

Transitions: what drives them and how are they managed?

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Project team

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Problem definition

Transitions are societal transformations in which society or a complex subsystem structurally changes in a continuous, gradual way. Transitions are the result of a dynamic interplay among multiple factors, which mutually shape each other but at the same time have their own trajectory of development. Technological transitions (TT) – transitions in which technical change is a prominent element – may offer sustainability benefits and are therefore interesting for public policy.

The programme aims to synthesize and deepen our understanding of technological transitions through the development of a database of 5-6 transitions and a detailed study of the ongoing transition in waste management.

The following major research questions serve as a guideline for our research project:

- Are there identifiable transition phases such as the predevelopment stage, take-off stage, breakthrough stage and stabilisation stage? Can such stages be operationalised?
- To what extent were TT foreseen, expected and intentionally managed, at the different stages? What was the role of widely shared expectations?
- Are there common strategic behavioural patterns in transitions (such as regime actors first fighting a new development pioneered by niche actors and later on sustaining it)?
- What role did incremental innovation play in TT? Did it help to sustain the old regime ('sailing ship effect') by defending it against a new development or did it provide opportunities for further change ('stepping stone dynamic')?
- Does the interplay of technical change and institutional change differ in different transitions and in various phases of a particular transition? Does technical change lead/precede institutional change or is it the other way round?
- What was the role of public authorities (in different phases)? What do the transitions tell about the proper role of public authorities and public policy in various transition stages? More specifically, what does transition management look like for waste management?

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The programme consists of two projects

Project 1

Construction and analysis of a database of technological transitions (TUE, project leader Prof Bart Verspagen b.verspagen@tm.tue.nl)

The issue of technological transitions (TT) is receiving a great deal of attention, especially in the Netherlands, where the change process towards sustainable energy, transport, agrofood and spatial use is conceptualised as a transition issue involving technical change, social and cultural change, and policy change. A model of transitions has been developed, drawing on evolutionary economics and social system approaches of technology. The perspective is described in Rip and Kemp (1998) and Geels en Kemp (2000) and applied in various projects in the Netherlands such as the TIN projects (Technology in The Netherlands in the 19th and 20th Century) and the MATRIC project. It is also used in the ICIS-MERIT project on transitions and transition management for the 4th Dutch National Environmental Policy Plan (NMP-4). The aim of this project is to give the theoretical perspective a wider empirical basis and systematically look at specific phases, patterns and mechanisms within the general transition perspective. It also aims to operationalize these findings through a set of indicators. To do so a database of 5-6 technological transitions will be created, allowing for comparisons across TT.²

The principal aims of the database project are:

- 1) Construction of a database of 5-6 case-studies of TT that occurred during the 20th century. This will give a wider empirical grounding to the multi-level perspective, but also allows for cross-sectoral investigation of patterns, mechanisms and indicators in TT. This involves exploration of various ways to quantify aspects of technological transitions, such as the duration of transition phases, the use of market shares and investment.
- 2) To make steps toward quantification of the multi-level perspective, which so far is qualitative. Quantification of aspects of TT will allow statistical analysis with database variables to identify common patterns and mechanisms

Project 2

Institutional change in the transition of waste management in the Netherlands (UM, project leaders Dr René Kemp r.kemp@merit.unimaas.nl and Prof Jan Rotmans j.rotmans@icis.unimaas.nl)

This project sets out to examine an issue we know very little about: institutional change during transitions. We still lack a broad theory of institutional change. According to North (1991) it is price changes that drive institutional change but this overlooks the changes in

² Originally we wanted to examine 15 technological transitions (as a first step towards a data base of 50 transitions). But due to a severe budget cut we had to reduce the number of cases to a maximum of 6.

We have selected the following cases for study:

1. Industrial energy production and distribution: from steam engines to electric motors (1880-1920)
2. Lighting: from gas light to electric light (1890-1920)
3. Entertainment: From public cinemas (film) to private television watching (1930-1970)
4. Mechanisation of agriculture (1940-1970)
5. Telecommunication: the emergence of cellular phones (1960-present)
6. The transition from coal to gas for cooking, space heating and electricity generation.

policy belief systems and values at the macrolevel as a pressure and the practical concerns of engineers and managers who are pressing for institutional change in the name of practical sense. The project does not aim to build a general theory of institutional change but will contribute to a better understanding of the drivers of institutional change and the dynamic interplay of institutional change with technical change and economic change. Institutional change is analyzed in the domain of waste, where a transition is taking place in the management of waste: from originally an activity of landfilling undertaken by municipalities, to an activity of landfilling and incineration, to a wider industrial activity, with private and public waste management companies specialising in waste collection, treatment and recycling and the institutionalisation of waste prevention and management in companies, in a changing economic and policy environment.

The project seeks to analyse to what extent institutional change in the waste transition is *endogenous* to changes in the economics of waste, advances in waste technology or independent from such developments, as something related to political factors, policy learning, accidents or policy developments at the EU level.

Special attention will be given to the following issues:

1. the extent to which institutional change within the waste transition is an endogenous process, resulting from the interplay of technological change and economic change or an exogenous process independent of the transition.
2. the extent to which the consequences of institutional change were foreseen and aimed by private and public parties
3. the attempts at managing the waste transition and the effects of steering
4. how the ongoing transition may be further stimulated into a sustainable direction, through transition management based on a modulation philosophy with learning and institutional adaptation as important objectives.

Innovative nature of the programme

The programme offers an analysis of those factors that economic analysis usually treats as exogenous or given: taste, preferences, institutions and technology. In analysing institutions special attention will be given to *non-formal* institutions: routines, standard operating procedures (practices), shared assumptions and dominant (policy) views (belief systems), and to managerial and engineering common sense within sectors, which in our opinion constitute important elements of the institutional matrix or the rules of the game. The project will document changes in such institutions and will seek explanations for it—economic explanations, power explanations and learning explanations.

A key concept of the project is *co-evolution*. Transitions are believed to be the outcome of co-evolution processes which are not uniform but differ in time, depending on the stage of the overall transition. The term co-evolution will not be used in a loose sense (as is common in the literature) but is tied to a model of transition that is described in Rotmans et al. (2000).

Theoretical framework and research methodology

The subprojects will make use of the evolutionary, multi-level technology in society perspective of Rip and Kemp (described in Rip and Kemp, 1998 and Geels and Kemp, 2000), and general systems theory, which have been combined into a *stage model* of transitions which is described in Rotmans et al (2000 and 2001) and Kemp and Rotmans (2001). The transition model sees transitions as the outcome of exogenous and endogenous developments. For a transition to occur it is necessary that different developments come together. A

transition cannot be caused by one factor, like an innovation or a price change. It consists of a combination of reinforcing mechanisms (Rotmans et al., 2000). This means that the project will go beyond deterministic, mono-causal explanations. Two key aspects of any transition are *time* and *scale*.

With regard to time the following four phases are distinguished (Rotmans et al., 2000):

1. The *pre-development* phase of dynamic equilibrium where the status quo does not visibly change but in which the seeds for change germinate.
2. The *take-off* phase where the process of change gets underway because some innovations break out challenging the status quo and finding wider application and support.
3. The *acceleration* phase where visible structural changes take place through an accumulation of socio-cultural, economic, technological, ecological and institutional changes that reinforce each other. During this phase there are collective learning processes, diffusion and imbedding processes.
4. The *stabilisation* phase where the speed of the social change decreases and a new dynamic equilibrium is reached.

It is hypothesised that in the four stages nature of technical change and institutional change will differ. In the predevelopment phase, technical change is mostly incremental aimed at improving an existing system, with some research oriented to radical options and some experimentation. In this phase institutional change consists of new networks and new forms of governance at the local level. In the take off phase we have growing investment in new technology and changes in market organisation, with some regime actors contributing to the new technological regime, creating a domino effect (by giving credibility to the a development and by creating a strategic game). In the acceleration phase, when the new system becomes more economical, investments will be stepped up and the institutional environment will increasingly adapt to the new possibilities. In this stage the regime rules change. The project will examine for the 5-6 technological transitions whether these assumptions hold true for all transitions or for a group of transitions.

With regard to *scale* the micro-meso-macro scheme of Rip and Kemp (1998) of niches, regimes and (socio-technical) landscapes will be used. The socio-technical landscape (macro level) is the landscape that sustains us. It relates to material and immaterial elements at the macro level: material infrastructure, values and beliefs, the macro economy, demography and the natural environment. The second level, that of regimes, is a central element. This element will receive a great deal of attention. Regimes are rule sets which are implied in practices, rules and roles. The rules consist of normative rules and shared assumptions (such as the consensus about the relevant problems and solution directions). The third level, of niches, refers to places of nonstandardised practices and technologies. Niches are the place in which novelties originate and mature. The novelties can be a technical innovation, a new form of governance or a new practice such as organised car sharing. In niches the seeds of change germinate with the help of the resource base and specific selection criteria (Levinthal, 1998 and Kemp et al., 1998 and 2001).

The project will use the above multi-level, multi-domain, multistage model to analyse transitions. It will analyse to what extent the transitions are teleological (oriented to a particular goal or vision), deterministic or evolutionary (Boulding, 1970). In terms of economics it will build on the economics of technical change (in particular technology life-cycle approaches of industrial evolution (Abernathy and Utterback, van de Ven), the work on path dependence and bandwagon effects (Arthur, David, Verspagen and Silverberg) and on

institutional economics (both heterodox and orthodox approaches) through the focus on regimes and rules of the game.

The following research methods will be used: secondary analysis of historical studies, statistical analysis of indicators, pattern mapping (project 1), desk research, interviews and process tracing and workshops (project 2).

Relevance to policy

In the Netherlands transition management is seen as a promising concept for public policy to achieve a greater coherence in public policy and aligning private action and public action towards the goal of sustainability. Dutch environmental authorities have adopted the concept of transition management as a guiding principle for sustainable development policy. It is a key element of the new environmental policy plan (NMP-4) that came out this summer. The Ministry of Environment, Health and Physical Planning (VROM) furthermore choose transition management as priority theme. Waste management (the focus of project 2) is chosen by VROM as a pilot case for transition management.

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