valuable for readers interested in the opportunities, problems and subtleties associated with the introduction of new technologies. In this workbook we discuss the example of transport, and introduce the Strategic Niche Management (SNM) perspective. SNM is a new technology policy perspective developed to enhance the more widespread diffusion of promising new technologies. SNM focuses on the design of demonstration projects and societal experiments. In the DG XII project 13 cases of SNM projects and experiments have been evaluated. Important contributions to this workbook, especially with regard to the constructive applicability of the underlying concepts, also have been made in a complementary project on "Strategic Management of New Sustainable Transport Innovations (NEST)". This project was carried out by the European Science and Technology Observatory (ESTO), a network of research institutes in Europe funded by the Institute for Prospective Technological Studies (IPTS) in Seville.

In this workbook many references are included to these cases, either in the form of a brief story or as a way to exemplify a more abstract point. Because the focus of SNM is on how to combine economic, social, and environmental objectives as an integral part of a process of introducing technological options, it is particularly apt for any transport technology policy aiming at sustainable development. The workbook provides recommendations and ideas for structuring the set-up and implementation of demonstration projects (or societal experiments). In particular, it will help in organising, framing and guiding a first planning workshop for a demonstration project.

The SNM process, laid out in a draft version of this workbook, was tested at the conference on "Strategic Management for Clean, Innovative Transport Technology and Sustainable Mobility" (Seville, 8-10 June 1998), in collaboration with transport operators, manufacturers, policy-makers, and planners of demonstration projects. This was particularly fruitful for a planning support tool such as SNM, which is actually meant as a "self-assessment" tool for the actors involved in the process of introducing new technologies.

# Table of Contents

<b>By way of Introduction</b>	<b>7</b>
At an auto show near you.....	7
<b>1. General Introduction to Strategic Niche Management</b>	<b>9</b>
1.1 Why do we need Strategic Niche Management?.....	9
1.2 Why do new solutions fail to enter the market? .....	10
1.3 How does radical change occur?.....	10
1.4 Who should read and use this workbook?.....	11
1.5 How to read this workbook? .....	12
<b>2. Exploring the Theoretical Background of Strategic Niche Management</b>	<b>14</b>
2.1 How does innovation take place? .....	14
2.2 How do innovations enter the market? .....	15
<i>Coupling of expectations</i> .....	17
<i>Learning processes</i> .....	18
<i>Network formation</i> .....	18
2.3 The relation between experiments, niche formation and regime development.....	19
2.4 Patterns of niche formation and regime shifts.....	19
<i>Pattern 1: Technological niche proliferation</i> .....	20
<i>Pattern 2: Development of market niches</i> .....	21
<i>Pattern 3: Regime transformation</i> .....	22
<b>3. Summary of case studies evaluated from a SNM perspective</b>	<b>23</b>
Characteristics of the 16 case studies.....	23
1. Large-scale trial of light weight electric vehicles (EVs) in Mendrisio, Switzerland .....	23
2. La Rochelle (France) electric vehicle experiment.....	23
3. Coventry Electric Vehicle Project .....	24
4. PIVCO EV development, including rental project in Oslo and station cars project in California ...	24
5. Electric vehicle projects in Germany: .....	25
6. City centre logistics in Düsseldorf .....	25
7. Praxitèle experiment with self-service rented electric vehicles .....	26
8. ASTI (Accessible Sustainable Transport Integration) project.....	26
9. Car sharing in Switzerland, Germany and the Netherlands .....	27
10. Bikeabout loan-a-bike scheme .....	27

11. Automated Zone Access Control in Bologna, Italy . . . . .	28
12. MOVE-INFO-REGIO . . . . .	28
13. 'Rolling Highway' projects in Sweden . . . . .	29
14. Autonomous railroad trucks . . . . .	29
15. Natural gas buses in Brussels. . . . .	30
16. Bus priority at traffic lights in London . . . . .	30
<b>4. Strategic Management of Experiments and Niche Formation Processes</b>	<b>31</b>
4.1 Identifying a new technology/concept. . . . .	33
<i>Issue 1: Incremental vs. radical departures from the dominant regime</i> . . . . .	33
<i>Issue 2: Path dependency.</i> . . . . .	36
4.2 Designing an experiment . . . . .	37
<i>Issue 3: The structure of a network</i> . . . . .	38
<i>Issue 4: Successful experiments and successful niche formation processes</i> . . . . .	40
<i>Issue 5: Protection measures and competitive incentives</i> . . . . .	40
<i>Issue 6: Involvement of users.</i> . . . . .	42
4.3 Implementing an experiment . . . . .	43
<i>Issue 7: Communication with the wider public</i> . . . . .	44
<i>Issue 8: Broader expectations of partners</i> . . . . .	46
<i>Issue 9: Learning about the different facets of an experiment.</i> . . . . .	48
<i>Issue 10: Learning about underlying assumptions regarding mobility.</i> . . . . .	50
4.4 Expanding an experiment to a niche . . . . .	50
<i>Issue 11: Changes in the carrying network</i> . . . . .	51
<i>Issue 12: Complementary policies</i> . . . . .	52
<i>Issue 13: Transfer of the experiment to other places.</i> . . . . .	53
<i>Issue 14: Changing requirements during niche expansion</i> . . . . .	54
4.5 Review of the protection of an experiment . . . . .	55
<i>Issue 15: Structure and timing of specific protection measures</i> . . . . .	56
<i>Issue 16: Generalised protection of a niche</i> . . . . .	56
<i>Issue 17: Continuation or termination of an experiment.</i> . . . . .	58

<b>5. Storylines of Strategic Niche Management Practices</b>	<b>59</b>
Story 1: Unintended Consequences.....	60
Story 2: Walk before You Run.....	61
Story 3: Selecting Partners.....	63
Story 4: Balancing Ambition.....	64
Story 5: Funding to Death.....	66
Story 6: Listen and Learn.....	67
Story 7: Anticipating Opposition.....	68
Story 8: Great Expectations.....	70
Story 9: Network Amnesia.....	71
Story 10: Driving Lessons.....	72
Story 11: Managing Style.....	73
Story 12: Seeking Complements.....	75
Story 13: Blind Optimism.....	76
Story 14: Overprotection Racket.....	77
Story 15: Co-operation among competitors.....	78
<b>6. Recommendations and Final Assessment</b>	<b>79</b>
6.1 Levels of success of Strategic Niche Management.....	79
<i>Level 1: Successful management of an experiment.....</i>	<i>79</i>
<i>Level 2: Major contribution to niche formation.....</i>	<i>81</i>
<i>Level 3: Potential contribution to a shift towards a sustainable transport regime.....</i>	<i>83</i>
6.2 On the application of the SNM perspective.....	86
6.3 The usefulness of SNM for different types of experiments.....	88
<b>7. A workshop programme</b>	<b>89</b>
7.1 Choice of technology.....	89
7.2 Designing an experiment.....	90
7.3 Implementing an experiment.....	90
7.4 Scaling up an experiment.....	90
7.5 End of protection of an experiment and modification of the transport regime.....	91
<b>8. By way of conclusion</b>	<b>92</b>
Business Day Trip - Bristol to Oxford which are 120 km apart.....	92
<b>Further reading</b>	<b>94</b>
<b>The research team</b>	<b>96</b>

## By way of Introduction

### At an auto show near you...

*Imagine you are able to visit a European Auto Salon exhibition early in the next Millennium. As you walk through the stands, imagine yourself as a fleet manager looking to "green" your fleet operations and consider the vast range of transport technologies on offer....*

Strolling up and down the glittering isles, you first pass the usual compliment of super-minis, saloons and vans that use the cleanest conventional fuels. These include direct fuel injection, lean-burn, advanced diesel-turbo, rotary engine and the "3 litre" (per 100 km) car. There is also a large selection of alternative fuel options on display. Natural gas, LPG, methanol, ethanol and bio-diesel vehicles are all prominently displayed. You already know that these incremental design improvements can reduce life-cycle fuel consumption and toxic emissions to levels very close to those of "zero-emission" vehicles. Indeed, you see that one company is displaying a petrol fuelled car which, using a new high efficiency palladium catalyst, meets the latest Californian ULEV certification standard. You are keen to look at the other stands, showing more radical transport options.

Next you come to an area dedicated to the latest battery powered electric vehicles. On offer are compact cars and electric scooters with state-of-the-art batteries including nickel-metal hydrid, lithium-carbon, zinc-air and the so-called "plastic" batteries. Charging units on offer range from slow overnight systems to the fast "opportunity" charging points, which can refuel an EV in less than an hour. Among the vehicles there are displays of "on-board" electronic controllers that enable use of efficient a.c. motor systems and reduce the complexity of roadside charging posts. Although pure EVs environmental performance can be truly "zero-emission", you remember that this depends on how the electricity is produced.

Pushing through the crowds, you come across the hybrid stand displaying vehicles that combine the advantages of ICE and EV technology. Two main types are shown - "series-hybrids" with an electric drive train, and "parallel-hybrids" with the capacity to be powered by mechanical or electric traction. What really impresses you is their price. Although they are still subsidised by their manufacturers, hybrids are relatively cheap. They have the capacity to run as true ZEVs within urban areas, while at the same time they are capable of the long range when under fossil fuel power. As a potential vehicle buyer, however, you wonder how long it will be before new pure electrics steal the show.



Feeling a little overwhelmed, you next come to the highlight of the exhibition, the first solar EV to be offered to the market. The sleek lines are very popular with the public who have queued for hours to drive it on the simulated daylight test track. Its popularity comes from the TV adverts running since the last century. Just think of it: no refuelling, no noise, no emissions. The only drawbacks are the single seat, zero payload capacity and very high price. Perhaps, you think, you will come back to a similar stand in 2020 and buy one.

Back to reality, you next arrive at the fuel cell stand. For decades fuel cell EVs have been heralded as the ultimate vehicle technology and the long term solution for road transport, combining as they do, high efficiency, zero tail-pipe emissions and long vehicle range. Indeed, the more general "hydrogen economy" has been considered by some to be "inevitable," providing a solution to the long term storage of renewable energy. Although many agree that the fuel cell provides the ultimate in EV technology in the longer term, how to get there continues to be a matter of debate. New methanol fuel-cell cars, however, are beginning to appear on the market. At the right price and with renewable hydrogen fuel, you consider them as definite contenders for a "green" fleet.

You then take the lift to the first floor, and for a moment wonder if you are still in the same exhibition. In area equal to the ground-floor displays, there is not one vehicle to be seen. You quickly realise that this is the telematics section. You don't have to walk far before coming across the first product on offer. A small portable screen is thrust into your hand. It's a satellite global positioning system. On it you can see a plan of the exhibition building and a flashing arrow indicating your own position. As you walk about, the position is updated in real time. As a fleet operator you know that the use of these units in vehicles would be a real advantage in reducing fuel costs and avoiding traffic delays. They are definitely an asset to green mobility; as long as you ignore the energy needed to launch the satellites! Nearby stands display other information wares. Internet ticket booking systems, road information signs, interactive information displays and fleet route optimisation systems. The last impress you the most, given that you know that no exact algorithm actually exists for the "travelling salesman" problem.

Returning to the ground floor, you review the incredible array of technological options that are offered. You had hoped that visiting the exhibition would have helped you to arrive at a decision about which fleet technology would best suit your requirements. But, if anything, you feel more confused. Sipping a double espresso at the coffee shop, the thought occurs to you that with all these technologies competing against one another, it is perhaps still too early to say which one will end up becoming the dominant mode of sustainable road transport. Perhaps, you wonder, it might be better at this stage to set up a small experiment to test a new vehicle in real-world conditions. Then you would get a fleet and learn something on the way. When you get home, you think you must find that book on strategic niche management.

# 1. General Introduction to Strategic Niche Management

## 1.1 Why do we need Strategic Niche Management?

Many organisations and people have been highlighting the desperate traffic situation in many European cities and on major roadways, pointing to a number of adverse impacts: congestion, local air pollution, greenhouse gas build-up and climate change, serious noise pollution, the overuse of land for transport purposes, traffic accidents and fatalities, etc. Simultaneously, as part of a quest for sustainability, several new and interesting ideas about alternative technological and organisational solutions to the transport are proposed. Prototypes are developed, experiments with new mobility forms are carried out, and new freight transport concepts are tested. In the EC DG XII project "Strategic Niche Management as a Tool for Transition to a Sustainable Transport System," 13 cases have been evaluated. In the related project "Strategic Management of New Sustainable Transport Innovations" another 3 cases have been added. (For a complete list see Chapter 3.)

Many of these initiatives remain isolated experiments, however. The new technologies and associated new forms of mobility do not create a larger market. In addition, many solutions do not seem to address the challenge of sustainable development. They do not create a basis for a high mobility and low emissions. Nor do they consume low levels of energy or space. Something seems to go wrong with these initiatives. *Strategic Niche Management* can be perceived as a management tool to address this lack of broader diffusion of what may be called sustainable technologies.

Strategic Niche Management is defined as follows:

The creation, development and controlled break-down of test-beds (experiments, demonstration projects) for promising new technologies and concepts with the aim of learning about the desirability (for example in terms of sustainability) and enhancing the rate of diffusion of the new technology."

The philosophy behind most technology policy activities is that some form of market failure leads to under-investment in research and development, and that government through its technology policy should focus on stimulating pre-competitive R&D. This, however, has led to a clustering of R&D and subsequent over-investment, sometimes involving wasteful duplication in a number of technological fields. And diffusion is still lacking.

The development of the SNM perspective can be perceived as an attempt to correct this by developing a theory, and a set of more practical ideas, on how to start early diffusion processes leading to greater integration of new technologies and their economic, social and environmental context. This is in line with discussion on the European Commission's Fifth Framework Program with its emphasis on citizens' needs, and a better exploitation of R&D outputs by means of demonstration projects and technology transfer activities.

## **1.2 Why do new solutions fail to enter the market?**

Innovation experiments fail for any number of reasons. These include technological barriers, policy failures, the underdevelopment of the market and the infrastructure, uncertainties about actual environmental or other benefits of new technologies and an attachment to the values associated with existing ways of doing things, such as the flexibility and freedom of the private car. These factors are often interrelated and reinforce each other. Together they form a structure that favours innovations in small steps and often blocks more radical change. In innovation economics this situation is called a lock-in. Future socio-technical change is determined by choices made in the past. This also entails that the established system benefits from several implicit protective measures, owing to the fact that the policy framework is usually designed in a way that facilitates the efficient operation of that system. Under such conditions, it is difficult to establish something that differs significantly from the existing system, for it would require wide-ranging technological, social and organisational changes. Consequently successful innovation towards sustainable development in transport is not just a matter of technology, but at least as much a matter of its socio-economic context, of mental frameworks, of individual behavioural patterns, and of institutional and organisational patterns. In the language of Strategic Niche Management this is called the dominant "technological regime." It is difficult to change because of multiple interdependencies. This regime causes failures in the broader diffusion of many (more radical) solutions.

## **1.3 How does radical change occur?**

Within the context of technological regimes, radical new solutions require protected spaces within which to develop momentum. We call these spaces technological niches. Such niches are born by networks of organisations and people interested in the development of a specific application. Niches are formed when a technology or concept is taken out of the R&D phase into actual use, under special conditions that provide the needed protection. The protection is given by the group of actors nurturing the technology and often funding further developments. A niche consists of a whole series of mainly loosely coupled demonstration projects (experiments), initiatives aimed at the creation of lobbying platforms for the new solution, and studies profiling its advantages and drawbacks.

SNM must be seen as a tool that endeavours to assist in building niches for new technologies, mainly through "smart experimentation".

We tend to prefer talking about experiments instead of demonstration projects, because of the former's association with the laboratory. Demonstration projects often aim at convincing others of the usefulness of a certain innovation, while SNM aims to explore and learn in a quasi-controlled manner about the practicality outside of the R&D setting. The idea is that only the experience of the experiment can generate a view towards the necessary development and articulation of user requirements, design modifications, support measures and environmental effects.

Experiments are also a first step towards the development of a niche for new transport technologies and mobility concepts. While an experiment is carried out under "laboratory-like" conditions, developing a niche means exposing the innovation step-by-step to real-world conditions. It involves a second stage of interaction with users and learning about constraints and requirements in a less isolated environment than an experiment.

Smart experimentation and subsequent niche formation do not automatically lead to regime shifts and radical change. It could lead, first, to a long process of niche proliferation - that is, a process of continued protection. In other cases market niches may develop without further protection. Regular market transactions prevail. In other cases still, over a number of years proliferation of technological niches (protected spaces) and market niches may result in a regime shift, i.e., a shift in the technological foundation and in mobility patterns. Such a broad change cannot be brought about by niche development only, let alone SNM. If it takes place, it will be the result of a combination of successful SNM, niche development and a set of other factors such as exhaustion of perceived technological opportunities within the dominant regime, a dramatic change in energy prices and government policies and the emergence of a new set of values which incorporate sustainability. SNM is a crucial aspect of this complex process. Above all, it sets in motion a transition path that will help sustainable transport technologies hit the road.

## 1.4 Who should read and use this workbook?

This workbook addresses the following question: how can promising experiments be set up and converted into more widely used technological and social concepts? Such experiments would have to be very carefully designed and take into account the different technological, organisational and social contexts. To varying degrees this holds not only for radically new concepts, but also for a rather incremental departure from existing models of transport provision. Strategic niche management, and this workbook in particular, aim to highlight ways to improve the design of transport experiments.

Its message is not simple, given all the interrelated factors with an impact on the success of an experiment. It is, however, an extremely exciting and important one. This workbook addresses issues which are not part of standard management procedures as in setting up a project team, a financial construction, a user survey, etc. Rather, this workbook focuses upon those factors which influence the widespread diffusion of a chosen socio-technological path.

This workbook 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. The early, experimental phase of Strategic Niche Management may be of more interest to actors in charge of setting up and organising individual projects. Later phases of niche development are expected to be more relevant to the work of authorities or agencies responsible for running technology programmes. Here, individual experiments and the dissemination of experiences are elements of a wider policy strategy of building niches. We believe that any person who discusses the use of sustainable technologies, investment and the creation of experiments, be it in government departments, manufacturing companies, transport operating companies, or 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.

## 1.5 How to read this workbook?

This book can be read in many ways. First of all from cover to cover, going back and forth through it. We invite you to do this because it will be a rewarding journey. It will introduce you to the following items:

- Innovation theory (chapter 2);
- A summary of 16 demonstration projects (chapter 3);
- 17 key dilemmas to consider if you are involved in experiments with new transport technologies (chapter 4);
- 15 stories which each exemplify key elements (chapter 5);
- 13 cartoons providing another way of presenting key ideas;
- A reflection on how to define the success of an experiment and Strategic Niche Management (chapter 6);
- A hand-out for multiple ways of using the SNM perspective (chapter 6);
- A workshop programme to try out the added value of SNM (chapter 7).

The different elements of the workbook complement each other. This holds in particular for the workshop programme and the issues and dilemmas underpinned by the storylines. The workshop programme provides guidance on how a debate that takes aspects of SNM into account could be set up and structured.

It is indispensable, though, to have understood first what the issues and dilemmas really mean. Similarly, the analytical work of trying to understand issues and dilemmas in a given experiment does not have much effect if it is not complemented by efforts to involve other stakeholders in a workshop-like setting.

Many cross-references are present in the text. For example, when reading about dilemmas, you will be referred to stories and summaries of demonstration projects. Thus a second route through the text is to start with the dilemmas and read about some of the stories and projects simultaneously. A third route entails starting with some of the stories and then going back to the key dilemmas. The entire text builds on several fundamental ideas about the nature of technical change. New metaphors are introduced to stimulate your thinking. The key ones are experiments, niches and regime shifts. These represent three levels of change. This must be kept in mind when reading this workbook, and can be explored in more depth in chapter 2.



## 2. Exploring the Theoretical Background of Strategic Niche Management

Strategic Niche Management is based on a specific understanding of how to define technology and socio-technical change. We will not provide a detailed account of this understanding. For a full elaboration we refer to the companion volume *Experimenting with New Technologies. Strategic Niche Management for Sustainable Transport* (working title). In order to make this workbook more readable, it is useful to provide some insight into the theoretical background of SNM. In particular, we will discuss two crucial ideas: (1) the nature of socio-technical change and (2) the concepts of niche formation and technological regime transformation.

### 2.1 How does innovation take place?

Technology, and especially transport technology, is more than technical hardware. It may often comprise technical elements, but the organisational innovations and new mobility concepts which do not require hardware modifications can be regarded as new technology because they aim to use the hardware in a different way. Furthermore, the definition of technology used in this workbook places emphasis on the knowledge needed to operate a transport system or concept. This knowledge is not only embodied in the brains of the technical experts but as much in the social practices and needs of any individual involved in some way in transport - as a citizen, a transport operator, a manufacturer, a government agency, a freight forwarder or an interest group. Therefore, when using the term "technology", the social context is always included.

Introducing radical new technologies requires some reflection upon an essential feature of technological change. Technology does not appear *deus ex machina* through the removal of political, social, economic and other barriers. Instead, when technologies come out of R&D they can be seen as "fluid options" which embody a number of assumptions about how the technology can be best used and about the kind of necessary boundary conditions. The design of technology and its assumptions are in need of further testing. Such testing will result in a better specification of the design itself but also of the user needs and boundary conditions. Many innovation studies have shown that appropriate testing requires the active inclusion of users, policy-makers, researchers and in some cases representatives of a broader public. Foremost, testing must be viewed as a learning process in which the potentialities of a new technology are articulated and accepted. These include design features, user characteristics, values associated with its use, policy preconditions, etc.

First, it should be clarified how a specific set of technological options and their related use patterns and organisational changes may contribute to sustainable development. The extent to which a technology can be called sustainable cannot be anticipated fully in advance. It must be assessed and developed during the introduction process. Second, testing is a process of articulating, specifying and sharing a set of expectations and visions of the real potentialities of new technologies. Finally, testing could lead to the emergence of a strong network of actors willing to invest in and carry a new technology forward. These processes will ultimately lead to the development of better technologies and possibly a much smoother diffusion process, since the technology and its social environment achieve a better fit. Testing also offers the opportunity to clarify during the experiment if, when and how the introduction of new technologies may contribute to sustainable development. SNM builds on this insight.

Strategic Niche Management is a deliberate attempt to make visible and productive the co-development of technological options, use, policy measures and sustainability. It will help actors to negotiate and explore various interpretations of the usefulness and conditions of application for a specific set of technological options. Thus SNM highlights choices and options and will make the introduction process transparent and doable for all parties involved, including producers, users and policy-makers.

## 2.2 How do innovations enter the market?

What follows is a theoretical account of new technologies or concepts in need of a protected space or a "technological niche". The formation of a niche will allow a first round of diffusion and upgrading. The final fate of new technologies or concepts developed in a niche does not depend on niche formation only. Broader changes within society and the further development of more mature as well as competing technologies also play a role. A technology introduction strategy, SNM aims to contribute to the development of niches through organising experiments. Therefore it is crucial to know which processes shape niche development. Setting up an experiment from a SNM perspective entails not only making the experiment a success, but also making a contribution to a broader process of niche formation.

The slow diffusion of environmentally preferable technologies is by no means exceptional. There are many factors that impede the development and use of new technologies, especially new, more radical technologies requiring changes in user requirements, existing policies and infrastructures. In transport, for example, extremely high dependence on established infrastructures is a key factor inhibiting the emergence of innovative niches. These factors are interrelated and often reinforce each other. What we have is not a set of factors that act separately as a containment force, but a structure of interrelated factors that feed back upon one another, the combined influence of which gives rise to inertia and specific patterns in



the direction of technological change. But what exactly is this structure and how does it affect technological choices of technology developers, policy-makers and users alike?

Economists, historians and, more recently, sociologists have studied regularities in technological change and have proposed concepts to account for the ordering and structuring of technology. A particularly useful concept is "technological regime". A famous example in the innovation literature is the DC3 aircraft. This aircraft, developed in the 1930s, defined a particular technological regime: metal-skin, low-wing planes and piston-powered engines. For a long time engineers had some strong notions regarding the potential of this regime. For more than two decades innovation in aircraft design essentially involved better exploitation of this potential - improving the engines, enlarging the planes, making them more efficient. In road transport we can discern an analogous regime, related to the use of internal combustion engines and cars.

We define a technological regime as:

*"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 notion of technological regime helps to explain why most change is not radical. It is aimed at regime optimisation and incremental change rather than regime transformation and radical change. It is now possible to understand why so many new technologies remain on the shelf. They do not match the rules embodied in the existing technological regime. But how does a regime transformation occur?

While there is no set of general rules as each transition is unique, historical studies suggest that niche formation is a crucial step in technological regime transformation. A niche can be seen as a specific domain for application in which producers and users - sometimes with third parties such as governments - form an alliance to protect new technologies against harsh market selection. Military demand often provided a niche for fledgling technologies. Plenty of famous examples of niches are available from the history of technology. The steam engine was developed by Newcomen to pump water from mines, and clocks were first used in monasteries where life was arranged according to strict timetables. These niches are important for the development of a new technology. Niches are instrumental for the start of a new regime and the further development of a new technology. Apart from demonstrating the viability of a new technology and providing financial means for further development, niches helped to build a constituency behind a new technology and set into motion interactive learning processes and institutional adaptations in management, organisation and the overall institutional contexts. All of which are all important for the broader diffusion and development of the new technology.

Niche developments occur in two (partly overlapping) forms. Niche development starts in protected spaces, that is, in places where regular market conditions do not prevail because of special conditions created through subsidies and an alignment between various actors. Such protected spaces can be called technological niches. They are often played out in the form of an experiment. Examples are experiments with electric vehicles in various European countries and cities, as in La Rochelle, Rügen, Göteborg, etc. Technological niches can develop into market niches, that is, into applications in specific markets. An important difference with market niches lies in the latter's dominance by regular market transactions and the emerging mass production of the products to be delivered to such markets.

Within these technological niches a number of key processes take place that determine its ultimate fate. Three key processes are:

- coupling of expectations;
- learning about problems, needs and potentialities; and
- network formation.

### **Coupling of expectations**

In the early years of development, the advantages of a new technology are often not evident. Their value still has to be proven, and there are many forces of resistance. In order to position the new technology, the interested actors therefore make promises and raise expectations about new technologies.

The promises of a new technology are an important element in niche development. Promises are especially powerful if they are shared, credible (supported by facts and tests), specific (with respect to technological, economic and social aspects), and coupled to certain societal problems which the existing technology is generally not expected to be able to solve. In order to couple expectations of the technologies to societal problems actors must translate their own expectations to other actors and engage in co-operation. Furthermore, activities need to be developed to substantiate the expectations, e.g., by conducting research or employing experts. When sufficient support has been gained and the niche has been formed, close attention has to be paid to the development of the expectations. Niche formation merges with the development of a "market of expectations".

## Learning processes

It is important to learn more about the barriers to the development and introduction of the new technology and how they may be overcome. Many of the barriers involve uncertainty and perceptions. Learning (about needs, problems and potentialities) would be an important aim of strategic niche management policies. The following aspects must be included in the learning process.

1. *Design specifications*: Which adjustments to the technology are required? What is the scope for learning economies, and for overcoming initial limitations?
2. *Government policy*: What changes in fiscal policies and legislation are necessary in order to make an application of the technology possible or to stimulate its use? Should the government assume a different role?
3. *Cultural and psychological meaning*: Which symbolic meaning can be ascribed to the new technology? For example, can it be labelled and promoted as a safe and environmentally benign technology, as a "feminine" technology and/or as a technology that befits a modern lifestyle?
4. *Market demands*: For whom (which users) is the new technology produced and what are the consumers' needs and requirements? How can the technology be marketed in an economically sound manner?
5. *Characteristics of the production network*: Who could produce and market the new technology and fuel (in the case of transport)?
6. *Characteristics of the infrastructure and the maintenance network*: Which complementary technologies, capabilities and infrastructure must be developed, and by whom? Who looks after the maintenance of the new technology? Who is responsible for recycling or waste?
7. *Nature of societal and environmental effects*: What effects does the new technology have on society and the environment?

## Network formation

The development of a niche also may require the formation of a new actor network. Such a network will be a mixture of old and new actors. Actors with vested interests in other technologies generally will not be interested in stimulating a new, competing technology. They may participate in the developments for defensive reasons but will show no real initiative. At the same time, these actors are often needed for expanding the niche. Yet new actors may bring fresh perspectives and may better understand how to develop a new technology. Public authorities could help to create such networks.

## 2.3 The relation between experiments, niche formation and regime development

As outlined earlier, niche formation depends on processes taking place within that niche, that is, on experiments that need to build on successful learning processes, the coupling of expectations and network formation. Experiments can then develop into niches by growing beyond a local scale or by merging with other, similar experiments. In any case, without experimentation there are only limited possibilities for niche formation.

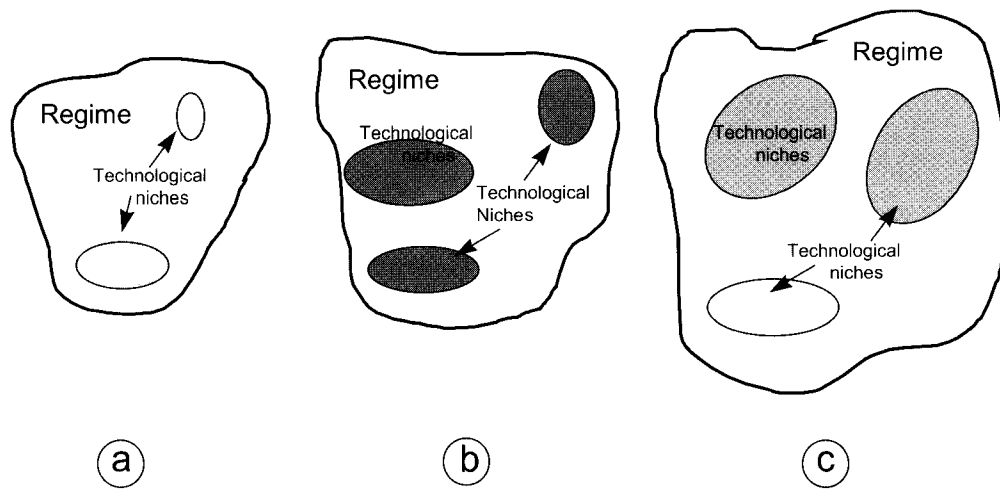
The process of niche formation occurs also against the backdrop of the further exploitation of technological opportunities within the existing technological regime and a set of deeper structural trends and factors. Examples of the latter include globalisation, miniaturisation of micro-electronic computers and use of information technologies, changing relationships between governments and markets (more or less liberal), technological transition in non-related fields which will have an important implication for the transport regime, shifting mobility patterns, etc.

The success of niche formation is thus linked to developments both within the niche (i.e. experiments) and at the level of the existing regime and broader societal and economic trends. So it is the *coincidence* of both developments - successful processes within the niche reinforced by changes at regime level and trends - which determine whether a niche will expand successfully and finally lead to a shift of the embedding regime. In other words, experiments and the regime represent the two levels of change upon which the formation of a niche crucially depends.

## 2.4 Patterns of niche formation and regime shifts

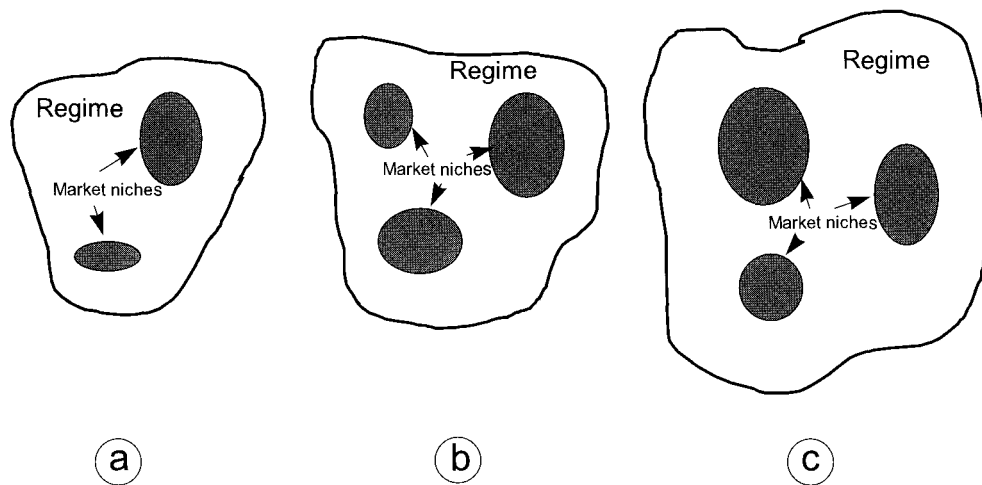
The concepts of regime and niches make it possible to discern three generic patterns of development, or three possible and likely combinations of building blocks. Applied to electric road vehicles, for example, these can be characterised as follows:

### Pattern 1: Technological niche proliferation



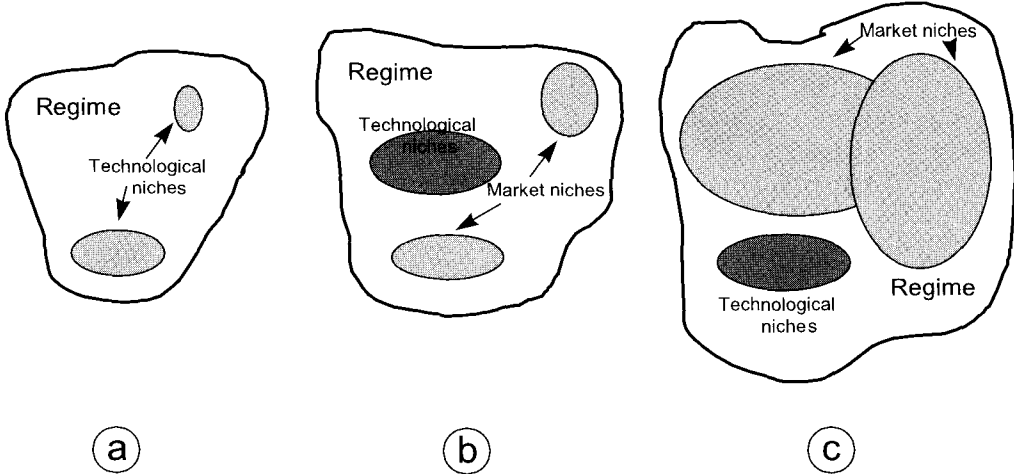
A continual process of new experiments with electric vehicles will not result in any substantial market share. Electric vehicles are not able to compete with gasoline cars and therefore can be nurtured only in a protected space (technological niche). Experiments with electric vehicles will mainly result in reinforcement of the existing regime which becomes much better in meeting societal demands for cleaner, safer vehicles. Congestion is alleviated in part through the development of new modes of recreation and labour patterns inducing a reduction of mobility.

## Pattern 2: Development of market niches



Electric vehicles are used in various market niches that are economically sustainable. Their scale and scope are limited, however. Only a restricted number of users, cities and/or countries switch towards electric drive and hardly any effects are visible at the level of the existing regimes. Two effects can be discerned. Existing trends towards producing energy-efficient gasoline cars are strengthened and more R&D is funnelled into other alternatives than electric drive. This pattern will lead to a growing overall market (and mobility) covering a number of different niche markets.

**Pattern 3: Regime transformation**



Electric vehicles develop into the dominant form of transport, based on a new combination of public and private transport. Gasoline cars are only used for specific purposes, such as long trips.

### 3. Summary of case studies evaluated from a SNM perspective

#### Characteristics of the 16 case studies.

##### 1. Large-scale trial of light weight electric vehicles (EVs) in Mendrisio, Switzerland

technology/concept	partners	objectives	period, costs, follow-up
electric vehicles (passenger cars; 350 planned), recharging stations (normal and fast charge)	Federal Energy Agency (funding), municipality (host), research institutes (evaluation), car importers, electric utility (recharging), canton, partner communities, sponsors. Project manager is InfoVEL centre in Mendrisio	substituting 8% of vehicles in Mendrisio by EVs, through over 50 promotional measures; monitoring energy consumption, evaluating marketing strategies, assessing role of EVs in new mobility system. End goal: 8% EVs in Switzerland.	start June '95; 5 years duration; costs 23.5 mln. ECU (33% federal government, 43% users buying EVs, 10% car importers, plus sponsors, cantons and municipality); no follow-up planned

##### 2. La Rochelle (France) electric vehicle experiment

technology/concept	partners	objectives	period, costs, follow-up
50 electric vehicles (passenger cars and minivans), recharging stations (normal and fast charge)	car producer PSA (vehicles), state electric utility (recharging facilities), La Rochelle municipality (host, incentives)	analyse technical behaviour of the vehicles in real use by individual and professional customers, the use of recharging outlets, and the behaviour and satisfaction of EV drivers; and prove the existence of a market	Dec. '93- Dec. '95; PSA spent 9.1 mln. ECU on the experiment; follow-up: new experiments (Vedelic, Autoplus, Liselec, Coventry EV Project) and commercialisation of electric vehicles by PSA



### 3. Coventry Electric Vehicle Project

technology/concept	partners	objectives	period, costs, follow-up
14 EVs (mini-vans and passenger cars), recharging points. Cars are of the same make as in La Rochelle experiment.	Peugeot (vehicles), Coventry city council (host, incentives), Energy Saving Trust (funding), electric utilities EME (recharging points) and PowerGen (chargers), Royal Mail (user)	demonstrate potential of electric vehicles to reduce energy consumption and pollution, take away misconceptions and ignorance about EVs, and assess commercial potential in UK	start Feb '97; duration 1 year, but probably prolonged until end '98; costs 0.62 mln. ECU, part funded by Energy Saving Trust; follow-up: probably 50 extra EVs under ZEUS programme, perhaps larger minivans

### 4. PIVCO EV development, including rental project in Oslo and station cars project in California

technology/concept	partners	objectives	period, costs, follow-up
purpose-built two-seater electric vehicles on aluminum space frame with thermoplastic body	PIVCO is owned by Bakelittfabriken (plastics technology), Norwegian Post, oil company Statoil, and a state-owned bank. Other partners include Oslo Energi (utility), Hydro Aluminium (supplier) and R&D institutions.	build a new kind of transportation vehicle for short trips in cities according to a new concept with recyclable plastic and aluminum; to help reduce environmental problems	PIVCO founded in '91; car rental project Oslo May '96 - Nov '96; station cars U.S. since Oct '95; total development costs 100 million Nkr; station cars project received 1.2 mln. ECU in external funding; follow-up unclear, U.S. joint venture doubtful.

## 5. Electric vehicle projects in Germany:

### Rügen project, large-scale test by German Post, and Sixt pilot project InnerCity E-Mobil

technology/concept	partners	objectives	period, costs, follow-up
<p>Rügen: 60 EVs (passenger cars, minibuses, mini-vans, midibuses) with three different advanced battery systems; Post: electric mini-vans and minibuses with zinc-air batteries (60 EVs planned, but only 6 delivered) plus infrastructure for regenerating and distributing the batteries; Sixt: EVs with navigation system and telephone, for rent at four railroad stations</p>	<p>Rügen: 5 car companies, 4 battery manufacturers, 2 scientific institutes (monitoring), project management DAUG, project supervisor TÜV Rheinland, federal ministry of science and technology; Post: German Post, 2 car companies, battery firm Electric Fuel, consultancy, TÜV Bayern, chemical firm (battery regeneration); users: authorities, utilities and German Telecom); associated partners in Sweden and South Africa. Sixt: car rental firm Sixt, German Railroads, car company Renault.</p>	<p>Rügen: testing battery/drive systems; ecological and energetic evaluation; evaluation of fast-charge technology; evaluation of acceptance; and demonstrating safety of EVs; operation of solar plant Post: assess if new zinc-air batteries were suited for daily and economical use as energy storage for EVs in fleets of German Post and others; Sixt: test integration of railroads passenger traffic and motorised individual traffic across different traffic carriers; examine everyday customer acceptance of electric hire vehicles; gain image.</p>	<p>Rügen: Oct. '92-Oct. '96; costs 30 mln. ECU (industry: 16, ministry: 13, Land Mecklenburg: 0.3); no follow-up planned; Post: start Dec. '95; not finished by completion case study; costs: no information; no follow-up planned. Sixt: April '96-Sept. '97; costs: no information; no follow-up planned.</p>

## 6. City centre logistics in Düsseldorf

technology/concept	partners	objectives	period, costs, follow-up
<p>a co-operative city centre logistics scheme for delivery of packages and goods to retailers by forwarding agencies using trucks and vans</p>	<p>Land of North-Rhine-Westphalia, city of Düsseldorf, Chamber of Industry and Commerce, university of Münster institute</p>	<p>To identify and test the feasibility of a city centre logistics concept developed for the city of Düsseldorf; the experiences were to provide a basis for regular operation.</p>	<p>Feb./March '97: test run with 6 forwarders (of 80 who expressed interest in the experiment); costs: no information; no follow-up.</p>

## 7. Praxitèle experiment with self-service rented electric vehicles

technology/concept	partners	objectives	period, costs, follow-up
electric vehicles (passenger cars, 50 planned), telematics (communication, localisation), smart cards, inductive charging stations; in later stage automatic driving	transport operator CGEA, state electric utility (recharging), Renault (EVs), tele-communications company, St. Quentin municipality, national transport R&D institute, national telematics R&D institute.	objectives: demonstrate the usefulness and economic feasibility of Praxitèle system, geared towards testing the technology and learning about user experience, use patterns and acceptance	start Oct '97; duration 1 year; costs 4.5 million ECU (industrial partners: 2.1, Min. Transport: 0.6, St. Quentin: 0.5, EU DG-12: 0.3, EU DG-7: 0.1, RATP: 0.2, plus others); follow-up: larger-scale experiments in other cities

## 8. ASTI (Accessible Sustainable Transport Integration) project

technology/concept	partners	objectives	period, costs, follow-up
minibuses (three electrically driven, three CNG-fuelled) with trip scheduling and satellite vehicle location software	Camden Community Transport (project leader and user), Iveco Ford, Stomont Trucks (vehicles), utilities British Gas and London Electricity, battery producer Chloride, Power-Gen (recharging), Wave-driver (drive/recharger), software firm, a supermarket chain, MIRA (evaluation)	improve access to mobility of elderly, disabled and infirm people by developing an efficient on-demand service with minimal environmental impact, ultimately develop better and more efficient community transport service in Camden	end '94 - end '97; costs 2.85 mln. ECU (Camden Borough: 0.7, EU LIFE: 0.65, public/voluntary sector partners: 0.6, private sector partners: 0.6, Dept of Trade and Industry: 0.3); follow-up: service to become permanent part of Camden Community Transport operations; diffusion to other transport providers

### 9. Car sharing in Switzerland, Germany and the Netherlands

technology/concept	partners	objectives	period, costs, follow-up
shared (conventional) cars and vans, reservation and accounting software	car sharing is organised in co-operatives ('Mobility' in Switzerland; local co-operatives in Europe gathered in association ECS) and commercial firms (esp. Netherlands)	make shared cars available to members of co-operatives or clients of commercial firms and thus stimulate more ecological transport patterns	start '87; in Switzerland in May '97: 700 cars, 14,000 users, 400 locations; costs: no information; follow-up: further growth

### 10. Bikeabout loan-a-bike scheme

technology/concept	partners	objectives	period, costs, follow-up
shared bicycles (100 in July '96), three depots with automated, smart-card operated racks, closed-circuit television supervision	University of Portsmouth (operator), Portsmouth City Council (incentives). EU funding through Hampshire County Council	raise awareness of alternatives to cars for intersite travel, make bicycles more accessible for daytime travels, provide safer environment in which bicycles can be used (e.g. bicycle paths)	start Oct '95, fully operational July '96; costs 0.5 mln. ECU, part-funded by university, City and County; follow-up: racks supplier was granted rights to sell the whole Bikeabout system; first client was Rotterdam

## 11. Automated Zone Access Control in Bologna, Italy

technology/concept	partners	objectives	period, costs, follow-up
vehicle recognition by transponders and cameras, road-side stations at entry roads to limited access zone, central computer	Electronica Santerno (supplier), city of Bologna (user, installation), Ministry of Environment, and Region (funding)	implementation of automated control of access to the limited traffic zone to replace the existing manual system, in order to reduce congestion and associated noise and pollution and reduce costs	start July '94 (six of 13 planned roadside stations), stopped Sept '94, restarted autumn '97; costs: 2.4-2.6 mln ECU; follow-up: completion and modernisation of the system in Bologna, and diffusion to other cities (esp. Rome and Como)

## 12. MOVE-INFO-REGIO

technology/concept	partners	objectives	period, costs, follow-up
traffic management systems: traffic and travel information (telephone, radio), local public passenger transport, traffic planning information, freight transport management. INFOREGIO includes Dial-A-Bus subproject and satellite-based locating and navigating system for public transport	MOVE working group: Land Ministry of Economic Affairs, Technology & Transport, electronics companies Siemens and Bosch, car producer Volkswagen, Hanover city and district, NDR (radio). MOVE society: Greater Hanover communal cooperative and Trans-Tec (firm). INFO-REGIO: Volkswagen, Greater Brunswick communal cooperative, Brunswick public transport company, cities of Brunswick and Wolfsburg, university, other institutes and firms	MOVE: develop and introduce products and/ or systems/ subsystems to the market which potentially would improve mobility, and contribute to traffic management during EXPO 2000. INFO-REGIO: maintaining and developing the regional industry, ensuring mobility to all, and creating ecologically sound traffic processes	MOVE initiated in '86, INFO-REGIO in '92; no practical experiments yet, but planned in 2000 (EXPO); estimated costs of MOVE traffic management centre 6.5 mln. ECU plus maintenance

### 13. 'Rolling Highway' projects in Sweden

technology/concept	partners	objectives	period, costs, follow-up
trucks on railroad wagons (waggons leased from German railroads company).	<p><i>Westcoast:</i> Swedish railroads company SJ, forwarding and shipping agents, road carriers, county council.</p> <p><i>The North:</i> freight division of SJ, food retailer ICA</p>	<p><i>Westcoast:</i> demonstrate technology and assess environmental benefit and interest among road carriers.</p> <p><i>The North:</i> offer efficient, cheap, environmentally adjusted distribution transport on a route previously served by road trucks</p>	<p><i>Westcoast:</i> June - Nov. '96; estim. costs 0.6-0.9 mln. ECU, incl. 0.1 mln. ECU subsidies (50% EU, 50% county), very low revenue;</p> <p><i>The North:</i> start '94; costs equal to transport by road trucks, but 30,000 ECU more than by double-decker trucks; follow-up: Rolling Highway project on westcoast by SJ and Norwegian Railroads since Jan '97; other rail transport projects of SJ Freight with food/ wholesale retailers (including ICA).</p>

### 14. Autonomous railroad trucks

technology/concept	partners	objectives	period, costs, follow-up
<p>1) driverless, signal-controlled traction unit</p> <p>2) regional freight train concept by reson</p>	<p>1) innovations unit German Railroads (project leader), freight division of German Railroads (operator), Aachen Polytechnic (conceptual preparation), Federal Railroads Agency, plus others; Volkswagen Transport is client</p> <p>2) no partners committed to the project</p>	<p>1) practical test of technology in semi-commercial operation to articulate safety requirements for driverless operation</p> <p>2) develop marketable product to revive regional economy and contribute to solving traffic and environmental problems</p>	<p>1) start April '96; duration unspecified; costs not disclosed; follow-up unclear</p> <p>2) still a concept; continued attempts of realisation</p>

### 15. Natural gas buses in Brussels

technology/concept	partners	objectives	period, costs, follow-up
20 twelve-meter low-floor buses by Belgian manufacturer with natural gas engines from German producer	Region of Brussels-Capital (project manager and commissioner), Brussels public transport company (proprietor and operator of the buses), Flemish Institute for Technological Research VITO (co-ordinator, monitoring); broad accompanying committee	Come to well-based views on the energetic, environmental and social aspects of the natural gas technology for buses and prove that natural gas is a fuel of full value	first bus May '93, other 19 in early '94; costs: no information; follow-up: lessons learnt were useful input for NGV projects in Mechelen and Kortrijk, and, based on Brussels experiment, legislative initiatives were taken in Belgian parliament to foresee a regulatory framework and provide incentives for purchasing NGVs

### 16. Bus priority at traffic lights in London

technology/concept	partners	objectives	period, costs, follow-up
traffic lights at end of bus lanes allow buses to get ahead of other road vehicles (system is called SCOOT); this complements scheme where 4,000 buses were fitted with transponders which turn traffic lights to green as bus approaches or keep light green for bus to pass	London Transport (project manager), several London boroughs including Camden (funding), companies contracted to London Transport to run the actual bus services, and technology consultants TRL	To enhance the performance of buses compared to other traffic means: improve reliability and punctuality to stimulate bus use and remove private cars from the road	duration: ?; costs: no information; follow-up: London Transport will adopt scheme for real-time information about 'next buses' and measures to assist in the enforcement of parking restrictions; TRL also adopted SCOOT for the city of Southampton

## 4. Strategic Management of Experiments and Niche Formation Processes

Based on the perspective of SNM, this chapter introduces a number of important issues concerning the organisation of experiments leading to niche formation. The aim here is to provide a navigational guide to the different stages of SNM. It gives an overview of those issues crucial to the success of a socio-technical experiment and niche formation process. The emphasis will be placed on those aspects which are distinctive from a Strategic Niche Management perspective and reveal typical dilemmas, trade-offs and key processes during the introduction of new transport technology.

These issues arise in the five main stages of a Strategic Niche Management process (see Table 4.1). *The stages themselves should not be seen as consecutive steps, but rather as overlapping and interrelated activities.* The time dimension is important, insofar as the activities to be undertaken at a later stage build on earlier, often irreversible decisions in previous stages. This implies the need to anticipate the requirements of later stages in the initial design phase.

An experiment usually stretches from the initial diffusion phase of a new technology to the time when a technology is sufficiently stabilised to survive without protection, to be replicated or extended and to induce a transformation of the technological regime in transport. In other words, SNM aids in making the transition from a *technological niche*, where technically feasible projects are protected, to a *market niche*, where the technology or concept survives under the prevailing market conditions.

Before embarking on an experiment it is important to be clear about the objectives to be pursued. Defining the objectives will allow for an evaluation of the different alternative technologies and the results of the experiment. For certain actors these objectives may be of a short-term economic nature. Yet social objectives such as overall transport efficiency or reduced environmental impact increasingly play an important role from a public and political perspective. "Sustainable transport" is a label that covers the set of shared objectives of many actors. SNM is particularly suitable for dealing with a transition towards a more sustainable transport system because it couples social, economic and environmental requirements with the developmental process of new technologies. The technologies which are of major interest for a Strategic Niche Management experiment usually point beyond the existing transport regime and contain at least the promise to greatly alleviate socio-economic or environmental problems. The move is towards a more sustainable transport system. Electric drive is a case in point because it contains the promise of longer-term moves towards a more sustainable transport regime. The short-term promises, however, appear to be rather modest.



The seventeen key issues, dilemmas and trade-offs that have been identified as critical to the success of an SNM experiment will be discussed briefly. The attempt is to draw up a number of suggestions, which could be helpful in making future experiments more successful. Reference will also be made to the storylines in Chapter 5. As the storylines are drawn from actual experiments, they may not always perfectly match the more abstract issues raised, but they should illustrate the arguments.

**Table 4.1: Overview of phases and key issues of Strategic Niche Management**

<b>Phases of an SNM-Process</b>	<b>Key Issues</b>
<i>Identifying a new technology/concept</i>	(1) <i>Incremental or radical departures from the current transport regime</i> (2) <i>Path-dependency</i>
<i>Designing an experiment</i>	(3) <i>The structure of networks</i> (4) <i>Successful experiments and successful niche formation processes</i> (5) <i>Protection measures</i> (6) <i>Involvement of users</i>
<i>Implementing an experiment</i>	(7) <i>Communication with the wider public</i> (8) <i>Broad expectations of partners in an experiment</i> (9) <i>Learning about the facets of an experiment</i> (10) <i>Learning about underlying assumptions regarding mobility</i>
<i>Expanding an experiment to a niche</i>	(11) <i>Changes in the network structure</i> (12) <i>Complementary policy measures</i> (13) <i>Transfer of an experiment</i> (14) <i>Changing requirements during niche expansion</i>
<i>Review of the protection of an experiment</i>	(15) <i>Structure and timing of specific protection measures</i> (16) <i>Generalised protection of a niche</i> (17) <i>Continuation or termination of an experiment</i>

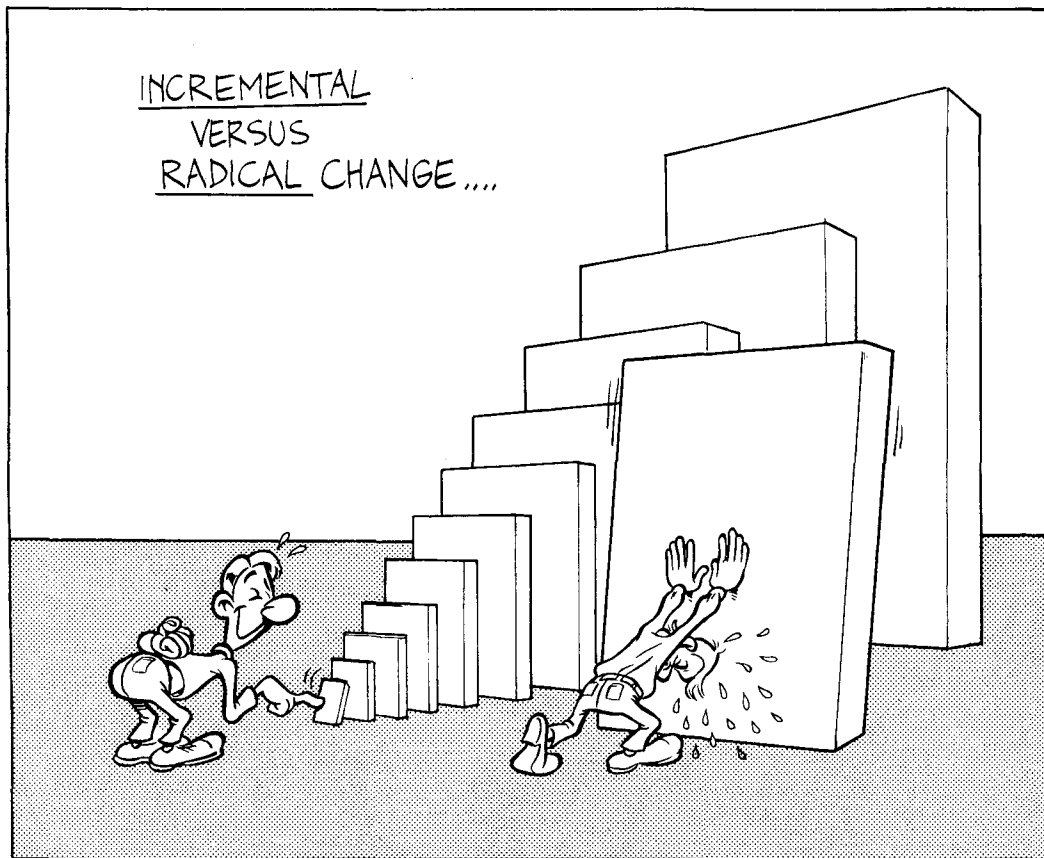
## 4.1 Identifying a new technology/concept

The starting point of any experiment, and thus of any niche development process, should be the mobility and transport problems faced in a specific case. A rough idea of a new concept to be implemented has to be developed by analysing the current situation in terms of mobility needs and objectives, and by exploring new alternatives to respond to them. Depending on the specific problems addressed and objectives pursued (for instance, a more sustainable mobility system for the city), a variety of social and technological options may be of relevance for the targeted problem. The first stage of SNM is to identify these options and give a first approximation of their implications, advantages and disadvantages in technological, economic, institutional, social and process terms. This will also entail the anticipation of the barriers and dilemmas that the new concept would have to overcome in relation to the dominant mobility regime, as expressed, for example, in the positions of the different stakeholders.

Moreover, the objectives associated with an experiment or niche development process need to be made clear. Currently "sustainable mobility" tends to be regarded as a guiding socio-economic and long-term objective, but as long as it is not specified more concretely, it is not a very helpful device for evaluating individual experiments. In other words, in this first phase one should already think about some of the key elements of the later Strategic Niche Management process. The concept identified as promising should be sufficiently specific to inspire other stakeholders, and sufficiently open to be modified during the further experimental process. Below, two major dilemmas during this initial phase are highlighted.

### **Issue 1: Incremental vs. radical departures from the dominant regime**

An experiment with a new technology or concept can represent a minor change in our mobility and transport regime, but it also can have substantial implications for technological structures or mobility behaviour. A concept that differs in many respects from the existing dominant technological regime in transport may be in line with the long-term objective of moving towards a sustainable transport system. But it may find only little support because it is regarded as too challenging and too much oriented towards long-term benefits. Trying to overthrow our current transport system in one go would be regarded as simply unrealistic. A specific experiment should not be overloaded with challenging objectives that can hardly be met within a reasonable time-frame. The Praxitèle experiment pursued very challenging objectives, involving the development, introduction and integration of a broad range of completely new technologies. In spite of meticulous planning this has prevented the full support of a number of important actors in the network and has resulted in a rather negative perception of the entire experiment. In the end, it could not meet the high expectations developed at the outset. (See story 3)



*... seek to keep open a variety of options ...*

On the other hand, technologies that remain close to the current transport context and do not represent a substantial departure from present practices are not really helpful for improving our transport systems. Such experiments may find quite a number of supporters because they represent low-risk options. They do not, however, contain a real promise of change towards sustainable transport.

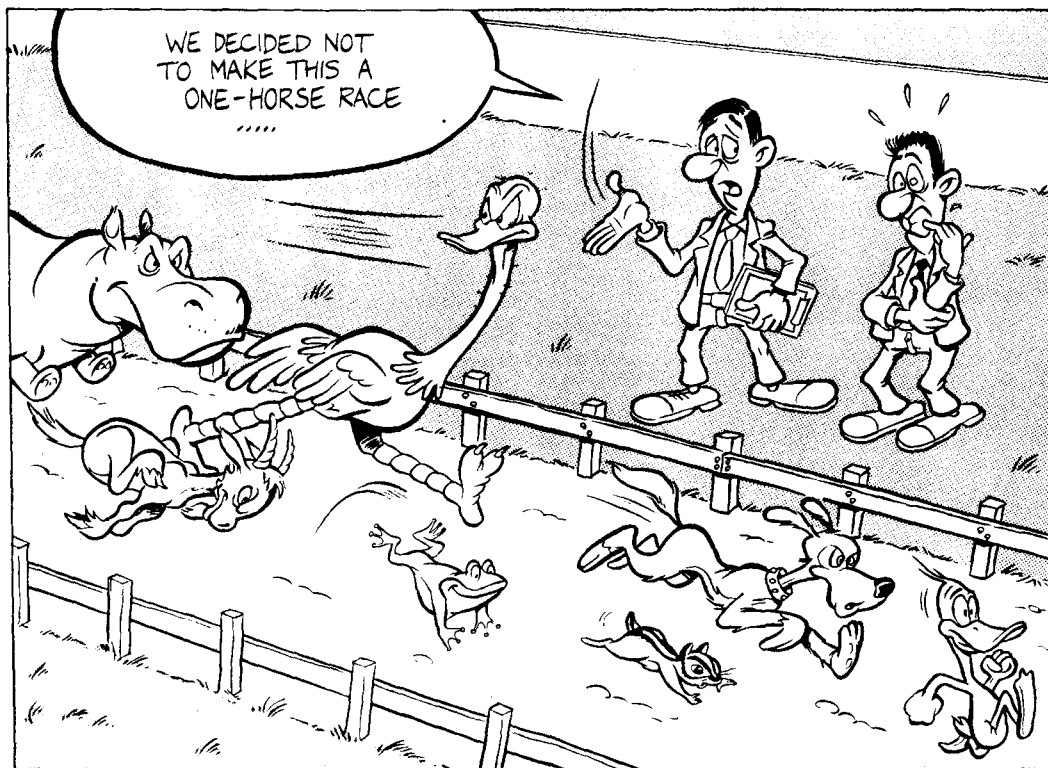
For example, the electric vehicle experiment in Coventry had rather modest aims. They could be met quite easily but in terms of moving towards a more sustainable transport system it was a rather unsuccessful experiment. (See story 3)

Finding a good balance between challenging and achievable objectives is thus the first recommendation for a successful experiment. The success of the car-sharing initiatives indicates another important lesson, namely that a technology which starts off close to the existing transport regime, but promises substantial changes in the longer term, has a high probability of success. While car-sharing essentially builds on our current type of individualised car transportation, it alters significantly the way we use them and makes us more conscious about our real mobility needs. (See stories 4 & 5)

**Suggestion 1:**

Choose a technology or concept which is as close as possible to the existing regime, but which allows to induce more radical changes later on

## Issue 2: Path dependency



*... seek to keep open a variety of options ...*

A decision needs to be made whether to select one technology for an experiment right from the beginning ("picking the winner"), or to follow a more flexible approach of keeping a number of options open. While the first approach focuses efforts and commitment and thus allows for purposive progress along one technological trajectory, it entails the risk of "locking in" to early path dependencies. This does not allow for major changes if the boundary conditions of an experiment change, with regard to improvements in competing technologies, regulations, etc. Most of the experiments under study made such an early choice and had to struggle with adjustment problems down the line.

The second option - keeping a portfolio of options open - allows for more substantial corrections to an experiment once new findings have been made. This strategy has been followed in the case of Mendrisio where in fact a "social laboratory" has been set up where manufacturers can have their technologies tested. (See story 7) As a modification to this second option, complex experiments can be set up in consecutive phases or in parallel modules that enable intermediate changes after each of them. This has been the case for the autonomous railway truck concept developed in South-East Lower Saxony (consecutive phases, see story 9) and in the Praxitèle experiment (parallel modules, see story 3). Obviously, the possibility of keeping the options open and developing different technological pathways in parallel is also a question of available resources. A compromise between openness and the financial constraints must be found.

**Suggestion 2:**

Seek to keep open a variety of technological options; therefore phase your experiments and organise them in modules in order to avoid their becoming too complex.

## **4.2 Designing an experiment**

Once a promising concept has been identified and selected, an adequate experimental environment needs to be designed and implemented. During the design phase, several decisions have to be made which will determine the further structure and implementation of the experiment. The network to be set up, the protection measures to be put in place, the role of users in the experiment and the longer-term perspectives regarding the development of a technological niche - all are of great importance. Moreover, the relationship between the experiment and other competing innovations needs to be carefully monitored, because the latter may outperform the selected concept in the course of time. Experimental design also needs to take into account future changes of the embedding technological regime in order to be "robust" with respect to significant changes in the environment. Each of these aspects requires thinking carefully about the trade-offs between an open setting (which facilitates learning) and tight control (which closely steers the experiment).

### Issue 3: The structure of a network

The design of the network to carry out an experiment is a crucial element in the design phase. It requires a choice between a number of possible constellations. For example, the involvement of many different actors may be helpful in establishing a broad base of support, but too large a network may increase the risk of making decision formation complex and slow. The experiment becomes unmanageable.



*... the design of the network to carry out an experiment is a crucial element in the design phase ...*

While it is essential to achieve good coverage of the most relevant actors (such as technology suppliers, operators, authorities and users), one should aim for a rather limited number of partners. The partners, however, should guarantee a high mobilisation potential (see below) in the longer term, that is, in view of a wider niche development process. Similarly, a clearly defined network of highly committed partners may be very effective in implementing an experiment, but it may be too inflexible and closed once changing boundary conditions of an experiment require the modification or restructuring of the network.

The same problem can emerge in networks which are centred around one or a few dominant actors, like a single large company. This may give a project stability and provide access to knowledge, financial status and resources (in other words, a high "mobilisation potential"), but it also brings about problems of bureaucracy and organisational conservatism. These can hinder learning and critical reflection about an experiment. Small companies are often better at learning to improve the technology, but their limited resources and influence put serious constraints on their ability to start up and organise the more widespread diffusion of a new technology. In addition, companies involved in many interrelated activities often may be rather reluctant to engage in radically new technology. If they do they may tend to follow a cautious strategy. New bottom-up initiatives by small actors may therefore be highly effective and desirable for initiating the development of infant transport technologies, but they may require encouragement, for instance, by way of easily manageable forms of governmental support.

In essence, a network for an experiment should be driven and guided by a network manager, even if the experiment has to rely on the joint effort of all partners. This joint character is crucial because the network members have to bring in their complementary fields of expertise needed for the different aspects of an experiment. The support and legitimacy which public policy-making institutions can lend to an experiment are very helpful for facilitating such a joint effort.

These network problems can be illustrated by looking at some of the cases studied. The trucks on rails experiment on the Swedish west coast met with limited success. Within the large organisation running the experiment, no exchange of experience from earlier projects of a similar kind in another division took place. (See story 2). In the ASTI experiment, on the contrary, a network of highly committed partners could be established which were able to learn from each other and were stimulated in their actions by some highly motivated individuals. (See story 1)

**Suggestion 3:**

Keep the experiment sufficiently broad in terms of partners (users, suppliers, government, operators) and have committed partners in the team.



#### **Issue 4: Successful experiments and successful niche formation processes**

There is a clear difference between the objectives of an experiment and the importance it may have for a niche development process. An experiment can be very successful with regard to its pre-defined objectives, but it may be without any major impact on the evolution of the wider technological niche to which it belongs. A good experiment does not guarantee a valuable contribution to niche development if, for example, the level of aspiration is very low.

On the other hand, even an experiment that has apparently failed may be a success when looking at its role for niche development. Important lessons can be gained from a failed experiment. It is important to make these lessons and insights available to others working in the same niche and on similar experiments. In this sense, a failed experiment may turn out to be extremely successful for advancing the technology and its wider deployment.

These two extremes are exemplified by the EV experiment in Coventry and the Praxitèle case referred to earlier. The former was successful in meeting modest objectives but provided limited insights for the niche development process. The latter case has allowed for major improvements that are expected to have a significant impact on the development of the entire EV niche in Europe. But the view so far is that it has been of limited success.

#### **Suggestion 4:**

A successful experiment needs not be conducive to niche formation, and vice versa.

#### **Issue 5: Protection measures and competitive incentives**

In the design of the protection measures needed for the experimental technology, a careful balance ought to be struck between overprotection and a high level of selection pressure. It is important to select (or define) a protected space in which the new technology can be used at relatively low costs and can cause as little disruption and discomfort as possible. At the same time, selection pressures need to be stimulated to prepare the technology for market forces. In other words, one has to look for situations where a minimum level of protection is sufficient to further the development of the technology.

In practice, such protected situations can be established by defining certain applications (e.g., the use of solar cells for pleasure boats), geographical spaces (a region or a city) or organisational units (a company). Additional specific local protection measures can be applied in such spaces, either in the form of regulations (such as access restrictions), financial measures, or (in a bottom up manner) the willingness of idealistic users to bear certain disadvantages of the new technology. The case studies provide information on these types of protection measures.

Established technologies are already protected by a number of mechanisms that stabilise their dominance. Similar mechanisms need to be implemented to establish a new technology or concept. Industrial standards are a formalised example of such mechanisms but they tend to be rather conservative in scope. Others are the shared visions about what is regarded as feasible. An important protection mechanism for a new technology is thus to convince the actors and stakeholders involved in its implementation that it is in fact a feasible and reliable option.

Government support and protection can be of crucial importance in order to give an experiment legitimacy and stability in the start-up phase. On the other hand, for the partners, the need to provide complementary funding can make the experiment a risky project in financial terms. In addition, the reliance on external protection may weaken the development of autonomous learning processes. Finally the need to tackle the formal administrative side of government support represents a burden, especially for small partners. The car-sharing initiatives in Switzerland faced exactly these types of difficulties when bidding for a government grant. (See story 4)

The crucial dilemma of protection measures is that they should protect the technology and at the same time stimulate its advancement and prepare it for the selection pressures of a market environment. Measures that essentially simulate market mechanisms while reducing their pressure can be very effective. Others such as access restrictions or a different taxation system may be designed to pre-empt the conditions of the envisaged technological transport regime of the future. Such a strategy has been applied in the cases of La Rochelle and Mendrisio, where the protection measures attempted to tip the economic balance in favour of the new technology, while keeping the normal incentive mechanisms in place. (See stories 12 & 7)

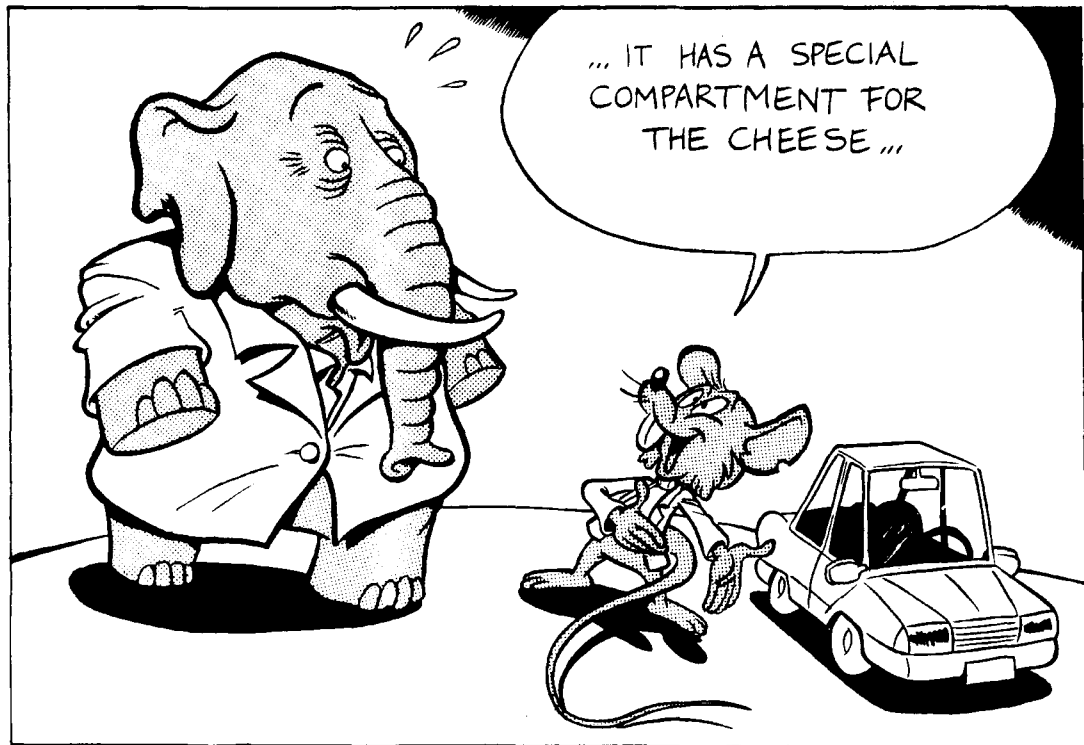
Too much protection is likely to result in a technology that fails under regular market conditions, once protection is lifted. An example from the case studies is the PIVCO electric vehicle, which has received very strong protection from some of the main industries in Norway as well as the government, but when tested in practice outside the network was barely accepted by the users (See story 11).

**Suggestion 5:**

**Explore which types of market pressures could be operational in the experiment.**

## Issue 6: Involvement of users

Probably the most important issue in the design phase concerns the extent to which the experiment can assess the requirements and needs of the potential users. There should not be too wide a gap between the experimental conditions and the conditions under which the technology will be applied on a large scale. This gap can be bridged by preparatory measures. Users should be put in a position that allows them to voice their requirements critically and communicate them to the network of actors involved in the experiment. This provides inputs for product improvement. In fact, major innovative impulses can come from the user side, as was the case in the car-sharing initiatives in Switzerland. (See story 5) They were borne by the users in a bottom-up manner. A negative example is the trucks-on-rail case on the Swedish west coast, where essential user needs were widely ignored. (See story 2)



*... assess the requirements and needs of the potential users...*

In a similar way, the interests of the shop-owners in Düsseldorf were not sufficiently taken into account when implementing the experiment with city freight distribution. (Story 15)

However, the profile of users changes during the lifetime of an experiment and even more when it develops into a larger niche. Pioneer users can be expected to meet a rather narrow profile of needs; they tend to be quite positive about the technology in question and are willing to accept certain inconveniences. The mass of users is more sceptical and has different and more differentiated requirements than the pioneer users. Trying to meet the requirements of the pioneer users at any costs can lead to dangerous path dependencies which prevent the customisation of the technology to the needs of the wider public once it enters the diffusion stage.

The involvement of users does not come about automatically; it needs to be planned in the design of the experiment. Monitoring activities, regular meetings and the active involvement of users in the actual development and design process of an experiment are some of the options available to achieve involvement.

**Suggestion 6:**

Create opportunities for the active involvement of pioneer users in the early phase of an experiment, and of mass users in its later phase.

### **4.3 Implementing an experiment**

The implementation of an experiment is often the most difficult stage of the SNM process, because a balance needs to be struck between protection and selection pressure, between targeted implementation and openness to change. This needs to be done not only in theory (as in the design phase) but in the real world where the initial plans may face opposition and institutional inertia.

Barriers of very different kinds can hamper the effectiveness of an experiment. They may be technical; that is, complementary technologies, the necessary infrastructure or the appropriate skills to operate the new technology may be lacking. The barriers also can be of an economic nature. The new technology may be unable to compete with conventional technologies due to the prevailing cost structure. Manifold social and institutional barriers exist as well. They relate to established transport practices and habits or to conflicts of interests among companies affected by an experiment.

The final objective during the implementation of an experiment is to learn about these barriers and to adjust and attune the technology, the social practices and the assumptions regarding mobility. These learning processes not only change the expectations of the partners in an experiment; they also affect the communication with outsiders to the experiment.

## **Issue 7: Communication with the wider public**

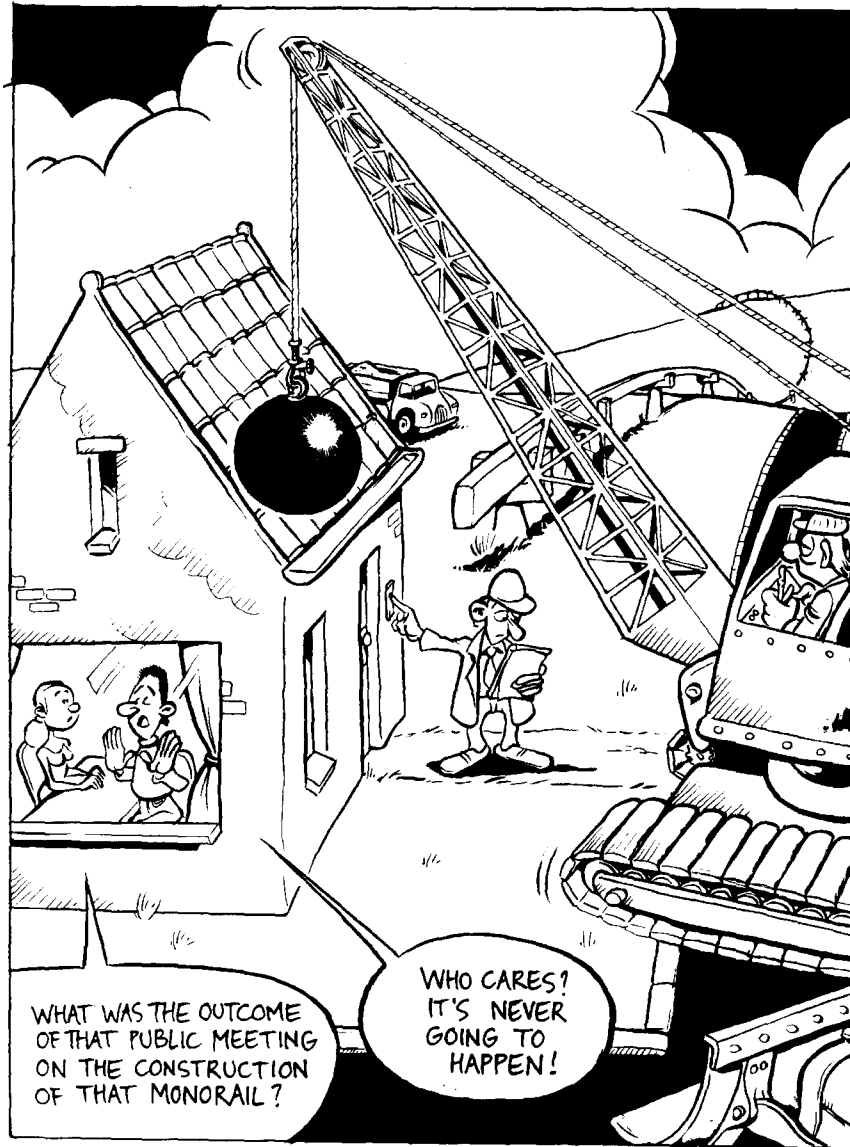
It is important to distinguish between the users of an experimental technology and the wider public affected by it. The latter can be represented by political actors, by neighbourhood organisations, by trade associations, etc. Experiments are regularly met with scepticism and opposition, be it from the public, from political actors or from the established transport communities, because negative side-effects are feared. An experiment may have to be entirely abandoned if the opposition from the wider public is very strong. On the other hand, outsiders to the experiment can provide important inputs for innovation, just as they can represent important sources of opposition. This implies that the communication of the public's needs to those carrying out a demonstration project is important for learning of the technology's unexpected side-effects, including the side-effects on those who are only indirectly affected by the new technology.

In Bologna, for example, the introduction of the zone access control system was delayed due to the resistance of trade associations (among others), which feared a reduction of sales if the access to the city centres was restricted. (See story 6) Driverless trains developed in Germany ultimately may be unsuccessful due to (excessive) safety concerns, raised by outsiders to the experiment. (See story 9)

This points to the need to check, elicit and monitor the interests and motivations of the relevant actors outside of an experiment, and especially the potential sources of critique. Certain preventive measures can help to prepare for such kinds of critique. If differences of interest are at the core of opposition, then compensation measures may help to alleviate the problem. The involvement of critics in the planning process of the experiment also can help to overcome opposition.

### **Suggestion 7:**

**Create opportunities for discussing results of the experiment with groups that are not actively involved in the experiment but are affected by it.**



*...side-effects on those who are affected by the new technology...*

## **Issue 8: Broader expectations of partners**

In the early years of technology development, the problems and promises of a new technology are often not evident and need to be proven. Promises of a new technology can be very powerful forces in advancing its development, especially when supported by solid facts and tests on their social and technological implications. Partners involved in an experiment have often quite different expectations with regard to the technology. They may differ in terms of their level of aspiration (from modest to utopian) as well as in terms of content. Different interpretations or visions are developed by different partners with regard to how the technology should look in a couple of years' time. These expectations are often vague and tacit, but they are strong motivational forces and therefore important for partners making real commitments. On the other hand, a certain degree of convergence of interpretations of the new technology needs to occur among the partners in order to achieve a targeted collaboration.

During the process of niche management, it is therefore essential that the problems, expectations and often tacit interests of the partners participating in an experiment are made explicit and are addressed in the network. In the end the partners need to agree to a common and co-ordinated strategy for moving the experiment forward. The MOVE-INFOREGIO case has shown how diverging visions and interests can endanger and slow a promising experiment. The car industry did not engage fully and extensively in the MOVE project. They felt the interests of motorised individual traffic were being subordinated to those of regional and local public transport. (See story 10) Similarly, in the case of city logistics in Düsseldorf, the freight forwarders were not really willing to co-operate with their competitors (Story 15).

This implies that it is not enough to monitor the performance of a new technology and the associated user needs. Of equal importance are the reactions of the network partners during the time span of the experiment so that commitment remains high. Specific mechanisms and procedures should be anticipated in an experiment to deal with changing expectations of the partners. Close co-operation between the partners (as in the case of the Bikeabout scheme) is feasible in a smaller network. Mendrisio provides a good example of the outcome of monitoring all partners and users in a more complex experiment. (See stories 8 & 12)



*...partners involved in an experiment have often quite different expectations with regard to the technology ...*

**Suggestion 8:**

Monitor the tacit and vague expectations and visions of participants and articulate them specifically.



## **Issue 9: Learning about the different facets of an experiment**

Experiments are unique socio-technical laboratories for learning about the problems, shortcomings and barriers a new technology face. They are often the only way to learn from users and to find out which modifications are required to make the technology viable. At a first level, such learning processes refer to the technology in question and require articulation of the full range of implications. These can be:

- technical aspects and design specifications, for instance regarding requirements of adjustment to the technology to overcome initial limitations;
- complementarities with existing systems and infrastructures, including the establishment of adequate maintenance infrastructures as in the case of recharging infrastructures for EVs;
- the production constraints of the technology, for example regarding the need to apply advanced production technologies for lightweight materials;
- the market pressures which the technology will encounter, for instance regarding the user/consumer needs and requirements. In the case of the trucks on rail experiences in Sweden this aspect was not given sufficient attention;
- the implications for government policies at different levels, such as the adjustments of the policy framework (in terms of fuel taxes or access regulations, for example) needed to make the technology viable;
- the social and environmental benefits expected from the new technology, which often serve as justifications for government policies; these benefits are not necessarily shared and need to be made explicit as the debates about the advantages and disadvantages of electric vehicles have shown; and
- the cultural and psychological meaning of a new technology which can differ substantially from that of established technologies; for example car-sharing reflects a very different emotional relationship to the vehicle than individual car ownership.

The case studies have shown that experiments usually cover only part of the learning processes, and do so with varying degrees of success. Competitive elements and incentive mechanisms can represent strong stimuli for learning and creativity, especially when different alternative possibilities for implementing an experiment are available. Here, the challenge is to find the right balance between competition and protection to make the learning process as efficient as possible.

The experiment needs not achieve its initial objectives for learning to take place. Failures contribute (and are even essential) to learning, especially if a technology is to be developed and implemented further in different experimental settings. Learning about an experiment is obviously closely related to the issue of monitoring what has been articulated and making it explicit.



*... which symbolic meaning can be ascribed to the new technology ...*

**Suggestion 9:**  
Seek broad coverage of opportunities for learning about new implications of a technology

## **Issue 10: Learning about underlying assumptions regarding mobility**

Beyond the experiment-specific aspects of learning, there is also a second level of learning dealing with the way users and project partners think about mobility. Usually, everybody has certain implicit assumptions in mind about standard patterns of mobility behaviour as well as about what he/she regards as desirable. For example, the availability of individual vehicles favours an attitude of having immediate access to a transport means at any time. In contrast to this, the information systems developed in the MOVE-INFOREGIO project enable far better planning of trips. (See story 10) Similarly, the need to plan trips in advance leads to a more conscious reflection by the users about their actual mobility needs. Both intermodal transport chains as well as car-sharing schemes are more favourable to forward-looking mobility behaviour because they require at least some degree of advance planning. (See story 4 & 5) Such a planned mobility is increasingly facilitated and made more flexible by advanced travel information and telematics systems. These examples, as well as the case of light-weight electric vehicles in Mendrisio (see story 12), show that users also have to learn about their own mobility needs which they may perceive differently when new types of technologies become available.

This type of "second-order learning" about social practices is important not only throughout the experiment, but in particular when a more radical experiment is scaled up and exits the laboratory. It then starts to challenge the dominant mobility regime and subsequently induce behavioural changes on a larger scale. This implies that second-order learning needs to be goal-oriented, for example with regard to the achievement of a "sustainable" mobility system, even if this may be a quite fuzzy vision.

### **Suggestion 10:**

Reflect upon existing mobility patterns and changes which the new technology may bring about in relation to the mobility objectives pursued.

## **4.4 Expanding an experiment to a niche**

When approaching the end of a single experiment the question of follow-up will arise. This means that 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 that makes it relevant beyond the local level. In large experiments an increase in scale may already be anticipated from the start (such as in the case of Praxitèle), 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 that 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 the integration an experiment into the context of similar activities going on elsewhere and establishing its technology on a larger scale. The 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 in the network, the setting up of partner experiments, or a modification of the regulatory and political framework facilitating 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. Four important issues for which a network of partners of an experiment should be prepared are discussed in the following.

### **Issue 11: Changes in the carrying network**

When moving from a small-scale to a large-scale experiment the decisive factors for progress and success change. A small experiment can still progress on the basis of the idealism and the initiative of some individuals who are rather loosely interconnected. 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. This has become evident in the case of the transformation of the car-sharing initiatives in Switzerland (which started off as bottom-up grassroots movements). They became centralised and professionally organised organisations once a certain size of the network was reached and the old organisational structure could no longer cope with the changing operating conditions. (See story 5)

However, the example also shows that neither grassroots movements nor professional networks are the keys to success. Rather, it needs to be recognised that both types of organisations have advantages that are brought to bear in different phases of an experiment or niche development process.

Beyond mere professionalisation, changes in the membership structure of a network may have to be considered as well. 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. Impulses from outsiders or new members can also redirect an experiment and give it new momentum, and thus be very positive for its success. A well-known example is given by the history of Smart. Only when Volkswagen had been replaced by Daimler-Benz did the development of the Smart vehicle (which can be regarded as a large scale experiment) go ahead.

The management of an experiment differs from the management of a niche also 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.

**Suggestion 11:**

Be aware of changing requirements in terms of network structure  
in the course of the progress and scale-up of the experiment.

### **Issue 12: Complementary policies**

Once a new technology leaves the test-bed of an isolated and usually small-scale experiment, it becomes important to connect it to its wider social, economic and political context. This scaling-up process depends in many cases on fitting it 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 the case of the Bikeabout project, for example, several complementary policies were put into place to encourage non-car drivers to use bicycles, but they were not sufficient to discourage people from using their cars. (See story 8)

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. This was the idea behind the City Logistics programme in North-Rhine Westphalia, for example (See story 15).

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. In the case of PIVCO, the involvement of the largest Norwegian firms provided both legitimacy and financial support. (See story 11)

It may prove difficult to move beyond the experiment. The case of the light electric vehicles in Mendrisio shows some promising starting points for scaling up. In parallel with the experiment, a number of other

Swiss cities have received limited support for electric vehicle projects and are already quite well prepared to take over the experiences from Mendrisio and extend the experiment in these locations. The city of La Rochelle has followed a very interesting approach as well, because its EV-oriented policy has been complemented by the establishment of a network of companies in the region which are involved in EV-technology development.

**Suggestion 12:**

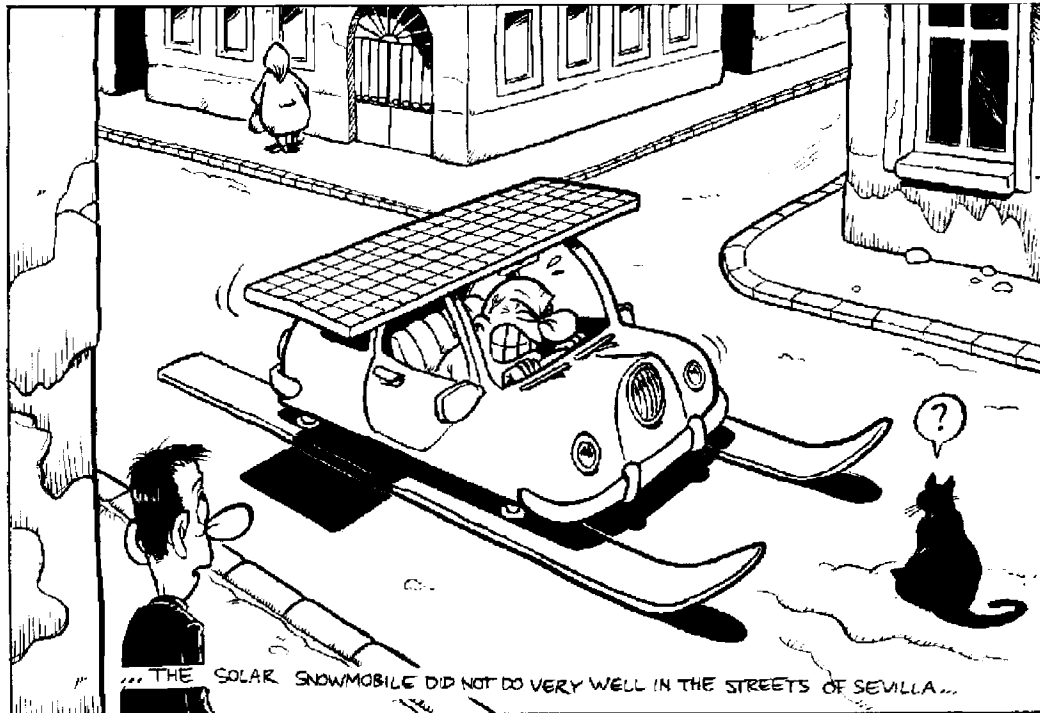
Consider which kinds of complementary policies could be conducive, needed or detrimental to the experiment.

**Issue 13: 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 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. The dissemination of experiences and lessons has benefits not only for those participating in the experiment, but especially for new and follow-up projects. The failure of the Rolling Highway experiment on the Swedish west coast is to be blamed on the lack of the transfer of lessons learned in another similar experiment in the north of Sweden. The development of a wide network of contacts with other activities going on in the same niche or field helps to make an experiment a "success", in this broader sense of disseminating experience, even if it is perceived as a failure in itself. The Coventry electric vehicle experiment is a good example of such a "spin-off" from earlier experiences in La Rochelle. When undertaking the experiment they obviously learned a lot from these earlier experiences. (See story 13) Also, the city logistics programme in North-Rhine Westphalia facilitated at least some limited exchange of information among different experiments. (Story 15)

**Suggestion 13:**

Look for opportunities to replicate an experiment and try to keep the experiences stored in a network.



*...look for opportunities to replicate an experiment ...*

#### **Issue 14: Changing requirements during niche expansion**

The transfer issue has shown how the management of individual experiments and the whole niche are interconnected. However, the conditions for the new technology change significantly when it is upgraded from an experiment to a broader niche. In particular, the mass users, to whom the innovation needs to be targeted in a wider transport technology market, have a different and more diversified profile than the original "pioneer users" who may have accompanied the experimental phase. While originally a targeted learning process may have been crucial to the experiment, the possibilities to provide a customised service or product for a broad variety of users are more important in the phase of niche expansion. Moreover, pioneer users are more willing to accept certain disadvantages of the new technology and may be very happy with it. A normal customer may be less tolerant and require her own personal quality and performance standards to be met. The main risk is that the positive experiences with the pioneer users may

lead to overoptimistic estimations of the market potential of a new technology or concept. Evidence for this effect is provided by the experiences with electric vehicles (Stories 4 and 10) or car-sharing (Story 11).

**Suggestion 14:**

The technology or concept needs to be customised  
when the pioneer market turns into a mass market

## 4.5 Review of the protection of an experiment

Strong protection can smother autonomous, bottom-up learning processes and improvements that are necessary to make the new technology or concept fit for market competition. There needs to be a credible threat of removal of protection in order to exert enough pressure for improvement. An important aspect of an experiment is thus the phased breakdown of protection. This raises the question of results, impacts and follow-up activities. Protection is usually removed at the end of the experiment, but sometimes during the course of the experiment.

It is possible that the breakdown of any protection will result in an unprotected continuation of the experimental activity, extension and growth. In this case, the positive experiences in the experiment have created sufficient momentum in terms of support, experiences and improvements that the experiment can be expanded and can be made to survive even under unprotected conditions. The technology is ready to enter a market niche.

The protection of a niche differs from the protection of an experiment. While an experiment usually benefits from very specific, situational protection measures, a niche can be protected by adjustments of the policy and regulatory frameworks.

Many experiments end up with no planned follow-up activities. This usually will be perceived as a failure, but even in this case the experiment may play a useful role in delivering valuable insights for new experiments with the same or a similar technology, and thus for the niche development process as a whole. In order to continue to exploit the findings of a failed experiment, one also should consider in detail the different "exit options", i.e., the possibilities to stop the niche development process with the end of an experiment because the results do not justify an extension on a larger scale.



### **Issue 15: Structure and timing of specific protection measures**

The duration and nature of protection of an experiment is something to be negotiated, before and during the experiment. Protection should be removed in two instances. First, it may be removed when there is little or no sense in maintaining or extending protection, that is, when the prospects for the technology are dim. Second, it may be removed when there is no need for protection, because the technology is highly successful and sufficient stabilising and reinforcing mechanisms have been established, such as a network of supporters, users and suppliers. Obviously, this is the ideal result of an experiment and in the cases studied only the car-sharing experiment has led to such an expansion, enabled by a restructured organisation. In most cases, some kind of protection remains necessary for further development of the technology.

Project evaluations by outside experts may help to determine the need for maintaining (a high level of) protection. Protection is best phased out in a gradual, orderly manner, in order to prevent transition problems for the people and companies involved

#### **Suggestion 15:**

**Seek to establish productive and smart ways of protecting an experiment**

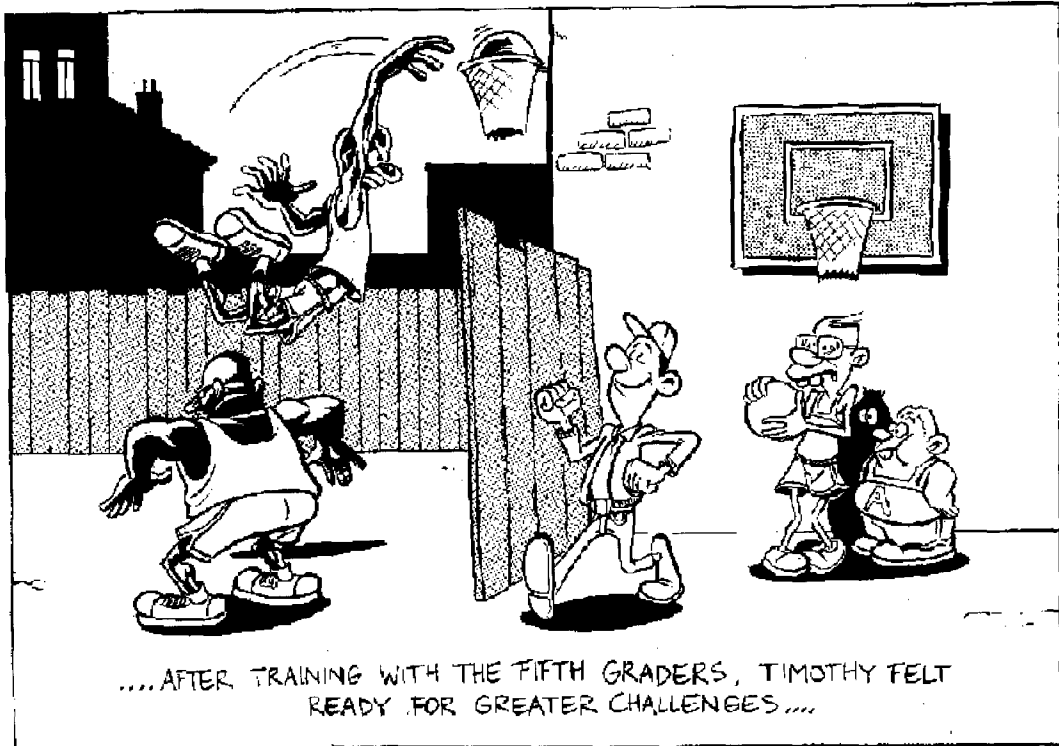
### **Issue 16: Generalised protection of a niche**

More widely used technologies may be implicitly protected by the dominant regulatory and policy framework rather than by very specific measures. This protection is more generic and provides the general settings for all kinds of transport technologies and concepts, including the niche technologies. The tax regime, environmental regulations, generalised access restrictions in cities, speed limits, organisational integration of providers of different types of transport services, etc. are all examples of such generalised protection mechanisms. In the car-sharing example (Story 11), this kind of niche protection was achieved once co-operation agreements were made with the local transport operator in Zurich or with normal car-rental firms. In general terms, one could say that a technology has become compatible with the dominant technological regime, because either the technology or the regime has been adjusted.

The technologies that have emerged within the dominant technological regime of transport are usually protected by similar mechanisms. For example, the financing arrangements for road infrastructures protect the car regime, and the fuel tax system favours combustion engines because the external costs are not fully considered. The crucial challenge for the establishment of a new niche is therefore to establish certain generalised protection mechanisms that favour the new technology and thus reinforce the niche. Obviously, the decisions about such generalised protection are taken at the political, often national, level. The process of network development and learning thus needs to be moved from the experiment level to the niche level.

A "robust" innovation should be able to survive in a variety of regulatory and policy frameworks without having to recur to specific protection measures. Such aspects ought to be considered early on during the experiment

Suggestion 16:  
Seek to establish productive and smart ways of protecting  
a niche as part of the prevailing transport framework



*...a "robust" innovation should be able to survive without protection measures...*

### **Issue 17: Continuation or termination of an experiment**

Once an experiment has evolved into a self-sustaining niche, protection measures can obviously be removed. This ideal case is not very common, however. What to do if an experiment cannot be upgraded to a niche without maintaining specific protection measures for a long period of time? This can happen if, for example, no generalised protection measures can be established which would allow for the further development of the technology market within the normal legal and regulatory framework for transport. Obviously, if the technology is very promising in the long term, it may still be justified to keep the specific protection, but usually one will have to find ways to stop an experiment.

Two major problems have to be addressed when abandoning an experiment. First of all, many actors have invested emotionally and financially in the project. They may feel that their investment and efforts will be lost. This is probably an inevitable consequence, but it will be easier to accept if the risk of withdrawal of protection was clear right from the beginning of an experiment. As mentioned before, this pressure can even be a very strong stimulus for creativity, if the threat of withdrawal is credible.

Secondly, the lessons learnt in a failed experiment can still be very valuable for other experiments and development processes. It may sound strange, but the dissemination of information about failed experiments can be as valuable in terms of learning as success stories. Often the accumulated knowledge of an experiment gets lost because there is no carrier organisation anymore. As the experiment was based on a network - that is, on a rather informal organisation - the knowledge can be saved if a new organisation can build on the experiences made, for instance, if a different experiment targeting the same problem area is set up. (See Story 2). "reson" is a stable organisation behind an experiment which appears to be a failure, but the lessons learnt are kept and can be brought to bear in other experiments.

**Suggestion 17:**

When phasing out a niche development process, try to enrol the established network into the development of other options for addressing similar problems.

## 5. Storylines of Strategic Niche Management Practices

To illustrate the issues raised in Chapter 4 it is useful to consider particular lessons which have emerged from previous European transport projects. A number of elements from the cases studied clearly indicate good solutions to the SNM process at different stages, and some of the lessons will be revisited in the following "storylines". These examples illustrate a number of key issues, showing how typical problems can be successfully or badly addressed. These are now presented to stress particular issues that can affect successful project management.

The stories in this chapter can be read independently, as a group or in conjunction with the 17 issues discussed in Chapter 3. Many of the stories are designed to highlight more than one issue; also each issue may be illustrated by a number of stories (see overview below). Therefore, to assist with using the stories, the tables given below show how the issues and stories compliment each other in discussing the main points raised by Strategic Niche Management theory.

Issues...	Corresponding stories...
Issue 1: Incremental vs. radical departures from the dominant regime	1, 4
Issue 2: Path-dependency	2, 10
Issue 3: The structure of a network	3, 9
Issue 4: Successful experiments and successful niche formation processes	4
Issue 5: Protection measures	5, 14
Issue 6: Involvement of users	6, 9
Issue 7: Communication with the wider public	7
Issue 8: Broader expectations of partners	8
Issue 9: Learning processes about the different facets of an experiment	9, 6
Issue 10: Learning about underlying assumptions regarding mobility	10
Issue 11: Changes in the carrying network	11, 13
Issue 12: Complementary policies	12, 15
Issue 13: Transfer of an experiment	6, 9, 15
Issue 14: Changing requirements during niche expansion	4, 10, 11
Issue 15: Structure and timing of specific protection measure	14
Issue 16: Generalised protection of a niche	11
Issue 17: Continuation or termination of an experiment	2

<b>Stories...</b>	<b>Case-Studies..</b>	<b>Corresponding issues...</b>
Story 1: Unintended Consequences	Bikeabout	1
Story 2: Walk Before You Run	Autonomous Rail Road Trucks	2, 17
Story 3: Selecting Partners	ASTI	3
Story 4: Balancing Ambition	Coventry + Praxitéle	1, 4, 14
Story 5: Funding to Death	Car Sharing	5
Story 6: Listen and Learn	Coventry	6, 9, 13
Story 7: Expecting Opposition	Bologna	7
Story 8: Great Expectations	MOVE + INFOREGIO	8
Story 9: Network Amnesia	Swedish Rail	3, 6, 9, 13
Story 10: Driving Lessons	Mendrisio	2, 10, 14
Story 11: Managing Style	Car Sharing	11, 14, 16
Story 12: Seeking Compliments	Bikeabout	12
Story 13: Blind Optimism	La Rochelle	11
Story 14: Overprotection Racket	PIVCO	5, 15
Story 15: Co-operation among competitors	Düsseldorf	12, 13

## Story 1: Unintended Consequences

For short-distance travelling, cycling offers a cheap, efficient, fast and healthy mode of mobility. It can improve human health and reduce congestion and transport generated pollution. Though bicycle loan schemes offer a way of enlarging the bicycle sector, many previous projects have faced serious operational difficulties and have failed due to the bicycles being stolen or vandalised in their open racks. The Portsmouth Bikeabout experiment seeks to address these issues by applying advanced technology to provide a controlled and protected environment for a shared bicycle scheme. In the project, one hundred bicycles are offered for short-term use and can be collected from three secure automated cycle depots. Users are issued with a Bikeabout smart card to be inserted into the console at a depot. The computer instructs an electronically controlled rack to release or accept a bicycle, events that are centrally recorded. The system is reliable, works well and no bicycles have been stolen or vandalised.

A significant part in the project has been played by the supplier of the electronic bicycle stands, B. Dixon-Bate Ltd. Although not technically a "partner" on the scheme, they have exceeded their duties as a supplier and carried out detailed development work with a software company. Under the terms and conditions of the EU funding agreement the official partners of the scheme, Portsmouth City Council and the University, have not been allowed to personally profit from the scheme; nor have they considered

commercial development to be within the remit of their organisations. However, they have been prepared to allow B. Dixon-Bate to take over the Bikeabout concept and market it as their product. With this additional profit incentive, the company have subsequently sold the system to the city of Rotterdam where several Bikeabout depots have been built.

Although Bikeabout aims to promote cycling, in the future the smart card technology and operational system developed for Bikeabout could relatively easily be transformed for application on other types of rental or loan schemes. Indeed, B. Dixon-Bate are currently investigating the application of the concept to an electric car loan scheme (like the Praxitèle project). This opens the way for smart card technology to be instrumental in a highly strategic and radical shift in the transport sector. Applied to cars as well as bikes, the smart card system could be used to promote a paradigm-challenging regime change relating to the ownership of and access to motorised transport. Smart cards also have the potential to facilitate a means of combining modes such as bicycle, car hire and public transport, all accessed using one smart card.

The Bikeabout scheme has not strictly "forced" new technology to emerge; rather it has provided the impetus to apply existing technology. This has given partners new incentives to refine and develop the system and to seek to extend the range of marketable applications originally considered. Although the original project had quite modest aspirations, the experiment has shown the partners that the technology employed can be applied to a very large number of applications. Some of these will challenge the existing private car dominated transport regime.

**Lesson:**

Well chosen small innovations can lead to unexpected opportunities  
which can have major impacts upon the existing transport regime.

## **Story 2: Walk before You Run**

The German railroad company aims to gain shares in the market segment of shorter distance freight transport by introducing rail freight innovations. These include the short train unit "CargoSprinter", which can be operated according to the "Train Coupling and Sharing" concept, the driverless, signal-controlled traction unit SST and the development of autonomous railroad trucks. The latter technology involves unmanned, self-powered wagons operating on-demand. These would allow quick and flexible shorter distance transport of relatively small volumes of freight between any two points on the railroad network (as occurs at present with road transport).

The SST provides a good testing ground for some of the concepts of autonomous rail trucks as they are both driverless (in principle) and are operated when required by the customer, without the need of a fixed schedule. However, contrary to autonomous railroad trucks, the traction unit tows several wagons and is controlled by signals transmitted by induction loops under the track. The main goal of the SST project is to test and demonstrate the technology for driverless operation of trains, and stimulate the definition of legal boundary conditions, especially in relation to safety provisions. The tests have been reasonably positive though there has not yet been actual driverless operation, as a driver always has to be on-board for legal and safety reasons.

The first step in the development of autonomous railroad trucks will be to get the technology working and a test track is being planned for this purpose. The technology involved in both steps is quite different, and only the safety requirements and associated psychological concerns among customers and wider public also will be applicable to autonomous railroad trucks.

In parallel with the SST experimentation is the "regional freight train" concept proposed by the regional development agency "reson". This consists of the development of short trains for flexible, on-demand operation in the region (step 1) and later of autonomous railroad trucks (step 2).

What is interesting about these two concurrent series of experiments is the planned stages which constitute a phased development of autonomous railroad trucks. In the short term, it is unlikely that full autonomous trains will be realised, especially since legal issues relating to safety issues and infrastructure modifications have to be addressed. However, the success of the CargoSprinter and the early testing of SST have shown to both the project partners and external observers that the ultimate goal is worthy of continued development.

What is of note here is that, as the projects have been staged in their design, the concept of autonomy on the rail network has been methodically developed with a degree of success. If a project had aimed for total autonomy from the start, it would clearly have failed. As it is, as each stage is completed, the concept can be demonstrated to the wider transport community and lessons learnt can be incorporated within the next phase of development.

**Lesson:**

Modular projects allow for changes to be made in light of the experience gained.

### Story 3: Selecting Partners

The ASTI project involves the development and introduction of a small fleet of electric and compressed natural gas powered mini-buses accessible to people with reduced mobility. The choice of the partners has proved crucial for the success of the project. In particular, what has emerged in this experiment is the importance of the partners' commitment. This is not always the case, as project partners are often more interested in short-term goals such as improving public relations, receiving government funding and selling components. For ASTI, it has been critically important to assess the motivations of participating actors and link up to their core motivations and not to the periphery of their interests. The project has therefore sought to distinguish between "partners" (participants that are willing to share in the responsibility for the success of the experiment) and "suppliers" (who have little or no stake in the process and are more-or-less expendable).

In order to find committed partners for the ASTI scheme, a form of competitive selection was chosen by the central project team. Interested organisations had to convince the team of their ability to work co-operatively. Unlike conventional tendering which merely aims to find the most competitive price, this process was designed to test the commitment of the potential partners. ASTI initially contacted around hundred potential partners, from which forty replies were received. After involved discussions had occurred, preferred companies were invited to meet with the ASTI team, to see the project site and describe what they could bring to the project. ASTI then had to balance what the organisations offered with the mix of partners that ASTI required and which would constitute a viable partner network.

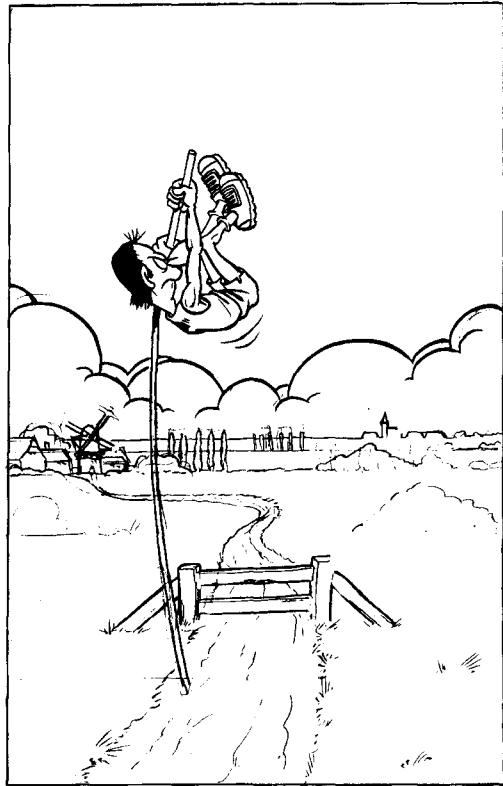
For some areas of expertise, there was more than one bidder. Of the two battery companies approached, one merely quoted a price for the batteries required and was rather unco-operative. In contrast, the other company were not only open to the proposal, they were also very enthusiastic about the ASTI project and were impressed by the integrated battery and engine management electronics. The latter company were obviously more likely to contribute to ASTI's success and were therefore chosen to join the project. In the event they have "performed excellently". The commitment of this company together with the other partners has been a major contributor to the project's high level of success.

**Lesson:**

**Committed partners increase the chances of project success.**



## Story 4: Balancing Ambition



*...high-risk, high reward project vs. low-risk, low achievement project...*

The Praxitèle EV rental project makes electric cars available for self-service rental. The concept aims to increase intermodal travel in and around urban areas to reduce congestion and improve air quality while maintaining access to individual modes of mobility.

Praxitèle is an example of an experiment with an excessive level of ambition that to some extent has risked the success of the short-term, self-service rental concept. The project aims to introduce a new vehicle technology (the pure-EV) and simultaneously maximise the vehicle usage by making "praxicars"

available for short-term rental. To further complicate the project, several new technologies are being applied to enhance the ease of self-service access to vehicles. These include:

- a non-contact smart card operated by users, automatic induction charging to simplify vehicle recharging procedure;
- real-time digital information link between cars and management centre;
- on-board electronics to assist driver and calculate rental cost;
- mathematical modelling to optimise vehicle allocation at pick-up points; and
- multimedia, user-friendly and interrogative information points at "praxiparks" where the cars are located.

The effect of making all these radical technological introductions at once is that it has increased the risk of technical failure. This may be at the expense of the concept itself which may suffer as a result. If any one of the new elements fails, it might have the effect of giving bad publicity to what is a very interesting idea - self-service public electric vehicles as a form of individualised public transport. The strategy chosen is therefore one of high risk, with associated high rewards if the project succeeds as intended. This approach hindered the project in its early attempts to attract funding as the organisations approached were unsure about backing an experiment with so many new innovations.

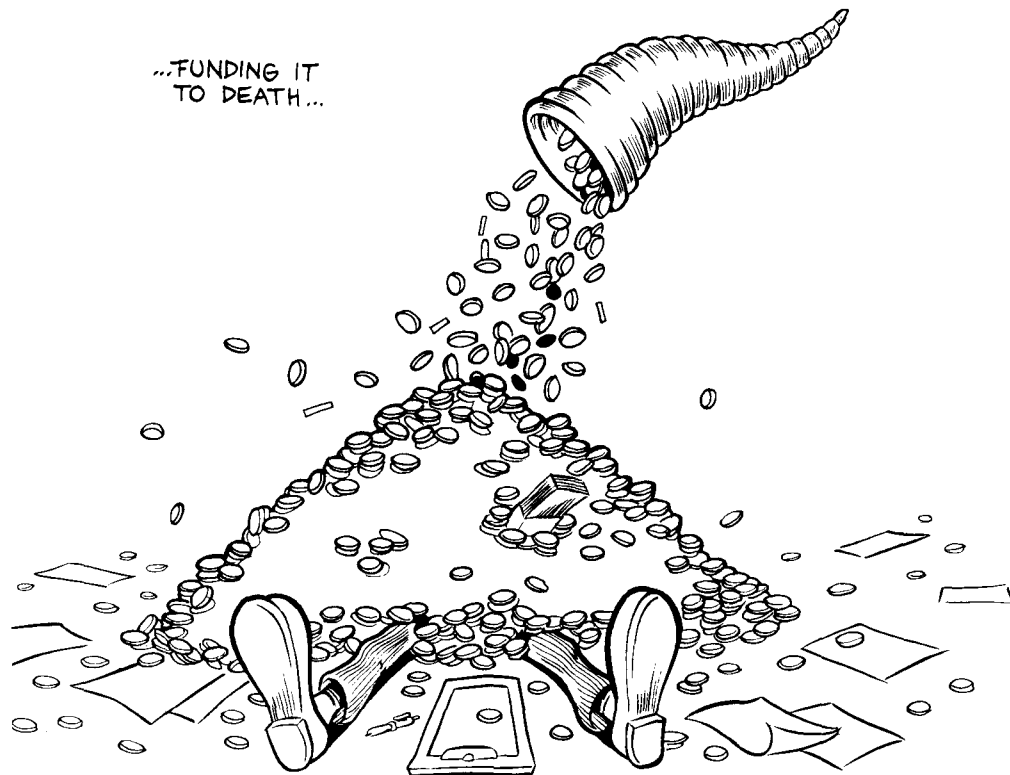
In contrast, consider the Coventry Electric Vehicle Project. It is currently demonstrating EVs in the UK with the aim of alerting fleet users to electric traction. Originally, the partners of the project also wanted to implement a self-service style experiment. Due to the perceived financial risk, the subsequent project, however, became less ambitious and now involves a simple EV fleet demonstration. Therefore, in contrast to Praxitèle, the Coventry Project is a low-risk experiment. Coventry will certainly succeed in achieving its stated (but unambitious) goals. (The project forms part of PSA's staged development of a commercial EV beginning with the experiments at La Rochelle.)

These two extreme cases raise the question of how projects can balance the need for worthwhile long-term goals with ones that remain achievable. Whereas Praxitèle is taking many risks in challenging the existing patterns of car ownership and use, the Coventry project is more likely to succeed in attaining its goals. Yet it does not aim for significantly changing patterns of car ownership and use. At present, it is too soon to say which strategy will be more or less successful in challenging the current conventional transport regime.

**Lesson:**

**Balance the drive for high-risk, high reward project innovation  
with a low-risk, more conservative incremental strategy.**

## Story 5: Funding to Death



*...financial assistance can change the evolution of an experiment...*

The issue of external funding arose for Swiss car-sharing initiatives in 1991 when a new government programme was launched by the Swiss Department of Energy (BEW). Under this programme, the Swiss automobile club VCS proposed to assist with the technological and organisational development of the car-sharing concept. As VCS wanted to promote the idea of car-sharing and not a particular organisation, it actively encouraged the interaction between the two car-sharing organisations operating at the time - ShareCom and ATG. VCS acted, therefore, as the intermediary between the two car-sharing co-operatives and the funding agency BEW.

The unexpected availability of a significant grant was initially welcomed by the two co-operatives. To be eligible for funds, they each had to detail projections for how the money would be used, and to receive the government funding, ShareCom and ATG had to allocate a significant proportion of their own funds to match the external grant. Thus, by receiving external funding, both organisations had to allocate some of their own assets and scarce human resources in ways that otherwise they might not have done.

For the above reasons, the management of the co-operatives began to consider the sizeable sums of governmental money as a potential threat to rapidly growing organisations such as theirs. In the words of one project manager; "we coined the term 'subsidising to death' with regard to governmental support projects. The problem with these clearly defined projects running over a period of two to three years is that they are only in part financed by the confederation. The rest we had raise by ourselves. This caused us to undertake far riskier endeavours than we would have done otherwise... Sometimes, we feared our decision to start such a project could break our neck." As a consequence they feared that they would set false priorities by being tied to an externally funded project.

We can therefore conclude that although external funds are often an essential element for a project's operation, partners need to remain alert to how financial assistance can change the evolution of an experiment. This can become increasingly difficult to monitor when other factors lead to rapidly changing circumstances within and surrounding a project.

**Lesson:**

Governmental financial support of experiments may sometimes have ambiguous effects.

## **Story 6: Listen and Learn**

The Coventry Electric Vehicle Project (CEVP) utilises 14 Peugeot "106 Electric" cars and vans. These replace existing petrol and diesel vehicles and are used by five organisations in the Midlands region of the UK. The CEVP built upon many years of previous experience in electric vehicle testing in France, in projects such as those at La Rochelle. Like its predecessors, the CEVP has continued to involve a network of users, including fleet operators, local authorities and electric utilities.

Building on the previous level of experience in France where private EV sales have proved less than expected, the CEVP has sought to focus all of its market development activities on fleet use. One of the most important fleet operators in the UK is the Royal Mail which operates one of the largest vehicle fleets in the UK, including 14,000 2.3 m<sup>3</sup> volume capacity vans and 28,000 commercial vehicles. Therefore Royal Mail Midlands, the regional section of Royal Mail and one of the premier fleet users within the West Midlands region, were invited by Coventry City Council to be partners in the city's EV project.

What makes Royal Mail such a useful partner is that they are highly motivated to experiment with alternative vehicle types. This arises from the fact that while they have a duty to deliver to all parts of the country, there is the very real possibility that conventional vehicles may be restricted in certain urban areas in the near future. Indeed, possible access restrictions of certain vehicle types was anticipated within Royal Mail in 1994, and they were aware early on of the need to demonstrate to local authorities and the public that Royal Mail were attempting to minimise the environmental impact of its distribution and delivery road vehicles. Furthermore, Royal Mail has much experience in project management with extensive in-house procedures for effecting change and introducing new technologies.

Therefore, it comes as little surprise that Royal Mail have conducted a thorough driver training programme and set-up an extensive monitoring procedure within the CEVP. They have also fed back their comments on their experience of using the 106 Electric van to Peugeot. In particular, as a result of using the 106E for postal operations, they identified the need for a larger volume capacity van for delivery and collection services due to the low density of letter and parcel freight. Given that Royal Mail are such an important fleet purchaser, Peugeot have decided to introduce the electrified version of the Partner Van to be available in a right-hand drive version from mid-1998. This learning has certainly increased the commercial potential of electric vehicles in the UK. Already, many of the project partners have decided to purchase EVs to use as part of their fleets, in addition to the vehicles used within the CEVP. This includes Royal Mail, Coventry City Council and PowerGen who are intending to buy a number of 106Es and Partner Vans for fleet use.

**Lesson:**

Incorporate high profile users within the experimental partner network

## **Story 7: Anticipating Opposition**

The city of Bologna is the first European city to install an automated zone access control system ("SIRIO") around the city centre, replacing manual enforcement that has been in effect since 1989. Through the use of roadside stations (at the entry gates), "transponders" on-board the vehicles, optical car license-plate readers and a central computer, SIRIO is able to establish the identity of vehicles passing through any given entry gate and verify vehicle authorisation. The first four entry gates were installed in 1994 and the system achieved full operation in the Autumn of 1997.

Access to the zone is allowed only for permit holders, taxis, public transport and the emergency services. 46,000 transponders were sold to people with access authorisations, compared to 82,000 permits handed out under manual control.

Although initial technical problems associated with SIRIO have been solved, the partners failed to foresee and deal with opposition from car owners without permits, local businesses within the limited traffic zone (LTZ) and the right-wing political parties that supported the protests. The trade organisations feared that SIRIO would reduce sales due to the LTZ policy in the city centre and that customers would do their shopping elsewhere (though there is a lack of information on the effect that LTZs actually have on the economic turnover of city centre businesses).

Indeed, early on, several companies took the organisers of SIRIO to court to gain increased access to the traffic-free zone. Though the establishment of the zone in 1989 was approved by the population in a local referendum in 1985, the municipality did not question the continuing support for its limited access policy in the city centre; support which, it seems, had withered away over the years (indicated by increasing infringement of the access rules).

In retrospect, more attention should have been given to communication about SIRIO with the car owners and the general public. Also, the concerns of the trade businesses could have been taken more seriously by having the SIRIO experiment accompanied by a monitoring process to study the effects on commerce. Experience elsewhere has shown that in the long-term, sales can actually rise in LTZs. Therefore, monitoring patterns of trade in Bologna is likely to have produced results which would have alleviated the fears of the local traders.

We can conclude that when there are many "losers" in a project, their opposition needs to be addressed, or at the very least, monitored. Counteractive measures can take the form of education and publicity which explain the reasons for the restrictions and remind the public of the associated benefits of less congestion, better pedestrian access and improved air quality. Alternatively, losers need to be compensated (not necessarily financially) or given alternatives such as increased access to public transport routes to the restricted zone. Though this was attempted in Bologna where an (unsuccessful) Park-and-Ride service was set up to persuade car users not to drive into the centre, this in itself was unable to counteract the opposition to the scheme.

Despite the problems surrounding the implementation of SIRIO in Bologna, the cities of Rome and Como have recognised the potential of the technology to restrict access within their own city centres.

**Lesson:**

**Prepare pre-emptive strategies to deal with possible opposition to the project before they occur.**

## Story 8: Great Expectations

Expectations are high concerning the potential of telematics to help reduce congestion and pollution problems associated with conventional road traffic. Through the PROMETHEUS research project, the car industry has begun to assess the potential of information and communication technologies applied to the management of traffic flow.

On a regional level, a number of projects with the aim of implementing such technologies have been initiated. These include projects as MOVE in Greater Hanover and INFOREGIO in adjacent Greater Brunswick, Germany. Although similar in that they both seek to apply telematics to improve traffic flow, MOVE aims to increase the efficiency and hence attractiveness of local and regional public transport, whereas INFOREGIO is directed towards improving informatics for motorised individual traffic.

The projects MOVE and INFOREGIO are intended to be integrative, bringing together actors from the car-based traffic system and the public transport system. The project complexity itself has caused problems, bringing together as it does partners with very different skills, experience and project expectations. For example, though they were co-initiators of the co-operation, the car industry has taken an ambivalent position. They have been somewhat unwilling to extend their traditional core competency as developers and producers of vehicles to the role as "system operators". Also for the car industry and their suppliers as well as for the participating public traffic companies, tensions have arisen due to the integrative approach of the project. Interactions across traffic carrier and company borders often have been taken as threats to the partner's internal company core areas. This has been a major reason why the traffic telematics projects in the region have been difficult to implement.

As both projects have a common desire to be operational as part of the EXPO 2000 in Hanover, there are growing pressures within each project network to meet the projects' goals. This has brought to the surface the project partners' different expectations and priorities. Such a difference in perspective has required continuous co-ordination between what has been envisioned and what actually could be achieved. This "levelling out" has taken place between the project partners themselves and between partners and the overall societal project environment, the ongoing "discussion" being conducted via private and public events such as symposia, lectures and project presentations. Through these processes, the partners have arrived at common solutions, and the projects have been able to integrate and remain "on track".

**Lesson:**

The expectations of all parties need to be continuously articulated to ensure co-ordination of partner activities.

## Story 9: Network Amnesia

This story describes two Swedish "rolling highway" experiments. This is a transportation mode where complete trucks or trailers are transported by train on special wagons. It is already an established transport option in Switzerland and Austria (transalpine freight transport) as well as Germany.

The first experiment was carried out in the north of Sweden and involved the regional distribution of freight for the food retailer ICA. In this project, SJ (the Swedish railway company) organised a rail transport service for ICA trucks using wagons leased from Germany. The experience proved highly successful because the service (planning of schedule etc.) was customised to ICA's requirements, thanks to good co-operation between the two companies. ICA has subsequently become increasingly interested in train solutions for their distribution activities.

In a second project, SJ wished to set up a rolling highway system to decrease the heavy road traffic and related pollution problems caused by trucks on transit through Sweden to and from the continent of Europe. Unlike the northern experiment, the experiment on the west coast was far from successful even though the technology employed was largely the same. Several factors for the failure were identified and included the presence of strong competition from ferries and road trucks and unprofessional project management. In particular, SJ did not involve their own employees with experience from the project with ICA; persons who may have been able to foresee problems on the west coast experiment. The main reason why the west coast project failed was the failure of SJ to involve the road carriers or the forwarding and shipping agents in the planning process. As it turned out, the timetable did not fit the road carriers' requirements.

The lesson here is that the railroad company's departments did not learn from each other's experiences. There was no mechanism in place for the dissemination of learning within SJ, so that the positive experience from the northern experiment, especially with regard to the contacts with the client, was not transferred to the west coast experiment. Surprisingly, despite the failure of the second experiment, it was stated by several road carriers that they are still very interested to use the service in the future if the railroad company can solve the remaining problems (i.e. improve the time table). Thus the west coast experiment may serve as a negative experience, leading to improved experiments in the future.

**Lesson:**

**When designing a new experiment, seek out and utilise previous relevant experience.**



## Story 10: Driving Lessons

In the 1980s, a number of small and medium-sized enterprises, university institutes, interested individuals and spin-off firms built up a support and innovation network for the development and diffusion of light-weight electric vehicles (LEVs). These initiatives addressed some of the most pressing technological problems regarding light-weight construction for vehicles and electric propulsion. This has led to a large-scale experiment with LEVs in the Swiss town of Mendrisio. In the words of one of the project partners, "the large-scale test (...) is not only a pilot- and demonstration project, but an uncommon, large-scale practical test on a scale of 1:1."

One aim of the Mendrisio experiment is to provide a forum for comparing the many types of LEVs on trial. Extensive vehicle monitoring has been introduced to assess the LEV's actual (as opposed to bench-test) road performance. Data collected will be used to calculate the environmental impact of LEV use. The vehicles within the experiment use a wide range of battery, re-charging and drive-train systems. Therefore, the experiment avoids the risk of getting "locked into" any one particular type of LEV technology by simultaneously trying several potential technologies in parallel.

However, the project intends to involve learning that goes much further than the conventional technical testing of vehicles and market assessment of potential sales. Instead, the experiment is seen as a sort of laboratory for sketching the diffusion path of LEVs. In other words, lessons are sought for how to scale-up the use of LEVs in Switzerland and beyond. First, a set of political support measures will be tested to see which were most effective in order to promote market diffusion of LEVs. These promotional strategies include evaluation of different policy measures such as vehicle subsidies, reduced vehicle taxes, reduced fuel and parking costs and access to charging infrastructure. The effects of offering advantageous access to complimentary mobility methods such as car-sharing, rental, taxi and public transport are also being monitored. The relative effectiveness of these measures will indicate how a politically supported diffusion process could be generalised at a national level.

In addition to the evaluation of technology and promotional measures, an assessment of people's mobility patterns is being conducted. This includes the question whether LEVs can constitute an element of new, integrated forms of individual mobility. Analyses of the mobility patterns of the LEV-users in Switzerland show that LEVs have the potential to lead to a more sustainable individual transport system. Though individual mobility of the users is not reduced, LEV-users undergo a number of learning processes. Their modal split changes (the LEV soon becomes the most frequently used vehicle), they drive more cautiously and they are more conscious about energy use in transportation.

Lesson:

Experiments should be used to question underlying assumptions at all levels; these include technology options, technology diffusion strategies and effects upon patterns of mobility.

## Story 11: Managing Style

From the mid-1980s onwards, ShareCom and ATG each have offered the public car-sharing services in Switzerland. ShareCom's organisational structure was very much "bottom-up", and their official slogan was "using instead of owning", with members volunteering their services to perform the duties necessary to maintain the car fleet operations. In contrast, ATG perceived themselves more as service providers rather than a co-operative venture. The members performing maintenance or administrative tasks were compensated for their time and work.

Despite contrasting management styles, both ventures were highly successful in attracting new users. As the membership numbers grew, ShareCom and ATG began to overlap in the regions they serviced. This introduced an element of competition, suggesting that some co-operation or a merger might benefit both organisations. Both were resistant to changing their founding philosophies, however. For example, ShareCom understood itself as an "organism that divides into more and more cells over the course of time" which went against the need for a more centralised organisational structure.

In the early Nineties, the Swiss automobile club (VCS) wished to support car-sharing and proposed a project to the Swiss Department of Energy (BEW) to assist with the technological and organisational development of the concept. As VCS wanted to promote the idea of car-sharing and not a particular organisation, it actively encouraged the interaction between ShareCom, ATG and BEW. Then in 1996, Zurich's public transport authority wanted to co-operate with a car-sharing organisation within the region. This was to involve a transferable ticket designed to encourage the use of intermodal travel. Although ShareCom had a much larger membership within the region, the locality opted to work with ATG, with its more professional approach.

These events increased the tensions within ShareCom and led to the resignation of the founding member from the governing board. This freed up the organisation and led to a process of internal structural change. As a result, and after a period of consultation, both parties were able to realise the similarity of their goals and the benefits that would follow from a merger. By 1997, a merger was agreed and Mobility CarSharing was formed. (Some "fundamentalist" members keen to implement the original community-based philosophy subsequently left ShareCom.)

The critical point here is that you have to find the balance between voluntary support and professional ethos. If one opts too quickly for the latter, one may lose too much support from the former. This was also ATG's problem. They always positioned themselves as highly professional but still relied significantly on the support of the users. Therefore, one needs to be aware that although pioneer milieus may be appropriate at the early stages of an experiment, with expansion, an organisation needs to implement a stepwise process of professionalisation if the service is to be offered to a wider audience.

Lesson:

At all stages within a project, chose a management style which maximises operational effectiveness.

.... AN AUTOMATED RESERVATION SYSTEM  
STARTED TO BECOME INEVITABLE FOR THE  
CAR-SHARING PROJECT ....



## Story 12: Seeking Complements

The Portsmouth Bikeabout scheme seeks to address the problems encountered by earlier bicycle-sharing experiments. The experiment applies advanced information technology systems to provide a controlled and protected environment for a shared bicycle scheme. In the project, one hundred bicycles are offered for short-term use and can be collected from three secure automated cycle depots. (See also Story 1.)

Initiated by Portsmouth University and the local authority and funded by the EU, the Bikeabout scheme aims to "encourage forms of transport other than the private car". In keeping with the University's mobility policy, the goal of the project is to increase the use of bicycles and reduce driving within the University campus. The scheme has three locations at which bikes can be collected and returned. In addition, the council have laid a new bicycle lane between the two initial Bikeabout depots as well as two signal controlled crossings where the route crosses heavily trafficked roads.

Since the Bikeabout project has come into operation, there has been an increased awareness of the importance of the bicycle as a mode of transport. There also appears to have been a significant increase in the number of people cycling. The scheme has failed, however, to attract significant numbers of car drivers to use the bicycles provided. The bicycles are well used, but by people who formerly walked, used public transport or their own cycles. It even has generated new journeys, since the new option for personal mobility has meant that a number of trips are now possible within a reasonable period of time.

The fact that car drivers have not been tempted to change to other forms of transport can be understood if we consider the role of complimentary measures in the success of a project. Although Bikeabout offers car drivers access to a more environmentally friendly mode of transport ("carrot"), it offers no disadvantage ("stick") to those who continue to drive. It is generally acknowledged that the Bikeabout scheme would have been more effective if used as part of a wider, integrated policy that implemented restrictions to car drivers while offering them an alternate travel mode. This could have included a further reduction in the number of parking spaces for cars together with increased parking charges, which is being considered.

**Lesson:**  
Complementary measures, external to the experiment, might be required to achieve project goals.

## Story 13: Blind Optimism

By the end of the 1980s, PSA was convinced that their pure-EV concept was ready for demonstration. A strategy was defined which would culminate in mass production and marketing of electric vehicles. One question still had to be answered, however: would private users be willing to buy electric vehicles? To address this issue, the La Rochelle experiment was set up to demonstrate 50 prototype EVs. These were rented to private motorists and companies (a supposedly representative sample of the targeted customers for EVs) in order to study user reactions and the technical viability of EVs in urban areas. The experiment was heavily monitored and included the recording of users needs and experiences from the very beginning. All the partners were very satisfied with this experiment and considered it a great success.

In addition to the vehicle's successful performance, the general level of user satisfaction was found to be very high and their perception of the electric vehicle positive. Half of the users involved in the experiment decided to buy the EVs they had tested, an indication of the motivation and enthusiasm of individual users for electric vehicles. In addition to the interest among test users, the La Rochelle experiment was also a success in stimulating interest from the public and the media. Though the actors had themselves organised an intensive public relations strategy around the experiment, even they were surprised by the high level of interest shown. As a result of this success, PSA made the decision to start commercial production of EVs in 1995. The initial target was to sell 2,000 cars per year, rising to 10,000 annually by the year 2000. Despite the huge success of the project, sales of PSA electric vehicles have never reached the numbers projected. In 1996 PSA sold just over 1,000 vehicles. First results from 1997 were even worse. Only 140 EVs were sold in the first half of the year.

To find an explanation for the overoptimistic sales expectations, we must look at how users were selected for the La Rochelle experiments. It seems that the choice of users influenced the result of the experiment and thus the expectations. In retrospect, we can see that the selected users were already "pro-EV" and did not represent the "average" motorist. Perhaps a less interested partner should have been brought in at the latter stages to assess the marketability of what is essentially a very expensive, short-range vehicle. They would have been more likely to have used a true sample, not chosen a priori according to criteria which would affect the result. This would have given a more realistic picture of the public's readiness to buy an EV. As it was, there was a large gap between the experimental conditions (biased pro-EV sample) and the conditions under which EV technology was applied on a large scale (public ignorance/scepticism about EVs).

**Lesson:**

Seek out independent observers to assess the extent of the project's success.

## Story 14: Overprotection Racket

The City Bee is a small, purpose-built, two-seater EV developed by PIVCO, a Norwegian company. It is owned and supported by Statoil, Norsk Hydro, Oslo Energi, the Norwegian Post, and Bakelittfabrikken, the largest companies in Norway. The aim of the PIVCO experiment is to develop and produce an electric vehicle for a niche market in urban and suburban transportation. Ten City Bees were tested in the car rental project in Oslo and forty have been tested in the Bay Area Station Car Demonstration in San Francisco. In total, the 50 City Bees have been driven and tested over a total distance of 50,000 km (about a factor of ten less than what is usual for conventional vehicle testing).

The project has received a significant amount of government subsidy, due to the fact that there is no national car manufacturer in Norway. PIVCO is regarded by some politicians as an opportunity to build an indigenous motor industry. All partners have much invested in the project in terms of finance and prestige. In addition, there is a great deal of popular support for clean environmental technologies and the public feel very patriotic about the project. These views have been significant for the support of the project in spite of technical problems that have occurred with the vehicle and the questionable suitability of using a battery-powered EV in a cold country with mountainous terrain. For these reasons, the expectations of the car's success are simultaneously very high and appear somewhat unrealistic when compared to the vehicle performance in tests so far.

The City Bee has been strongly promoted. In 1994 the car was adopted as the official car of the Winter Olympics in Lillehammer, which gave it global exposure. This publicity led to the City Bee being tried in California as a "station car"; the vehicles were leased by Californian companies for their employees to commute from railway stations to the workplace. This experiment was not an unqualified success (drivers did not wish to continue to lease the cars), suggesting that the publicity and testing were outpacing the need for methodical testing and development. Indeed, it is questionable whether the car should have been tested in the US, as the City Bee is not allowed to be driven on the freeways because of its limited speed and small size. In particular, it is ill-suited for car-pooling due to its two-person capacity. Furthermore, while protected from competition, it has taken PIVCO a long time to develop the City Bee. In the meantime, several major motor manufacturers have developed their own two-seater EVs, such as Toyota's competitively priced "eCom". Therefore it will be increasingly difficult for PIVCO to compete with these products in the two-seater EV market.

**Lesson:**

Overprotection of a technology can unrealistically raise expectations of its potential and draw attention away from a poorly devised experiment.

## Story 15: Co-operation among competitors

City centres provide a pleasant atmosphere for shopping and leisure activities, but the quality of the living environment is affected by the noise and air pollution of trucks. Even if the distribution traffic only accounts for a small part of the city centre traffic, the disturbance is perceived as great by the inhabitants. The traditional organisation of delivery to shops, which is carried out by many small distributors, plays an important role in causing the nuisance. Centralised distribution (City Logistics) organised at a distribution centre at the edge of the city is considered to provide a firm basis for improving the quality of the inner city.

In the early 1990s, German municipalities became increasingly interested in the concept of city distribution centres. In a number of cities all over Germany, projects and pilot studies are currently being undertaken to introduce feasible and efficient city centre logistics concepts. Expectations regarding city centre logistics schemes are high in Germany, and the motivation of the actors responsible for technology programmes for city logistics are very strong. Forwarders also have demanded new solutions to improve their competitiveness and to prevent new regulatory measures in the area of city traffic.

As part of the pilot programme "City centre logistics/city logistics" (set up by the Land of North Rhine-Westphalia), the city of Düsseldorf and the Düsseldorf Chamber of Industry and Commerce funded a feasibility study on city centre logistics. One part of the study was a five-week trial run to test the concept in Düsseldorf and disseminate the findings to other interested cities. The trial also aims to "fine-tune" the Düsseldorf scheme in order to ensure a feasible and reliable concept.

The trial run, however, revealed several shortcomings, problems and unexpected barriers. Most of these problems were due to a lack of commitment and communication amongst the stakeholders, especially the forwarders. This is demonstrated by the effect of the pricing system applied for the trial run. The trial run used a simplified rate system, based on the total weight of packages from one forwarder. This rate system favoured those forwarders who had to deliver a lot of small packages to a number of different retailers. It is assumed that even during the trial run, some forwarders used the scheme for the time-consuming and (and therefore expensive) delivery of small shipments and dealt with heavier shipments as usual without going via the distribution centre. This shows the importance of commitment and co-operative behaviour above and beyond all technical questions.

**Lesson:**

**Monitor carefully potential barriers to co-operation between partners in an experiment, especially if they have competing stakes and are prone to free-riding**

## 6. Recommendations and Final Assessment

### 6.1 Levels of success of Strategic Niche Management

In the preceding chapters experiments have been discussed in terms of their "success" without explicit reference to what is meant by this term. In Chapter 3 a number of key issues, dilemmas and trade-offs were raised, relating to the design of the experiment. It was pointed out that success is thought to be achieved only if the pre-defined objectives of an experiment are met. From the SNM perspective other dimensions of success should be considered beyond such a narrow definition. An experiment has to be assessed with regard to its contribution to the development of the technological niche. Furthermore, a successful experiment also would further a transition to a more sustainable transport system, i.e., a shift towards a different transport regime. Therefore we have to deal at least with three different levels of success.

In order to assess an experiment at these three levels, it is useful to develop a set of criteria to serve as a checklist for the evaluation of success. Such an evaluation can be done in principle before, during and after an experiment, even if the results in the first instance are vague and subject to a high degree of uncertainty. Some of the criteria suggested in the following reflect the key issues and dilemmas, but here a broader reflection of the relevant aspects of success at the level of the experiment, niche formation and regime shift is sought.

#### **Level 1: Successful management of an experiment**

The most obvious level of assessment addresses the experiment only, without dealing with its wider implications. In many respects, this may reflect good management practice, but it emphasises specific issues of technological experiments. The fairly specific success criteria are particularly interesting to those actors who run an experiment ("experiment managers"). They highlight some of the concrete insights of SNM.

A first set of criteria must take up the definition of the objectives. The criteria determine the extent to which an experiment may be perceived as a success. For example, excessively challenging expectations and objectives are detrimental. The second and third group concern the networks of partners and users of the technology under exploration. The fourth set of criteria comprises the identification of an appropriate technology and the definition of its selection conditions. These are defined by the location as well as by the protection measures introduced. The next two sets of criteria address issues of project management and communication in the wider sense, which include the establishment of procedures to monitor technological and social changes. The two final sets establish





VI. Communication	Accompanying research, monitoring of effects Experiment documentation Active marketing of the experiment/technology Consideration of potential opposition to the experiment/ technology.
VII. Achievement of originally stated goals	Technical operation of the components, vehicles, infrastructure working as expected Sales image and demonstration of markets Register problems of embedding the technology in a social and political environment
VIII. Assessment of experiment by institutions outside the experiment	Local support of the project Political opposition Visibility in the community which supports the technology

### **Level 2: Major contribution to niche formation**

Experiments with new transport technology or concepts are meant not only to meet certain project specific objectives, but also to contribute to a broader learning process that helps to establish a technological niche. This requires the consolidation of the technology as well as the networks behind it. A single experiment still leaves many development options open, and the niche formation processes should extend the scale of application of a technology and help to define it in more detail. This definition phase establishes what is often called a "technological trajectory", that is, a shared guiding notion for the most promising technology for a certain niche.

**Table 6.2: Success criteria at the level of niche formation**

Criteria Set	Criteria
I. Lessons learned and unexpected relationships identified regarding essential factors in the innovation	Desirability of the technology Performance of the technology under real life conditions Acceptance, images and learning processes on the side of users Problems in the institutional environment
II. Guiding technological innovation	Setting standards with regard to products, technologies Selecting promising designs and/or creating variation Developing new technological components Indicating ways to reap economies of scale and/or identifying problems with lock-in
III. Serving as a stepping stone for further niche development	Could future experiments learn substantially from the successes and failures of the experiment? Did it lead to a better understanding how the niche could be more successfully developed? Could it be used to better specify the balance between protection and competitive pressure?
IV Building and consolidation of a constituency	Did networks become more stable, more diversified, actors more committed? Have expectations become more specific? Could political support be mobilised in order to improve acceptability and market prospects?
V. Promises of a more widespread diffusion of the technology	Is there a coupling between emerging demand and the reaping of economies of scale? Could a substantial market niche be identified by the experiment? Are there any signs that protection could be phased out in the short to medium term?

In this sense, the five sets of criteria above specify the conditions under which an experiment can be expected to contribute to niche formation processes. Some of them may sound similar to those applied at the level of the experiment, but the niche formation criteria do not apply to the local context of an experiment but rather to the wider, often national context for the application of a new technology. It is important to keep the difference between experiment and niche in mind. An experiment is an isolated and usually protected space for testing a new technology or mobility concept under very specific conditions. A niche already represents a highly visible element of the wider landscape of alternative mobility solutions, often consisting of several interconnected experiments. Adjustment already has taken place between the new technology or concept and the wider context for its application.

The first set of criteria addresses different elements of learning about the relationship between the technology and its social context, including user acceptance, learning processes and institutional compatibility. The second set concerns choices between different technological alternatives for the niche, but are based on the experiences gained in preceding experiments. In other words, the listed criteria aim to define the technological trajectory for the niche. The criteria mentioned in the third and fourth sets raise issues related to improving the understanding of the niche development processes and the reinforcement of support for the technology. The fifth and final set specifies future promises associated with the technological niche, and thus the expectations regarding the more widespread diffusion of the technology.

The management of a niche being a less clear-cut activity than the management of an experiment, it is obvious that the success criteria are also more abstract. However, they could be relevant to "niche managers" who perceive an interest in being a pacemaker for a mobility innovation, which is expected to establish itself in the medium-term. For example, government institutions or agencies are actors who could draw interesting lessons from applying these criteria in the selection process for new project/experiment proposals.

### **Level 3: Potential contribution to a shift towards a sustainable transport regime**

It is very difficult to assess whether a new technological niche or especially a single experiment would contribute to a shift towards a more sustainable transport regime. A transport regime is a highly aggregate concept, and the uncertainties inherent in any experiment or emerging niche are so great that only the rough promise of a regime shift behind a technology can be evaluated. Some tentative indications, though, should be given of the types of aspects which have an influence on whether niche formation processes (and thus also an experiment) have the potential to contribute to a regime shift. This third level of assessment should indicate clearly whether an experiment and a technological niche actually help to improve our transport system in the longer term.

The first set of criteria aims to check the matches and mismatches which may arise between the new technology and the established transport regime. Compatible technologies will face fewer barriers and less opposition and therefore will diffuse more readily. The criteria in the second set go a step further by specifying requirements for changes in the prevailing regime, if the new technology diffuses more widely. In other words, they aim to identify those boundary conditions which are crucial for the survival of the new technological niche. Criteria for the development potential of a technology are addressed in sets three and four. The third set of criteria aims to assess whether a new technology has a high *development* potential (technically speaking), while the fourth set specifies whether it matters for the *application* potential, that is, for the improvement of our transport system. In the fifth set, the actual indicators of sustainable transport are given which in the end should contribute to solving problems of congestion, noise, environmental pollution, and land use, while maintaining high quality transport services.

In policy terms, the criteria at this third level are particularly relevant for government, because they reflect the normative dimension of what is regarded as a desirable future for transport as well as how an experiment and/or niche can be assessed from this perspective. Similar to the second level of criteria, the issues raised at this third level could be useful for the assessment of projects and experiments, even if they are quite vague in their current formulation and may still require further elaboration.

**Table 6.3: Success criteria with regard to the potential for a regime shift**

Criteria group	Criteria
I. Compatibility with main elements of the existing transport regime	Existing institutions Lifestyles Large scale infrastructure Spatial structures
II. Robustness and dependence of the niche development path on specific frame conditions	Strong regulations Fundamental changes in tax regime Value shifts Major technological advances Shortage in the supply of primary energy resources
III. Development potential	Promise for technological improvements at the level of components and system integration? Are there any economies of scale (at the level of production, the market, infrastructure, etc.) to be expected? Does the technology potentially contribute to a new set of innovations? Synergy with current development trends in transport technologies (complementary technologies)
IV. Scope of application	Is the technology potentially applicable over a wide range of applications and for a majority of customers? Are there barriers for a global diffusion of the technology? Is it restricted to specific areas with specific conditions of infrastructure, culture, income?
V. Degree of sustainability	Is there any indication on the potential to lead to new lifestyles, changes in perception and appreciating consumption alternatives? Are new mobility forms developed? Does the niche fit into an intermodal transport regime?

## 6.2 On the application of the SNM perspective

Until now the research on Strategic Niche Management has focused on applying this new perspective to a series of case study experiments with new transport technologies. Thus Strategic Niche Management has been developed as a tool for analysing past experiences, as a "lens" for studying and analysing experiments with new technology. Structured learning from past experiences provides insights on how to improve the planning and implementation of future experiments. SNM has helped to sharpen our thinking about experimental situations and how the management of experiments may be improved.

This first type of application has been at the core of the two projects underlying this workbook.

Above and beyond this, it is promising to explore three other opportunities for applying SNM "constructively". Can SNM be used as a "tool" to support decision-making, planning and forward-looking analysis? For the moment, these constructive applications have been explored to a very limited extent. It would be instructive to test them under real-world conditions, in experiments currently planned or in an early phase of design.

### *1. SNM as a support tool for experiment planning*

For practitioners in the field of transport, the SNM perspective and the list 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 the processes of introducing new technologies, beyond standard management practices. Obviously, these aspects are not an off-the-shelf toolbox. They require an understanding of the processes of niche formation. Some first attempts have been made to explore the use of SNM as a guide for planning concrete experiments, but it is still too early to draw conclusions as to the value added. In order to provide clearer evidence of its constructive potential, SNM would have to be used and tested in the design and implementation of an actual experiment with new transport technology.

### *2. SNM as an evaluation tool for policy making*

Demonstration projects are an important element of transport technology policy, but many are not followed up once the funding is stopped. The criteria to assess the success of an experiment as developed in this workbook concentrate on two aspects of major interest to policy-making: the potential for wider diffusion when the demonstration phase is over, and the contribution a technology would make in the longer term to the establishment of a sustainable transport system (that is, to a regime shift). The criteria could be applied before, during or after an experiment, and would thus inform choices between promising and less promising projects. They also could be used to make funding decisions.

### 3. *SNM as a prospective analytical tool*

SNM opens up several opportunities for analysis in a forward-looking perspective, that is, for an exploratory analysis structured along the lines of SNM. This should not be misinterpreted as a linear planning process because such an exercise would have to take into account the numerous uncertainties and risks inherent in technological and social change. It could be done by applying SNM within a framework for scenario development, for instance. Within such a framework, SNM provides the tools to describe qualitatively different experimental pathways and niche development processes. The descriptions of these pathways would take into account the different trade-offs, dilemmas and breakpoints which are critical to Strategic Niche Management processes, but also the transformations of the carrying networks and of the technology itself. In other words, Strategic Niche Management could be used to construct technological niche development pathways within broader transportation scenarios.

The chapters of this workbook have provided inputs for a number of these applications:

- Chapter 2 introduced the main concepts for analysing past experiences. In Chapter 5.1 a specific list of assessment criteria was proposed.
- Chapter 3 suggested and discussed a number of dilemmas and trade-offs that are of major importance for planning an experiment with new transport technology. They are meant to complement current best management practices in view of the specific risks of technological experiments.
- The criteria list in Chapter 5.1 also can be used to support the evaluation of demonstration projects in the realm of technology policy by addressing significant issues associated with the longer-term impact of a new technology.
- The workshop programme in Chapter 6 can be used in the start-up phase of an experiment in order to think jointly with partners and users about some pitfalls and opportunities to be considered during the experiment. It also can be used in later phases for assessing the progress and the achievements of an experiment.
- Prospective analysis would require drawing on several of the elements introduced in this workbook, especially the conceptual background of Chapter 2 and the workshop programme of Chapter 6. However, these are only some of the elements needed for a scenario-based prospective analysis.



## 6.3 The usefulness of SNM for different types of experiments

The great diversity of case studies investigated so far has highlighted that SNM can be useful to varying degrees and in different ways. In essence, five different types of experiments can be distinguished among the cases studied:

1. *Technology testing experiments* to try to answer the question whether a technological element in a systems context really works as expected. The EV tests on the German island of Rügen are a good example of such an experiment, as are the first phases of the autonomous railway truck experiment (Story 2).
2. *Demonstration projects* to prove to interested parties that a system as a whole works as predicted, as in the MOVE and INFOREGIO experiments (Story 8).
3. *Market acceptance and market introduction experiments* to find out how users really react when confronted with the technology. The EV experiment in La Rochelle pursued this objective (Story 11).
4. *User driven development of a new product* that aims to optimise and improve bottom-up initiatives in order to establish new mobility forms. The professionalisation of car sharing is a case in point (Story 11).
5. *Regionally based experiments for the development of a new mobility system* to combine in a co-evolutionary manner new forms of mobility with new technological solutions. The Mendrisio case could be interpreted as such an experiment (Story 10).

From the beginning SNM has been conceived as an approach to complement good conventional management tools. While the relevance of SNM as instructive perspective for how to run such an experiment increases from type 1 to type 5 in the above classification, the inverse is true for conventional management tools.

SNM does not aim to provide "do's" and "don'ts" in order to reduce the number of "bad" projects. Rather, it provides a clearer specification of what a certain experiment is likely to achieve. In other words, SNM helps to carry out experiments in a more conscious and reflexive way. As a consequence one could identify early on whether an electric bus introduction experiment in city X would be able to achieve a contribution to sustainable transport. Similarly, one could possibly avoid adopting the false expectation that the freight distribution centre at the outskirts of city Y will not be successful as long as local industry does not trust the manager. On the other hand, those societal bodies who want to promote sustainable transport through experiments would be guided to see more clearly what the planned experiments really mean in terms of sustainability. In other words, SNM could be helpful in shaping more realistic expectations for an experiment.

## 7. A workshop programme

Building on the suggestions for constructive use of SNM, a first element would be a set of questions to be raised at different stages of an experiment. In practice, this could be done in an interactive setting (a "workshop"), with the objectives:

- To run a start-up or preparation workshop for an experiment;
- To support the detailed planning phase of an experiment;
- To monitor the progress of an experiment, either during or after an experiment.

Obviously the importance assigned to each question in the workshop programme depends on the objectives.

This workshop programme reflects the structure of analysis suggested in chapter 3, but goes beyond that list of dilemmas and trade-offs. The integration of the list with the success criteria developed in chapter 5 leads to a checklist of questions to be kept in mind and discussed during the different stages of SNM.

This workshop programme is meant to support the analysis of ongoing or planned experiments in order to check for a number of issues of importance from the perspective of Strategic Niche Management. It certainly is not meant to be a "cookbook" for successful experiments, but rather a tool to stimulate thinking about potential risks and pitfalls. In this sense, it must be seen as complementary to the body of the workbook which has outlined the conceptual background and the key issues of Strategic Niche Management, illustrated by a number of storylines. The workshop programme adds a process dimension to the analytical focus of the workbook. Without a thorough analysis of issues, trade-offs and criteria, the foundation for an interactive workshop process would remain weak. Similarly, an SNM-type analysis would be ineffective because its results are not discussed and transferred to other actors and stakeholders.

### 7.1 Choice of technology

- What are the key technological and social needs to be improved and changed in the area of transport? Which problems need to be solved?
- What are the goals and objectives met by the implementation of the technologies, both in terms of the short-term performance objectives and the long-term contributions to sustainable transport?
- Does the technology represent an incremental change only, or does it imply a radical departure from our current transport regime?
- Does the technology under consideration imply making early choices leading to strong path dependencies?

## 7.2 Designing an experiment

- Where, for how long and on what scale should an experiment be carried out?
- What requirements can be formulated with regard to the network of partners carrying the experiment?
- To what extent does the experiment contribute to the further development of the technological niche in question?
- What are the specific success criteria and objectives of the experiment?
- What form should effective protection measures for the experiment assume? How will these be offset by selection (or real market) pressures?
- How will the users of the technology be involved in the experiment?

## 7.3 Implementing an experiment

- Which intermediate goals and milestones are to be formulated, and how will progress towards the achievement of these milestones be monitored?
- How can effective communication with the public be set up, including the marketing and visibility of the experiment? How can local support be obtained and opposition reduced?
- What are the broader and fuzzier expectations that the partners associate with the experiment? What do they actually want to get out of the experiment?
- Which measures ought to be established in order to facilitate learning about the experiment, including questions of documentation and monitoring? Which management style is most appropriate to facilitate learning and stimulate responsiveness from partners as well as users?
- Beyond learning about the experiment itself, are there mechanisms in place to further learning processes about mobility behaviour and the integration of the experiment in its social context? What social changes can be triggered to facilitate the acceptance of the technology?

## 7.4 Scaling up an experiment

- Have the motivations and interests of the partners involved changed during the experiment? Does this affect the set of participating partners?
- Will it be necessary to adjust and change the network structure during and/or after the experiment?
- Does the experiment allow for changes to the components of the technology or its overall design? Can improvements be made which also may change the expectations of the partners and users?
- Do the protection measures need to be reshaped?
- Which complementary policy measures would be needed in order to implement the experiment or technology on a larger scale?

- Can opportunities be identified for transferring the experiment to other locations? Can the lessons learned be transferred to this new experiment?
- How is the wider social acceptance and the political support expected to develop? Is it necessary to mobilise further support for the technology?
- Does the technology allow for exploiting economies of scale or other reinforcement mechanisms? Does it promise a more widespread diffusion across different applications for many customers and market niches? What are the major barriers to diffusion?
- May protection be phased out in the foreseeable future?
- Which advances have been made in competing technologies? What does this imply for the technology in question?

## **7.5 End of protection of an experiment and modification of the transport regime**

- Can a clear time-scale be given for the removal of protection measures? How should the structure of protection change over time?
- Which changes in infrastructure and spatial structures does the technology imply?
- Is there complementarity between the technology in question and other ongoing technological changes? Can important complementary technologies be identified (regarding intermodality, for instance)?
- Which wider institutional and organisational changes does the technology imply?
- Which changes of the legal framework (regulations, tax regime) and the transport regime does the technology imply in order to be viable without specific protection?
- Does the technology have consequences for changing lifestyles and mobility styles? Would it go along with value shifts of transport users?

## 8. By way of conclusion

### Business Day Trip - Bristol to Oxford which are 120 km apart

<i>The Present...</i>	Time
Check oil and tyres of car for the business trip the night before	
<i>The planned route will use first a local motorway (10 km) which links with the main East-West motorway. After following this road East for 60 km, the route uses a local road for the remaining 50 km</i>	
Prepare to leave home	6.45
Find car keys and get into car	6.50
Drive to local petrol station	6.55
Fill petrol tank and buy snack for breakfast - pay by bank card	7.00
Drive through city commuter traffic	
Encounter road works in city centre	
Join congested traffic on motorway	7.15
Drive 120 km to Oxford	
Drive at an average speed of 90 km/h	
Eat breakfast in car while driving.....feel tired.....	
Listen to radio during journey	
Arrive in the outskirts of Oxford City.	8.35
As parking is full in centre, signs direct you to a park-and-ride	
Find parking space, look for change and pay with cash	8.40
Wait for bus to town	
Bus arrives for town centre	8.50
Bus takes you to central stop	9.00
Walk remaining 0.5km to office...arrive a little late...	9.05
Need to be in Oxford office by 9.00 am	

Time

...The Future

Log on to Internet the night before. Order Dial-a-Ride taxi and MonoPod\* for next day's journey; pay for whole trip by SmartCard.

*\* "MonoPods" use upgraded high-technology national railway track network. They are autonomous rail modules that travel either independently or link together to form "MonoTrains". All transits of Pods are autonomous though co-ordinated by a central computer.*

- 7.00 Dial-a-Ride taxi arrives. Solar-assisted hybrid minibus takes you to local MonoPort via reserved vehicle lanes.
- 7.10 Arrive at MonoPort
- 7.15 Check in at desk
- 7.20 Enter reserved personal Pod
- 7.25 MonoPod leaves Bristol Port. En route, computer controlled Pod links with other Pods going in same direction towards Oxford. During transit you are able to work, rest, watch TV and can request a stop at any port on route to if you wish. Pods can travel at a max. speed of 140 km/h. Eat light breakfast in comfort. 30 km from Oxford, some Pods disengage and continue on separate track to London. Three Pods continue with you on the Oxford spur.
- 8.30 Arrive at Oxford Port in centre of city.
- 8.35 Pick up a one-seater Micro-EV from rental stand (1 day rental is part of Pod ticket). All EVs have fold-up bicycle for local use. Drive on reserved Micro-EV lanes to office.
- 8.45 Park at rear in Micro-EV only parking.
- 8.50 Enter Office with 10 minutes to spare

...as it is a sunny day, decide to cycle down to the river at lunch-time on bicycle supplied with the EV...

## Further reading

Grablowitz, Alex, P. Board, Matthieu Craye, and Matthias Weber (1998): *Strategic Management of Sustainable Transport Innovations*, Research Report, Seville: Institute for Prospective Technological Studies.

Hoogma, Remco, René Kemp, Johan Schot, and Bernhard Truffer (forthcoming): *Experimenting with New Technologies. Strategic Niche Management for Sustainable Transport* (working title).

Kemp, René, Johan Schot, and Remco Hoogma (1998): "Regime Shifts to Sustainability Through Processes of Niche Formation: The Approach of Strategic Niche Management", *Technology Analysis & Strategic Management*, Vol. 10, No. 2, pp. 175-195.

Weber, M. and Hoogma, R. (1998): "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, pp. 545-566.

### **Case study reports for the research project "Strategic Niche Management as a Tool for Transition towards a Sustainable Transport System":**

Black, Colin (1998): *The Bikeabout Experience: An automated smart card operated bike pool scheme*. Milton Keynes: Open University.

Harms, Sylvia and Bernhard Truffer (1998): *Stimulating the Market for Light Weight Electric Vehicles: The experience of the Swiss Mendrisio project*. Dübendorf: EAWAG.

Harms, Sylvia and Bernhard Truffer (1998): *The Emergence of a Nation-wide Carsharing Co-operative in Switzerland*. Dübendorf: EAWAG.

Hoogma, Remco (1998): *Introduction of Automated Zone Access Control in Bologna, Italy*. Enschede: University of Twente.

Hoogma, Remco (1998): *Towards Autonomous Railroad Trucks: Rail freight transport innovation in Southeast Lower Saxony*. Enschede: University of Twente.

Lane, Ben (1998): Promoting Electric Vehicles in the United Kingdom: A study of the Coventry Electric Vehicle Project. Milton Keynes: Open University.

Potter, Stephen (1998): Greening Transport for Disabled People: A study of Camden Community Transport's 'ASTI' project. Milton Keynes: Open University.

Prätorius, Gerhard and Karlheinz Lehrach (1998): MOVE-INFOREGIO: Implementation of a road traffic information project in the Hanover region of Germany. Braunschweig: reson.

Prätorius, Gerhard and Karlheinz Lehrach (1998): Operation of Electric Road Vehicles in Germany: Investigation of selected examples. Braunschweig: reson.

Schwartz, Birgitta (1998): Trucks on Trains: A comparison of two 'Rolling Highway' experiments in Sweden. Göteborg: University of Göteborg.

Schwartz, Birgitta and Kanehira Maruo (1998): An Outsider Initiative in the Emerging EV Market: The PIVCO adventures in Norway and California. Göteborg: University of Göteborg.

Simon, Benoît (1998): Praxitèle: An experiment with self-service rented electric vehicles in France. Maastricht: MERIT.

Simon, Benoît and Remco Hoogma (1998): The La Rochelle Experiment with Electric Vehicles. Maastricht/Enschede: MERIT/University of Twente.



# The research team

This workbook is based on research which was carried out by a multi-disciplinary and international team of researchers with backgrounds ranging from academia to industry and from natural sciences and engineering to economics and social sciences.

*Project co-ordinators:*

- Dr. Johan Schot and Remco Hoogma, Centre for Studies of Science, Technology and Society, University of Twente, The Netherlands
- Dr. René Kemp, MERIT, Maastricht University, The Netherlands

*Project partners:*

- Dr. Kanehira Maruo, Centre for Interdisciplinary Studies of the Human Condition, University of Gothenburg, Sweden
- Dr. Birgitta Schwartz, Gothenburg Research Institute and Department of the Environment, Sweden
- Dr. Gerhard Prätorius and Dr.-Ing. Karl-Heinz Lehrach, reson (Regional Development Agency for Southeast Lower Saxony), Germany
- Dr. Bernhard Truffer and Sylvia Harms, EAWAG (Swiss Federal Institute for Environmental Science), Switzerland
- Dr. Stephen Potter and Ben Lane, Design Innovation Group, The Open University, United Kingdom
- Colin Black, The Open University and Oscar Faber plc, United Kingdom
- Benoît Simon, CIRED, France and MERIT, Maastricht University, The Netherlands
- Dr. Matthias Weber and Dr. Per Sørup, Institute for Prospective Technological Studies, Joint Research Centre, Seville, Spain