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A practioner's view on Strategic Niche Management

Towards a future research outline

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Abstract

Strategic Niche Management (SNM) is a tool to support the societal introduction of radical sustainable innovations. However, it has been mainly used in retrospective to analyse historical case studies. This report discusses SNM from a practioner's perspective with the main aim to articulate questions that should be addressed for translating SNM from an ex-post to an ex-ante tool. The main conclusion is that an SNM tool should focus on the level of 'niches' rather than single projects, i.e. SNM should aim to support (program) managers who aim at orchestrating the interaction between multiple experiments.

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Summary

Strategic Niche Management (SNM) is a tool to support the societal introduction of radical sustainable innovations. SNM attempt to tackle the following barriers to successful implementation of sustainable technologies:

- Technological factors: the new technology lacks technical stability, does not perform sufficiently, or there is a lack of complementary technologies.
- Government policy and regulatory framework: the new technology does not fit existing laws and regulations.
- Cultural and psychological factors: the new technology does not fit user (or societal) preferences and values.
- Demand factors: the new technology does not fit user demands (e.g. it is too expensive).
- Production factors: the new technology does not fit firms' expectations about what the user wants or the new technology is expected to compete with firms' core products. Therefore firms are reluctant to invest to take the new technology into large scale production (and therefore does not profit from economies of scale).
- Infrastructure and maintenance factors: there is not yet an infrastructure of maintenance network.
- Undesirable societal and environmental effects: new technologies may solve problems but also introduce new ones.

Strategic Niche Management has been very effective in *analyzing and explaining* historical transitions and emerging innovation. SNM scholars have identified three interrelated processes influencing the potential success of the introduction of an innovation in society: 1) the voicing and shaping of expectations and the power of these expectations in turning promises about the innovation into requirements that contribute to the embedding of the innovation, 2) the importance of creating networks involving different kinds of actors in the project, and 3) the importance of first and second-order learning processes in projects. But as the name suggests SNM also aims to be a technology *management* strategy that contributes to the development of niches through organizing projects (Weber et al. 1999). SNM particularly aims at organizing projects with potentially radical and sustainable technologies in their early development phase. SNM, in short, aims at organizing projects under conditions of considerable uncertainty with respect to technological specifications and user context. Both the technology is considerably different from existing technologies and the market is not yet defined. As a tool, SNM falls in the category of market research techniques that can lead to emphatic design as identified by Dorothy Leonard (1998).

What is still lacking are detailed and practical *guidelines* for practicing project- and niche builders. Until today SNM has been mainly used in retrospective to analyse historical case studies. At best, the current SNM approach can be used in contemporary experimentation as a means to reflect upon the actual practice by means of making an historical analysis of the situation. SNM has, however, not yet been put into practice by actually supporting or even facilitating a new experiment. There does not exist a body of literature that delivers a coherent and step-by-step guideline for experimenting in practice.

SNM should focus on the niche level, as defined by Geels and Raven (2006a, 2006b), and support (program) managers who aim at orchestrating the interaction between different experiments on the more local level. There are already sufficient management tools that focus on the individual project level. The SNM tool would have much added value in providing guidelines for the management of multiple projects and their interaction. The level of analysis of the SNM tool would be a forum of interaction, and not focus on the practical daily management of local projects. SNM can especially orchestrate the bottom-up (from the local level) construction of a

shared set of expectations and thus of rules on the global niche level, which can in turn shape the actions on the local level, legitimise actions and legitimise increasing investments of all relevant resources. The orchestration of a constant interaction among local projects and between the local and the global level can then contribute to the successful reproduction and continuous strengthening and broadening of the set of global shared rules and thus contribute to the stabilization of the niche.

This report discusses SNM from a practioner's perspective with the main aim to articulate questions that should be addressed for translating SNM from an ex-post to an ex-ante tool. An outline for future activities to construct a toolkit can be found in the box at the end of this summary. A future activity that has not yet been mentioned is to analyse an existing instrument called Socrobust. Socrobust is a method developed by STS researchers (Laredo et al., 2002; Verbong, Mourik and Raven 2006) as a support for technology developers and project managers having to deal with breakthrough innovations, innovations that potentially raise problems of acceptance as they are displacing existing practices and shaping important elements of societies.

Research questions for a future research outline on Strategic Niche Management

Research questions dealing with the differences between experimental projects and niches:

- What are the differences between a niche and a local project in terms of the processes of articulating expectations, learning, networking, protecting?
- Should the SNM tool focus on the level of projects or on the level of a niche?

Research questions dealing with factors influencing the creation of niches:

- What are internal and external preconditions (with respect to the niche) for the creation of a niche, in the five steps towards creating a niche?
- What different strategies should niche actors use to facilitate the creation of a niche under different forms of regime instability in terms of causes and level of instability?

Research questions dealing with policy strategies to facilitate the creation of niches:

- What kinds of policy instruments are available, with what kind of effect on the protection of projects and niches?
- Which kind of policy actors can use what kind of policy instruments?
- What instruments are suitable for the protection of local projects and which for the protection of niches?

Research questions dealing with the five steps towards the creation of niches:

- Who is the intended user for the SNM tool?
- Should an SNM tool focus on all five steps or only on the actual niche creation steps 4 and 5?
- Who should choose the most appropriate innovation?
- How to assess what the most appropriate innovation is?
- How much should the innovation deviate from the regime that it aims to change; in other words on what aspects/dimensions should the fit be tolerable and on what aspects should the fit be optimal?
- How to assess what the transition potential of an innovation is?
- How much contextually bound (in terms of location, actors, lessons learned) should the local project be?
- How to organise this scaling up from local level to niche level, and what conditions are necessary to do so and who should do it?
- How can an innovation strategically use the possibilities to fit within one regime, to

grow and in time change another regime?
- How can the multiple regime analysis be translated into a SNM tool that allows for an analysis of lock-in/ lock-out effects of an innovation due to interactions between different regimes?
- Which actors should take up what activities in the five different steps?
- What is the role of the three interrelated niche processes in each of the five steps?

Research questions dealing with the articulation and shaping of expectations:
- Who should manage this process? What are his characteristics?
- What is the difference between the process of articulating expectations on the level of a local project and the level of a niche?
- When to stop with articulation of expectations and alignment of expectations and network?
- How much 'fit' is sufficient, when is a technology a tolerable fit and when an optimal fit?
- How to deal with questions of power in the articulation and shaping process?
- How to involve missing voices/minor voices and their expectations?
- How to elicit 'hidden' expectations?
- How to involve unwilling actors and how to deal with conflicting expectations?
- Which expectations are most relevant, and should therefore prevail?
- How to prevent strategic behaviour in the process of articulating expectations?

Research questions dealing with network process:
- How to choose such a network manager?
- What are the tasks of the network manager?
- How much relative proximity to the regime should the outsiders have? How to measure this proximity?
- How many outsiders should be involved?
- How much power these outsiders should have in making decision about the innovation?
- How should the power distribution in networks be dealt with in general?
- How to prevent the use of outsiders to smooth the introduction of unsustainable innovations?

Research questions dealing with the learning process:
- Is the learning process in local projects different from that at the niche level?
- Who should organise the learning process?
- How to organize second-order learning within local projects and niches?
- How to prevent the different possible forms of 'wrong' learning?

Research questions dealing with the creation of protection for a niche:
- How to minimise the gap between the conditions under which the local project takes place and the condition under which the technology would have to function in real user context?
- What kind of internal and external (with respect to the niche) protection mechanisms can be identified?
- What kind of internal and external processes can occur that must be prevented by means of protection mechanisms?
- To what extent is protection of projects different from protection of a niche?
- What different phases of protection exist and what kind of protection measures accompany these different phases?
- Which actor does the protection at which point in time?

1. Introduction

Why do so many sustainable technologies fail or never leave the R&D laboratory or showroom? Why are they not taken into large-scale production? These questions set off early research on Strategic Niche Management (Schot et al., 1994; Elzen et al., 1996). Scholars addressed these questions by investigating early market introduction of sustainable technologies and identify reasons for success and failure. Kemp et al. (1998) concluded that many sustainable technologies fail, because of:

- Technological factors: the new technology lacks technical stability, does not perform sufficiently, or there is a lack of complementary technologies.
- Government policy and regulatory framework: the new technology does not fit existing laws and regulations.
- Cultural and psychological factors: the new technology does not fit user (or societal) preferences and values.
- Demand factors: the new technology does not fit user demands (e.g. it is too expensive).
- Production factors: the new technology does not fit firms' expectations about what the user wants or the new technology is expected to compete with firms' core products. Therefore firms are reluctant to invest to take the new technology into large scale production (and therefore does not profit from economies of scale).
- Infrastructure and maintenance factors: there is not yet an infrastructure of maintenance network.
- Undesirable societal and environmental effects: new technologies may solve problems but also introduce new ones.

Building upon insights from evolutionary economics, SNM scholars argued that these factors exist, because new technologies compete with well established technologies, which are embedded in *technical regimes*, referring to 'rules' such as cognitions, beliefs, organisational structures and scientific methods, that guide technological development within and between firms (Kemp, et al., 1998; Rip and Kemp, 1998). These rules make firms 'blind' to alternative technologies and lead them to prefer to build upon the well established technological trajectories that developed out of the past. Building upon Rip and Kemp (1998) and adding insights from sociology of technology, Geels (2002, 2004) widened the concept of technological regime from purely the variation environment and included the selection environment. Not only firms are bounded by rules; also other social groups such as users, policy makers and scientists are often blind to radically different technologies. Their preferences, activities and methods are also attuned towards using, regulating or improving the dominant design. Hence Geels rephrased the concept into *socio-technical regime*.

Yet the same scholars also acknowledge that sometimes radical innovations do succeed. Examples are transitions from coal and oil to natural gas (Winskel, 2002; Correljé and Verbong, 2004) and from horse-drawn carriages to the automobile (Geels, 2005a; Geels, 2005b). To understand such historical transitions a multi-level perspective was developed, which added two levels (Rip and Kemp, 1998; Geels, 2002). The first level is the 'socio-technical landscape' and highlights the role of events and developments in the exogenous environment: developments and events that cannot be controlled by single actors. It is a rather descriptive concept that refers to broad societal trends such as macro-economic developments (e.g. recessions, global oil prices). But the concept is also used for referring to rapid historical shocks and events (i.e. the Chernobyl explosion) that put pressure on existing regimes and create windows of opportunities for radical innovations.

The second level was called *niches* and build upon insights from Strategic Niche Management (SNM). In this perspective radical transformation of regimes starts in *early niche markets*: distinct application domains where users have different preferences than mainstream users. Many historical examples support this assumption such as the application of solar cells in space travel and mobile phones for business people. These early adopters were often willing to pay a higher price, because of particular benefits they gained from the innovation. For sustainable innovations, however, early niche markets often do not exist (benefits are at the collective level of societies; no individuals are willing to invest) or are too different from mainstream markets (e.g. solar cells for space traveling). Markets for sustainable innovations have to be created, for example by providing subsidies or through strategic firm investments. Through a long process of experimentation in pilot plants, market and technology can develop in a process of co-evolution. By actually using an innovation, users create or learn about new needs, policy makers create regulatory frameworks that fit the innovation and industrial actors learn to improve the innovation and reduce costs. SNM scholars have called these special niche markets *technological niches*.

The multi-level perspective and Strategic Niche Management have been very effective in *analyzing and explaining* historical transitions and emerging innovation. SNM scholars have identified three interrelated processes influencing the potential success of the introduction of an innovation in society: 1) the voicing and shaping of expectations and the power of these expectations in turning promises about the innovation into requirements that contribute to the embedding of the innovation, 2) the importance of creating networks involving different kinds of actors in the project, and 3) the importance of first and second-order learning processes in projects. But as the name suggests SNM also aims to be a technology *management* strategy that contributes to the development of niches through organizing projects (Weber et al. 1999). SNM particularly aims at organizing projects with potentially radical and sustainable technologies in their early development phase. SNM, in short, aims at organizing projects under conditions of considerable uncertainty with respect to technological specifications and user context. Both the technology is considerably different from existing technologies and the market is not yet defined. As a tool, SNM falls in the category of market research techniques that can lead to emphatic design as identified by Dorothy Leonard (1998).[1]

What is still lacking in the literature however, are articles that deal with the increased need for detailed and practical *guidelines* for practicing project- and niche builders. Some authors discuss this need and attempt to make a start with the creation of a tool or at least guidelines for practitioners (Caniëls and Romijn, 2006; Verbong, Mourik and Raven 2006). However, this is still very limited. One reason is that SNM authors themselves have been reluctant to translate historical analysis into practical guidelines. Historical case studies show the complexity, non-linearity and contingency of radical technological change. As a result SNM and multi-level perspective scholars have tended to emphasis complexity and contingency and argue that transitions are by definition impossible to manage (at least in a traditional planning and control approach to management). No single actor is able to grasp and control the full complexity of transitions.

[1] Empathic design is based on market research that focuses on actual observed customer behavior instead of the traditional espoused and or self-reported behavior; emphatic design further is conducted through direct interaction between actors with deep understanding of the technological capabilities of the innovation and product users and finally emphatic design draws on existing technological capabilities. Leonard identifies several strategies to achieve an emphatic design. First, firms can use their developer's "market intuition" since these developers often are user developers and industry experts; second firms can use the instrument of market matching, which entails either technology transfer or partnering with customers in the development process. A third strategy is to use anthropological expeditions such as observing user practices, capturing practice on film or role playing the future. A final strategy involves market research techniques. These techniques vary from extrapolation of trends, development of scenario's of the future and lastly market experimentation. SNM fits this last market research technique.

However, if SNM is to be used as a management approach (as the name suggests), detailed and practical guidelines for practitioners that are involved in actually setting up projects and niches are necessary, but without losing insight about non-lineary and complexity of transitions. In other words, what can a practioner do to guide and modulate transitions towards sustainability given the complex, multi-level and multi-actor world he or she is operating in?

In the course of this paper we will conclude that SNM can best focus on the niche level, as defined by Geels and Raven (2006a, 2006b). There are many management tools that focus on the level of single projects. SNM can make a difference in supporting (program) managers who aim at orchestrating the interaction between different projects. As such, the level of analysis of the SNM tool would be a forum of interaction, and SNM would not focus on the practical daily management of local projects. SNM can especially orchestrate the bottom-up (from the local level) construction of a shared set of expectations and thus of rules on the global niche level, which can in turn shape the actions on the local level, legitimise actions and legitimise increasing investments. The orchestration of interaction among local projects and between the local and the global level can then contribute to the reproduction of successful niche practices (while disposing unsuccessful ones), and thus contribute to the stabilization of a niche that holds the potential to initiate system change.

This paper should be read as a practitioners view on SNM. The paper aims at identifying questions that emerge from a practioner's perspective, which are necessary to address to make SNM not only an ex-post framework for analysing historical cases, but also an ex-ante tool for practitioners to smartly and reflexively set up projects with radical innovations and creating niches aimed at contributing to system change. Each section will end with a summarizing box of relevant questions. The paper explicitly does not aim to provide a theoretically sound, and complete review of SNM literature. We invite readers to explore some of the references in the text below.

2. SNM: from an ex-post framework to an ex-ante tool

2.1 Experimental projects, technological niches and market niches

A first issue that needs elaboration in the SNM literature is a clear definition of the difference between experimental projects and between technological niches and market niches. SNM authors agree that the different concepts require different management approaches. However, for an outsider the current use of the concepts experimental projects, technological niche and market niche is confusing. If SNM is to be used as an ex-ante tool for practitioners it should be clear who the targeted user of an SNM tool is and what the level of analysis is to which SNM applies.

A first definition of the concepts 'market- and technological niche' follows from evolutionary economics where a market niche is defined as part of the selection environment and already has to deal with the rules of the selection environment (Astley, 1985). In a market niche the conditions allow for a specific alternative. As discussed in the introduction a technological niche is set clearly apart from the selection environment as a niche that needs (economic) protection because its advantages do not outweigh its economic disadvantages with respect to the existing technologies in the selection environment.[2]

Weber et al. (1999) make a distinction between experimental projects and niches as being different levels of analysis, and demonstrate differences on many aspects, i.e. the involved actors and the internal processes. Weber et al. (1999) define an experimental project as the first step towards the development of a niche, and they see a niche as consisting of multiple more or less tightly coupled experimental local projects, or of an experimental project whose scale is expanded to a size that makes it relevant beyond the local level.

In addition, for SNM it is relevant to make a distinction between different kinds of experimental projects. Kemp et al. (2006) discuss experimental projects that experiment with innovations without the explicit aim to contribute to system innovation in the long term. These experimental projects, taking place in the scientific or business context, revolve around testing, evaluating and demonstrating. When referring to an experimental project from an SNM perspective, Kemp et al. (1998) stress that the experimental project deals with an innovation that is either new and radical in terms of a new market or a new technology or a combination of both, and explicitly aims at system change. This kind of experimental project revolves around search heuristics, exploring and discovering. Another important aspect is that these experimental projects explicitly aim to set a co-evolution of both the market and technology in motion.

Geels and Raven (2006a, 2006b) acknowledge the confusing mixture of concepts and propose a different definition which forms a sound and pragmatic base for the development of a tool for practitioners. They argue that the niche level is a global level or field level, carried by experimental projects in different locations. Through bottom-up local processes generic, location-independent rules can emerge on the global field level. Niche processes as such have a local dimension of local projects and a global dimension of shared rules. The local dimension concerns local actors, local knowledge and a specific configuration of the innovation.

[2] One could argue that the actors working on this technological niche and apparently feeling the need to develop this alternative are (often) also part of the existing regime and thus part of the selection environment. This would mean that the technological niche also is a market niche, but that the market share is smaller. A market niche then would serve a need for which no other immediate alternative exists, whilst a technological niche has to compete with other alternatives or already existing and dominant technologies.

Knowledge, so Geels and Raven emphasize, is however never only local but also partly global, particularly when it concerns scientific knowledge and visions. Actors participating in these local projects often also play a role on the global level, and it is exactly this dual identity that facilitates the exchange of knowledge and expertise between the local and the global level.

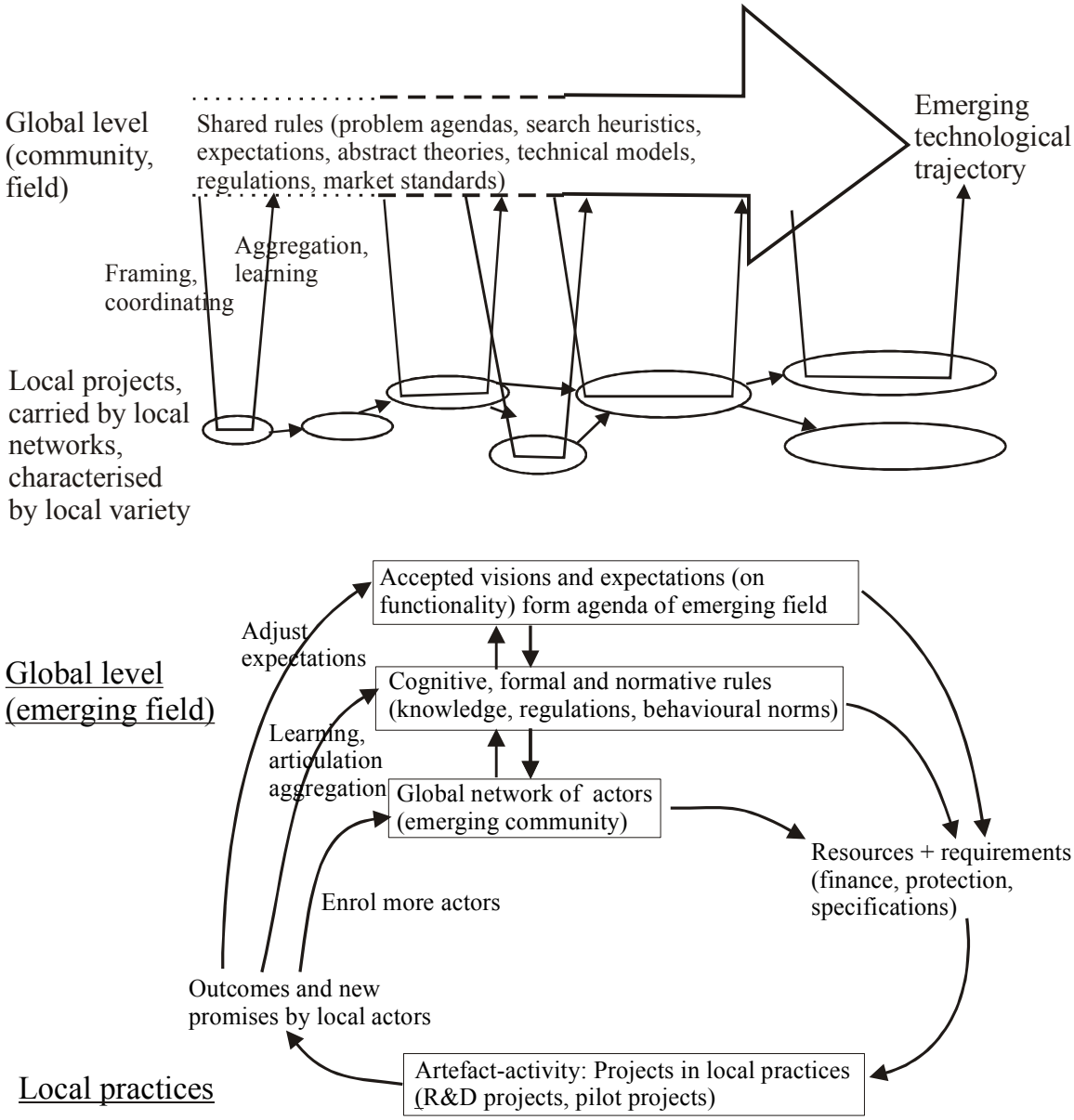

Figure 2.1 *Local-global distinctions in niche development trajectories*
Note: The upper figure illustrates how a global niche level emerges through an aggregation process of various local projects. The lower figure explicitly links the two levels to the three niche processes identified by SNM scholars (expectations, networking and learning).
Source: Geels and Raven (2006b).

Geels and Raven's definition of local projects and niches does make the level of analysis more clear. One issue, however, remains underdeveloped, i.e. the distinction proposed by Weber et al (1999:11) regarding development in time. Weber et al. (1999) claim that a niche "involves a *second* stage of interaction with users and learning about constraints and requirements in a less isolated environment than an experiment" (Weber et al., 1999:11). As such a niche consists of experimental projects that are further developed in terms of their interrelatedness, a niche is the result of accumulation of projects in time and a niche is less protected and more subject to market conditions than local projects.

In the remaining text, when we discuss the differences between experimental projects and niche processes, we refer to the definitions as proposed by Geels and Raven, taking into account the time factor as discussed by Weber et al.

Research questions dealing with the differences between experimental projects and niches:
- What are the differences between a niche and a local project in terms of the processes of articulating expectations, learning, networking, protecting?
- Should the SNM tool focus on the level of projects or on the level of a niche?

2.2 The creation of a niche

A second issue that has been investigated in SNM research concerns the (external) factors influencing the creation of niches and the strategies that can be followed to create temporary protected spaces for both local projects and niches. We will discuss both in some detail.

2.2.1 Factors influencing the creation of niches

Different scholars have identified many conditions facilitating niche processes. Astley (1985) for example states that niches are created when, due to processes internal to the selection environment, the selection criteria become (temporarily) less severe. In other words, when the selection environment is in a (temporary) state of destabilization, a more radical innovation can grow and break through.[3] There is no need for an optimal fit as is the case when the selection environment is stable and has strict selection criteria. According to Astley, when the selection environment is destabilised, organizations can create a new niche for a potentially radical innovation by means of technology push. SNM literature also stresses the temporary windows of opportunity that arise when the selection environment consisting of regime and landscape temporarily destabilizes due to processes internal to regime and landscape. In addition, SNM not only focuses on the business perspective of stressing the potential to create a niche through technology push, but also focuses on the potential of creating niches through demand pull from the side of policy makers and other relevant stakeholders. SNM lacks, however, guidelines on how to do this.

Caniëls and Romijn (2006) also observe that users of SNM and the multi-level perspective find it difficult to allocate certain influencing factors uniquely to either the regime or the landscape. When working with SNM in practice, we encountered another problem of operationalising the multilevel perspective. This perspective takes the position of an innovator/firm of innovative technology as point of reference. Hence what can be influenced (factors on niche level), what is difficult to influence (factors on regime level) and what is impossible to influence (factors on landscape level) are identified from the perspective of a firm. This becomes in particular problematic when (as many scholars do) the niche level is conceived as the local level, the regime level as the national level and the macro level is conceived as the global level. In practice, for example many policy makers function on the national (and international) level and they find it easier to influence events on these levels than to influence events on the niche level. Different actors thus have different positions in different networks and thus different perspectives on possibilities to influence events.

[3] Astley (1998) identifies (increase of) costs, (lack of) intercommunication and adaptation to environment (or lack thereof) as reasons for stability and instability in the selection environment.

Caniëls and Romijn (2006) therefore propose (when using SNM as a tool) not to use a categorisation based on regime and landscape, but based on the SNM users' ability to influence the events. They propose to categorize conditions as either preconditions that need to be fulfilled to make experimentation occur, and conditions that stimulate and or enhance but are not absolutely necessary. The first category is most important when translating SNM into a tool, and Caniëls and Romijn (2006) divide this category into conditions that can be manipulated on the short term and conditions that cannot be manipulated in the short term but can change over time. Among the necessary conditions Caniëls and Romijn (2006) distinguish the following:

- The availability of sheltered spaces for incubation.
- The possibility for continuous evaluation and incremental improvement of the technology.
- The technology must exhibit possibilities for capturing temporal increasing returns or learning economies.
- The new technology should be open to development into different directions.
- The technology should be favoured in certain application due to its advantages, to such extent that its disadvantages count less.

Caniëls and Romijn (2006) summary of necessary preconditions is certainly valuable. The added value in the process of translating the SNM framework into a tool could be enhanced if these necessary preconditions could be extended to include all necessary preconditions at all five steps of relevance for smart experimentation (which will be discussed in the next section). The conditions discussed by Caniëls and Romijn (2006) focus mainly on the necessary preconditions for the technology and thus foremost apply to the first step in experimentation: the selection of a suitable technology to experiment with in a local project. For the other steps necessary conditions also include for example the availability of sufficient powerful actors that are willing to participate in the local project, and another necessary precondition could be the presence of a network coordinator that is able to elicit the voicing of expectations, and map these with mapping tools to highlight complementarities, gaps, lacking details and specificity. The identification of these preconditions for each step and each process within an SNM experimental project is another research subject for future SNM agenda's.

Raven (2005) identifies three factors influencing the creation of market niches. First he argues that market niches come into existence through a parallel development pattern that follows from expectations that are broad enough to encompass multiple but similar product definitions. This parallel development results in a larger scale, double-loop learning and offers a back-up strategy since even when one product definition does not survive, others will. Second he stresses that historical analysis demonstrates that the creation of market niches always is accompanied by continuous development due to a very broad and powerful network, which protects and shares learned lessons. Finally Raven identified that the creation of market niches is characterized by increasing stability and robustness of the niche, as a result of double-loop learning processes.

Raven's findings correspond to the three market experimenting strategies that firms can use to create a new market as identified by Leonard (1998). These three are: Darwinian selection which is parallel experimentation with product definitions that are similar in terms of performance and functions; product morphing is continuous development and adjustments to one product following evaluations of this product and lastly vicarious experimentation which entails learning about first mover failures and developing a product on the basis of the mistakes made by other firms. What Raven (2005) implicitly suggests, is that for successful market niche creation, a combination of all three forms of experimenting is most effective. You need both the parallel experimentation, the constant reformulation of the product design following evaluation and you need to learn from failed experimental projects.

Raven (2006) made a first attempt at combining knowledge about regime instability with possibilities for a radical innovation niche to use this regime instability to breakthrough. He discusses four niche-regime interactions in a matrix. The vertical axis represent the stability of the regime (from low to high), the horizontal axis represents the stability of the niche measured by the quality of the three relevant niche processes. When regime stability is high and niche stability is limited the niche has limited potential to grow and become embedded widely. When regime stability is high and niche stability is high too the niche is a potential promise, but will have to compete heads on with the existing dominant technologies. When regime stability is low and niche stability is high, the niche has the greatest potential to successfully and rapidly grow and result in a system change. When regime stability is low and niche stability is low, Raven argues that this niche is a missed opportunity.

Raven's (2006) matrix is also contributing to the practicality of the SNM approach, but to be really useable for practitioners, the matrix should be more nuanced. Regime instability can have different causes and also different levels of instability and the strategies of niche actors should aim at contextualising their strategies to hook up with these causes and the level of regime instability. For example, when regime stability is high and niche stability is high too, hybridisation might be the most feasible strategy, in the hope that when regime instability increases, the technology has gained sufficient momentum to break free and stand-alone.

Research questions dealing with factors influencing the creation of niches:
- What are internal and external preconditions (with respect to the niche) for the creation of a niche, in the five steps towards creating a niche?
- What different strategies should niche actors use to facilitate the creation of a niche under different forms of regime instability in terms of causes and level of instability?

2.2.2 Policy strategies to facilitate the creation of local projects and niches

Research conducted on this topic is extensive. However it does not yet sufficiently make explicit the distinctions between the strategies different actors involved in the process can or should adopt. In literature dealing with the formation of networks for smart experimentation (Hoogma 2000; Hoogma et al., 2002) and literature dealing with the internal process of voicing and shaping expectations about the innovation, the involved group of actors is viewed as a heterogeneous group. However, in literature dealing with strategies to create local projects and niches, most authors discuss the group of actors involved in local projects or niches as a rather homogeneous group. In addition, in the discussion of available strategies and steps, the authors often do not discriminate between activities aimed at smart experimentation and those activities aimed at the creation of niches.

Raven for example (2005) distinguishes three ways for policy makers to create niches. First policymakers can use the central planning of niches within the classical steering paradigm that makes use of formal policy instruments such as regulation, rules and laws. Second policymaker can use the bottom-up market model, attempting to steer the market by means of incentives and tax exemptions. The third way is aimed at creating networks consisting of all relevant actors for the innovation trajectory by means of facilitating seminars, workshops and local projects. Raven (2005) positions SNM as an instrument that fits this last strategy.

Geels and Kemp (2000) advise policymakers to use generic instruments to exert pressure on the existing regime and stimulate different alternative but complementary technologies (for example hybrid technologies) by means of more specific measures. In addition Geels and Kemp stress the coordinating role policymakers can play in coupling niches. But in this report the practicality of the guidelines is still missing, as the authors are the first to admit.

Policymakers are not a homogeneous group. Policy-makers can operate on a local level (municipalities), regional level (provinces) and national or even international level (ministries, EC). For all three categories of policymakers different strategies are available, and not all kinds of policymakers can facilitate the creation of niches. For policymaker at the level of municipalities and provinces, strategies such as the use of incentives and tax exemptions is already much more complicated to achieve than for policy makers at the national or international level. Also the third strategy aimed at creating networks consisting of all relevant actors for the innovation trajectory by means of facilitating seminars, workshops and niche projects is a rather difficult strategy for the more local policymakers. On the other hand, these more local policymakers are the actors that are involved in setting-up smaller scale local projects. They often are not able however, to link different local projects that exceed their municipal or provincial boundaries, and as such are not the right actors to participate as coordinators in creating niches.

More research is thus necessary both on the issue of different policy instruments for local projects and niches, and on the issue of different policy actors and their ability to protect projects or niches, and the instruments available to them.

Research questions dealing with policy strategies to facilitate the creation of niches:
- What kinds of policy instruments are available, with what kind of effect on the protection of projects and niches?
- Which kind of policy actors can use what kind of policy instruments?
- What instruments are suitable for the protection of local projects and which for the protection of niches?

2.2.3 Creating local projects and niches in five steps

Several authors (Kemp et al., 1998) (Weber et al., 1999) identified five overlapping and interrelated activities or steps to be followed in the creation of a niche. In this literature, again those actors that should take up the different activities are not sufficiently identified. What these authors propose is that all five steps are necessary to create a niche. However, steps 1, 2, and 3 deal with the level of local projects, and only steps 4 and 5 apply to the actual niche creation. A question arises whether an SNM tool should focus on all five steps or only on the actual niche creation steps 4 and 5. This question is directly related to the intended users of the SNM tool. If these users are innovators in firms, focusing the tool on step 1 tot 3 is most fruitful, since these are the steps of relevance for innovators dealing with radical technological innovation. These innovators, for different reasons ranging from competitive issues to time management issues, will have less ambition to couple their individual project to a wider set of projects. If the tool however is aimed at program managers and policy actors, the reverse is at hand. These program managers and or policy actors will have different reasons for not dealing with projects on a local individual level. These actors, in addition, will not want to be put in a place where they have to pick the most promising technology, as step 1 entails. They will claim that this selection is typically a market mechanism. For them, linking the individual projects and facilitating learning and networking will have their focus.

The first step deals with the selection of the most promising candidate technology. Key issues in this decision are whether the technology or concept is an incremental or radical departure from the current regime. The advice from SNM is to choose a technology, which is close enough to the existing regime to inspire stakeholders, but can induce more radical changes later on because it is open to modifications in later stage (Weber et al., 1999). However, what is not discussed is how close the technology should be to the existing regime, and how to identify the potential for modifying a technology in later phases. A list of indicators would be valuable to measure the complementarities. Caniëls and Romijn (2006) also mention that the technology should not be too complex, both in size as in scope. This complexity can be added later on. In

addition, Kemp et al. (1998) suggest that a change agent should champion the technology. This champion, however, is particularly relevant for the project level, since he is directly linked to a specific technology. Such a champion could of course very well represent projects in forums on the niche level. Caniëls and Romijn (2006) import knowledge from radical innovations studies stating that the champion role can be vested in different people and should be a combination of a hands-on project champion and a promoter at the higher level of the firm. They further refer to Brown et al. (2004) and Roep et al. (2003) who discuss the personal characteristics of this champion: open, reflective, adventurous, etc. These characteristics would also apply to a manager on the niche level. A very important characteristic for the niche manager is however, that this actor should be neutral in terms of which technology he champions for. Choosing the technology is not a task for the niche manager.

For this first step to become a practical step in setting up a local project, a list of indicators should be devised to assess the position of the new technology, based on the alignment of the technology with policy rules, norms, production structures, infrastructures, maintenance structures, user preferences, etc. Hoogma and Schot (2001) and Leonard (1998) devised a matrix to assess the level of alignment (fit or stretch) of a technology to both the existing dominant technology and to the user practices. This matrix could be extended to include a more detailed analysis of fit and stretch with respect to more issues than that of the general level of technology and market. It should be assessed how much deviation is strategic, in other words on what aspects the fit should be tolerable and on what aspects the fit should be optimal. This could be analysed by means of historical cases already subject to SNM analysis. Raven (2005) found this categorizing of the fit and stretch of a new innovation problematic. The matrix functions when an innovation only deals with one dominant regime. However, many radical innovations interact with multiple regimes at the same time. As such, Raven argues, an innovation can fit one regime, i.e. the energy regime and stretch another, i.e. the agricultural regime. This multiple regime perspective, that allows an analysis of the fit of an innovation with one regime and stretch of another regime might be used strategically since the different regimes interact and implementation of an innovation in one regime can lead to both lock in and lockout effects in another regime.

So, next to answering the question who should do the choosing of the most appropriate technology, and how to assess what the most appropriate technology is, an additional issue is that from a niche perspective it is wise to simultaneously have multiple local projects running, organized and coupled in such a manner that learning can occur within and between these local projects (Weber et al., 1999). An additional advantage of exploring different technological options simultaneously is that from the start a larger market size is taken up and that learning can occur faster than with sequential experimentation. (Raven, 2005). The technologies for these different local projects could be identical, but it could also be strategic to experiment with similar but sufficiently different technologies. This is another question that requires further research. Keeping multiple options open does deal with the normative question of how to end an experimental option once lessons learned demonstrate that this option is not viable or has negative societal or environmental effects that outweigh the advantages. What is important is to set up local projects in such a way, that although different options are experimented with, the ending of one of these options does not also entail the ending of participation of actors involved around this option. In first instance, revenues and costs need to be divided smartly and to be linked to a bounded time frame, to mitigate the potential resistance of actors against the ending of a particular option due to vested interests. This issue is discussed in the section on learning.

The second step SNM scholars discuss is identifying the most appropriate setting for the local project, where the advantages of the technology weight more heavily than its (economic) disadvantages (Kemp et al., 1998; Weber et al., 1999). Designing the setting also entails the set up of the relevant network with insiders and outsiders, users and producers, setting up protection mechanisms, defining the role of users, and identifying longer term goals and perspectives.

Weber et al. (1999) also propose to include external independent evaluators to assess the local project. I will discuss most of these issues in greater detail in the section dealing with the three niche processes.

From using SNM in practice it follows that attention should be paid to the actual location for the local project. The local projects should not be too contextually bound and should be easily reproduced. If they are set up in such a way that much of the lessons learned are very much locally bound and in addition bound to local actors, diffusing these learning experiences has not much added value.

The third step SNM literature identifies is that the local project should be set up in terms of writing down goals, aims, expectations, promises, and also installing rules, regulations, and other relevant protection mechanisms. In addition, learning to achieve reflexive experimentation becomes one of the most important processes from this step on (Kemp et al., 1998; Weber et al., 1999). Reflexive experimentation refers to proceeding in small steps, taking into account the limited foresight, and readjusting the experimental setting in reaction to gained knowledge. According to Grin and Hendricks (2006) reflexive experimentation is linked to reflexive governance and refers to bottom-up heterogeneous networks aimed at double loop learning and attempting to facilitate change in the structure and agency of a system and engage diverse actors to this goal. Kemp et al. (2006) identify reflexive learning as *social* learning about underlying expectations and visions, changes in societal beliefs, norms and values, responsibilities, questioning the given norms and rules and reformulating expectations, redesigning the technology and restructuring the network to enhance the potential fit of the new innovation with the implementation environment.

One major lesson learned from this reflexive experimentation is that different actors play a different role at different stages of the experimental project. More research is required on this issue since as Caniëls and Romijn (2006:11) state: “the SNM literature is decidedly vague about who should be doing what”.

The fourth step deals with the scaling up of the local project to the niche level. One means to do so is by installing public support measures. This step has not yet received much attention from SNM researchers. This step is the first step actually dealing with the niche level. And SNM should foremost focus its practical guidelines to this step and the following step. There are already many project management tools that aim at managing ‘single’ projects for a rather limited time period. It is exactly the management of the long-term interaction between ‘local’ projects with the aim of creating a niche that can contribute to system change that can be a major contribution of SNM. How to organise this scaling up from local level to niche level, and what conditions are necessary to do so is an important research question.

Caniëls and Romijn (2006) make a first step at defining important issues for this step. They assess that first and foremost those managing this scaling up should be aware that radical innovations require different commercial strategies than incremental innovation. Lynn et al. (1996) and Leonard (1998) also argue that the strategies should aim at creating both a new market and a new technology. This co-evolution of market and technology through probing and learning is exactly what SNM aims at. Caniëls and Romijn (2006) emphasize that this strategy also requires the involvement of competitors in the niche project. Caniëls and Romijn (2006) do not deal with this issue of orchestrating this participation. This is, however, a problem in network managing that is very much present in many practical local projects, also to a lesser degree when dealing with non interested or not sufficiently committed actors. I will discuss this issue in more detail under the section on networking.

The last and fifth step aims at dismantling this protection to promote the independence of the innovation on support and increase its economic competitiveness. Step five has not yet received much attention from SNM researchers, but like step four, this step should be the focus of SNM tools. We will discuss this issue of dismantling protection in more detail in a later section.

The identification of these five steps is very much relevant for practitioners and can certainly be used as starting point for the translation of SNM from an analytical framework to a practical guide for smart experimentation and niche formation. A gap that needs to be closed to make this translation possible becomes very much apparent when dealing with SNM literature that focuses on the three internal niche processes contributing to the success of local projects and niche formation. This strand of literature is not sufficiently coupled and integrated with the literature about the five steps in smart experimentation and niche creation. For each of these steps it should be analysed which processes play a role, to what extent, and which actor should actively participate in these processes at what point in time in the procedure. In addition, the processes have been analysed ex post for many case studies. Particularly lacking are practical guidelines on how to coordinate these three processes, and guidelines about who should coordinate these actions. Finally, these processes are discussed as internal niche processes. However, the processes also play a role in local projects, although with different emphasis and scope. In the following sections I will briefly discuss the available knowledge about these three processes, and continue discussing the possibilities for devising practical guidelines, and the existing research gaps.

Research questions dealing with the five steps towards the creation of niches:

- Who is the intended user for the SNM tool?
- Should an SNM tool focus on all five steps or only on the actual niche creation steps 4 and 5?
- Who should choose the most appropriate innovation?
- How to assess what the most appropriate innovation is?
- How much should the innovation deviate from the regime that it aims to change; in other words on what aspects/dimensions should the fit be tolerable and on what aspects should the fit be optimal?
- How to assess what the transition potential of an innovation is?
- How much contextually bound (in terms of location, actors, lessons learned) should the local project be?
- How to organise this scaling up from local level to niche level, and what conditions are necessary to do so and who should do it?
- How can an innovation strategically use the possibilities to fit within one regime, to grow and in time change another regime?
- How can the multiple regime analysis be translated into a SNM tool that allows for an analysis of lock-in/ lock-out effects of an innovation due to interactions between different regimes?
- Which actors should take up what activities in the five different steps?
- What is the role of the three interrelated niche processes in each of the five steps?

2.3 Internal niche processes

The three most important internal processes are first the voicing and shaping of expectations and the power of these expectations in turning promises about the innovation into requirements that contribute to the embedding of the innovation, second the importance of creating networks involving different kinds of actors in the niche, and lastly the importance of first and second-order learning processes in niches. In the following sections I will continue discussing these processes.

2.3.1 The voicing and shaping of expectations

The voicing of expectations is one of the three interrelated internal niche processes that determine the fate of the niche. These expectations are expressed on three different levels (Van Lente, 1993). First expectations are expressed on the level of the technology. These expectations are problem oriented and deal with the specifications for the technology. Expectations on this level are e.g. issues of up scaling, reducing costs, or the characteristics of a specific fuel cell type. A second level on which expectations are expressed is the meso or regime level. This is the level of a field or sector. These expectations are function oriented, more qualitative. Expectations on the meso level deal for example, with the concept of fuel cells in transport sector as a means to reduce emissions. The last level on which expectations can be formulated is the general or macro level of society. These expectations are 'scenario' oriented, general and broad. Expectations on this macro level deal with the fuel cell as part of the hydrogen economy: the energy carrier of the future, resulting in reduced dependence of the Middle East, generating democratisation, giving power to the people (Jeremy Rifkin). Expectations on this scenario level typically are only used when the technology is still contested.

Van Lente (1993) claims that expectations have a dual function: they are both resource and actant. We will not go into detail on these functions, but merely mention them bullet wise. When dealing with a new technology, its potential advantages and problem-solving characteristic are not yet fully known. Actors involved in the development therefore need to position this technology and do so by means of making promises and voicing expectations about the innovation and its role in the wider system (Van Lente, 1993). Expectations are thus a means to facilitate the construction of a shared research agenda, to guide search processes, to increase the quality of design process through enhancing the specificity and finally to attract resources such as financial and managerial resources, actors, knowledge and expertise. The articulation of expectations also reduces risks, uncertainty and indeterminacy; legitimise and thus attracts resources (financial, managerial, actors, knowledge, expertise) and actors (credibility) and as such mobilize actors into the creation of a network (Van Lente, 1993).

According to Van Lente (1993) expectations also create and demand performance from actors because of the script that is inherent in their formulation. Expectations are a story, a script, with reverse salient and opportunities. The expectations formulate a problem for which the technology will provide a solution. The scripts in the expectation deal with the allocation of roles for different actors to make the solution happen, and as such position actors, enrol them into a network. This script deals both with the present and the future performance and use of the technology and the actors around the technology, and position actors both within and outside of the niche.

In addition the articulation of expectations, in combination with the common felt need for progress creates need for alignment and consensus. The phase following the initial articulation of expectations deals with the shaping of specific and coherent expectations. In much of the literature, it is expressed that the goal of voicing expectations is to make these expectations more robust. Robust expectations among the actors inside the niche prevent differences of opinions destabilising the niche from within. Robustness here is defined as expectations becoming more specific, detailed and consistent and broadly supported within the relevant network. (Kemp et al., 1998; Raven, 2005) Convergence into robust expectations should at least result in a common and coordinated strategy for moving the local projects forward.

This shaping of robust expectations takes place simultaneously with the creation of a network, since the expectation is also a script positioning actors within a network and defining their roles now and in the future. As such, expectations create and structure interaction between actors in niche, regime and landscape.

Finally, what expectations can do is turn a promise into a requirement (Van Lente, 1993). Expectations both make technology to be expected, especially when the articulations are voiced, discussed and consequently shaped as a result of networking and learning processes. If this takes place, the expectations become more and more specific and start to define the design criteria. As such the expectations become agenda's on the niche level, but they can also become agenda's on the level of as sector or field or even on the level of society in general. If expectations become locked on the regime and landscape level they start to guide new research areas on regime and landscape level and can as such contribute to the creation of new niches, and reinforce existing niches (Van Lente, 1993). Following this line of reasoning, one could claim that working towards the incorporation of these expectations on the agenda's at the functional and societal level is a mechanisms aimed at protecting the niche against destabilisation as a result of external factors, i.e. conflicting research agenda's.

Expectations are not fixed, actors change their views and their expectations, not only as a result of the coordinated voicing of expectations, but also in reaction to changes in the exogenous environment (Raven, 2005; Van Lente, 1993; Hoogma, 2000).

The voicing of expectations in a local project has a different aim than the voicing of expectations in the niche phase. Among others local projects are aimed at diversity, temporarily creating a non-conflict zone, and learning about the possibilities and limitation of the technological design. When dealing with niches, the process of voicing expectation is much more focused on convergence, strengthening the strongest elements, linking them to regime issues thus enhancing protection of the niche. These differences need to be worked out in detail.

In practice, the actors on the level of the local projects with artefacts usually have no difficulty in voicing and shaping expectations on the level of the technology. However, in practice, it becomes very much apparent that the actors in these local projects find it extremely difficult to voice and certainly to construct shared expectations on the level of the function of the innovation within a field or sector or even larger, its role within a wider transition on the level of society. In addition, in practice these local project actors find it almost undoable to voice and construct their expectations on all three levels in interaction with actors from other local projects. SNM can contribute to this process, by managing the interaction between the different local projects, and by managing the interaction between these local projects and the wider selection environment (regime and landscape).

Another issue is that although SNM literature emphasizes that expectations legitimise participation, in practice they often complicate the participation of outsiders. Participation is typically unproblematic when expectations are shared and viewed as truthful, and to some extent realistic. However, at the early beginning of a development trajectory the design specifics and performance expectations are still very much under debate. And when a radical innovation is accompanied by so much uncertainty and lack of specificity, expectations of outsiders can be very different from those of the developers of the technology, the insiders. Orchestrating the participation of outsiders who, due to their diverging expectations are either not willing to participate or either not welcomed by the insiders is yet another issue that needs practical guidelines. I will discuss this issue in more detail under the section on networking.

Practical guidelines also lack with respect to other issues. First it is not clear who should manage this process of articulating expectations, and what the characteristics of this manager should be. Furthermore, the creation of robust expectations in the niche phase (specific, detailed, consistent and broadly supported within the relevant network) is aimed at designing the technology such that it 'fits' sufficiently with the dominant system, but is different enough to embed the potential of a system change. In SNM literature, however, practical guidelines on both how to manage the process of voicing expectations and shaping robust expectations is not discussed.

Questions that arise are for example when to stop with articulation of expectations and alignment of expectations and network? How much 'fit' is sufficient? Practical instruments to facilitate this process of voicing and shaping, in both local projects and niches needs further development. Part of the Socrobust instrument that I will briefly discuss in the concluding section could be used to structure SNM processes.

Practical guidelines on how to actually elicit the voicing of expectations are yet another necessary part of SNM. Eliciting different and possibly conflicting expectations requires an actor who is able to manage this process in such a manner that all parties feel secure enough to voice their expectations. In addition, this managing actor also needs to identify the frame of thinking that drives the thinking and handling of these actors. If only expectations are articulated, the process of shaping a robust set of expectations occurs blindly, whilst knowing what drives and shapes the expectations allows for constructive negotiation and a reflexive shaping process. The Zaltman metaphor Elicitation technique that identifies the metaphors, constructs and mental models of customers is worth analysing for its suitability in an SNM process. Further, practical guidelines are necessary to deal with questions of power in the articulation and shaping process. Which expectations are most relevant, and should therefore prevail? How to involve missing voices/minor voices and their expectations?

This issue of multiple (not necessarily diverging) expectations following from different frames of thinking can also strategically be used in SNM. Instead of attempting to converge these possibly similar but not identical expectations into one shared expectation that directs the research agenda and shapes the products' definition, the similar (but different enough) expectations can be taken as a starting point for parallel local projects with more or less similar technologies, corresponding with the Darwinian experimentation as defined by Leonard. And because these expectations are rather similar and are translated in parallel local projects, learning can take place as in the product morphing experimentation that Leonard identifies. In this manner, two of the necessary conditions for effective market niche creation that Raven (2005) identified can be met.

Another issue relates to conflict, opposition and strategic behaviour that can arise in the process of voicing and shaping expectations. The articulation processes discussed in SNM focus mainly on the more constructive aspects of relevance for the innovation: who needs to produce the innovation, who would be the users and what are their demands, what is the symbolic meaning that can be attributed to the innovation, etc. What is not sufficiently developed yet is the articulation of possible deconstructive elements, opposition and barriers, the involvement of unwilling actors (Caniëls and Romijn, 2006) and the discussion on actual short-term actions that should be undertaken to achieve both the constructive elements built-up and the tackling of the oppositions.

A practitioner[4] remarked that deconstructive elements can also stem from working with 'open' agenda's and competitive 'outside' actors. Open agenda's can result in rather strategic behaviour, because competing actors can play out their conflicting interests in an open but destructive way. Another problematic issue with these open agenda's is that actors who are part of the regime, but participate in the local project or niche, only for the duration of the project meetings can strategically decide not to take into account their conflicting interests. However, if the commitment of these actors stays limited to the actions within the project meetings and is not translated into actions at the level of regime or niche, the niche is doomed to fail.

[4] Communication with Karel de Greef, May 2006.

Research questions dealing with the articulation and shaping of expectations:

- Who should manage this process? What are his characteristics?
- What is the difference between the process of articulating expectations on the level of a local project and the level of a niche?
- When to stop with articulation of expectations and alignment of expectations and network?
- How much 'fit' is sufficient, when is a technology a tolerable fit and when an optimal fit?
- How to deal with questions of power in the articulation and shaping process?
- How to involve missing voices/minor voices and their expectations?
- How to elicit 'hidden' expectations?
- How to involve unwilling actors and how to deal with conflicting expectations?
- Which expectations are most relevant, and should therefore prevail?
- How to prevent strategic behaviour in the process of articulating expectations?

2.3.2 Networking

The process of networking is the second of the three interrelated internal niche processes that determine the fate of the niche. This process has been discussed extensively by many authors, and requires little additional research. What is required, however, is again the development of a practical guideline on how to manage the networking process. We will discuss briefly the insights on networking that are discussed in SNM literature, and comment along the way.

The reasons for networking are manifold. Van de Poel (2000) claims that networks reduce complexity, scale, investments, risks, and uncertainty. Network also create co-ordination of the set of heterogeneous actors involved, by positioning these actors in relation to each other and by positioning the actors in different poles of for example science, technology and markets. Networks, in other words, materialize expectations and the accompanying division of roles and tasks. Another role of networks is that the interdependency in a network transforms behaviour from instrumental to strategic behaviour. This change in behaviour facilitates the creation of alignment inside a niche. Every actor has specific perceptions and expectations. The network aims at convergence of these different and possibly diverging expectations through orientation of actors inside the network on behaviours of other actors both inside and outside of the niche. In order for this alignment to occur, however, the different actors need a substantial history of cooperation or interaction, the network needs to be stable and the relationships between actors need to be formalized, for example through contracts.

Networks can facilitate innovation, due to the collective participation of different actors. To maximize the potential of creating radical innovations, both insiders and outsider actors (with respect to the dominant regime) are needed in a network (van de Poel, 2000). To foster radical innovation networks need to be composed of both dedicated network builders' and 'reactive network actors', newcomers and incumbents, users and non-users and insiders and outsiders. Particularly the outsiders play an important role in radical innovation networks. Van de Poel (2000) claims that outsiders (with respect to the dominant regime) in a niche context can demonstrate 'rule breaking' behaviour and thus initiate innovations. Insiders of the regime have often vested interests in the dominant regime (that have a high inclusion in the existing regime due to time, money, resources) and therefore follow these rules to maintain the stability of the regime. For these insiders, breaking the rules would not only possibly destabilize the regime, it would also lead to punishment or even exclusion from the regime. Van de Poel (2000) claims that outsiders however, have nothing to loose, usually have not too much invested in the dominant regime and can thus demonstrate rule breaking behaviour that leads to radical innovations with the potential of creating a system change.

What is not answered in SNM literature, is how many outsiders should be involved, how much power these outsiders should have in making decision about the innovation. Power distribution in general is a topic that has not received attention in SNM literature.

Van de Poel (2000), Weber et al. (1999) and Schot (2001) suggest that to increase the potential of system change of a radical innovation, the outsiders involved in the innovation network should have a relative proximity to the regime, but not share all rules. How much proximity or how to measure this proximity is an issue that has not been dealt with yet. And these outsiders should have access to and possibility to mobilize the following resources: actors, knowledge, financial and managerial resources and finally the public opinion or users (Van de Poel 2000). Van de Poel distinguishes between three kinds of outsiders. First he discusses the outsider firms who can introduce new artefacts. These firms can mobilise knowledge and expertise, financial and managerial resources. A second category of outsiders concerns professional engineers and scientists who can introduce new designs, criteria, approaches, concepts. These outsiders can mobilise knowledge and expertise. Finally van de Poel identifies a third category of outsiders: the societal pressure groups. Van de Poel argues that these outsiders typically lack the ability to mobilise knowledge and expertise, financial and managerial resources, but that they have the potential to mobilise public opinion, they often are lead articulator of protest or needs and they can mobilize insiders in the regime with less vested interest such as users and legislators.[5] Van de Poel therefore claims that to create niches, these three groups of outsiders need to form coalitions and networks.

Involving these different groups of insiders and outsiders, user and producers, incumbent and new actors, create dynamic relations in a network and between the network and the outside context. These dynamic relations can result in active learning about the technology and its context and as such networks foster learning of actors in coordinated way. This learning can result in alignment between niche and outside influential actors (macro-actors) and learning within the network can create alignment between niche and other networks within the dominant regime.

Weber et al. (1999) point to the fact that participation of this diversified set of actors in innovation networks needs to be orchestrated from the very beginning on. They stress the need for a network manager who drives and guides the network around a niche, even if the network relies on the effort of multiple partners. Rip (1995) labels this manager an alignment actor and proposes that such an actor can be a specially created actor such as a platform, but also a government actor or a large firm. Caniëls and Romijn (2006) claim that the network manager should ensure active involvement of all relevant groups at an early stage of all participating actors in defining the local projects' and the niches' goals, budget and schedules. In addition, they claim that the manager should organize public and project conferences and meetings at regular interval. This orchestration also entails the managing of sufficient reciprocity between the participants with respect to the distribution of costs and benefits (Caniëls and Romijn, 2006). This distribution should not only be orchestrated within a local project, but even more so when different technological trajectories are simultaneously tried out as Raven (2005) adheres. Otherwise actors will not easily allow their respective local project to die out, even though negative effects or lock-in situations have been identified for that option.

Different authors in the field of science and technology have commented on the advantages and pitfalls of involving outsiders in technological decision-making processes. A general comment that is made is that involving these outsiders can lead to a democratisation of technological development. Involving these outsiders in an early stage can facilitate a smoother introduction of a technology, because possible oppositions have been identified and reacted to in a pre-market entry phase. However, the pitfalls are numerous.

[5] Irwin and Wynne (1996) have demonstrated, however, that these societal groups become increasingly professional and consequently are increasingly able to mobilise all necessary resources.

To mention a few: first, the involvement of outsiders to increase the potential for smooth introduction can also be used strategically to smooth the introduction of possibly non-desirable technologies. Further, as discussed in the former section, firms can participate from a strategic need to hamper the introduction. Users and outsiders are not always able to think 'out of the box', and use associative thinking to categorise the new innovation, which can hamper the development of radically new products (Leonard, 1998). A general comment often made is that involving outsiders is not effective if these outsiders do not have the ability to influence the technological development. This ability to influence the development is however, no guarantee for a more societal robust technology (or process). In addition, empowering outsiders is often not agreed with by the developers of the innovation.

A last issue relates to the representativity of the outsiders. Caniëls and Romijn (2006) discuss the need for careful selection of representatives. They identify several lessons that can be learned from radical innovation literature. In this branch of literature it is emphasized to make sure that the actor network is diversified in terms of gender, race, age and personality profile, and that all individual actors should have professional breadth and broad personal networks. In addition, if they are core members they should be committed to the project for at least fifty percent of their time.

However, even when the actor network is diversified on this individual level, this does not guarantee the correct representation of groups. Even within a group, many diverging perspectives can occur. In innovation management literature the interpretive flexibility of perspectives is not sufficiently emphasized. If the focus is on different groups of users and other stakeholders, these still are often too much depicted as homogeneous groups. In most cases however, the focus is not even on groups but on the market environment as a whole. When constituting a network of representatives, the diverse set of users and their different perspectives, also within a social group should be taken into account. Analysing these frames of thinking and handling both of and within groups prior to selecting representatives should be part of the SNM strategy. Perspectives can be institutionalised and thus become more formalized in business strategies, institutions, and NGO's, which makes it easier to select representatives. Another issue concerning representatives is identified by Hendricks and Grin (2006). They claim that particularly when dealing with radical innovations, there are many contested notions of representativity. If these issues of contestation are not solved, the project may suffer from successful attempts to delegitimise it.

A last issue relating to the formation of a network is that not all actors are always willing to participate or commit themselves to the local project or niche. Weber et al. (1999) suggest that one way of creating commitment is through competitive selection in the formation phase of the network. From a practical experience, we found that arguments for participation need to be focused on their relevant frame of thinking: for many actors this is cost effectiveness. And although this cost effectiveness can lead to incremental innovation aimed at optimising the existing regime, the argument can be turned around. It can be demonstrated (by means of calculations in models dealing with technological learning) to these actors that although short term revenues are higher with incremental innovation, on the long-term costs for implementing a necessary radical innovation (e.g. due to increasingly steep targets for emission reduction that can not be met with more incremental innovations), will be much higher because of the shorter time span for implementing the infrastructure. This argument of cost effectiveness for these actors is the goal for participating, but for the network manager this argument is a means to another end, i.e. a system change towards sustainability.

SNM authors have also analysed the relationship between networks and the kind of niche that emerges from these networks. Hoogma (2000) demonstrated that the composition and alignment of a network influence the direction and scope of niches. Hoogma suggests that the way a network is composed influences the direction of the niche in terms of either fitting or stretching the existing technological and or the existing market and user practices dimension. He argues that interaction between producers, users and actors with radical different view in a network is essential, although no guarantee for a stretch strategy. Hoogma (2000) also demonstrated that the alignment within a network influences the possible impact of a niche in terms of its scope and scale. Hoogma (2000) argues that the more alignment within the local project and between the local project and its surrounding networks, the more successful the niche-development, in terms of replication and branching will be.

However, I feel that a note of caution is in place here. External alignment processes partly result in the adaptation of a technology to external pressure to improve the fit between the technology and its implementation environment (the regime). This fit can range from an optimal fit (incremental innovation) to a tolerable fit or even to a misfit, depending on how much alignment is achieved. Therefore, the process of managing a network and managing the internal and external articulation and alignment processes is also a process that aims at creating or maintaining a good tension between the new innovation and the existing regime. The networking process and the alignment should aim at both stabilizing the niche by internally aligning expectations (Hoogma 2000), but at the same time destabilizing the regime to such extent to make a radical introduction possible.

Several authors have demonstrated that the process of networking in the local project phase is different that networking in the niche phase (Weber et al., 1999). These differences become apparent when focusing on the mechanisms needed to move from the experiment to the niche level. Weber et al. (1999:51) identify the following niche network mechanisms: the dissemination of information, the extension of the network of actors and stakeholders to also involve competing parties in the network, the setting up of partner experiments, and or a modification of the regulatory and political framework.

Actors involved in a network in local projects are usually more local actors, and the users are often lead users. Actors in niches also include competing actors; more diversified mass users, actors with complementary competencies, and actors on a more general level. Weber et al. (1999) claim that the networking process in a niche is about interconnecting activities, facilitating exchange of information, bringing debate to political level. Caniëls and Romijn (2006) further argue that the network composition of a local project may need to change in order to facilitate niche formation. Weber et al. (1999) conclude that local projects often are less formally coordinated than niches. Local projects that move to the niche scale and start to link up need formalization and a more professional organization, among others because niche networks are vaster and consist of more and often also new actors.

All the above theoretical expertise and knowledge constitutes the perfect stepping-stone for the next step: drawing up a practical guideline on how to orchestrate the formation of network. Few practical guidelines exist, and much of the future efforts in SNM research should focus on extending these guidelines. Some important future research questions are bulleted in the box below.

Research questions dealing with network process:

- How to choose such a network manager?
- What are the tasks of the network manager?
- How much relative proximity to the regime should the outsiders have? How to measure this proximity?
- How many outsiders should be involved?
- How much power these outsiders should have in making decision about the innovation?
- How should the power distribution in networks be dealt with in general?
- How to prevent the use of outsiders to smooth the introduction of unsustainable innovations?

2.3.3 Learning

Learning is the last of the three interrelated internal niche processes that determine the fate of the niche. Learning in local projects and niches is focused on the changes necessary to couple with opportunities and overcome oppositions/barriers in the environment outside of the local project and or niche with the aim to make the new innovation function properly. Weber et al. (1999), and Kemp et al. (2006) have identified that learning in niches should entail learning about the necessary technical development and infrastructure issues such as i.e. design specifications and required complementary technology and infrastructure; learning about the development of the user context, i.e. user characteristics/requirements and user meanings/beliefs. Learning about the societal and environmental impact, i.e. safety, energy/emissions, employment, well-being/welfare; learning about the necessary industrial development, i.e. the production and maintenance network and competitive designs, and finally learning about the government policy and regulatory framework, i.e. the institutional structures and legislation, the government's role and the necessary incentives and subsidies.

There are many strategies for learning. Learning-by-searching aims at improving the innovation due to R&D; learning-by-doing (Von Hippel and Tyre, 1995) aims at improving the innovation due to repetitive manufacturing and evaluating the product as it evolves and is used, learning-by-interacting aims at generating network interactions and using the input from multiple network participants to improve the innovation. A final strategy is learning-by-using (Rosenberg, 1986) which aims at improving the innovation by generating feedback from use of the innovation in local projects and using this feedback to further the design process. SNM proposes the last two strategies to structure the learning process in local projects and niches.

Kemp et al. (2006) position SNM and transition management as part of a learning cycle as described by Kolb (1974, 1984). This learning cycle is constituted by four phases. The first phase is about practical and concrete experiences, which lead to phase two: reflecting upon the experiences. Phase three is about generalising these experiences to an aggregated level and phase four is translating these aggregated experiences into local projects, which in turn provide new practical and concrete experiences for another round in the circle of learning. Kemp et al. (2006) claim that when the learning cycle is repeated in another context, the scale of a local project grows and the learning and consequently the innovation become more robust and repeating the circle time and time again enhances the potential for the successful creation of a market niche.

Hoogma and Schot (2001), Lynn et al. (1996), Leonard (1998), Raven (2005) and Kemp et al. (2006) emphasise that the process of learning by using the innovation in local projects and by generating a network aimed at learning needs to be structured to generate the maximum of learning experiences and to generate a specific form of learning: double loop or reflexive learning.

Single-loop or first-order learning is the traditional method that aims at learning about the effectiveness of the technology to achieve pre-defined goals, and results in verification only (Hoogma and Schot, 2001). Kemp et al. (2006) also mention that this type of learning aims at learning about instrumental issues such as i.e. the solution to a technical problem or the effectiveness of an incentive. The learning occurs within a given frame of thinking and set of norms and rules. Double-loop or second-order learning is a reflexive method of learning. Kemp et al. (2006) identify two subcategories of learning in this double-loop way of learning. First they identify *conceptual* learning about a new concept, and second *social* learning about underlying expectations and visions, changes in societal beliefs, norms and values, responsibilities, questioning the given norms and rules and reformulating expectations, redesigning the technology and restructuring the network to enhance the potential fit of the new innovation with the implementation environment. Kemp et al. (2006) argue that this double-loop learning is reflexive to the extent that it can lead to changes in the frames of thinking of actors on both the level of the niche and on the regime level. The changes entail changes in thinking about the societal functions, norms and values in the existing regime to facilitate the implementation of the technology under analysis.

Kemp et al. (2006) link these three ways of learning (instrumental, conceptual and social) to the three levels of expectations as identified by Van Lente (1993). The instrumental single-loop learning is aimed at learning about the expectations on the level of the technology. The double-loop conceptual learning aims at learning about the expectations on the level of the regime. The social learning aims at learning about the expectations on the level of the landscape.

To make double-loop or second-order learning most effective, (Hoogma and Schot 2001), Lynn et al. (1996), Leonard (1998), Raven (2005) and Kemp et al. (2006) all stress the importance of involving a heterogeneous set of different actors in the network. In sum these authors emphasise the important role of outsiders and users as a source for second-order learning and for radical innovation. Raven (2005) explicitly claims that changes in expectations and visions, and as such changes in frames of thinking especially take place in reaction to confrontation with the external environment. Hoogma and Schot (2001) finally stress that for double-loop learning to occur, the network should make learning an explicit goal of the exercise. We discussed many positive and negative issues involved with this participation of different kinds of insiders and outsiders in the network in the previous section, and will not repeat this exercise here.

Hoogma et al. (2002) identified a relationship between the constitution of the network (involving traditional actors versus involving users and outsiders) and the occurrence of either single-loop or double-loop learning. When the network is constituted mainly of traditional actors who practice single-loop learning, the innovation will either die out or never leave the technological niche. If the network is constituted mainly of traditional actors who practice also double-loop learning, the innovation will never leave the technical niche or at best become an add-on technology to the existing regime. If the network is constituted of traditional actors, users and outside actors who only practice single-loop learning, the innovation will become an add-on technology to the existing regime or at best become a market niche. Finally, if the network is constituted of traditional actors, users and outside actors who practice double-loop learning, the innovation will at least become an add-on technology to the existing regime or at best contribute to system change and become an element in a new regime. Grin and Hendricks (2006) label this last network, a heterogeneous network aimed at double loop learning a form of reflexive governance in practice. They see these networks as bottom-up partnerships that attempt to facilitate change in the structure and agency of a system and engage diverse actors to this goal.

So, heterogeneous networks aiming at double-loop learning are a prerequisite for system change. The process of learning in local projects and niches has been discussed extensively by many authors, and requires little additional research. What needs further development, however, are again the practical guidelines for organizing the learning process. Particularly because double-loop learning is not a process that takes place autonomously if not managed.

Hoogma et al. (2002) and Raven (2005) demonstrated that most learning process are instrumental and single-loop processes. In addition, these authors discuss that learning usually is oriented at maximizing the potential of the technology, not analysing its role in a wider system change towards sustainability.

Other forms of learning can occur and will not positively contribute to the innovation's potential to contribute to system change (Ayas, 1996). For example learning can be role-constrained which leads to a situation where actors do learn about different technological and societal issues but do not translate these experiences into actions because they are stuck in role expectations or standard procedures dominant in the existing regime. Learning can also be situational which means that the learning experiences are not transferred to other local projects and niches. Learning can be fragmented in the sense that the experiences are not shared among actors, for example when learning experiences are tacit and embodied and not materialised in papers or manuals. Learning can be opportunistic and strategic and the distribution of learning experiences is hampered due to the strategic behaviour of powerful actors/firms who do not whish to see the experiences becoming public. Finally learning can be superstitious, which refers to actors taking the wrong actions, but thinking they are acting correctly based on a prior defined frame of thinking in which the actions fit. In SNM literature it is not discussed how to present these forms of wrong learning.

Again, the difference between learning in a project and learning in a niche are not sufficiently dealt with yet. One could expect actors in a niche to aim at learning from other local projects, and aim at learning about the possibilities for creating linkages with the regime, and aim at learning about protection mechanisms relevant for the niche. Actors in local project possibly aim at learning about infant diseases of their innovation, and less about the political and regulatory dimension.

Hoogma et al. (2002) and Raven (2005) explicitly mention that learning processes usually are oriented at maximizing the potential of the technology, not analysing its role in a wider system change towards sustainability. The problem however, is that the extent to which a technology will be a sustainable technology cannot be anticipated fully in advance. Technologies can have secondary effects, which mitigate the sustainable characteristics of the technology (Weber et al., 1999). It is inherently impossible to define all effects a priori. This only becomes apparent in time and after diffusion of the technology, and coordinated first and second order learning processes are important to recognize these effects. Paradoxically however, most learning occurs after more widespread interaction between the niche and the selection environment/regime. This interaction not only results in learning processes, but also in network formation, vested interests and in the institutionalising of rules, regulations, norms and other aspects favourable to the technology (path dependency). This leads to the embedding of the technology and increases the difficulty in altering the course of the development, let alone the ending of a technological development path.

Research questions dealing with the learning process:

- Is the learning process in local projects different from that at the niche level?
- Who should organise the learning process?
- How to organize second-order learning within local projects and niches?
- How to prevent the different possible forms of 'wrong' learning?

2.3.4 Protection

The last and fifth step in setting up and up-scaling a local project to the level of a market niche aims at dismantling protection to promote the independence of the innovation on support and increase its economic competitiveness. Weber et al. (1999) define the following protected situations: defining certain applications, geographical spaces or organizational units, which can be complemented with additional specific protection measures in the form of regulation, incentives. This protection enables actors, such as firms, users, policy makers and environmentalist, to learn during the niche phase.

As mentioned earlier, this step has not yet received much attention from SNM authors. At present Johanna Ulmanen (TU/e) is working on this subject. Typical for the lack of attention for this subject is that it is not labelled as one of the important niche processes. It could, however, be argued that creating protection both in the phase of a more local technological niche/ local project and also on the level of a niche, the creation of protection is one of the four interrelated niche processes that determine the fate of the niche. The process of creating protection is very much related to the voicing and articulation of expectations, since the result of this process has immediate consequences for the content and the scope of protection mechanisms. The process of creating protection is also very much interdependent on the process of networking, since the network should be constituted such that those actors are included and committed that also have the power to mobilize protection mechanisms, and finally the process of creating protection is interrelated with the process of learning, since the outcome of these learning processes influence the direction of the protection mechanisms.

Within the existing SNM literature, when dealing with protection, two issues are raised. First the actual creation of protection for niches and second the dismantling of this protection. SNM literature does acknowledge that protection of local projects and the protection of a niche differ. The necessary protection measures of a local project differ from those for a niche.

Creation of protection

The creation of protected space is important for a project. Projects usually face many uncertainties and (economic) disadvantages. To alleviate these uncertainties and disadvantages it is important that a project is carried out under more or less protected conditions. This protection can amongst others be created by means of incentives and subsidies which make sure that the (economic) disadvantages of a technology weight less than its (problem solving) advantages. Protection of local projects is therefore focused on creating an (economic) protected space for the experimental project. Protection measures consist for example of incentives, tax support or R&D allocations. Both policymakers on level of firms and of government coordinate this protection. According to Weber et al. (1999) these protection conditions provide the possibilities for learning about the desirability of the technology, and improve its technical performance and societal embedding. The gap between the conditions under which the local project takes place and the condition under which the technology would have to function in real user context should be minimised. More research on this subject is required. Weber et al. (1999) finally stress that a local project usually benefits from local specific measures.

SNM literature suggests that protection of a niche should be less severe and on a more general level than protection of a project, since a niche should (purposefully) much more be exposed to existing selection conditions. Protection of a niche aims at protecting the process of scaling up the individual (local) projects to the niche level. This protection consists of managing the three internal niche processes, and aims to mitigate possible internal (with respect to the niche) destabilising processes, increase internal stability of the niche and should be managed by the niche manager.

However, one could claim that market niches also require strong support and protection, but of a different content and on a different scale than projects, and that the central protection mechanisms for niches does not so much revolve around gradually dismantling protection, but around institutionalising factors that protect the niche both from processes within the niche that can destabilise it and against external destabilising processes (resistance from the regime).

Weber et al. (1999) discuss protection mechanisms against niche internal destabilising factors. They mention that convincing involved niche actors and stakeholders that a technology is in fact feasible and reliable and making vague expectations as specific as possible is a form of protection because it links the commitment of partners to specified expectations. Weber et al. (1999) also identify two protection mechanisms that aim at protecting the niche against external factors. First creating a network is part and parcel of the creation of protection against external pressure. A network creates momentum, gives body to a technology. The question that needs to be tackled however, is how much body in terms of numbers and how much power a network needs to gain enough critical mass to enable economical learning and to be able to advance institutional and regulatory changes that favour the new technology in a more long-term manner. This critical mass obviously is technology dependent. For example, when dealing with a new nuclear reactor, building ten of them already is full market penetration. When dealing with solar panels, ten panels is not even sufficient critical mass to start a local project. This issue need further study. Weber et al. (1999) further mention that protection can take the shape of parallel monitoring of the effects of a local project on societal and environmental context. They demonstrate how monitoring the effect of a public transportation local project and closure of parts of a city to private transportation affected commerce resulted in less resistance from the shopkeepers. Van Lente (1993) stresses the implicit protection against external destabilising factors that follows when a promise or expectation is turned into a requirement.

So, market niches no longer require protection by means of temporary incentives and subsidies, but they require the institutionalisation of rules that protect and stabilize the new innovation. Actually undertaking the actions necessary on all dimensions to overcome uncertainties and risks and to overcome barriers and oppositions and thus create the necessary preconditions for the widespread implementation of a technology, or, in other words, turning the promise of the innovation into a requirement, is part of the protection process for a market niche. As such, protection in the phase towards market penetration should be more oriented towards altering the dominant regime in terms of rules, codes, standards, regulation, and institutions.

Many authors have identified mechanisms resulting in the stability of the existing regime. Geels et al. (2004) identify several reasons for stability of a regime. All of these factors have one thing in common, and that is that they aim at stability through reproducing the system. First the authors discuss how economies of scale, learning-by-using, network externalities, informational increasing returns and technological interrelatedness increase returns of a technology and thus increases its stability. Legally binding contracts are another reason for stability of an existing system. The embeddedness of actors and organizations in interdependent networks with mutual role expectations that reproduce the system is a third factor causing system stability. Cognitive routines of engineers and designers, core capabilities, vested interests of firms are other factors increasing stability of a system. Systems also become stable because of their embeddedness in a society in which the following elements are aligned: lifestyles, institutional arrangements, formal regulations, and infrastructures. A last factor Geels et al. (2004) identify as leading to stability is the guiding of innovative activity within the system towards incremental change that optimises the functioning of the system in reaction to changes in the environment outside of the system but of influence on the system.

It might be valuable to research to what extent these same mechanisms, next to the three internal niche processes discussed earlier, would apply to increase the stability of a market niche.

Dismantling protection

Weber et al. (1999), Kemp et al. (1998) and other scholars have stressed the importance of gradually dismantling support in two cases. First when the technology will clearly not function as expected (both financially and socially). Caniëls and Romijn (2006) stress the difficulty of dismantling protection, particularly in the first case, because of vested interests. Kemp et al. (1998) label those actors resisting the dismantling of the protection in case of an unfulfilled promise 'angry technological orphans'. In addition, it can prove difficult to objectively assess that an option will not fulfil its promises.

Second, SNM authors stress that the protection measures in place for the project should gradually be dismantled when the technology has reached market niche level. This dismantling of protection can be done gradually by using a conditional form of protection from the early start. Caniëls and Romijn (2006) emphasize the value of conditional and temporal creation of protection. Weber et al. (1999) also emphasises that there needs to be sufficient threat of removal of protection to exert pressure for improvement. Conditional support refers to protection from policy or a firm under strictly conditional terms and set for a clearly defined period, and in addition these conditions (targets) can become increasingly ambitious over time. This conditional nature of protection and the accompanying stress of removal of the protection when conditions and ambitions were not met, enforce rapid and second order learning. So, not only does protection create possibilities for learning. Conditional protection forces double loop learning. This enforcement is implicit, but can be made explicit. Caniëls and Romijn (2006) propose that one of the conditions should be cooperation among local projects and increasing exchange of experiences. One could formulate an additional condition: the participation of outsiders.

Research questions dealing with the creation of protection for a niche:

- How to minimise the gap between the conditions under which the local project takes place and the condition under which the technology would have to function in real user context?
- What kind of internal and external (with respect to the niche) protection mechanisms can be identified?
- What kind of internal and external processes can occur that must be prevented by means of protection mechanisms?
- To what extent is protection of projects different from protection of a niche?
- What different phases of protection exist and what kind of protection measures accompany these different phases?
- Which actor does the protection at which point in time?

3. Conclusions: future research outline towards instrumentation

SNM is at this moment an analytical framework that builds on a tradition of historical analyses. The SNM literature on the processes relevant for facilitating and enhancing the potential market embedding of a potentially radical innovation is mainly retrospective. SNM literature on policy and business strategies to create niches and set up experiments; literature on the different steps of relevance for setting up an experiment; and literature discussing the three internal niche processes contributing to the success of experiments and niche formation is abound and very detailed. The research gaps mainly concern knowledge necessary to develop an ex-ante SNM tool. Within the Knowledge network System Innovations (KSI), this need has been identified, and the following two years will among others aim to deliver just such a guideline or toolkit for practitioners.[6]

At best, the current SNM approach can be used in contemporary experimentation as a means to reflect upon the actual practice by means of making an historical analysis of the situation. SNM has, however, not yet been put into practice by actually supporting or even facilitating a new experiment. There does not exist a body of literature that delivers a coherent and step-by-step guideline for experimenting in practice. As discussed in the introduction, SNM authors tend to emphasise complexity rather than inform practioner's how to deal with the complexity. However, as mentioned before, if SNM is to contribute to system changes towards sustainability, detailed and practical guidelines for practicing experiment- and niche builders are necessary and a balance needs to be struck between emphasising contingency and complexity and the need for practical and general guidelines.

SNM should focus on the niche level, as defined by Geels and Raven (2006a, 2006b), and support (program) managers who aim at orchestrating the interaction between different experiments on the more local level. There are already sufficient management tools that focus on the individual project level. The SNM tool would have much added value in providing guidelines for the management of multiple projects and their interaction. The level of analysis of the SNM tool would be a forum of interaction, and not focus on the practical daily management of local projects. SNM can especially orchestrate the bottom-up (from the local level) construction of a shared set of expectations and thus of rules on the global niche level, which can in turn shape the actions on the local level, legitimise actions and legitimise increasing investments of all relevant resources. The orchestration of a constant interaction among local projects and between the local and the global level can then contribute to the successful reproduction and continuous strengthening and broadening of the set of global shared rules and thus contribute to the stabilization of the niche.

An outline for future activities to construct a toolkit can be found in the box at the end of this section. A future activity that has not yet been mentioned is to analyse an existing instrument called Socrobust. Socrobust is a method developed by STS researchers (Laredo et al., 2002; Verbong, Mourik and Raven 2006) as a support for technology developers and project managers having to deal with breakthrough innovations, innovations that potentially raise problems of acceptance as they are displacing existing practices and shaping important elements of societies. The Socrobust method had to meet two targets: being flexible to adapt to a variety of situations and being useful for managers, and as such has operationalised the balance between contingency and practicality discussed earlier. A standard process around the same set of tools was developed for maximizing the value of the frame experiment. It was composed by a tool-kit and a protocol for interaction with managers, as a consultancy model.

[6] http://www.ksinetwork.nl/.

What is particularly of relevance for the development of an SNM toolkit is that the Socrobust instrument uses the process of mapping both the expectations of innovators (their desired future worlds) and mapping the present world. These different maps or networks are compared and possibilities for actions (by the innovator) to create the future desired world are identified. This process of mapping is based on the understanding of innovation dynamics, i.e. the innovation journeys, including the non-linear development (branching, alternative solutions) of an innovation and the larger technology evolution. As such, this mapping, in combination with the reflexive step of altering the projects visions, objectives in reaction to the learned lessons, could be a valuable instrument in orchestrating the process of voicing and shaping the expectations of the heterogeneous set of actors involved in the innovation network.

Although many of the aspects that need further elaboration in SNM literature (the actual formation of heterogeneous networks and the orchestration of learning experiences and the orchestration of the articulation an shaping of multiple expectations) also need to be worked out in more detail for the Socrobust tool to enhance its practical usefulness, it is certainly a valuable stepping stone for the creation of a SNM tool.

Research questions for a future research outline on Strategic Niche Management

Research questions dealing with the differences between experimental projects and niches:

- What are the differences between a niche and a local project in terms of the processes of articulating expectations, learning, networking, protecting?
- Should the SNM tool focus on the level of projects or on the level of a niche?

Research questions dealing with factors influencing the creation of niches:

- What are internal and external preconditions (with respect to the niche) for the creation of a niche, in the five steps towards creating a niche?
- What different strategies should niche actors use to facilitate the creation of a niche under different forms of regime instability in terms of causes and level of instability?

Research questions dealing with policy strategies to facilitate the creation of niches:

- What kinds of policy instruments are available, with what kind of effect on the protection of projects and niches?
- Which kind of policy actors can use what kind of policy instruments?
- What instruments are suitable for the protection of local projects and which for the protection of niches?

Research questions dealing with the five steps towards the creation of niches:

- Who is the intended user for the SNM tool?
- Should an SNM tool focus on all five steps or only on the actual niche creation steps 4 and 5?
- Who should choose the most appropriate innovation?
- How to assess what the most appropriate innovation is?
- How much should the innovation deviate from the regime that it aims to change; in other words on what aspects/dimensions should the fit be tolerable and on what aspects should the fit be optimal?
- How to assess what the transition potential of an innovation is?
- How much contextually bound (in terms of location, actors, lessons learned) should the local project be?
- How to organise this scaling up from local level to niche level, and what conditions are necessary to do so and who should do it?

- How can an innovation strategically use the possibilities to fit within one regime, to grow and in time change another regime?
- How can the multiple regime analysis be translated into a SNM tool that allows for an analysis of lock-in/ lock-out effects of an innovation due to interactions between different regimes?
- Which actors should take up what activities in the five different steps?
- What is the role of the three interrelated niche processes in each of the five steps?

Research questions dealing with the articulation and shaping of expectations:

- Who should manage this process? What are his characteristics?
- What is the difference between the process of articulating expectations on the level of a local project and the level of a niche?
- When to stop with articulation of expectations and alignment of expectations and network?
- How much 'fit' is sufficient, when is a technology a tolerable fit and when an optimal fit?
- How to deal with questions of power in the articulation and shaping process?
- How to involve missing voices/minor voices and their expectations?
- How to elicit 'hidden' expectations?
- How to involve unwilling actors and how to deal with conflicting expectations?
- Which expectations are most relevant, and should therefore prevail?
- How to prevent strategic behaviour in the process of articulating expectations?

Research questions dealing with network process:

- How to choose such a network manager?
- What are the tasks of the network manager?
- How much relative proximity to the regime should the outsiders have? How to measure this proximity?
- How many outsiders should be involved?
- How much power these outsiders should have in making decision about the innovation?
- How should the power distribution in networks be dealt with in general?
- How to prevent the use of outsiders to smooth the introduction of unsustainable innovations?

Research questions dealing with the learning process:

- Is the learning process in local projects different from that at the niche level?
- Who should organise the learning process?
- How to organize second-order learning within local projects and niches?
- How to prevent the different possible forms of 'wrong' learning?

Research questions dealing with the creation of protection for a niche:

- How to minimise the gap between the conditions under which the local project takes place and the condition under which the technology would have to function in real user context?
- What kind of internal and external (with respect to the niche) protection mechanisms can be identified?
- What kind of internal and external processes can occur that must be prevented by means of protection mechanisms?
- To what extent is protection of projects different from protection of a niche?
- What different phases of protection exist and what kind of protection measures accompany these different phases?
- Which actor does the protection at which point in time?

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