

The Eve of Transition

Themes and Challenges to Understand and Induce Transitions

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THE EVE OF TRANSITION - THEMES AND CHALLENGES TO UNDERSTAND AND INDUCE TRANSITIONS

SUMMARY

Sustainable development requires an encompassing set of transformations, described in this paper as a transition. Loosely defined, a transition denotes a long term change process in an encompassing system that serves a basic societal function (e.g. food production and consumption, mobility, energy supply and use, communication, etc.).

To stimulate the occurrence of transitions towards sustainability we face two major challenges, notably (1) to improve insights in the dynamic of transition processes and (2) to use these insights to develop strategies and policies to induce and stimulate the occurrence of transitions (also called transition management or transition policy).

These challenges define a research agenda and this paper identifies some of the main elements of such an agenda. The first section discusses ‘understanding transitions’ while the second addresses ‘inducing transitions’.

As a starting point the paper identifies three main characteristics of transitions, notably:

- they occur in encompassing regimes or systems;
- they imply a co-evolution of technical and societal / behavioural change;
- they are long-term processes (of the order of decades).

On the basis of these characteristics the paper identifies a variety of challenges for research to improve our understanding of transition processes.

This understanding should subsequently be used to inform strategies to induce transitions. The paper argues that transition policy should at least have the following main characteristics:

- it is in its very essence an interactive endeavour;
- it is a cyclic process of long-term visionmaking, defining near term steps, learning, monitoring progress and adaptation of strategies when needed;
- it is a long-term endeavour that implies the need for long-term commitment from the various actors involved.

With these starting points the paper identifies a variety of concrete challenges for transition policy and transition policy research. A final section argues that initial policy attempts will need to go hand-in-hand with transition research to benefit both the understanding of transitions as well as their inducement en route to a sustainable future.

INTRODUCTION

The road towards sustainability poses many challenges. There are many areas of human needs to be dealt with such as food, fresh water, health, shelter, mobility, energy, and many others. On top, there are many dimensions on which sustainability needs to be achieved, including technical, socio-economic, cultural, spatial, environmental preservation, distribution of wealth, etc.

Achieving sustainability in the broad sense therefore appears to require a dazzling multitude of changes. It requires an encompassing set of transformations that have been referred to by analysts

from different disciplinary backgrounds using a variety of concepts. Some of the best known include ‘system innovation’, ‘regime transformation’, ‘industrial transformation’, ‘technological transition’, ‘socio-economic paradigm shift’. I use the shorter phrase ‘transition’ to cover all of these in this paper.

Loosely defined, a transition denotes a long term change process in an encompassing system that serves a basic societal function (e.g. food production and consumption, mobility, energy supply and use, communication, etc.). In a transition, the technical as well as the social/cultural dimensions of such a system change drastically. This emphasis on the *co-evolution* of technical *and* societal change distinguishes transitions from more incremental change processes which are primarily characterised by technical change (through successive generations of technologies) while the societal embedding of these technologies changes relatively little.

The notion of transition and comparable concepts have increasingly gained attention over the past years, in academic as well as in policy arenas. Policy makers are especially interested in transitions since incremental change is not believed to lead to sustainability in various domains and, therefore, a transition seems required to be able to tackle current problems in these domains.

To stimulate the occurrence of transitions towards sustainability we face two major challenges, notably (1) to improve insights in the dynamic of transition processes and (2) to use these insights to develop strategies and policies to induce and stimulate the occurrence of transitions (also called transition management or transition policy). These challenges define a research agenda for a transition to a sustainable future.

In this paper, I will identify some of the main elements of such a research agenda. The first section discusses ‘understanding transitions’ while the second addresses ‘inducing transitions’.

Available and future research results have to be used to inform policy strategies to actually stimulate the occurrence of transitions. Because of our present limited knowledge of transition processes these policy attempts will be of a tentative nature and the evaluation of their results will have to be used to improve these policies. In a final section I will argue that such initial policy attempts will need to go hand-in-hand with transition research to benefit both the understanding of transitions as well as their inducement en route to a sustainable future.

Part 1: UNDERSTANDING TRANSITIONS

Transitions vs. incremental change

In the 1960s and 1970s, it became widely acknowledged that the development of industrial societies has had serious negative effects. Production and consumption patterns inherent to this type of society had resulted in large-scale pollution and the destruction of the natural environment. Since, environmental policy has succeeded in addressing the most urgent problems but at the same time it has become clear that new, often more global, environmental problems are emerging, partly because of continued economic growth and societal processes like increasing levels of consumption. Solving these problems has proved extremely difficult. Despite the adoption of the notion of sustainable development by most governments as a basic policy principle, it is clear that the transition to a ‘post-industrial’ society will not necessarily result in a more sustainable society, that is a society that is characterised by a better balance between economic, social and ecological performance. Ensuring that a transition does lead to more

sustainable societies is a major challenge for society in general and for environmental policy in particular.

Over the past decade the transition to sustainable development has become a central theme in the work of many organisations, including government bodies, NGOs, professional organisations, researchers, global environmental change networks, etc. Technological change has been defined as crucial for such a transition in various publications and also in recent White Papers of the EU and various national governments. This position, however, has met fierce criticism by those who portray technology as part of the problem and emphasise the need for deeper changes in the culture and structure of our western (and other) economies and societies.

Both positions are too simple, however, because technological change cannot be so easily separated from structural and cultural change. The key starting point in this paper is that both kind of changes are highly related, forming a seamless web. For example, any change towards more sustainable mobility patterns will include new technologies interacting with social and cultural changes. The consequence is that any transition to sustainability will imply a high level of social-cultural change coupled to a similar high level of technological change. Several concepts have been proposed in the literature to denote such a major change, including ‘system innovation’, ‘regime-transformation’, ‘socio-economic paradigm shift’, ‘(socio-) technical transition’, etc. In this paper, I use the notion of *transition*.

Transitions are defined as major changes in the way societal functions such as transportation, communication, energy supply, feeding, housing and water management are fulfilled. Such major changes typically involve a co-evolution of a number of related elements, including technology, infrastructures, symbolic meanings, regulation, scientific knowledge, industry structures, user behaviour, etc.

This summing up illustrates that transitions are extremely complicated processes which makes transition research a very messy type of endeavor. Attempting to create some order in this mess I will start by analysing transition processes as innovation processes.

Starting from this angle, I will first make a distinction between radical and incremental forms of innovation. Although this distinction has its problems it can help to clarify the notion of transition.

Innovation studies has shown that most innovation tends to be of an incremental nature. New technologies developed and brought to market are typically variants of existing technologies that can be used by customers with little or no extra instruction or training, using existing infrastructures and allowing them to use it in a way they always did, possibly with some extra features valued by the user. With successive generations of technology a pattern thus emerges of gradual technical change with relatively little change in terms of the societal embedding of this technology. In innovation studies the concept of ‘technological trajectory’ is used to describe such a path of development. (Dosi 1982)

At the same time, radical alternatives to such a trajectory are developed but because of a variety of reasons they have a hard time breaking through. These reasons include:

- production: production processes are tuned towards existing technologies and systems. Radical alternatives may require huge write-offs and new investments;
- regulation: regulation is tuned towards existing systems and may create barriers for novelties with unanticipated characteristics;

- user preferences: users are used to an existing system and for a variety of reasons are reluctant or resistant to accustom to new types of behaviour;
- infrastructure: radical alternatives may require new infrastructures which may create a huge barrier for (wide) application;
- investment needs: the combination of new production facilities and new infrastructures requires much higher investments than for upgrading an existing system;
- uncertainty: existing systems ‘work’ while radical novelties are typically characterised by a combination of known and unknown elements. The uncertainty often includes its ‘sustainability performance’. Some argue, for instance, that electric vehicles are ideal because they produce no local emissions while others argue that their overall emissions (counting also the emissions to generate electricity, losses in battery recycling) may be worse or that they may lead to more motorised mobility instead of walking and cycling which is also a negative aspect from a broader sustainability standpoint;
- low expectations: given these barriers, a variety of actors share a broad disbelief that a radical alternative can make it which subsequently becomes a self-fulfilling prophecy: big companies keep focussing on the old technology, regulators don’t stimulate the alternative, financiers are unwilling to invest in the risky novelty, nobody wants to take the risk to create a new infrastructure, users stay away from it; etc.

Looking at these barriers it should come of no surprise that most innovations tend to be of an incremental nature. Still, history shows that radical transformations or transitions do occur. For instance, the development of motorised road transport about a century ago and its broad penetration of society led to unprecedented changes although the barriers to such a transformation in the early part of the 20th century were enormous. Also more recently, such transitions did occur, for instance in connection with the development of microcomputers, information technology and the world-wide web. Also here, barriers were enormous and anyone who would have predicted 25 years ago that within a two decades the majority of households would buy thousands of euros worth of computer equipment would have met broad scepticism if not worse.

So, historical analysis of innovation leads to the conclusion that most innovation tends to be of an incremental nature but broad transitions do occur. An example to illustrate the distinction is given in the box below.

At the end of the 18th century short distance passenger transport was mostly by foot or with horse-drawn vehicles. For long-distance transport there were ships and trains but these were used only by a relatively rich minority. At the turn of the century, a variety of alternatives became available although they were still used only by minorities. These included mass transport means (e.g. electric trams as a substitute to horse-drawn trams) as well as private transport means (cars with different types of propulsion systems, including electric, steam and combustion engines). During the 1910s, the internal combustion engine gained the upper hand and the alternatives were marginalised. Still, the basic structure of the transport system remained largely unaltered and horses were still dominant.

In the U.S., the big change came in the 1920s and 1930s when cars gradually replaced existing means and became the main mode of transport. Western Europe followed one or two decades later, partly because of the second World War. This change constitutes a true transition with the construction of new infrastructures (paved roads, fuel stations), new legislation, and, most significantly, a completely new attitude towards travel for commuting, for leisure and to visit friends and relatives.

After this transition was more or less completed, in most developed countries somewhere in the 1960s, development by no means stopped. Trains, cars, buses at the turn of the second milenium are incomparable to those of the 1960s in terms of emissions, energy consumption, performance, safety, comfort, etc. Still, in terms of the terminology of this paper this is not seen as a transition but as a pattern of incremental innovation since the basic structure of the system in terms of legislation, infrastructures and user behaviour remained largely unchanged since the 1960s.

The need for transitions

Going back to the issue of sustainability, the distinction between incremental innovation and transition helps to clarify the discrepancy between what is going on and seems to be needed. Also here we see the incremental path in trying to achieve various societal objectives, e.g. a cleaner environment. Continuing the example of passenger mobility, this path has rendered significant successes. Since the 1960s, emissions of atmosferic pollutants has decreased by a factor of ten or more. Fuel efficiency of cars has also improved considerably. With proven technologies, both characteristics can be improved further.

The main issue is whether the continuation of this path will lead to a sustainable transport system. There are good reasons to doubt this. Internationally, the issue of CO₂ emissions presently is highest on the environmental agenda. In the longer term, reductions of 80% or more are thought to be necessary. There is general consensus that this cannot be achieved only by improving the efficiency of vehicles with internal combustion engines. Automakers as well as many others with technical blinkers then point to the potential of fuel cells in achieving this. The future may prove them right, it may not. The careful conclusion should be that it is indeed recommendable to develop this path but it is also risky to bet on it.

Furthermore, sustainable transport is not just an issue of low emissions of pollutants and CO₂. It is also an issue of accessibility and liveable cities. To achieve this, it is clear that there is a fundamental flaw in our current transport system. This system is characterised by the massive use of cars that are mostly used to transport just one person for an average of one hour per day. The rest of the time the cars just sit idle and use precious urban space. This gives the car system an overall efficiency of about one percent.¹ Only a drastic improvement of this efficiency will render a sustainable system which requires to play down the role of the car and replace it with other means of transportation. This implies a need for new vehicle technologies (mass transport or the other extreme, vehicles tuned to transport just one passenger), new infrastructures, new logistics, new legislation and, not least important, change of travel behaviour – a true transition indeed.

This poses an enormous challenge, obviously too large for current generations of policy-makers and transportplanners. The typical approach is to improve the current system by small incremental steps to tackle the most pressing problems and not worry about where such an approach might eventually lead to. The car continues to be treated as a holy cow and more innovative minds who argue that more fundamental changes are needed and even possible meet general scepticism.

In conclusion, a transition in the mobility system seems to be needed while, at the same time, it appears extremely difficult if not impossible to achieve. A comparable argument can be made for

¹ Vehicles being used only about 4% of the time up to about one quarter of their passenger capacity.

many other areas of basic human needs, especially if we look on a global scale at issues like the supply of fresh water, food production, energy production and consumption, etc.

Fortunately, not everybody is sceptical about the need and possibility to induce transitions that lead to more sustainable development paths. It has been recognised in various policy networks and research programmes. In the Netherlands, for instance, several ministries have formed transition teams that are wrestling with the challenge of embarking on a hardly visible path in a misty environment because the body of knowledge about the dynamic of transitions is still very limited. What they have to base themselves upon is a rather narrow base of research insights and policy experiences.

Characterising transitions

The main challenge for research then is to gain a better understanding of the dynamic of transitions in such a way that it also suggests possibilities to induce and stimulate the occurrence of transitions.

A first important issue is to be more specific on the nature and character of transitions. A first main characteristic follows from the ambition to make these insights of use for sustainability challenges. Many of these challenges are defined at the level of some of the basic human needs mentioned before, including water, food, energy, mobility, etc. It then makes sense to define transitions at the same level, i.e. the level of the regimes (or systems)² related to these needs, notably the water, food, mobility regime, etc. This leads to the first main characteristic of transitions:

Characteristic 1: Transitions are defined to occur in encompassing regimes (systems) in relation to basic human needs. Each of these regimes is characterised by range of technologies, infrastructures, patterns of behaviour, cultural values, policies, etc.

The second main characteristic comes from the discussion above on innovation processes, making a distinction between incremental change and a transition. It can be described as follows:

Characteristic 2: Transitions imply change processes that affect all or a large part of the dimensions mentioned in the first characteristic. They are at least characterised by a combination of technical and societal / behavioural change, also described as a process of 'co-evolution'.

This characteristic implies that a transition denotes a structural change in our society. Such a transition will involve the adoption and diffusion of new technologies embedded in new economic, social, institutional and cultural relations. Changes are required at the level of systems of production, distribution as well as consumption. More specifically, transitions display the following attributes:

- *Multi-actor*: They will involve a wide range of actors, including firms, consumers, NGOs, knowledge producers and governments;

² In the literature, both concepts are used to indicate more or less the same entities. I prefer the concept of regime to system since most studies using the latter usually emphasise technical characteristics, sometimes by explicitly calling them 'Large Technical Systems'. (Hughes 1983, Mayntz and Hughes 1988) The notion of regime stresses co-evolution, i.e. the interplay between different types of actors and factors. (Rip and Kemp 1998, Geels 2002) In this paper I will therefore use the concept of regime, occasionally followed by a bracketed (system) for readers more familiar with the latter term.

- *Multi-factor*: They are not caused by a change in a single factor but are the result of the interplay of many factors that influence each other. They are a combination of technical, regulatory, societal, and behavioural change.
- *Multi-level*: They imply change at various levels: at the micro-level of individual actions, at the meso-level of structuring paradigms and rules (regimes or systems) and at the macro-level comprising wider societal and cultural characteristics and trends such as individualisation and globalisation.³

The third main characteristic is an empirical observation from a broad range of historical transition processes notably that these type of multidimensional changes take a very long time to develop. The example of passenger mobility in the box above provides a clear example.

Therefore:

Characteristic 3: Transitions refer to long-term processes of multi-dimensional change, taking of the order of decades.

Challenges for research

On the basis of the preceding section we can identify various challenges for research. A first point of departure are the three main characteristics described above, notably:

- encompassing regimes (systems);
- co-evolution (multi-actor, multi-factor and multi-level);
- long-term (decades).

A second point of departure are the barriers to transitions described in an earlier section.

Transition research should analyse how such barriers can be overcome.

A third point of departure comes from historical research on innovation processes and transitions in particular. As described before, most innovation tends to be of an incremental nature. At the same time, in any regime usually small groups can be found that are working on the development of radical alternatives. They are working against the odds because of the barriers given above, which have the effect most of these radical innovations don't make it and die out after a while. Occasionally, however, such innovations do succeed in breaking through and become the trigger for a long-term change process that eventually forms a transition.

The important conclusion from this is that the seeds for a transition usually do not come from the 'core' of a regime but from the periphery or even from outside a regime. Therefore, in the analysis of transitions it does not suffice to look at existing regimes (systems) only but it is also necessary to have an open eye for what may initially seem to be misfits.⁴

On the basis of these points of departure we can identify various challenges for transition research that are discussed briefly in the following sections.

³ Such a multi-level perspective has been developed by various researchers at the University of Twente and has been taken up by others. (Rip and Kemp 1998, Geels 2002, 97-109.)

⁴ In recent work the arena's in which such novelties are developed are often called technical niches or just niches. (Hoogma 2000, Kemp et al. 1998)

What are transitions? How can they be characterised?

As described above, transitions are seen as long-term societal transformation processes with a pervasive character in relation to an area of basic human need.⁵ They involve the co-evolution of technological, economic, social-cultural, ecological and institutional developments in various functional domains and on different, interacting levels over a long time span. The concept however stills needs more articulation with regard to the essential features of transitions, the identification of paths towards transition and a classification of such innovations. Research topics may include:

- Is it possible to distinguish driving forces in transitions?
- Is it possible to distinguish different phases in transitions,⁶ consisting of different processes and activities?
- Is it possible to distinguish different types of transitions?⁷ Some of the main differences may include:
 - ♦ The main ‘drivers’ of a transition; they may come from within the regime (system), from a more aggregate level, be more technological or more societal/cultural driven, etc. The issue of main drivers will especially be crucial when trying to analyse (im-) possibilities for managing transitions.
 - ♦ Different ‘transition paths’, possibly related to different drivers and characteristics from the regime in which it occurs.
 - ♦ The role of various forms of ‘common interest’ which is a crucial factor when thinking about transitions towards sustainability.
- The dynamic of (various types of) transitions.

These topics constitute the major task for the years ahead. It will be required to carry out a wide variety of studies in different socio-technical domains (regimes, systems), look at different levels, look at different ‘environments’, confront the findings and generalise beyond the individual studies.

⁵ As illustrated before these needs include food, water, shelter, materials, energy and some others. This would imply that we are looking at about a dozen systems in total.

In policy studies, a regime and a transition are usually defined in relation to political entities, e.g. concerning the transition from a centralised to a market based economy in Eastern Europe. Within the framework of this study, however, I want to use these terms to explore innovation processes that are characterised by a co-evolution of technical and societal / behavioural change. But even then, the unit of analysis can vary. In some studies a system or a regime is defined in connection with a specific practice, e.g. travelling the ocean as was done in a historical analysis of the transition from a sailing-ship based regime to a steam-ship based regime. (Geels 2002) It is clear that developments at each of these levels should be studied to understand transitions and it may not be fruitful to impose a definition of what may count as a transition. But we should be aware that they may occur at different levels, that the mechanisms for these different levels may differ and that we should therefore develop a conceptual language to relate findings from studies at these different levels. One way to tackle this is to make a distinction between system innovation and a transition in which a system would be defined at a lower level of aggregation (e.g. the car-system and the public transport system) and a transition would consist of a combination of several system innovations (these two systems together forming the ‘mobility regime’).

⁶ In recent work, four such phases have been proposed: (1) emergence of novelty, (2) specialisation in market niches, (3) wide diffusion, take-off and (4) wider transformation. (Rotmans et al. 2000, Geels forthcoming)

⁷ Geels (2002, 124-129) distinguishes two general types, notably (1) technological substitution route with bottom-up, technology-push character and (2) wider transformation with broad co-evolution character.

Integrating disciplinary research

For this we need to develop international networks of researchers with different disciplinary backgrounds that frequently interact, already in the defining stages of various projects to ensure that the findings can later be related. The brief discussion above on the complexity of transition processes indicates that their dynamic can only be understood by combining insights from a variety of different angles, including:

- focus on the long term perspective, highlighting the macro level aspects;
- focus on the micro level, on the ‘seeds for transitions’, i.e. the novelties that are initially developed in small arenas (or niches);
- theories that attempt to grasp transition processes as a whole;
- analysis of developments in various concrete domains, including energy, mobility, water, food;
- analysis of and proposals for transition management / policy.

The broadness of these angles reflects the necessity of combining insights from a variety of different disciplines. Transitions are multi-dimensional phenomena and their understanding therefore requires multi-disciplinary input, including fields like:

- innovation studies;
- (socio-) economic research;
- history of (socio-) technical change;
- policy studies;
- science and technology studies; etc.

All of these disciplines analyse specific aspects of transition processes but in an actual transition these aspects occur concurrently. The challenge therefore is to integrate findings from different disciplines to grasp the process as a whole.

It will not be easy to build an interdisciplinary research agenda since different disciplines look at various phenomena using different concepts. It is still quite a challenge to translate a variety of transition issues into research questions for different disciplines in a fashion that also allows translating the findings back and interpret and combine them with the findings from other disciplines.

Integrating different levels of analysis

Transitions combine developments at different levels, the micro level of actions of individual actors, the meso-level of socio-technical regimes (which is the level at which transitions are defined) and the macro level broad societal, even global characteristics and change processes. Various disciplines and concrete studies typically focus on one of these levels and it is a major challenge to integrate concerning these different levels. We need some sort of integrative analytical framework (or frameworks) that allow zooming in and zooming out.

Revisit history

There is enormous variety of historical case studies of regime (system) changes and socio-technical changes. Although most of these were not conducted with a transition perspective in

mind they can teach us a lot on the dynamic of transitions. By combining insights from several case-studies we may be able to identify general and/or broad patterns in transitions.⁸

One of these patterns is that after a fuzzy period in which it is unclear whether a novelty will survive at all there seems to be a sort of turning point after which further penetration and development of the novelty seems to become more or less autonomous, thus marking the transition. According to the historian of technology Thomas Hughes (1983), systems⁹ can acquire momentum, which makes it difficult to change their direction of development. Economists have pointed at the 'lock-in' and 'path dependency' of systemic infrastructural technologies.

Still, historical studies also show, for example in the field of energy regimes, that regimes can undergo major transformations or can be (partly) replaced by other regimes. (Correljé and Verbong, forthcoming) A further historical analysis of regime dynamics can provide useful information on the dynamics and driving forces behind transitions.

How are barriers overcome?

Above, I described a number of barriers that make it difficult for novelties (or radical innovations) to make it in an existing regime. These barriers include:

- production barriers;
- regulatory barriers;
- user preferences tuned to existing regime;
- infrastructure requirements;
- investment needs;
- uncertainty about costs, externalities, performance, etc.;
- low expectations.

These barriers are usually subject of research in various disciplines and, as stated before, one of the main challenges is to integrate these findings.

Research to investigate these barriers often tends to focus on the production side, i.e. on the role of innovators and industries, either as whole sectors or as separate companies or even individuals. There is far less work on the role of two other key types of actors, notably regulators (public authorities) and users to overcome these barriers. Let me therefore expand a bit on the essential role they play.

Existing legislation often constitutes a barrier for a transition since the regulations are usually tuned to an existing regime with different characteristics. As a result it may be even illegal to work with a novelty in the public domain (e.g. with the first electric vehicles). But there is also an other side. Regulators can use their legislative powers to stimulate the development and use of novelties. The same electric vehicles are a clear case in point as their use was stimulated by various city and national governments. Regulators thus have a choice to be either be very active in stimulating innovation or to impede it. Which role they choose is influenced by their assessment of the range of barriers listed above. If they have low expectations of the potential of the novelty they are not likely to stimulate it. They may find the uncertainty too large. They may

⁸ A research group at the University of Eindhoven (Netherlands) is currently working on the development of what they call a 'historical database' of transitions to facilitate this type of research.

⁹ Hughes uses the concept of system rather than regime.

not be prepared or lack the funds to invest in required public infrastructures. Moreover, these barriers are not constant and may change over time.

Public authorities have a range of instruments at their disposal to influence the innovation process, both in terms of the characteristics of technologies (e.g. through environmental standards) as well as to either encourage or discourage their use (e.g. through taxes, subsidies). Which (combination of) instruments they choose has been investigated widely in policy and governance studies but a major shortcoming is that this is typically done from the perspective of realising a relatively well defined objective in the near term. Transitions, however, are about more vaguely defined objectives and longer term processes. This therefore requires a re-assessment of the role of public authorities.

Also users play an important and very varied role in the dynamic of transitions that is not always acknowledged in the analysis of innovation processes. Transitions involve radical restructuring of the means whereby individual, household and social functions are fulfilled. This implies a radical restructuring of the ways in which new products and services are either manufactured or delivered. So we can expect the decline of some production sectors and the expansion or novel development of others, a topic that has been widely investigated within various disciplines.

However, such restructurings of the *supply* side are intimately connected – indeed we have to acknowledge that they *co-evolve* – with restructurings on the ‘demand’ side, that is with changes in the products and services that individuals, households and institutions require and use as well as changes in the cultural meanings that are given to new ways of consuming. In short, transitions involve the development of new consumption patterns and preferences and new cultural attitudes and practices that support them, along with the development of new production arrangements. In particular we have to explore how can we experiment with the change and reconstitution of *consumption* preferences and relations. Therefore, special attention should be given to active the role of the users and consumers.

The survival, development and break-through of novelties

Transformation inducing novelties initially typically appear as misfits in relation to an existing regime. This raises a range of issues concerning how they may yet survive, how they develop further so that the misfit can become a ‘partial fit’ and how it is possible that from this point on it is not the small novelty that adapts to the regime but it is the regime that transforms to fit the novelty. The issue is even more pressing since existing regimes tend to defend themselves against the perceived threats of novelties. For instance, when electric vehicles (EVs) became seriously pushed and promoted by the Californian authorities to reduce the emission of pollutants the automakers increased their efforts to reduce the emissions of conventional vehicles in order to marginalise the EV novelty.

Obviously there are actors that are prepared to work against the odds but what strategies do they use to change the odds? Initially they may be just a few guys working from a shed but to make the novelty grow they will have to liaise with others who should also be prepared to work against the odds. There is a need for technology developers who are willing to invest time, effort and money (the entrepreneurs). There is a need for users who deviate from mainstream and use a technology with clear disadvantages. In innovation studies and economics these are sometimes called the leading edge consumers or first users. There is a need for regulators who are willing to stick their neck out and give preferential treatment to the novelty. There is a need for investors who are willing to take large risks (e.g. venture capitalists).

They will need to form a heterogeneous network of actors who go a long way to counter all the threats to the novelty's survival. These so-called regime builders can be groups of engineers and technicians, but also financial institutions or government agencies. The role of regime builder is not static but can change in the course of time; for example, one group can replace another. These actors or regime builders supposedly have the greatest influence on the successful development of regimes, which makes them an obvious target for research on transition.¹⁰

Their influence depends on the room for manoeuvre and the ability to manage junction points and keep the process going. Recent developments in a variety of regimes like the Internet or the regime of electricity supply seem to indicate a increasing loss of central co-ordination and control. In these cases, it is much more difficult to identify the regime builders. One of the questions is what this means for our understanding of regime development and the possibilities of planning and managing regimes.

Final remark

For the sake of this paper, to give a general overview, these issues have been formulated very broadly and one of the main tasks ahead is to make them more specific. This cannot be a unilateral affair, however, and needs to be carried out in interaction between various researchers which also requires building the networks of researchers to carry out the work and to relate each other's findings. In the Netherlands, a first attempt at this has been made by developing a national research program by researchers from various Dutch research institutions that has been submitted for funding to a national research programme financed directly by the Dutch government.

PART 2: INDUCING TRANSITIONS

The nature of transition policy

Since transitions could help to achieve sustainability an important follow-on issue is how insights in the dynamic of transitions can be used to inspire 'transition policy' or 'transition management', as it is sometimes called. (Rotmans et al. 2000, 2001) The complexity of transition processes and their long duration implies a warning that such policies cannot be based on simple steering philosophies. Such policies will need to take into account interaction between different stakeholders, unpredictability, a need to monitor ongoing processes and adapt strategies if needed, and, by implication, a need to leave room for learning and feedback. (Lynn et al. 1996) Possibly, such policies will need to combine existing policy instruments with some new approaches and assessment methods to identify the optimal mix in specific circumstances.

Transitions are multi-factor, multi-actor and multi-level and can only be understood in terms of co-evolutionary processes which link up these actors, factors and levels. These processes are characterised by high levels of uncertainty, unpredictability, and risk, and, therefore, are open-ended learning processes. Influencing, rather than steering, such processes will certainly be difficult, but it may not be impossible. Part of the challenge is to influence developments at an early stage, when irreversibilities have not yet set in (cf. discussion on 'momentum' and 'path

¹⁰ As mentioned before, the arena's in which these 'misfitting' novelties are developed are called (technical) niches. The strategy followed by the regime builders to prepare the novelty to be able to link up to the regime is called 'strategic niche management' (SNM). (Hoogma et al. 2002, Kemp et al. 1998) The role of these regime or network builders has also been stressed in Elzen et al. (1996).

dependency' above) and one can attempt to tip the balance between desirable and undesirable developments

The emphasis on learning and anticipation, however necessary, is not a guarantee that the desired directions will be realised because attempts to set directions will be contested. Policy interventions need to take the existing dynamic into account and cannot realise a drastic deviation from current courses of development. The policy objective should therefore be to find ways to modulate on-going dynamics so that it bends slightly in the direction of desired objectives. A slight initial bend, however, provided the new course is consistently maintained, can lead to drastically different outcomes in the longer term which, after all, is what transitions are about. This approach is like Charles Lindblom's notion of "muddling through" (Lindblom and Woodhouse 1993) but with an added element: understanding the dynamics of development allows one to identify opportunities for intervention and specify how such interventions can be productive.

To modulate the ongoing dynamics implies a need to assess these dynamics and to take into account the strategies and objectives of the various actors involved. To realise this, public authorities have to become a player in innovation processes on equal footing with other players and engage with them in discussions on desired (longer term) objectives. Thus they engage in a process of vision building in which all actors involved can balance their own interests against broader societal objectives which are often brought in by governmental actors.

Such a process of visioning is a necessity when the objective is to induce a transition rather than incremental innovation. In the latter case, the longer term development path is the result from opportunistic attempts to develop near term solutions to pressing problems. This will lead to a very crooked course of development of which it is very questionable that it will lead to sustainability in the broad sense. When striving for a transition, by contrast, an explicit attempt is made to identify a longer term sustainability objective, however vague, and to try and develop a path towards the realisation of that objective. Longer term visions are then a necessity to be able to evaluate whether ongoing developments are 'on course' and to adapt strategies when this appears no longer to be the case.

The visions developed in interaction between different types of actors subsequently need to be translated into (a variety) of near term steps that are necessary to realise them. If the visions are broadly shared among different types of actors, it may be relatively easy to develop consensus on these steps and their realisation may not encounter serious obstacles. If there is considerable dissensus, however, each of the actors will take their own responsibility and, for the time being, attempts to manage the broader process are likely to be futile.

As stated in the beginning of this section, the objective to induce a transition implies a necessity to monitor ongoing transition processes and leave room for learning and adaptation. Because, furthermore, public authorities need to interact with other actors in the process on equal footing this implies that this monitoring and assessment of progress will need to be of an interactive nature as well. Thus, processes of visioning and defining near term steps are not a once of affair but need to have a repetitory nature with a frequency depending upon the pace of development.

The above implies that governmental actors become a sort of *primus inter pares* in active networks that try to realise a transition. Every actor will need to play an active role in these processes, attempting to reconcile their individual interests with broader societal objectives. Policy thus gets a broader managerial meaning than it usually has in current practice and for that reason the term 'transition management' may more appropriate than 'transition policy'.

Summarising the above, transition management or transition policy has at least the following main characteristics:

- it is in its very essence an interactive endeavour;
- it is a cyclic process of long-term visionmaking, defining near term steps, learning, monitoring progress and adaptation of strategies when needed.
- because of the long-term visions and the cyclic character it is a long-term endeavour that implies the need for long-term commitment from the various actors involved.

Challenges for Transition Policy Research

Although transition policy thinking is very new, various scholars have already taken up the challenge to identify specific elements of policies seeking to induce transitions, identifying promises as well as limitations. (Rotmans et al. 2000; Teisman and Edelenbos 2002) Reflecting the complex nature of transition processes, these scholars come from different disciplinary backgrounds and it is important that such ideas are discussed in an interdisciplinary fashion to try and identify some common themes that can serve as a stepping stone for more focused further work.

If we want to use research findings to develop more precise recommendations for transition policy we can hardly rely on direct historical evidence for the simple reason that past transitions were rarely the result of dedicated attempts (policy or otherwise) to realise them. What we can do is to try and combine insights from two different bodies of research notably (1) the dynamic of historical transitions in which various forms of policy intervention did play a role and (2) analysis of policy intervention to stimulate innovation (if not transitions then incremental innovation).

Above, I already identified various research challenges in connection with the first area of research and I will elaborate the second area a bit in the next section. One issue that stands out is the need for interactiveness identified above. This has consequences for the role of various actors in transition processes as will be discussed in a following section.

Options for governmental authorities to induce innovation

In policy science, three general governance paradigms are distinguished (see Table 1): (1) the traditional top-down model with a central role for (national) government and hierarchical relations, (2) a bottom-up or market model with a large degree of autonomy for local actors, and (3) a policy network model of shared rule-making and agreements between interdependent actors with diverging values and beliefs. These three governance paradigms not only differ in their basic philosophy, but also in their instruments. Formal rules and regulations are common in the command-and-control paradigm, subsidies and taxes in the market model, and network management, learning processes, experiments, and interactive policy making in the third paradigm.

	Classic steering paradigm (top-down, command-and-control)	Market model (bottom up)	Policy networks (processes and networks)
Level of analysis	Relationship between principal and agent	Relationship between principal and local actors	Network of actors
Perspective	Centralised, hierarchical	Local actors	Interactions between actors

	organization		
Characterisation of relationships	Hierarchical	Autonomous	Mutually dependent
Characterisation of interaction processes	Neutral implementation of formulated goals	Self organization on the basis of autonomous decisions	Interaction processes in which information and resources are exchanged
Foundational scientific disciplines	Classic political science	Neo-classical economy ('rational economic man')	Sociology, innovation studies, neo-institutional political science ('bounded rationality', uncertainty, learning, interacting)
Governance instruments	Formal rules, regulations and laws	Financial incentives (subsidies, taxes)	Learning processes, network-management e.g. experiments, demonstration projects, vision building at scenario workshops and foresight, networkbuilding through seminars and strategic conferences, public debates (e.g. Rathenau)

Table 1: Different governance paradigms (based on De Bruijn et al., 1993, 22)

While the traditional model has been dominant at least since World War II, the market-model gained prominence in the 1980s. In the 1990s interactive modes of policy making became more popular. In this less hierarchical, more decentralised mode of governance public and private actors interact in networks, exchange information, and learn from each other.

With regard to innovation, the traditional model focused on changing the selection environment by setting performance or safety standards. The market-model focused on stimulating variety, by giving R&D subsidies or setting up technological research programs. Sometimes demand was stimulated by providing buyer subsidies. The network paradigm positioned itself between supply-push and demand-pull policies, by focusing on the learning processes and building of social networks necessary for innovation. Metaphorically, while supply-push and demand-pull policies increase the *pressure* on innovation, network and learning policies create the *channels* through which knowledge and products flow.

Although there have been shifts in the past, all three governance paradigms co-exist in current policy making. Above, I indicated that interactiveness and networks should be crucial constituents of transition management or transition policy. Thus, it seems that the third paradigm would be most appropriate. Although this is probably true this does not mean that the other two can be thrown overboard. I already indicated that processes of vision-making may or may not lead to consensus between different actors on longer term visions and near term steps. Maybe consensus is even more the exception than the rule. In cases of dissensus, individual actors will and will need to take their own responsibility which in the case of policy actors may imply they set some rules against the will of (some) other actors. In such cases they will need to rely on one of the other two paradigms which, therefore, also have their role to play in transition policy.

The discussion above raises several important questions, including:

- What are the possibilities of new instruments from the third paradigm for transitions?
Because this paradigm is rather new, its possibilities and effectiveness have not been entirely elaborated.

- If all paradigms have a role to play in managing transitions, which is most appropriate under which circumstances? Can this be related to different phases in transitions (e.g. invention and generation of new options, the linking of novelties to existing regimes, the wider diffusion of the novelties and transformation of the regime) which may require different policy interventions?
- What do the different policy paradigms imply for the role of different actors in supporting management of transition especially the balance between ‘private’ action and ‘public’ intervention/support?

Redefining the role of various actors

This last set of issues relates to a continuing debate over the roles of the public and private sectors in supporting new technological developments and the associated changes in market and other societal relations that go with the successful diffusion of new products and/or services. From the market-model paradigm governments should only finance ‘pre-competitive’ research. Governments should not interfere with the process of market development and diffusion, and leave that to private firms. In the market-model it is unfashionable (compared to the 1960s-1970s) for governments to ‘pick winners’ and to be involved in all stages of the product/market development process.

From a network and learning paradigm, however, it might be worth to revisit this public/private divide. In the interest of more radical change required to realise sustainability, public intervention and support might either be increased and/or take new forms. Since innovation in technologies and markets cannot be limited to the actions of individual firms, but involves networks of firms and other actors (especially users), the role of government agencies in ‘network governance’ can be legitimately re-examined. Possibly, public authorities need not pick the winners themselves, but could take upon them facilitating roles such as network builder, information exchanger, or agenda builder for the most desirable directions to be followed (as in Foresighting activities). In transition management there is probably no clear-cut divide between the public and private spheres – the question is how to balance the most effective levers of change.

Challenges for Transition Policy

The brief discussion above leads to the conclusion that there can be no such thing as *a* transition policy. Transition policy (or transition management in the broader sense) consists of a variety of efforts and actions, tuned to a specific situation and applied dynamically in the course of time as development progresses. Transition policy is a matter of long breath, far longer than the typical cabinet period which in itself may already constitute a serious barrier to carry it out. This poses the challenge of developing robust long-term policies that are relatively unsusceptible to whimsical political winds.

The discussion above makes clear that transition policy distinguishes itself from conventional policies in several ways:

- The ambition is to realise long-term ‘fundamental’ changes;
- Transitions cannot be managed in the strict sense, i.e. they cannot be steered by a central actor (government or other) to realise specific objectives.
- By implication, transition management is an interactive process that needs to take place between a heterogeneous set of actors, each acting on the basis of their own vital interests and expectations.

- Transition management requires anticipation methods and (interactive) visionbuilding processes. Some notion is needed on the direction in which to move to be able to identify ‘promising first steps’.
- It uses a wide variety of instruments and strategies applied with the intention to realise synergistic effects. Instruments may need to be tuned to specific phases or characteristics of ongoing transitions.
- Transition management is about a cyclic process of visionbuilding, taking action, evaluating the response to this after some time and subsequently taking new action. It’s a process of ‘learning-by-doing’, ‘learning by using’ and ‘learning by interacting’. (Rosenberg1982, Von Hippel 1988, Lundvall 1988)
- Transition management is not about solving today’s problems by tomorrow. It is about inducing and stimulating the development of longer term but more fundamental and more effective solutions that may even imply accepting that problems initially get worse.

With the current state of the art in the field in transition research it is possible to define certain elements (tools, strategies, tasks) that a transition policy should contain but we are still far removed from defining a transition policy ‘tool kit’ along with a manual on which combination of tools to use in which situation. Still, on the basis of tentative ideas that have already been developed transition policy could and should start now since developing the tool box has to be a combination of input on the basis of the analysis of past transitions along with ‘learning-by-doing’. Let me therefore highlight some of these elements that these ‘exploratory transition policies’ should contain:

- Policy makers need to acknowledge the exploratory and learning nature of transition policy and the instruments used. In various concrete steps, learning objectives should be specified and a critical evaluation of the lessons to be learned from each step should be carried out. Learning implies a substantial need to invest in monitoring and evaluation !
- For each domain of policy making (e.g. energy, mobility, agriculture) for which a transition policy is defined it is necessary to gain a good understanding of the recent history. Transition policy should attempt to ‘modulate the ongoing dynamic’, rather than countering it, and therefore needs to identify the main characteristics of the dynamic. To be able to identify possibilities and impediments for a transition the required knowledge has to include:
 - ◆ main current development trends that are likely to continue into the near future;
 - ◆ major stakeholders and their expectations on the most promising and/or desired developments;
 - ◆ major problems and expectations of major stakeholders on how they should be tackled;
 - ◆ ‘windows of opportunity’ in the regime: where are options for new developments to hook on?;
 - ◆ macro-level developments and how they might affect developments in the domain at stake (i.e. the regime or system);
 - ◆ micro-level developments of new options / solutions (niches), promising to tackle certain problems effectively but not being able to make it in the current situation (due to a variety of mismatches, barriers).
- In elaboration of the last point it is necessary to make an overview of ‘promising options’ for a transition that, in combination or by cross-linking with existing options, might provide fundamental solutions for current problems in the domain in question. Beware that an ‘option’ is not only defined by technical characteristics but also by its societal embedding (e.g. a specific way of use);

- For each of these options, it is necessary to make an inventory of barriers to realise them in practice along with possible ways to overcome them. Be creative in such assessments as all too easy characteristics of the current situation are taken for granted while transition policy (in contrast to conventional policies) try to develop paths to move away from some of these characteristics.¹¹

Note: transition policy assesses the potential of alternatives on different grounds than conventional policies. In conventional policies, the typical question is how we can implement an alternative option as quickly as possible to solve today's problem. This implies a focus on options that closely fit an existing regime, preferably those that hardly require change of behaviour of various stakeholders involved. Transition policy, by contrast, looks at options that provide fundamental solutions, also involving change of stakeholder behaviour.

- For each option, make an inventory of their promise to contribute to a transition, e.g. as an element of a desired future regime, as an option to combine with other options, as an option to put pressure on the regime to improve, etc. Make an inventory of the steps needed to fulfill these roles.
- Make an inventory of concrete policy options to enhance the chances for a transition to occur. These may include:
 - ♦ Put pressure on the existing regime (e.g. through regulation) which will stimulate regime to improve specific parameters but also encourage further development of alternatives;
 - ♦ Encourage development of alternatives and learning on their practical usefulness through experimentation, focussing on aspects suggested by the assessment of their promise (see above) and the barriers they face in breaking through. Look for favourable experimental settings with stakeholders who accept that many things may go wrong in a learning process.
 - ♦ Stimulate co-operation between various stakeholders to explore or realise certain options.
- Take concrete policy action in accordance with the the points listed above, taking into account what is possible given the actual political, societal and financial situation.
- The long-term and exploratory nature of transition policy are not likely to make it popular among politicians and policy-makers (and a range of other stakeholders) who want to see tangible results in the short term. One of the challenges, therefore, is to develop ways to 'measure progress' in transitions.¹² This is not only an issue for external legitimation but of necessity to carry out transition management (or) policy in a dynamic way: a system of milestones and evaluation methodologies will be required to assess the direction of change which will allow an evaluation of the effectiveness of past strategies and identify the need for adjustment.

The points above raise more questions than they answer but they do indicate that transition policy in several ways is distinct from known policies and consists of a combination of diverse instruments and activities. It also makes clear that it is a process type of approach rather than a 'point intervention' approach.

¹¹ For instance, in the current situation the claim (in practice taken to be a fact) that the majority of people will never do away their car may be founded on strong empirical evidence. In a situation, however, where there are effective and easy to use transport alternatives, in which car-use is slower and/or more expensive, in which parking cars is difficult and/or expensive, most people are quite likely to make a different choice. Such a dynamic assessments of barriers can also provide (partial) clues for potential transition paths.

¹² An attempt to do so is undertaken at the Dutch National Institute for Public Health, Environment and Nature (RIVM). Cf. Ros et al. 2003

The elements above are rather general and to be practically useful they should be specified further on the basis of earlier research on transitions, including findings discussed in several research papers that have been produced in the recent past.¹³ Furthermore, concrete policy recommendations need to be tuned to the state-of-affairs in concrete regimes. As a result, concrete transition policy for the energy domain may contain a different mix of approaches than, e.g., for the traffic and transport domain.

Still, in a general sense the approaches will overlap for different domains as will the evaluation methodologies to 'measure progress'. This makes it most useful to make comparisons between the effects of transition policies in various domains attempting to draw general conclusions that can subsequently be fed back into any of the domains. Hence, the ambition and nature of transition policy make a close and regular interaction with transition research quite desirable.

THE LINK BETWEEN TRANSITION RESEARCH AND TRANSITION POLICY

Although transition research is still in its infancy, insights developed thus far do allow making policy suggestions that can inspire current attempts to define and implement various forms of transition policy. Given the state of research these suggestions are tentative and of a general nature that requires further specification.

One way forward is to develop a better understanding of transitions on the basis of historical research. This will render better knowledge on the dynamic of transitions and should analyse the role of various factors in inducing, stimulating or impeding transitions under different circumstances. A better understanding of the dynamic could subsequently help to develop better founded policy suggestions on (im-) possibilities to induce and encourage transitions.

Still, however useful and necessary, the better understanding of transitions will not provide a sufficiently solid basis for transition policy for two reasons:

1. Past transitions were rarely the result of dedicated attempts to realise them. Suggestions for transition policy based on their analysis will by necessity be hypothetical and their value will have to be assessed by trying them out in practice.
2. Transitions are so complex with so many uncontrollable factors playing a role that attempts to steer or guide their course will always have an element of tentativeness and continuous feedback and adjustment will be necessary as time goes on.

Therefore, it is neither useful nor necessary to wait with attempts to induce transitions (or transition policy) until we have developed a better understanding of the dynamic of transitions. We can distinguish three types of activity that need to go on concurrently and that need to influence each other continuously, notably:

1. The analysis of past transitions on the basis of historical research: this should render a better and more refined theory (or theories) on the dynamic of transitions which can be used to refine and specify suggestions on (im-) possibilities for transition management.
2. Transition management (or policy) in practice: on the basis of current insights attempts at transition management should be started in various domains (e.g. food, water, energy, mobility, etc.).

¹³ In the summer of 2002 a workshop was organised at the University of Twente on these issues. Several of the papers presented there will be published. (Elzen et al., forthcoming). In the fall of 2003, several workshops on these topics are organised at the Greening of Industry Conference (San Francisco, 12-15 October) and the Open Meeting on Human Dimensions of Global Environmental Change (Montreal, Canada, 16-18 October).

3. Learning-by-doing: the attempts under 2 should be closely monitored and subsequent developments evaluated. Results can be used to enhance the understanding of transition processes (in combination with 1) and be fed back into the development of better suggestions for transition management or policy.

This combined approach will require a closer and more continuous interaction between policy and research than is common. To realise this may already constitute a challenge but is a necessary requirement given the complexity of the issue we are dealing with. It can be seen as a first go at realising the interactivity that is required in transition management.

Thus, the challenge to realise transitions towards sustainability in a variety of domains can only be fruitfully tackled when near-future attempts to induce them are carried out in close interaction with work on furthering the understanding of the dynamic of transitions. Still, given that so much work still needs to be done on both the understanding and the inducement side it makes sense to define separate projects for each area as long as the results are eventually related to each other.

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