Strategic Niche Management and Transition Management: different but complementary approaches

Discussion paper

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Introduction

This discussion paper sets out to compare two different, yet related, approaches to achieve sustainable development and (technological) innovation. Strategic Niche Management (SNM) (Kemp, Schot et al. 1998; Weber 1999) emerged as a novel concept by the end of the 1990's and is presented as a **research model** and **policy tool** to manage technological innovation within so-called niches. SNM is based on the multi-level conceptualization of socio-technical regimes, embedded in a slowly changing landscape and influenced by emerging niches. Transition management (TM) (Rotmans, Kemp et al. 2000; Rotmans, Kemp et al. 2001; Rotmans 2003; Loorbach and Rotmans 2006) was for the first time defined in 2000 as a policy or **governance approach** and later developed into a **policy model** to deal with long-term desired change and sustainable development. TM is based on the analytical concept of transitions as structural changes in complex (societal) systems and has been developed into an operational policy-approach.

Both concepts emerged roughly during the same period, were partly developed by the same or acquainted scholars (especially Kemp has contributed significantly to both theories) and originated both in the Netherlands. From a distance, both approaches seem to be highly similar in their origin as well as their descriptive or analytical basis. However, at closer glance there are a number of major differences between the two approaches. These differences are related to their historical evolution and scientific grounding, to their empirical basis and focus and to their operational approach. We will first shortly both theories at their current level of development. Then we will discuss their mutual historical evolution from which the differences in scientific background and basis become clear. We then compare SNM and TM in their differences in scope, focus and operational aspects. After a discussion of the differences we will argue that these stem from a fundamentally different scientific basis and research approach, but that their

complementary elements and similar ambitions are basis for mutual reinforcement rather than exclusion.

Strategic Niche Management

SNM refers to the process of deliberately managing niche formation processes through real-life experiments. The core idea is that through experiments with new technologies and new socio-technical arrangements processes of co-evolution can be stimulated (Hoogma 2002). Technologies – for example electric vehicles or smart cars - as well as the contexts (user preferences, networks, regulation, complementary technologies, expectations) in which they develop are worked upon simultaneously. In other terms, SNM aims at aligning the technical and the social. As a consequence new, more sustainable patterns might emerge, partly embodied in hardware (new technologies) and in new practices based on new experiences and ideas. Such experiments can be envisaged as (part of) a niche in which technologies are specified and consumers are defined and concretized. Experiments make it possible to establish an open-ended search and learning process, and also to work towards societal embedding and adoption of new technology (Hoogma 2002). It is thus based on the assumption that user needs and wants are not fixed. Rather, consumer wants are based on their reflection of what they experienced in the past, new experiences may alter perceived needs.

The inventor of the concept is Arie Rip, a philosopher and sociologist of technology interested in evolutionary approaches of socio-technical[1] change. Its origin can be traced back to scientific fields such as innovation and technology studies, history of technology and innovation management. It emerged in the context of a broadening of the focus of research on technology; from a narrow focus on the technological innovation process, towards a more integrative and inclusive perspective on technological development as a result of the interaction between technology and users/society. During the 1980's and 1990's, different technological innovation scholars developed similar ideas in this area. Well known examples are SCOT (Bijker 1987) and socio-technical regimes (Kemp, Schot et al. 1998; Rip 1998). Based on this more societal conceptualization of technological change and innovation, different strategies and methods (besides SNM) have been developed to influence the process of technological change, based on the socio-technical perspective: Constructive technology assessment, CTA (Schot 1997), Socio-technical scenarios, STSc (Elzen) and Sustainable Technology development (DTO, Jansen).

SNM, similar to TM, can be regarded as both a research model as well as a policy tool (Raven 2005). In terms of research model, it is used to better understand technological innovation trajectories and for this predominantly used in historical case studies. SNM research has thus shed light on conditions for successful emergence, different pathways of change and conditions and arguments for the protection of innovations. SNM has been conceptually further developed as research model and policy tool in joint publications by Dutch scientists Johan Schot, Remco Hoogma, René Kemp and Frank Geels and by

[1] Originally the term socio-technical system was coined in the early eighties in the context of organizational and business management (Trist and Emery) but has since then been applied much more widely in the context of the interactions between humans and technological infrastructures.

Matthias Weber and Bernhard Truffer. Experiments were studied in various projects of which the most important project was the project SNM as a tool for transition, an international project funded by the EU, the results of which are being published in (Hoogma 2002). In this project, SNM was defined as: 'strategic niche management is the creation, development and controlled phase-out of protected spaces for the development and use of promising technologies by means of experimentation, with the aim of (1) learning about the desirability of the new technology and (2) enhancing the rate of application of the new technology' (Kemp, Schot et al. 1998).

Strategic niche management is a concentrated effort to develop protected spaces for certain applications of a new technology. It differs from the "technology-push" approach that underlies most of today's technology promotion policies, by bringing in knowledge and expertise of users and other actors into the technology development process and to generate interactive learning processes and institutional adaptation (Hoogma 2002). The focus upon learning is an important aspect of strategic niche management. A second aim of SNM is to foster institutional connections and adaptations, to align technology and user environment. More specifically the aims of strategic niche management are:

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

Transition Management

Transition management is presented as a governance approach based on the analytical perspective of society as a patchwork of complex adaptive systems. These systems evolve, change and adapt and sometimes undergo structural changes or transitions. The TM concept was first formulated in collaboration between Rotmans, Kemp, Geels, Verbong and Molendijk (Rotmans, Kemp et al. 2000) but essentially developed by Rotmans, who brought in the multi-phase concept, and Kemp, who brought in the multi-level concept. In a later phase TM evolved into an operational model (Loorbach and Rotmans 2006) and policy practice. Simultaneously, TM is currently being developed as a governance theory and as operational governance approach.

Transition management as a new management concept contains the main characteristics of new forms of governance: network management, interactivity, pluralism, multi-level focus and social learning. Transition management is by definition a multi-actor process

with participation from government, societal organizations, companies, knowledge institutes and intermediary organizations. Because of this participation at various levels a multi-level network emerges within which different themes are discussed and tackled (Loorbach 2004). Transition management facilitates a range of processes and points them in the same direction with a combination of network management and self-steering. As such, transition management can be considered as a specific form of multi-level governance (Scharpf 1997; Hooghe and Marks 2001). The co-evolutionary perspective is partly based on the concept of 'mutual adjustment' (Lindblom and Woodhouse 1993). Various groups with a wide range of interests and ambitions attempt to get their own themes placed on the political agenda. By negotiation, adaptation, co-production and debate, actors change their own vision and redefine their own position and perceive the problem in a different manner.

The model of transition management tries to utilize bottom-up developments in a more strategic way by coordinating different levels of government and fostering self-organization through new types of interaction and cycles of learning and action. Transition management views social change as a result of the interaction between all relevant actors on different societal levels within the context of a changing societal landscape. It is thus concerned with the coordination of interaction and co-evolutionary processes. An important scientific perspective underlying TM is the complex adaptive systems paradigm, which defines the dynamics within complex systems: emergence, co-evolution and self-organization. TM sees society as a complex adaptive system and uses the analytical concepts and theoretical notions from complex systems theory as starting point for formulation of TM as governance theory.

Dutch public administration experts (Kickert 1991; Kickert, Klijn et al. 1997) have drawn lessons for management of complex, adaptive systems. In the meantime, complexity theory has evolved further (though the theory is still far from maturity) and more empirical knowledge has been gained from practical experience with the management of complexity (Geldof 2002; Rotmans 2003). Based on theoretical knowledge and practical experience with complexity theory, a number of conceptual starting points for TM are formulated. These starting points are partly descriptive, in the sense of basic principles and partly prescriptive in terms of rules for management.

- Managing at the system level is important. Unintended side effects and adverse boomerang effects can only be recognized. This implies adjustments at various (functional) scale levels. A complex, adaptive system cannot be directed from just one scale level; it has too many emergent properties: properties that are (still) hidden at a higher (or lower) scale level but are already beginning to emerge at a lower (or higher) scale level
- The status of the system determines the way it is managed. The dynamics of the system create feasible and non-feasible means for management: this implies that content and process are inseparable. Process management on its own is not sufficient – insight into how the system works is an essential precondition for effective management.
- Objectives should be flexible and adjustable at the system level. The complexity of the system is at odds with the formulation of specific objectives. With flexible

evolving objectives one is in a better position to react to changes from inside and outside the system. While being directed the structure and order of the system are also changing, and so the objectives set should change too.

- The timing of the intervention is crucial. The nearer one is to the critical point in the system, i.e. on the dividing line between two attractors, the more effective the intervention. Immediate and effective intervention is possible in both desirable and undesirable crisis situations. Crises are not necessarily negative and they can create room for maneuver towards a favorable attractor.
- Managing a complex, adaptive system means using disequilibria rather than equilibria. In the long term equilibrium will lead to stagnation and will in fact hinder innovation. Non-equilibrium means instability and chaos, which forms an important impetus for fundamental change. The relatively short periods of non-equilibrium therefore offer opportunities to direct the system in a desirable direction (towards a new attractor).
- Creating space for agents to build up alternative regimes is crucial for innovation. Agents at a certain distance from the regime can effectively create a new regime in a protected environment. For this to happen a certain degree of protection is needed (a nucleus) to permit agents time, energy and resources.

The operational model of transition management is described in various publications (Rotmans and Loorbach 2001; Loorbach 2002; Loorbach and Rotmans 2006). Transition management is a form of process management against a set of goals set by society whose problem solving capabilities are mobilized and translated into a transition programme, which is legitimized through the political process. Bottom-up initiatives and business ideas of alternative systems offering sustainability benefits are utilized, within the context of an over-all strategic vision that can be seen as a top-down frame of reference. This means that transition management does not consist of a strategy of forced development but on the other side of the spectrum also does not imply a strategy of laissez-faire.

Key elements of transition management are:

- Multi-domain approach
  Transitions inherently operate at multiple domains. Input from other domains than the prevailing domain are therefore important. In terms of lessons learned, innovative ideas, actors involved but also in terms of integral policy.
- Multi-temporal approach
  Transitions cover a long-term period of 25-50 years. This long-term timeframe can function as purposeful context for short-term actions and policy. In this way current policy can be embedded in a long-term perspective. Inspiring and imaginative visions on sustainable futures have an important, mobilizing function and are instrumental to maintaining the long-term focus and energy in the process.
- Multi-actor network approach
  Many diverse actors are involved in transition processes and every actor is trying to influence other actors. No single actor has the managing capabilities to fully control a transition process in a top-down manner. Networks of actors represent differences in power and perspective and network management aims to direct all actors involved jointly.

- Multi-level approach
  In any societal system there are different levels of organization with different dynamics, which require different strategies. At each level, specific types of actors participate, specific (policy) instruments are used and different competencies are needed. Each level should work towards the same goal in such a way that they reinforce each other (i.e. modulate).
- Deepening, broadening, scaling up
  Transition experiments need time and resources to develop and mature in niches before they can be embedded in the existing structures of the regime. This requires a sensible and smart strategy that consists of learning as much as possible from a transition experiment (deepening), repeating (with learning effects) such an experiment in a different context (broadening) and trying to apply a successful experiment at a higher scale level (scaling up).
- Keeping options open
  Selection of innovative options in a too early stage can have profound drawbacks and lead to a backlash (Rotmans et al., 2000). We first need to know more and learn about the pros and cons of available options before we can make a well-grounded decision. Through experimenting we can reduce some aspects of the high level of uncertainty so that it leads to better-informed decisions. To learn as much as possible from transition experiments they need to be diverse, deviate from standard options and include a certain risk.
- Focus on social learning
  Social learning is crucial to transition processes, because neither the definition of a problem nor the direction of the solution is unequivocally known a priori. In a transition context social learning is aimed at 'reframing', changing the perspective of actors involved. The learning process has three components: learning-by-doing (developing theoretical knowledge and testing that by practical experience), doing-by-learning (developing empirical knowledge and testing that against the theory) and learning-by-learning (developing learning strategies, applying and evaluating them).
- Linking content and process
  An essential issue in transition management is that the content is explicitly linked to the process itself. In other words: the complexity analysis of the societal system under observation also determines the opportunities for management and the instruments that can be applied using the framework described.

Comparing SNM and TM

At first glance the theories appear to be highly similar in terms of their focus on innovations, their integrative approach, the link to sustainability, a multi-level approach and the use of similar words such as niches, regimes, landscape and transition. This is understandable because both theories share the time (turn of the century) and place (Netherlands) of origin, although Strategic Niche Management (SNM) draws from a longer period of European wide empirical research. There also has been exchange in ideas and persons between the groups developing them. In some respects both SNM and TM are based on the same concepts (multi-level, regime) and in both theories cross-

references are made. Both theories have originated out of a societal commitment and a growing dissatisfaction with the apparent stagnation in fundamental progress or innovation in general. Both theories explicitly position themselves as an alternative to too narrow, too linear or too top-down approaches towards innovation, be it technological or societal. Furthermore both theories advocate the inclusion of matters of substance in the understanding and design of innovation processes, in order to favor innovations that potentially contribute to sustainable systems over innovations that have not such potential.

Analytically, both theories present themselves as tools to come to more integrated analyses preceding management or policy. Both theories recognize different phases with each its own dynamics in such a process and offer ways to structure and analyze these processes. In terms of their respective management approaches, both strive to radically change or even replace existing regimes by more sustainable ones. Both theories give importance to alternative visions of sustainable systems and innovations or other deviating practices as a learning opportunity about such vision and as tangible carrier of such alternative vision.

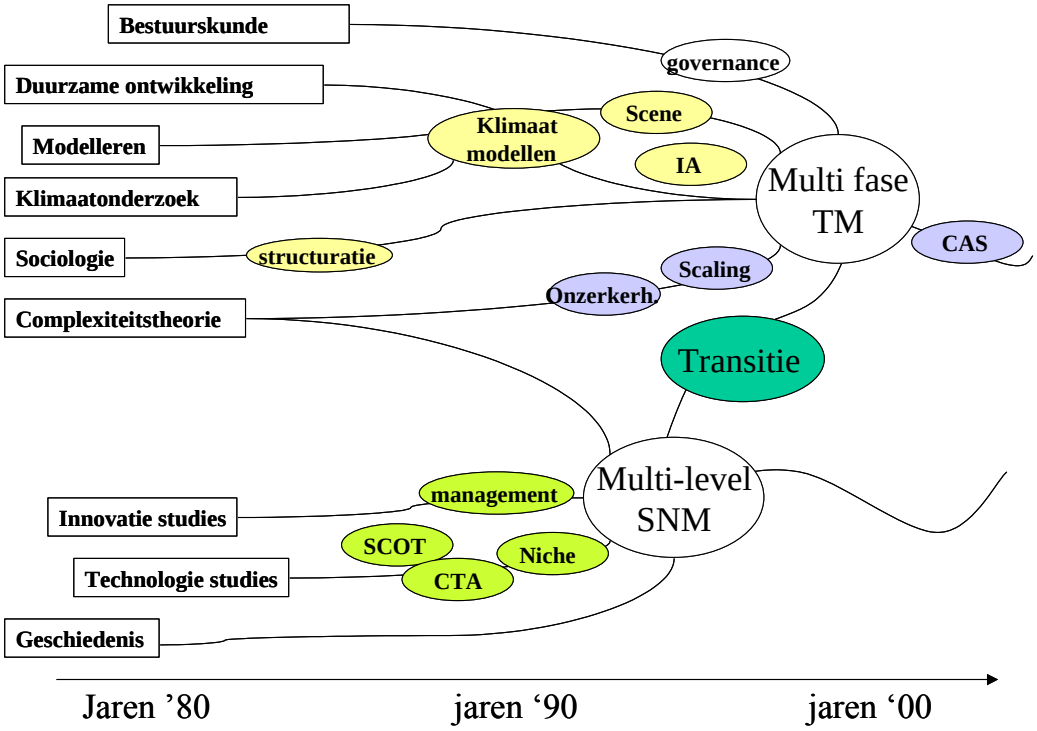
Historical differences

Historically, SNM and TM have very different evolutionary pathways, although at a certain point in time the two trajectories met and since then are developed at least in interaction, perhaps even co-evolutionary. SNM has its roots in technology and innovation studies, history of technology and socio-constructivist approaches to technology development. Over the last few years evolutionary economics have been incorporated in SNM and socio-technical research, but the evolutionary perspective has been part of the theory for longer. Already in 1994 and explicit reference was made to transitions of socio-technical regimes, in the context of technological regime shifts (Kemp 1994). The link between regimes and niche (management) and sustainable development is rather weak in the sense that although SNM focuses on 'sustainable technologies', there is no direct link to research on sustainable development nor are definitions of sustainability made explicit.

TM was first defined in 2000 based on the transition concept. In (Rotmans, Kemp et al. 2000), the technological transitions perspective was combined with the concept of societal transitions into the multi-level, multi-phase conceptualization of transitions as structural changes that are the result of interacting and co-evolving developments in different societal domains. The societal notion of transitions has a very long history (originally coined in the context of a demographic transition (Davis 1945)), but has been introduced in the context of structural societal changes and sustainable development during the 1990's (Rotmans 1994; Matthews 1997). In a UN-report (Matthews 1997) the different phases were defined that would later be taken up into the multi-level multi-phase transition concept. This notion of societal transitions emerged in the context of climate research, integrated modeling and sustainable development as a novel policy concept. Key concepts within these scientific domains were uncertainties, scale-levels and long-term development. Out of this a new field of research emerged, Integated Assessment (Rotmans 1999), that was concerned with complex societal problems that

were supposed to be addresses from an interdisciplinary perspective and needed to provide scientific result relevant for policy. Transition management has been further developed as a governance approach and been grounded into scientific disciplines as policy and political science, sociology and complexity science (Rotmans 2005; Rotmans 2006).

Their historical evolution explains for an important part the difference in focus and goal. SNM poses the question which trajectories a technology or technological system could follow to fundamentally change an existing socio-technical regime. In a sense, a technological starting point is given, through intelligent analysis one could sketch the technological starting point for successful change. Research in this context is instrumental for analysis and comparison of given solutions in the sense that research can provide insights and recommendations that innovation policy can use. TM takes a societal problem as a starting point and sees a search- and learning-process as the solution. In the context of a participatory process, both problems and solutions have to be developed, tested, explored and adapted, which in turn results in actual change. Research and analysis in TM is instrumental for such a process in the sense that it structures, directs and supports this process.



Picture: Overview of the evolution of SNM and TM

Differences in scope and underlying theoretical concepts

The different background of the two concepts also explains the difference in focus, approach and ambition Transition Management studies societal systems; Strategic Niche Management studies niches in interaction with socio-technical regimes. Although this

might be interpreted as mainly a semantic difference (one can apply a system perspective to analyze a regime), in practice these are different concepts that lead to fundamental differences in terms of analysis and to different implications for the operational aspects. Societal subsystems are in general interpreted in Transition (Management) literature to be functional subsystems within a society (e.g. energy, health care, mobility) or regions (e.g. a province). In many of the functional subsystem cases in TM literature (e.g. water, energy, waste) technologies play a dominant role, but the framework does not give technology a special position *a priori.* Starting point to arrive at the subject of study is a societal problem. A solution, direction or definition is not given but has to be found within a participatory process.

Strategic Niche Management takes a socio-technical regime as object of study, and within that context often a specific technology. Hoogma et al note: "…we have chosen to take technological change as the starting point since it is an obligatory point of passage for any movement towards sustainable development". Hoogma et al further state that any other starting point would probably result in biases towards other solutions: e.g. participation or economic incentives. Remarkable is that the selection of a specific technological option, and the assessment of whether such an option is sustainable or not, seems to be taken by the researcher. Raven (2005) does for example not explicate in his selection of the cases for his PhD research (manure digestion and co-firing) the sustainability of these options.

Strategic Niche Management builds on the Multilevel Perspective (MLP) of socio-technical change. The basic entities in this perspective are technologies that are part of (socio-) technological regimes. These regimes are in a sense 'technology centered'; that is, the institutional, economical, cultural concepts are related to a specific technology or technical system (e.g. car-based transport system, collective public transport, steam engine, manure digestion). Especially the explicit and implicit rules, the market conditions and the user/manufacturer perceptions of a technology are taken into account. They remain however 'technology centered' because the starting point are technologies, which the researcher selects.

The multilevel perspective used by SNM consists of three levels, whose definitions have evolved over time. The landscape consist of the larger context of the socio-technical regime, the regime of all the rules and other social constructs concerning the technology under study and niches (niche regimes) which deviate from the regime and thus provide opportunities to develop technologies that go against the dominating regime. Although not explicitly, the MLP and the way it is used in SNM has a strong market approach. Niches are for instance qualified as artificial (e.g. government grants) or market niches. Market is interpreted more broad than in the classical sense, in the way that cultural perceptions of users (and suppliers) are taken into account. However, a demand-supply thought is very central.

Transition Management on the other hand takes a societal system (this could be around a societal function or a region) as a starting point for analysis. Where SNM literature analyzes 'the car-based transport regime' (Hoogma et al 2002), TM refers to the

'mobility system'. This starting point – and some subsequent analytical and modeling choices - leads to a significantly different multilevel perspective within TM. First of all, TM neither takes a technological starting point nor any other domain-based starting point but incorporates all relevant stocks (basic qualities or substantial elements that constitute a system (Grosskurth 2005)) and their interrelations (flows). These comprise a system: a set of elements with specific interrelations and coherence. These elements could be analyzed and structured according to different functional levels: that of innovations, that of dominant structures and that of the systems as a whole in its societal environment. The multilevel concept used by Transition Management therefore is based on levels of aggregation in a societal system, quite independent of *what* is aggregated. The MLP is thus used in a slightly different way where in terms of analysis societal trends and general ideas, paradigms and worldviews related to a specific societal system are identified at the macro-level, at the meso-level focus is put on institutionalized structures, routines, actors and culture and at the micro level innovations are taken into account. Niches in this perspective are voids in the regime structure that offer possibilities for protected development of innovations (perhaps as *Trojan horses*).

This system-approach results to very different types of studies and research output between SNM and TM. For example in regional studies as preparation for transition management (Van de Lindt 2002; Deraedt 2005) a model of economical, social and ecological stocks and flows is used (Rotmans, Asselt van et al. 1998; Grosskurth 2005). These studies tend to be rough sketches of the state of a specific system and take into account historical developments at the different levels as well. They are developed with the object of providing basic structure and information for participants from a sector or system to evaluate and interpret. Other examples of TM analyses or topics are the main energy infrastructure (hydrogen, fossil or all-electric), the water management style, and spatial development of a region. It seems that TM tends to study problems that are mostly in the public domain problems, whereas SNM studies the public involvement in traditionally the private domain or that are on the supply-side. For example, in discussion of the transport sector – the by far best discussed sector in SNM literature – typically cases are being taken of technologies, which compete for the preference of the consumer with other options (e.g. taking a public bike instead of your car). Technological options that do not involve consumer choice (e.g. car free cities or regions) are much less emphasized.

Differences in prescriptive basis

Although descriptively the multilevel perspective used is quite similar, the prescriptive handling of this concept differs greatly between theories. SNM takes a more linear approach. The landscape conditions (e.g. running out of fossil fuels) brings along the requirement of change for the regime and selection criteria for new technologies and regimes. Next, niches developing and penetrating the existing regime are considered to change the regime and regime changes can lead to small changes in the landscape. In principal this process is acknowledged to be cyclical, but the consequences are not worked out in the theory. The theory is in this respect linear. Moreover, it focuses on the development of niches and its relation to the regime. This focus is of course already obvious in the naming of the theory. While in the beginning of SNM multiple niches and

multiple regimes (‘patchwork’) were distinguished (Rip 1998), it seems that later on more focus was put on a specific regime and multiple niches from which regime change could result.

SNM questions how barriers in the supply-demand systems can be overcome, this can be more classical economical factors – such as economies of scale – or more socio-psychological aspects as user perception of a technology. There is tension between solutions for individual barriers. Some barriers require protection of new technologies; other barriers can be taken away by early confrontation of technologies with for instance users and other market factors. SNM tries to balance these two by developing a selective shelter (niche) for new technologies in which technologies are not directly out-competed by incumbents, but do interact with ‘the real world’.

TM has a non-linear, dynamic view on the interaction between all the levels and the management thereof and states that all levels interact and mutually influence and reinforce each other. Transitions only come about when there is modulation: developments at all levels ‘work together’ toward a shared direction. TM puts for instance emphasizes on a direct connection between the macro- and micro-level. In a way it sees the locus of transitions more in the macro-micro interaction that in a specific niche or regime and therefore suggests ‘attacking’ the regime by circumventing it when trying to influence transitions. TM has neither a linear regime change model nor a supply-demand model. TM uses the more general –and vague– notion that systems (and especially their regimes) tend to optimalise themselves on the short term and especially to their internal functioning. Thus a long-term, alternative and broader counter movement can develop which in turn leads to adaptive behavior of the regime. In fact, only under very special circumstances, for example in times of extreme crisis, very powerful innovation or highly triggering visions, a truly structural change will occur at the regime level. The theories underlying TM thus ascribe to the regime much more adaptive characteristics and to some extent even agency. Where in SNM the regime is a rather static entity, in TM the regime actively reacts to, or even fights off, niche developments. This brings along many problems of recursion (e.g. ‘the regime perceives that I perceive that the regime perceives…’) and other problems typical for the social sciences.

Differences in prescriptive model

The above-discussed differences are not at the core of the management theories. In fact they could be considered to be different descriptive fundaments beneath both prescriptive theories. One could even state that both theories rebel against existing policy. On closer look, however, the criticism is directed at different policies. SNM antagonizes foremost against technology innovation policies and programs that ‘just’ give grants to specific parties for developing innovations, regardless of their interrelation or their potential contribution to sustainable systems. TM directs it criticism more against the shortsightedness of general policies for sectors or regions (e.g. health policy), the lack of ambition and general concern for sustainable development and societal innovation. ‘Polderen’ (broad stakeholder dialogues to reach pragmatic consensus) is considered to be the epitome of this phenomenon. TM proposes a ‘shadow’ track of out-of-the-box, long-term visioning, coalition building and experimenting. In a sense both prescriptive

models try to offers alternatives to existing approaches, be it at different levels. There are however also significant differences in terms of the basis for the prescriptive models as well as their level of development and the actual empirical basis.

SNM is mainly based on the study of recent cases of innovation projects and experiments. The SNM literature reflects on these empirical cases and reflects whether these cases could be considered examples of successful SNM. SNM – especially in its core scientific literature – shies somewhat away from describing what SNM would exactly entail when taken as a strategy to actually manage a newly emerging innovation. What SNM aims at is clear, *how* this should be done remains unclear. In this sense the claim of SNM being a 'policy tool' seems to be disputable. SNM is not operationalised to the level of an actual tool in the sense of scientific management concept or a process design, perhaps with the exception of one 'workbook' for SNM (Hoogma 2002), which seems to be for non-academic audiences. It becomes difficult to verify the prescriptive claim of SNM as effective policy tool.

What the SNM project (Hoogma 2002) found was that the experiments indeed contributed to learning but contributed little to institutional embedding beyond the creation of new networks. Through the experiments with alternative mobility a great deal was learned about the technical functioning of electric vehicles, scheduling software and electronic reservation and accessing systems for vehicles and about user satisfaction and behavior. Many things could not have been learned in another way, i.e. from surveys or controlled laboratory experiments. At the same time it was found that on certain issues not much was learned. Most of the experiments suffered from weaknesses that prevented the actors from obtaining useful knowledge, especially concerning the conditions for alternative systems of mobility. Of the 8 innovations described in (Hoogma 2002) only one diffused successfully: organized car sharing in Switzerland where the company Mobility car sharing has 59,400 members as of May, 2005.

The reasons why the experiments learned little on wider system change were the following (Hoogma 2002):

- Insufficient user involvement.
- Too much focus on technical learning
- The predominance of first-order learning.
- Minimal involvement of outsiders.
- The projects were overly self-contained

One important conclusion from the study is that the transformative power of experiments is small unless they are linked to long-term strategies for structural change involving policy makers. SNM should be expanded to include diffusion policies and policies for exploring structural change through system innovation (Hoogma 2002). Foresight may be used to promote a coupling between viewing and doing (Truffer 2004). So far it has been used as an intelligent form of incrementalism (learning by doing) for technology development and not so much as a model for developing and managing innovation processes.

The fact that SNM is not yet formulated as a practical policy tool is complicated by the lack of empirical testing of SNM. For example, Hoogma et. al. (Hoogma 2002) investigate a number of empirical cases to draw conclusions about the potential of SNM as policy tool. However, these empirical cases are examples of individual technology introduction, not about a higher level of niche management. Not surprisingly, these projects score poorly as effective SNM tools. One learns more about what SNM is not, than about what SNM would be. SNM scholars seem to be confronted with the basic problem that one cannot directly test a new tool by traditional backward-looking empirical research. Nevertheless their empirical research does provide valuable information on the current practice, which could be synthesized into an operational tool, which is again not done. Summarizing SNM has a strong empirical underlying that is well documented. However there is no clear description of what SNM as a tool entails and it is not put to the test in practice. SNM thus faces an operational gap.

In general, it seems that SNM has so far been predominantly used as a tool for analysis rather than as basis for policy, although it is presented as a policy tool. Studies from (Weber 1999; Geels and Kemp 2000; Geels 2002; Hoogma 2002; Truffer 2004) are very strong in analysis, but relatively weak in providing concrete handles for policy other than recommendations that are often hard to operationalize or are hardly communicated to policy. The operational side of SNM is more formulated in terms of how to analyze and structure (Weber 1999) than a policy model. The last few years, a number of contributions have been made that lead to a more prescriptive SNM approach (Raven 2005).

TM scholars uses an approach to which they refer to as 'Mode II' science of Gibbons (Gibbons, Limoges et al. 1994). This means that the prescriptive starting points form TM are used as a framework to structure, organize and coordinate actual policy processes and transition-arena's. These processes can be seen as cases or experiments that provide insights into the theoretical assumptions and starting point and help to redefine these. As a result, scholars that are actively engaged in putting TM in practice largely base the prescriptive model on personal experience. Unfortunately, these experiences and how these have lead to TM are barely described in the TM literature. Even if adequate description would be provided, action research approaches have fundamental methodological weaknesses if judged by conventional scientific standards.

The current existing literature is highly conceptual, and so far the practical experiences with the prescriptive model have barely been documented or published. The existing literature outlines a quite operational and detailed management cycle and management framework (Loorbach 2004; Loorbach and Rotmans 2006), even to the extent of lists of required competences of actors and required process tools and instruments in different phases. The presented instrument(s) are partly deductively arrived at from literature from sociology, governance and complexity science. However it also seems to be based on the lessons learned from action research. Because of missing link to the empirical material, these principles are weakly grounded. This makes TM a theory that has been operationalised and has been put to the test, but both the operationalisation as well as the

testing are so far not underpinned by adequate empirical documentation. TM thus faces an empirical gap.

The operational model for TM is visualized in a cycle and the policy tool developed for this is the transition arena (TA). This cycle consists of the following components (Loorbach 2002; Rotmans 2003; Loorbach and Rotmans 2006): (i) structure the problem in question and establish & organize the transition arena; (ii) develop a transition agenda, a vision of sustainability development and derive the necessary transition paths; (iii) establish and carry out transition experiments and mobilize the resulting transition networks; (iv) monitor, evaluate and learn lessons from the transition experiments and, based on these, make adjustments in the vision, agenda and coalitions. In reality there is no fixed sequence of the steps in transition management and the steps can different in weight per cycle. In practice the transition management activities are carried out partially and completely in sequence, in parallel and in a random sequence.

In the management framework we can distinguish three levels that continually influence each other: the strategic level (envisioning), the tactical level (negotiating) and the operational level (executing) (Loorbach 2004). Depending on the phase of the process, each level of management can be linked to specific types of actors and instruments. This results in a portfolio of approaches and management instruments that can evolve together with the actual progress of the process. The transition management process starts from a strategic, long-term perspective, making a thorough analysis of both alternative routes. As time progresses, the various routes within transition management will cross and intertwine and will influence and strengthen each other.

The transition arena model (TA) is a result of theoretical principles underlying transition management combined with empirically driven methodology. The transition and transition management theories provide an integrative framework that is used to develop specific use and function of different existing approaches and methods. For example, within the context of transition management, existing policy instruments and process methods can be used in a specific manner and in the context of a more long-term transition management process (Loorbach 2004). This goes from the selection of participants to the use of specific process methodologies like scenario's and visions to the use of participatory or even regulatory policy instruments. The TA is therefore a balanced result of practical experience and of theoretical reflections.

Although the TA model is not meant to be a blueprint approach and each transition context will pose different and challenging problems regarding the implementation of transition management, it does provide a framework for operationalizing transition management in a far more refined and coherent form than other policy methods or models. The TA is initially an instrument at the strategic level of transition management. The goals at that level are the development of shared problem definitions and long-term visions and goals as new societal attractor. It is also the instrument from which the other levels of transition management (tactical and operational) originate. Based on the process in the strategic TA, different sub-themes (related to sub-transitions) can be selected (in practice between 3 and 5 themes) often perceived as sub-systems. In terms of involved

actors, the arena is broadened by involving more domain- or theme-specific actors that represent specific interests, stakes or organizations. By mixing different actors involved in the strategic TA with new actors in sub-networks, a structure of arenas of arenas emerges.

Differences in starting points for inducing change

TM and SNM also differ in their scope and the starting point for inducing these changes. Both theories explicitly struggle to define prescriptive principles in a multi-domain (technology, economy, culture etc.), multi-actor and non-hierarchical (no leading actor) situation about which an analyst or actor with management ambitions has only limited information.

SNM is – as said – based on technologies as basic entities of study. Again a chicken-and-egg problem lures. SNM describes a method for learning about new technologies and creating the right selection environment, but with which set of technologies should one start? SNM solves the problem by stating that by a technology assessment analysis, promising technologies can be selected. The 'who' question is not addressed explicitly in SNM, but as the systems under study are on a lower level, one can easily imagine this to be for instance a ministry influencing a socio-technological system (whereas in TM the ministry would be part of the concerned societal system). Promising technologies appear to be selected by the researchers themselves (see for example: Hoogma 2002) as those technologies that would change the regime, **once** they would become part of the regime. However no indication or analysis is given **if** or **how** these technologies are likely to become part of the regime. This relevant – but unasked – question would bring a host of issues into SNM such as the timing of innovations in relation to the state of the regime and landscape developments, coalitions of the willing to support innovations, strategic and power plays etc. This point demonstrates the problem to focus on one specific level of the multi-level concept, in a highly dynamic and interrelated multi-level system.

TM's starting point – not withstanding the explicit acknowledgement that such a point might not exist in reality – is a generally perceived societal problem (always perceived by a diverse number of different actors, which is and indication that there is room for a TM process[2]). TM then starts with a rough integrated analysis of that specific system (done by system experts and domain experts) and selection of the specific actors for the transition-arena. TM assumes that the right actors can be selected on the basis of required competences, which are formulated based partly on literature and partly based on experience. This is however done in a not so strictly scientific way, which makes this a weak point in TM. When the ambition is to change a whole societal system, it could be questioned whether a non-democratic process is best suitable. TM literature also remains vague about *who* should select and further manage the process.

The all-encompassing nature of the theory makes it virtual impossible to make management principles to an actor, as all involved actors are already to be steered. In practice, policy entrepreneurs (that is the action researchers) seem to play a large role, but

[2] One could even say that then there is a transition emerging, or at least tensions are mounting between the regime and its environment.

this is not captured in theory yet. TM states that only in a participatory setting the system can be adequately understood and the state of the system can be valued and/or judged. The systems-approach is then much more an instrument to support a participatory process in terms of developing a shared understanding of the subject and a shared language and discourse from which problems and strategies can be discussed. This process actually is how TM steers or manages: through integrally and structured analysis and debate involved actors learn, reframe and re-construct their own perspectives and routines which thus indirectly leads to actual changes in the daily environments of actors involved.

Thus, TM takes a very broad scope and starting point, which leads to the problem that it becomes unclear *who* should undertake management steps and in general leads to a complex, even vague, management model. SNM takes a more modest approach by limiting itself to the management of niches for given technologies. However SNM runs into the problem that for niche-management information about many other aspects of the system (e.g. the regime, landscape developments) is required and the management of niches should constantly be adapted to changes at other levels. On these interrelations, SNM can barely provide answers.

Linking and complementing SNM and TM

The major differences between SNM and TM are the subject of study, the level of aggregation, the research approach and the prescriptive implications and models. Rotmans (Rotmans 2005) in his oration distinguishes between innovations, system innovations and transitions. Innovations are novel products or processes. System innovations are 'organization-transcending innovations that drastically alter the relationship between the companies, organizations and individuals involved in the system'. A transition is a 'structural societal change' as a result of a number of congregating system innovations. It could be that innovations are typical the domain of SNM, with the ambition of system innovations (as a synonym for socio-technical regime). Such changes are drastic and long-term, but a demand-supply mental model still suffices and a much more explicit and even linear relationship can be constructed between a regime and a specific innovation or niche

Bluntly stated, SNM focuses on niche management, TM focuses on system management. Since there are a large number of similarities not only in terms of analytical perspective but also in terms of normative ambition and conceptualizations of management styles and options best suitable, it seems logical to explore possible complementarities between SNM and TM. Analytically, the highly substantive oriented selection of promising technologies in SNM could be complemented by a 'transition management analysis' to get an insights in which options are likely to be incorporated in – or challenge - the regime and in which way. This combination could be used by parties in a transition that are primarily concerned with the niche-development, such as entrepreneurial firms

In terms of operational transition management, SNM seems to be a very valuable approach for the operational level where transition experiments are used as instruments to experiment with and learn about selected transition paths toward a desired future. In this

sense TM could provide a context that could be beneficial for the success of SNM through stimulating sensibility and ambition for change amongst societal actors and possible sponsors and adopters of the niche-innovation. In the case of a societal problem, a general TM approach can be used to arrive at specific options that are to be explored by a SNM. The SNM would in this case be the elaboration of the 'experimenting and mobilizing' step in Transition Management. Where TM is strong in participatory processes, social learning and agenda building, SNM is strong in development of specific innovation routes, technological learning and thoughts on organization of such a process.

Conclusions

Neither of the theories offer at this moment an operational, fully founded and empirically verified policy tool, although TM is much further in terms of operational application and establishment as regular policy practice. SNM can be seen as a relatively conservative approach in which on the basis of solid empirical research, recommendations are being made for limited, demarcated aspects of regime shifts or transition. There is elegance in its simplicity and analytical strength, yet serious doubts can be raised if such a demarcation will in reality be possible. This might be why SNM is not (fully) operationalised into a tool. TM offers an all encompassing, operationalised theory and model that is already being implemented, tested and refined in practice at a very large scale but that is far from complete and which lacks a documented empirical basis. Furthermore the all-encompassing ambition makes the theory more vague and complex.

It will depend on the specific research or policy needs which management model is most suitable. But it could be that both approaches are more than complementary. Recent developments show that the theories are extending into each other's scope. Two significant publications in this respect are a much more cyclical model by Geels and the exploration of the concept 'transition experiment' by Van den Bosch and Taanman. In a way, this growing overlap was already preluded on in many earlier publications in which publications about both theories recognized respectively the need to base the selection of technologies on a vision and coalitions (SNM) and the attention paid to learning-by-doing in Transition Management literature.

This ongoing evolution might change how the theories compare to each other. They might become two different, but each complete perspectives (that of societal systems and socio-technical systems) on the same subject. The central debate might subsequently shift from 'simple delimited approach' vs 'all-encompassing approach' debate, to a 'societal system' vs 'socio-technical system' debate. From Hoogma et. al.'s (2002) justification for SNM, two central questions in this debate can be derived: (1) Is technology a necessary stopping point for each regime shift (transition) to sustainability?; and (2) will indeed any non-technological biased approach, will inevitably be biased by another discipline? From the TM literature a third question can be brought into the debate: Should one start from the used technologies (in the broadest sense) in a system or the societal function of a system, in analyzing and managing transitions (regime shifts)?

Summarizing table

	Strategic Niche Management *…small to large…*	**Transition Management** *…large to small….*
Type of concept	Research model and policy tool	Governance theory and operational policy model
Type of theory	Focus on description, leading to recommendations on specific issues (based on traditional empirical research)	Focus on prescriptive concepts, leading to detailed instruments (based on experience in action research)
Object of study	Change of dominant technologies (broadly defined) within **socio-technological** systems …	Change of dominant structure in **societal systems** fulfilling societal functions / regions
Central descriptive, explanatory concepts	Multi-level model, innovation process	Multi-level, multi-phase complex systems model (transitions) and governance
Sustainability notion	Environment as goal, social and economic barriers and boundary conditions.	3 P-paradigm (people,profit,planet)
Operational concept	Manage niches strategically (Identify promising technologies - Design experiment - Implement experiment- Expand exp to niche - review)	TM cycle and transition arena
Drawing nearer by…	Elaborating on cyclical feed-backs between experimenting, coalitions, resources and visioning.	Developing the notion of 'transition experiments' and management hereof
Notion of regime	Rules	Structure (+agency)
Spreading entities	Technologies and practices (as carriers of vision)	New practices, structures and visions (moderately coupled)
Prescriptive starting point	Sustainable technologies (based on technology assessment)	'Suitable' persons (based on position in systems and meeting compentence requirements)
Multi-level interactions	Mainly micro-meso	Macro-meso, macro-micro, micro-meso
Functional scale	Mostly single experiment, niche	Sector / region

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