

Knowledge co-creation: Interaction between science and society

**A transdisciplinary approach
to complex societal issues**

**VU University Amsterdam
Athena Institute**

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Colophon

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NUMBER	TITLE
V.10e (2009)	Knowledge co-creation: Interaction between science and society A transdisciplinary approach to complex societal issues

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A.12 (2007)	Gezondheid en natuur verbinden – beleidsadvies over het inzetten van natuur voor gezondheid
A.13 (2007)	Kennisagenda Natuur en Gezondheid – in maatschappelijk perspectief

June 2009

This publication includes the perspectives of eight individuals involved in government, business and societal organisations. They voice, their experiences, anecdotes, reflections and expertise regarding the issues explored in this publication. How do they shape complex co-operation processes? What is the meaning of knowledge co-creation in their working practices? They are introduced below.

Jeroen Bordewijk

Senior Vice President Supply Chain Excellence, Unilever

In 2006, Jeroen Bordewijk concluded a 34-year international career with Unilever, covering such fields as production, R&D and supply chain management. In his last position as Senior Vice President Supply Chain Excellence, he was responsible for such issues as sustainability initiatives for the raw materials of Unilever's food division. These included internationally recognised programmes for fish and agrarian products such as tea, palm oil, tomatoes and deep-freeze vegetables. He was also the instigator of a number of international initiatives for sustainable agriculture, in which food industry companies and social organisations worked together. In addition, he has held positions on the advisory councils of a number of international plant refining and crop protection concerns. He currently plays an active role within organisations in the Netherlands and internationally which stimulate sustainable agriculture and socially responsible entrepreneurship. Jeroen Bordewijk has been a member of the Council of RMNO since 2004.

Frans Evers

Council Member RMNO

Since 1971 Frans Willem Rudolph Evers has been actively involved in the quality of the living environment, both in his work and in his spare time, his particular interests being the protection of nature and the environment. As Director of Administrative Affairs from 1980, and as Deputy Director General of Environmental Management from 1983 to 1987 at the Ministry of Housing, Spatial Planning and the Environment, his responsibilities included such issues as the development of planning of environmental policy, legislation for environmental impact reporting and international negotiations in the area of the environment. From 1987 to 1996, he was Director General of the Government Buildings Agency, where he improved the cooperation with market players. From 1996 to 2002, he was Director of the Society for the Preservation of Nature Monuments in the Netherlands. Frans Evers holds a post as Adjunct Professor at the Tilburg Institute of Advanced Studies of the University of Tilburg, and has been a member of the Council of RMNO since 2000. Frans Evers is a much sought after independent process manager and problem-solver, particularly in the field of spatial processes. His achievements include the realisation of the National Landscape of Low Holland and the 'Green Solution' (Groene Uitweg), a joint vision and implementation programme comprising all the relevant organisations and authorities in the Gooi and Vecht Region.

Gertjan Fonk

Project Leader Innovation Network

Since 2001, Gertjan Fonk is staff member of the Innovation Network for Green Areas and Agrocluster, where he is responsible for professionalisation through learning, and for monitoring and evaluation. He studied electro techniques (1980) at HTS, and Politics at the University of Amsterdam (1987). Gertjan worked at the SWOKA Institute for consumer research for 10 years. He obtained his PhD in 1994 at the University of Twente on a SWOKA study into the role of the consumer movement in technological development processes. After that (1999-2001) he worked for the Knowledge transfer en Anchoring programme of the interdepartmental research programme on Sustainable Technological Development (DTO-KOV)

Gertjan Fonk (Project Leader Innovation Network):
"It is primarily about resolving a social problem which is not handled adequately by the market. This is not successful with only scientific and technological development. It has to be embedded: it is about acceptance, legislation and regulations, and behaviour. You need an interactive process for this, whereby you bring together parties with different interests and perceptions".

Marga Kool

Water Board

Marga Kool (Apeldoorn 1949) is Dike Reeve for the Drenthe-Overijssel Water Authority Reest and Wieden and council member of the Association of Water Authorities. From 1991 to 1998, she was delegate for the College of the Provincial Executive for Drenthe. During this period she was one of the first public administrators to shape regionally-focused policy. She is a member of the Commission for Innovation in Public Administration (Inaxis), Chairman of the Drenthe department of the Koninklijke Heidemaatschappij (KNHM), Chairman of the Provincial Board of D66 in Drenthe, member of the Advisory Council of the State Forestry Service and Board Member of the

Drenthe Architecture Centre. Marga Kool has also written a number of publications, including, volumes of poetry, plays and prose works, including the novel: Een kleine wereld (A small world). She has a regular column in the Staatscourant. Within the RMNO, Marga Kool was the initiator of the project on: Mooi licht mooi donker, which put light disturbance and light pollution on the political agenda.

Marga Kool (Water Board): "This publication is about processes, and together with groups, together with citizens, doing something to resolve social problems. I am very pleased that thinking in science apparently has many parallels with how you realise policy, how you solve social problems."

Peter Nijkamp

Chairman NWO

Peter Nijkamp (1946) studied econometrics at Erasmus University Rotterdam (1964-1970). After obtaining his PhD (1972, with distinction), he became lector in 1973 and later (1975) Professor of Regional Economy and Economic Geography at the Free University Amsterdam. His research, which is primarily international, comprises such fields as regional and urban development, quantitative methods for policy analysis, mathematical modeling of spatial systems, environment and resources, transport and infrastructure, technological innovation, housing and employment markets, as well as the preservation of historic monuments. He is a prolific publicist in international scientific literature.

In 1996, he received the most prestigious scientific prize in the Netherlands, the Spinoza Prize.

In the policy field he is frequently invited to act as adviser for various ministries and international organisations and until recently was Chairman of the Language and Literature section of the Royal Netherlands Academy of Arts and Sciences, and also Vice President of this same organisation. He has been Chairman of NWO since 1 June 2002.

Peter Nijkamp

(Chairman NWO): "I feel still 100% a researcher and in my own research practice I have clearly stated that by broadening your perspective, by listening carefully to what people in society or in other disciplines have to say, you sometimes come across unexpected things which you would not have discovered if you had sat in isolation in your room."

Roel in 't Veld

Policy Adviser

Roel in 't Veld (1942) is Chairman of RMNO (Advisory council for research on spatial planning, nature and the environment). He is also a professor at the Open University of the Netherlands, Professor of Good Governance at the University of the Netherlands Antilles and lector in Democracy. He is also a member of the Supervisory Board of Netherlands KnowledgeLand and Commissioner for IBM the Netherlands, HSK Group and President Commissioner of ProRail. In the past, Roel in 't Veld has held such positions as Director-General for Higher Education and Scientific Research at the Ministry of Education, Culture and Science, Secretary of State for Education and Science and Chairman of the Supervisory Board of the IB Group. He was also Dean of the Netherlands School for Public Administration, Rector at SIOO, the Interuniversity Centre for Development in the field of Organisation and Change Management.

Roel in 't Veld has editorial responsibility for a wide range of publications, including works on process management and the Handbook on 'Corporate Governance'.

Annette de Vries

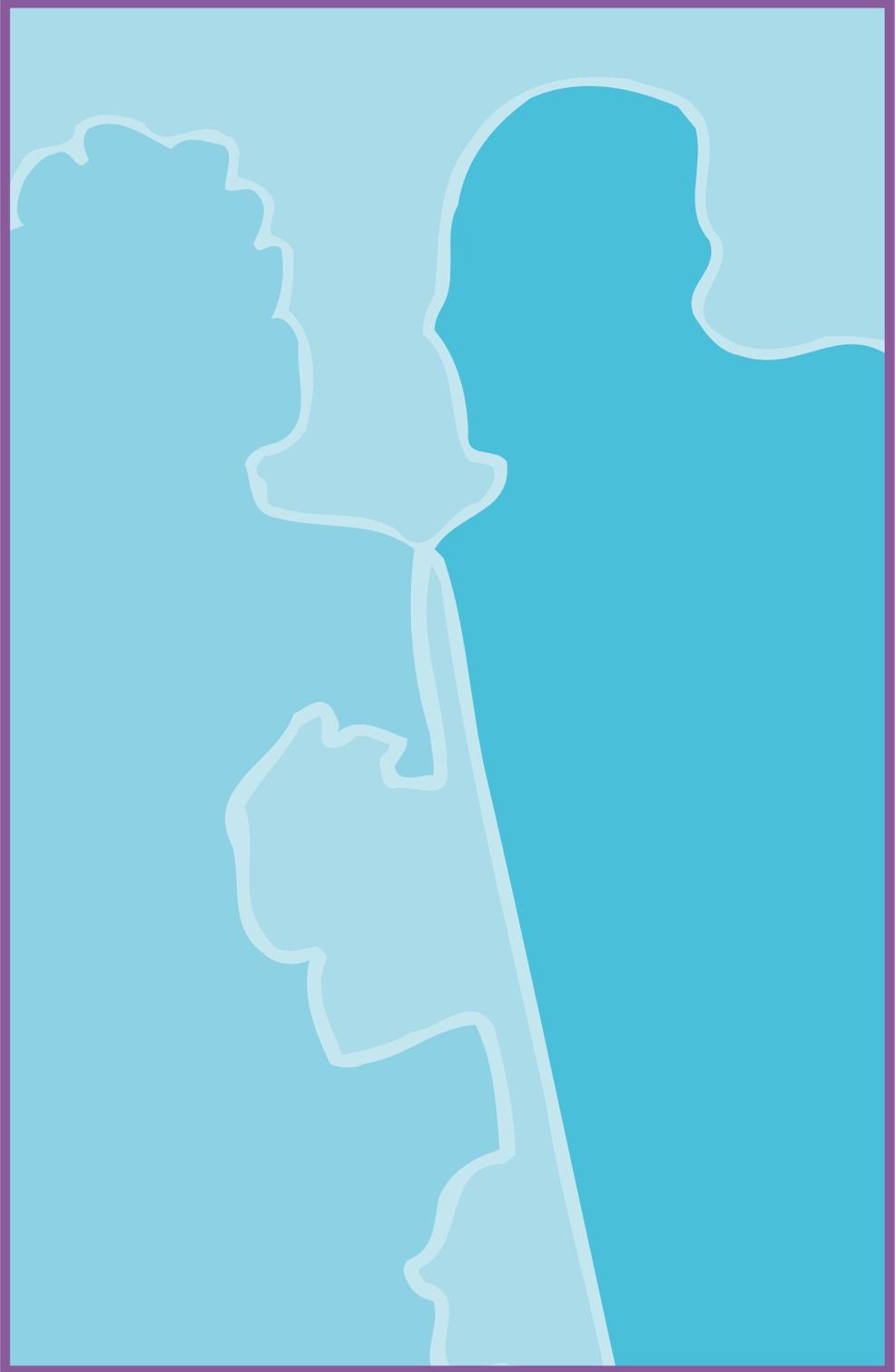
Real Prosperity Foundation

Annette de Vries (1965, social-cultural work and lawyer) is a networker 'pur sang'. She maintains an awareness of developments in the public arena (government, business and social mid-field) and the key actors within this area. She is able to relate these developments to the current situation as experienced by people in their private lives, or in their organisation or company, and vice versa. A match-maker between people and ideas. Annette questions and listens to people, encouraging and challenging them to look beyond their normal viewpoint, realistically and experimentally. She likes to develop and guide projects and processes focused on added value – and can reflect and report on these in such a way as to generate insight into the how and why. Relevant clients include 3VO (special congress), Duurzame Driehoek Brabant, District Office Utrecht NW (process supervision), St. Professional Ethics (starting conference), Utrecht province (lunch meetings, master class). Annette is a member of the board of the Netherlands Social Venture Network.

André van der Zande

Permanent Secretary, Ministry of Agriculture, Nature and Food Quality

André van der Zande (1952) studied Biology in Leiden, graduating in 1976 with distinction. He obtained his doctorate based on his dissertation on the subject of 'Outdoor Recreation and Birds: conflict or symbiosis.' He gained experience with policy-making and political-administrative processes in Gelderland and within the Ministry of Agriculture, Nature and Food Quality, has obtained practical experience with nature reserve and forestry management with the National Forestry Service in South Holland and management experience as a Director of large and complex research organisations in Wageningen, such as Alterra. As Director of Alterra, he was co-initiator and responsible for the development of an integral knowledge infrastructure for built monuments, cultural-historical landscapes and archaeology (KICH). Since May 2002, as Director-General at the Ministry of Agriculture, Nature and Food Quality, he has been responsible for rural policy, regional policy, nature and biodiversity, the countryside and large cities, spatial issues, recreation, fertilizer policy and general environmental policy.



Contents

Summary	11
Chapter 1 Introduction	21
1.1 Appeals for a different way of knowledge development	
1.2 Conceptual framework	24
1.3 From analysis to appeal	29
1.4 Objective and structure of the publication	31
Chapter 2 The role of scientific knowledge development	33
2.1 Mode-0: Autonomous	33
2.2 Mode-1: Instrumental	34
2.3 Mode-2: Transdisciplinary	38
2.4 Summary	43
Chapter 3 Epistemology	47
3.1 Characteristics of knowledge in the practice of interfaces	47
3.1.1 <i>Who has knowledge?</i>	49
3.1.2 <i>What is knowledge?</i>	55
3.1.3 <i>Different perspectives on knowledge</i>	57
3.2 The validity of transdisciplinary knowledge	59
3.2.1 <i>Knowledge integration</i>	60
3.2.2 <i>The nature of knowledge creation</i>	62
3.2.3 <i>Knowledge co-creation</i>	63
3.3 Summary	64
Chapter 4 Methodology	67
4.1 Process design	69
4.2 Success factors	74
4.3 Actor involvement	82
4.4 Structuring the problem	88
4.5 Summary	96
Chapter 5 Intransigencies	97
5.1 Pitfalls and bottlenecks	98
5.2 Boundary dynamics	102
5.3 Internal dynamics	106
5.4 Summary	110
Chapter 6 Conclusions	113
6.1 Results	113
6.2 Promoting transdisciplinary research within universities	116
6.3 Recommendations	117
6.4 Concluding remarks	119
References	121
Appendices	131

Foreword

The RMNO has developed into a socially service-oriented expert in the field of methods for bridging the gap between knowledge and policy.

In 2002, *Willingly and Knowingly*, the English version of *Willens en Wetens*, was published, which for the first time combined unstructured problems and boundary work. Two years later, *Rehabilitation for Cassandra* (*Eerherstel voor Cassandra*) appeared in which a new methodology for future research was developed. In 2004, the workbook *Sustainable Development and Future-focused Thinking* (*Duurzame Ontwikkeling en Toekomstdenken*) appeared, after which, in December 2004, a further workbook *Methodology of Boundary Work* (*Methodologie van Grenswerk*) was published. 2007 saw the publication of *Building Bridges*, in which the focus was on interdisciplinarity.

You now have before you the publication on transdisciplinarity: 'Knowledge Co-creation: interplay between science and practice' (*Kennis co-creatie: samenspel tussen wetenschap en praktijk*). The authors quite rightly adopt the viewpoint that this does not constitute an independent scientific revolution, but a process on the bridge between knowledge and policy. Learning processes which will promote a mature encounter with social complexity form the core of transdisciplinary activities. These processes represent a learning environment for both scientists and policy-makers, and demand interactivity, communication and a common striving for robustness from all parties involved.

The authors have produced an accessible book in which there is much to enjoy and a great deal to learn. For all those who are required to apply their extensive knowledge in solving complex social issues, I believe this book is an essential tool which will contribute significantly to the success of their work. For every researcher who is striving for relevance, it is a must.

I wish you much pleasure in reading this publication.

Roel in 't Veld
Chairman RMNO

Summary

In the 21st century we are confronted with complex persistent problems, that are not easy to resolve. As RMNO (the Dutch advisory council for research on spatial planning, nature and the environment) has been emphasising for some time, unstructured problems require a common learning process between different social actors. Specialist knowledge, professionals and professional practices impede a solution-oriented approach to problems. The complexity of present-day society requires a different approach to societal problems.

From all kinds of societal domains, attempts are being made to develop 'approaches and methodologies' which are better suited to today's problems. The Athena Institute, for example, has years of experience in combining the knowledge and experience of different societal actors at an early stage in shared learning and knowledge development processes. More and more scientists are applying multi-, inter- and transdisciplinary research to respond to the complexity of current issues, while policy-makers are involved in developing a new role for government by means of interactive policy-making or partnerships. In business too greater attention is being paid to the effects of production processes on man and the environment, and stakeholder relations are becoming increasingly important. The need for meaningful and practically oriented interactions is felt by all parties. At the same time, we see that 'integral', 'participative' or 'interactive' projects in reality often differ less from the regular practices than was intended. Two questions are therefore at the heart of this publication: What are the characteristics of new approaches to unstructured problems? And, how can we understand the problems of intransigence which are apparent in the practical application of these new approaches?

An important restriction which we have applied here is to describe the approaches to unstructured problems as they are formulated from the perspective of science (in particular in the area of transdisciplinary or mode-2 research) and thus not from policy, business, social organisations and all variations in between. This publication has been written in response to requests to clarify the method of transdisciplinary research for those who want to work with it. The term transdisciplinary research is derived from the substantive and organisational structure of universities, and this term is less meaningful for other organisations. However, the core of transdisciplinary research is co-operation between different organisations, and this means not only the traditional knowledge institutions but also citizens, employees in industry, the government, etc. Of course, knowledge generation at universities is very different from that in

	Relationship between science and practice	Presumed role of scientific knowledge (development)	Type of knowledge
Mode-0	SEPARATE Science and society are separate from one another.	AUTONOMOUS More scientific knowledge leads to more progress.	Monodisciplinary knowledge. Emphasis on sciences.
Mode-1	CO-OPERATION Co-operation between science and society. No change in working methods of either.	INSTRUMENTAL Development of policy-relevant knowledge leads to the resolution of societal problems and stimulates the economy. Harmonization activities.	Mono-, multi- and interdisciplinary knowledge. Natural and social sciences.
Mode-2	CO-PRODUCTION Practice and science both actively seek the best way to structure and manage complex change processes.	TRANSDISCIPLINARY Scientific knowledge (mono-, multi-, and interdisciplinary) is part of the joint solution process AND the process is part of scientific knowledge development.	Mono-, multi- and interdisciplinary knowledge. Also experiential knowledge.

Table 1. The role of scientific knowledge development in mode-0, mode-1 and mode-2.

ministries, within NGOs, in businesslife and among a society's citizens. Nonetheless, within transdisciplinary research, or put more generally mode-2 knowledge production and problem-solving, the different groups come together in a strong interactive oriented process. In this publication we want to clarify this mode-2 way of approaching problems in such a way as to make it relevant for those involved in and affected by these processes. We also include quotes of eight individuals involved in government, business and societal organisations. How do they shape complex co-operation processes? What is the meaning of knowledge co-creation in their working practices?

The role of scientific knowledge development

In this publication, we explore the basic characteristics of mode-2 research by comparing it to two other possible perspectives on knowledge develop-

ment: mode-0, in which science and practice are separate from one another, and scientific knowledge development is considered an autonomous process; and mode-1 where efforts are made to coordinate science and society, but the actual practice of science is not essentially altered. Mode-2 or transdisciplinary knowledge development involves intensive co-operation between science and society. We use the terms mode-0, -1 and -2 to indicate three ideal typical relationships between science and society. Whether the relationship is considered separate, connected or interactive will have consequences for the nature of the knowledge which will be developed and the methodology which is suited to this type of knowledge development. Moreover, the terminology is used for changes in knowledge production and changes in the approach to problems. In actual practice, no situation will fit the ideal typical description of mode-0, mode-1 or mode-2. The three perspectives can be useful in clarifying new forms of knowledge production for approaching unstructured problems.

In mode-0, scientific knowledge development is considered an autonomous process in relation to other societal processes. The assumption with regard to the role of scientific knowledge in the relation between science and society is that scientific progress also engenders societal and economic progress. How scientific knowledge is used in the societal domain is the responsibility of social actors. Scientists are only responsible for the production of objective, true knowledge and are inspired by the physical reality for the subjects of their research. This perspective is rooted in realism: it is possible to develop universal knowledge and to know truth. The scientific method is focused on revealing this truth about the physical reality. Different aspects of the physical reality are studied from different scientific disciplines. The emphasis is on monodisciplinary development and specialisation of natural sciences in particular.

Mode-1 is characterised by a simultaneous movement toward more specialisation and compartmentalisation, and more coordination, co-operation and interaction between the main institutions (actors) involved in knowledge acquisition and problem-handling. The institutions do not interfere with each other's method of working. The responsibility for knowledge acquisition lies primarily with knowledge institutions, and the responsibility for how to approach societal problems lies mainly with government and industry. The processes of knowledge acquisition and problem-solving are as such institutionally and methodologically separate from one another. There is, for example, no intensive knowledge integration between science and society: societal actors do not get involved in the design of scientific research, and scientists have little concern for the eventual use of the scientific knowledge in practice. The presumed role

of scientific knowledge development in mode-1 is that it is instrumental in resolving societal problems and stimulating the economy. To realise this, coordination activities are developed which set the direction of scientific knowledge development, for example, by giving financial incentives to particular research directions, but which do not influence the design and execution of scientific research. Objective and context-independent knowledge has to be translated into societal practice; it has to be made suitable for application. Knowledge of the humanities is also important here. Monodisciplinary knowledge is not always the most suitable for application in societal problem contexts: multi- and interdisciplinary knowledge development often leads to new innovations and societal applications.

In mode-2, there is no longer any clear distinction between knowledge development and problem-resolution, and the main responsibility for solving unstructured problems does not (therefore) lie unequivocally with one of the domains concerned. Both the scientific and societal domains are actively seeking the best way of structuring and managing change processes. Co-production corresponds with the idea that not only is scientific knowledge relevant for the resolution of persistent societal problems, but that social knowledge or experiential knowledge is also important. The different perspectives on the issue come together in a learning process, whereby in the course of the interaction implicit knowledge is made explicit, and new knowledge is construed, shared and tested. The participation of scientists in the process means that scientific knowledge is introduced, and the process contributes simultaneously to the development of new knowledge. Depending on the societal issue in question, mono-, multi-, interdisciplinary or experiential knowledge will to a greater or lesser extent be introduced and created. In this kind of process, 'socially robust knowledge' will be generated; this is knowledge which is not only scientifically reliable, but is also accepted and applicable in the social contexts in which the relevant issue occurs. Integration, participation, innovation and long term objectives (e.g. sustainability) are key words in the mode-2 way of problem-solving.

A mode-2 approach

In mode-2, intermediaries endeavour to achieve knowledge integration and commitment between the actors involved in the problem-solving process. How can joint learning processes be structured in which different actors develop new knowledge and solutions through the exchange of implicit and explicit knowledge? In a mode-1 situation coordination activities build bridges between two different worlds, while in mode-2 an environment is

created in which actors create mutual relations and meaning. Mode-1 focuses on seeking solutions for relatively concrete problems according to well-documented methodologies, while in mode-2 the emphasis is on creating the conditions for structuring problems and supporting the search for possible directions for solutions. This implies that no clear action plan or blueprint can be made for mode-2 knowledge development. It is, however, possible to identify a number of crucial elements.

First, the method for a mode-2 approach is related to the perspective on knowledge development and knowledge integration (or knowledge co-creation) in mode-2. This perspective assumes that we acquire knowledge, and ascribe meaning to this knowledge, through participation in societal practices, or Communities of Practice. According to Wenger (1998), a Community of Practice is characterized by the mutual commitment of the participants (instead of the formal structure of a project team), by sharing a common goal which is determined by all the participants together, and finally by a shared repertory of resources which become available in due course to ascribe meaning (or to create knowledge), such as routines, words, instruments, working methods, stories, symbols and gestures. Knowledge development is then a communicative process that takes place within a shared practice. Moreover, knowledge, communication and behaviour are inseparably linked; they create one another. From this perspective, knowledge cannot be seen as separate from practice or context, but rather is acquired or gains meaning within a shared practice, a Community of Practice. This knowledge creation process is at the same time the process through which knowledge is safeguarded – the intensive involvement of relevant actors in the process of knowledge co-creation ensures that ‘extended peer review’ takes place at the same time.

Second, a mode-2 approach focuses not only on the content, but also on the process and the different networks of which the participants and the project form a part. Mode-2 interventions thus focus on creating conditions at different levels: in addition to the acquisition of relevant competences by individuals, methodological principles at project level, conditions in the institutional context and correlation with the wider societal context are all essential ingredients for the intended changes. Applying carefully selected instruments does not work if the necessary competences and personalities are not present among the participants. And a ‘successful’ project that is separated from the context(s) in which it is implemented will be isolated and will not be understood, it will be unsuccessful and will not be replicated. So, efforts are made at the same time (or alternately) to develop a creative and innovative process at project level (the development of a new Community of Practice), and to achieve embedding and

support at institutional level (the creation of correlations between the new practice and the already existing practices in the environment of the project).

Third, a mode-2 approach is tailor-made and several cycles of observation – reflection – planning – action are undertaken. After observation and reflection, choices for subsequent planning and action steps are made jointly by the actors involved. This cycle is repeated as needed during the course of the project. At some times during the process, greater emphasis on competence development is required, while at other times more attention has to be paid to alignment with the institutional contexts of the participants. Also, the instruments and techniques to be applied have to be modified to take into account the local context and the specific dynamics of the situation.

Fourth, the mode-2 approach is not specifically focused on revealing the already existing viewpoints of the different parties, but on jointly developing, formulating and inquiring as yet unarticulated ideas, value conflicts and uncertainties. In mode-2, actors are not regarded as people who speak on behalf of others or in support of a particular interest, but as individuals who speak from their own knowledge and experience. The problem is defined and articulated in its own context and not from existing perceptions as already framed by the policy field, a special interest group or a discipline. Moreover, during the process, while solutions are being sought, the situation is regularly analysed, in a cyclical process.

Developing a mode-2 approach is, in short, an interactive and iterative process in which the intermediary continually makes assessments about the interventions and instruments to be applied. The objective of mode-2 methodologies is to bring people together productively and to create change within the research process. Methods in transdisciplinary research are almost always applied to achieve several goals simultaneously. It is the use of a combination of methods which constitutes a mode-2 project; the individual instruments are also applied in mode-1. The use of a combination of methods (triangulation) has the explicit aim of evaluating the knowledge acquired from different perspectives, thereby making it robust. The application of particular instruments or methods cannot then be standardised; the instruments have to be tailored precisely to the case in hand, where-by mode-2 principles are key to the considerations. In every situation, particular events can occur and other things can go wrong. Sometimes it is possible to progress quickly, sometimes it takes longer and sometimes the whole process has to be adjusted.

Internal and boundary dynamics

Since mode-2 processes focus on unstructured, societal problems, they cannot be implemented in isolation from specific contexts. A mode-2 project intermediary in addition to dealing with internal dynamics (that is the project team and the process design) has to deal with boundary dynamics (the participants involved, their institutional settings and the wider context). The intermediary and participants are faced with a challenge both as regards to the internal dynamics and the boundary dynamics. In the practice of present-day Western society, which cannot be definitively described as mode-1 or mode-2, friction between mode-1 and mode-2 is inherent. Mode-1 institutions and working methods are suitable for many problems. However, this methodology constitutes a challenge for the approach to unstructured problems. If one wants to address an unstructured problem, and to carry out transdisciplinary research, one will encounter difficulties with mode-1 institutions, rules, working methods and assumptions which are not congruent with the mode-2 approach. In practice, there is a high degree of resistance to change. Tensions will arise both in the boundary dynamics (for example, a mode-2 project in a mode-1 environment, or with mode-1 participants) and in the internal dynamics (for example, mode-2 intentions and mode-1 implementation). Such tensions can therefore be expected; they are almost unavoidable. Handling these differences is an integral part of the aims, tasks and skills of a mode-2 working method, project leader or participant.

The typology of mode-0, mode-1 and mode-2 can thus be helpful in recognising and articulating the pitfalls and intransigences which arise from tensions between the transdisciplinary project on the one hand and the different participants, institutional settings and the broader context on the other hand. Recognising that there is tension between mode-1 and mode-2 can raise the question of whether and how the two practices can be brought into alignment. Each participant in the mode-2 project has to deal with his or her institutional context which may or may not be congruent with the objectives and working method of the project. What 'task' or 'message' do people bring with them from their home organisation to the transdisciplinary research process? And conversely, how can participants legitimise their participation in such a project within their home organisation? Participants in mode-2 projects therefore have to make additional efforts to create alignment with their own 'bosses': in the case of scientists, this may, for example, be their own scientific culture. A condition of a successful mode-2 project therefore is that the intermediary who facilitates the transdisciplinary research should ensure that there is room and attention for this boundary work by participants.

Summary

For example, participants should be trained to act bi-culturally so that they can translate the mode-2 working method into the culture of their home organisations. In addition, in some situations, boundary objects can be created which have significance in two different cultures, or Communities of Practice. In other cases, a particular context is temporarily avoided because the chance of alignment between this context and the ambitions of the project are considered to be small. Also the building up of a network is crucial for the success of the mode-2 research process. A network of different actors at regime level can ensure balance and adequate support and resources to keep the project going and to ensure implementation.

In order to prevent pitfalls, it is necessary to be able to recognise them. For instance, sometimes the intermediary has mode-2 intentions but gives the transdisciplinary research a mode-1 interpretation. A way of recognising this is by explicitly organising reflection on the project, for example, by allowing a researcher to take part in the process and to reflect on it. Even when the process is supervised by a professional, experienced intermediary, reflection is essential. In some cases an interdisciplinary research team gives coaching, training and advice, as well as reflection and feedback via monitoring, to the mode-2 intermediary.

Recommendations

The following recommendations are made in conclusion of ‘Knowledge co-creation; interaction between science and society’.

Intermediaries who supervise mode-2 knowledge development:

Opt for a transdisciplinary approach if the problem to be addressed is unstructured. An unstructured problem is one that acts on several system levels, with different societal actors, and where there is no consensus about the problem definition or the most suitable direction for a solution.

At the start of a transdisciplinary research process, establish a number of principles which are suitable for the intended mode-2 nature of the process, using the following questions:

Internal dynamics

- How should we organise interactions between science and society?
How can we encourage the development of a set of shared visions, expectations, language and practices?
- How do we support open communication between participants and the development of mutual trust?

- How can we ensure a flexible process design, so that the process can be adapted to changing circumstances? What mechanisms can be built into the process to promote this?
- How can we make sure problem perceptions do not become fixed at too early a stage, and that people do not ‘jump to solutions’? What tools can be used for articulating a shared problem definition?
- Who should be involved in the process, on what basis and in what capacity?

Boundary dynamics

- What modus conflicts between project ambitions and environment can we already anticipate? What alignment strategies should we apply?
- How should we organise interactions between processes of knowledge co-creation, the development of support and implementation?
- How can we support the participants as they handle modus conflicts between the project and their home organisations?

Organise monitoring and reflection on the whole process, whereby the shared mode-2 principles are key.

Recommendations for science policy

Stimulate exchange of experiences in the area of mode-2 processes. What can we learn from international programmes such as the Swiss transdisciplinary network? And what can transdisciplinary researchers, interactive policy-makers and transition managers learn from one another?

Promote monitoring of and reflection on current transition programmes that act as intermediaries in making connections between science and society and creating new meaning to stimulate change. How do they interpret a mode-2 approach of knowledge co-creation and what can we learn from this? And how can the knowledge co-creation approach of these transition programmes be improved?

Encourage competence development whereby professionals are trained to fulfil and study the role of intermediaries in mode-2 research. Besides techniques, this is about sensitivity and experience. At universities, it is important that in master’s programmes, students not only acquire knowledge and skills in their specialist areas, but are also offered competences in the area of mode-2 research, thinking and acting.

Chapter 1 Introduction

1.1 APPEALS FOR A DIFFERENT WAY OF KNOWLEDGE DEVELOPMENT

The past century has seen a noticeable increase in prosperity in Western industrialised countries. Gross National Products are higher than ever, many diseases have been eliminated, life expectancies have risen, many technological advances have been developed to automate production processes which previously required heavy physical labour, opportunities to travel the world and to communicate with others have increased, etc. At the same time, in the 21st century we are confronted with persistent problems: environmental problems as a result of industrialisation, problems of food safety in the food chain, waiting lists in health care, etc. These problems are by no means easy to resolve. In the previous century we tried – successfully – to make progress by means of the specialisation of knowledge production (and the segmentation of society). Now we realise that specialised knowledge, professionals and professional practices provide insufficient means for a solution-oriented problem approach. From the perspective of a persistent societal problem, ‘specialised’ too readily means ‘fragmented’. As was argued in ‘Willingly and knowingly’ (In ‘t Veld 2000), the idea that ‘independent science’ can provide a more or less objective truth in these projects with regard to the best solution does not hold true. An interactive relationship between researchers from different disciplines and policy-makers is therefore proposed, "by working together on the structuring of the problem definition after which a shared knowledge basis (‘shared reality’) can be achieved". (In ‘t Veld 2000: 154). The complexity of society today, in which the classic distinction between science and policy (In ‘t Veld 2000: 147) or between science and society can no longer be taken for granted, demands a different approach for complex societal problems and a different role for scientific knowledge development within this approach.

Definition

"Transdisciplinarity is a new form of learning and problem-solving involving co-operation between different parts of society and science in order to meet complex challenges of society. Transdisciplinary research starts from tangible, real-world problems. Solutions are devised in collaboration with multiple stakeholders."

(Klein 2001: 7)

In recent years, appeals have been made from different scientific fields for a different form of scientific knowledge development, in which the perspectives of different actors are integrated in the identification, formulation and resolution of problems. The Athena Institute, for example, has years of experience in linking the knowledge and experience of different societal actors at an early stage in joint learning and knowledge develop-

**Roel in 't Veld
(Policy Adviser): "What
is important in other
than strictly scientific
issues is that perspectives
for action are created.
I talk in the plural because
there are often different
actors involved with
diverse theories of
action, diverse ratio-
nalities and thus
diverse assumptions
about what the
truth or reality
is."**

1

ment processes (Bunders 1990, Bunders and Broerse 1991, Bunders et al. 1996).¹ Transdisciplinarity as defined in the quotation in the box is a typical example of an argument for a different approach to the complex challenges of the 21st century. Transdisciplinary research is rooted in the 1970s but, particularly in recent years, it has been cited as a method for practically-oriented and solution-focused knowledge creation in heterogeneous collaborations.

Gibbons et al. (1994) describe transdisciplinary research as part of a different modus of knowledge production: mode-2 science and Jasanoff (2004) uses the term co-production to reflect the reciprocal relations between science and society.

Whatever name we give to this other method of knowledge production, over the whole course of the project there should be – much more than is currently the case – ‘co-development’ of processes in society, science and technology. Nobody can be aware of all aspects of unstructured problems. "At present, there are no longer complete experts." (Bunders 1992: 10) The approach proposed induces new relations between the actors and thereby attempts to structure developments in science and technology in favourable directions.

There are an increasing number of appeals for knowledge being developed in such a way that it better complements present-day problems, or is even integrated into the solution process.¹ In *‘Eerherstel voor Cassandra’* [*Rehabilitation for Cassandra*] the authors call for a different type of future studies whereby dissimilar types of knowledge about the future are linked with one another and alignment with the behavioural logic of the actors is sought (In 't Veld 2001). The assumption is that with these types of problems many different perspectives are possible, which all define and structure the problem in different ways; the view that one has of the problem and the knowledge which is relevant for it, will be different for the various actors involved.²

For unstructured problems (according to Hisschemöller et al. 1996), a learning process has to be organised in which the

**André van der
Zande (Permanent
Secretary Ministry of
Agriculture, Nature and Food
Quality (LNV)): "In LNV we asked
a large number of farmers to work
with us on so-called 'manure project'
field figures. This has everything to do
with transdisciplinarity because the
information and research results from
reputable research institutes, the normal
science, were decreasingly being regarded
as valid and legitimate by politics and
target groups. We therefore experimented in
knowledge circles together with 150 farm-
ers with establishing field figures for the
MINAS standards. This has led to very
surprising breakthroughs and insights."**

2

different actors participate. In this publication we discuss unstructured problems; the many uncertainties that surround major and persistent problems have led to arguments for a different, mode-2 approach. Moreover, it goes further than simply stating such appeals: experiments are also done with these new interactive, participative and integral methods of knowledge development, such as ‘integral design’, ‘constructive/interactive technology assessment’, ‘socio-technical scenarios’, ‘participatory integrated assessment’ and ‘participatory/interactive learning and action’. At present, many organisations lack the necessary individual competences and institutional conditions necessary to handle unstructured social issues structurally and systematically.³ We also see that projects which are implemented with the intention of co-production or transdisciplinarity often differ less from the standard working methods than was anticipated.⁴ The present traditional disciplinary culture at universities constitutes a significant barrier for a truly fruitful ‘co-development’ between different fields of science and different practices. To gain an insight into these new forms of knowledge production, the following questions seem to emerge:

Frans Evers (Council Member RMNO): "I really agree with the idea of development planning; of government, market and societal organisations achieving this together, three actors, side by side, enhancing one another, starting from their own strong point. But what I see in practice is that this is terribly difficult, and that civil servants in particular have the greatest possible difficulty in achieving what the Cabinet and the Lower House have formulated."

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Annette de Vries (Real Prosperity Foundation):

"I was at a meeting about learning for sustainable development. There was almost a conflict with a couple of people who are involved with riverbank landscapes. They want to get other people involved with the intention of co-production, but they actually go into the neighbourhood and say: 'Now look here, this is how it has to be done; do you want to help us?' They formulate a question about it, but they already think they know what it should look like and cannot or will not bring it up for discussion."

- What does this new form of knowledge production mean for our understanding of knowledge? What are the epistemological principles of mode-2 knowledge production?
- What are the characteristics of new approaches to knowledge production? What does a methodology of mode-2 science look like?
- How can we identify intransigencies which will become apparent in the practice of these new approaches? Can we offer some tools for handling these intransigencies?

‘Knowledge co-creation: interaction between science and society’ has been written in response to the request to clarify the method of transdisciplinary research for those who want to work with it. The term transdisciplinary research derives from the substantive and organisational structure of universities and this term has less relevance to other organisations. The key to trans-

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Marga Kool (Water Board): "In the Netherlands, we have a problem with waste water. Do we first transport it all to the waste purification plant and then remove the impurities? Of course, this is very expensive. So we then wondered whether it might not be better to separate it at the source. As a Water Authority, we have commissioned an investigation into whether we could separate urine from faeces in the toilet, because urine contains 80 per cent harmful substances from medicines, namely hormones. Industry is involved in this research because you have to know what kind of toilet bowls you need. Additionally, residents are involved because you have to be sure people are willing to have such an item in their homes. The Water Authority and STOWA are involved because you have to know what the purification will achieve. And you also have to have contact with other scientists because you need to know what can be separated at source, what substances can be extracted with what techniques, and what can you do with them? It is all very complex."

disciplinary research is, however, that there is co-operation not only from the traditional knowledge institutes such as universities, but also from citizens, employees of businesses, the government, etc.⁵ For these organisations, it will be of prime importance that an attempt is made to make a contribution to solving an unstructured problem and the term transdisciplinary research will have little significance. Of course, knowledge production within universities is very different from that within ministries, NGOs, businesses and citizens within society. Nonetheless, the various groups come together within transdisciplinary research or, put more specifically, in mode-2 knowledge production and problem approaches in a strongly interaction-oriented process. In this publication, we attempt to clarify this mode-2 working method, and in so doing to help those involved in and affected by these processes. For this purpose, we introduce below a conceptual framework which distinguishes between mode-0, mode-1 and mode-2. This framework forms the key for exploring the above-mentioned questions in this publication.

1.2 CONCEPTUAL FRAMEWORK

With calls for new approaches (such as transdisciplinarity) to unstructured problems, attention is often drawn to changes in our societal structure from a hierarchically organised, industrial society, to a society in which segmentation and compartmentalisation should make way for interaction and new combinations across professional disciplines.

We propose to use the concept 'mode-2' in this publication both for the assumed relationship between science and society and for the characteristics of knowledge production and the approach to problems.ⁱⁱ

	Relationship science - society
Mode-0	SEPARATE Scientific knowledge development and society are (relatively) separate from one another. It is unclear whether they have any significance for one another.
Mode-1	CO-OPERATION Co-operation between science and society. No change in the modus operandi of both actors. Society does not interfere in the structure of scientific research and researchers do not interfere in the use of scientific knowledge.
Mode-2	CO-PRODUCTION Science and society are both actively seeking the best way of structuring and guiding complex change processes. Their responsibilities differ, but their modi operandi are starting to become similar. Not only is scientific knowledge considered relevant, but also experiential knowledge.

Table 1.1 (Free according to Vasbinder in Fonk 2002)

The table above indicates a framework of different perspectives in the relation between science and society, which we indicate with mode-0, mode-1 and mode-2.ⁱⁱⁱ In this publication we intend to further develop the characteristics of mode-2 strategies in particular. We assume that the concept of mode-2 has less specific connotations than other terms, so that we can give a (new) interpretation of the different aspects of mode-2 knowledge development. For the purposes of clarification, we will first explain these three concepts with regard to different views on the relationship between science and society.

In mode-0, knowledge acquisition and the resolution of societal problems are two separate worlds; science and society are completely separate from one another in mode-0. Hoppe and Huijs (who do not use the same terminology) describe this as a kind of 'Enlightenment Model' whereby the primacy for knowledge development lies with scientists, without a specific request from society. The assumption is that new knowledge automatically seeps through to different social domains. "Science, like a kind of anonymous well-wisher, sends all kinds of interesting ideas in the direction of politics and policy, but scarcely bothers whether these ideas reach the intended destination or whether they are used there." (Hoppe and Huijs 2003: 14)

Externally financed research has increased three-fold in the last 15 years and scientists and research institutes are increasingly financially dependent on clients. The KNAW (Royal Netherlands Academy of Arts and Sciences) is therefore preparing an advisory document on a 'declaration of scientific independence.'

Newsletter ScienceGuide, 2005

We can recognise this image in recurrent calls for the independence of science (see previous page) and in the assumption that the role of scientific information officers is to be the messengers of these interesting ideas and new knowledge. Mode-o is therefore characterised by the autonomy of the three most influential institutions with regard to methods for knowledge acquisition and problem-solving. Each one focuses on its own demarcated functions. There is little exchange and there are hardly any other actors who (explicitly) play a role.

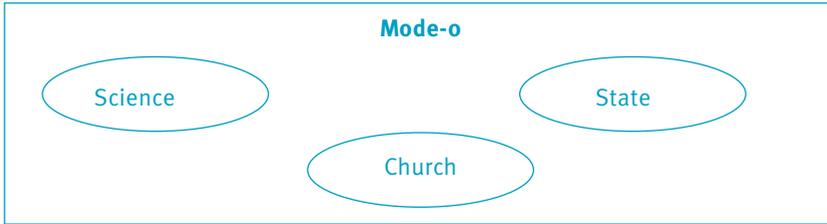


Figure 1.1 Relationships in mode-o

Frans Evers (Member of RMNO) "I recognise in this publication the policy life cycle of Winsemius. I recall that at that time I had long discussions with my departmental colleagues about steering research from the perspective of environmental policy. The discussions were about whether you should influence research in each of the four phases to the same extent. I remember very well that the more scientifically oriented were most interested in assignment formulation for phase 1, in which, according to the policy life cycle, the issue is still elusive for policy. Of course, that is the phase in which we should give the scientists maximum exemption. The second phase is the phase of increasing political attention, increasing controversies and increasing societal concern for problems; the phase in which maximum output control from policy to research is needed."

Mode-1 is characterised by a simultaneous movement to more specialisation and compartmentalisation and more coordination, co-operation and interaction between the four main institutions (actors) who are involved in knowledge acquisition and problem solving. The four institutions do not interfere with one another's *raison d'être* or *modus operandi*. The primacy for knowledge acquisition lies largely with knowledge institutions, while the primacy for societal problems lies largely with the government.⁶ The processes of knowledge acquisition and problem-solving are as such institutionally and methodologically separated from one another.⁷ There is, then, no complete knowledge integration between science and society: the

societal actors scarcely interfere in the structure of the scientific research and the scientists hardly pay any attention to the eventual use of the scientific knowledge in practice. At the same time, they are connected with one another through new processes or institutions, such as in the case of the sector councils that broker and switch between the different worlds of policy, research, social interests, businesses and different disciplines in different sectors with which they are connected.^{iv} (<http://www.toekomstverkennen.nl/english/index.html>)

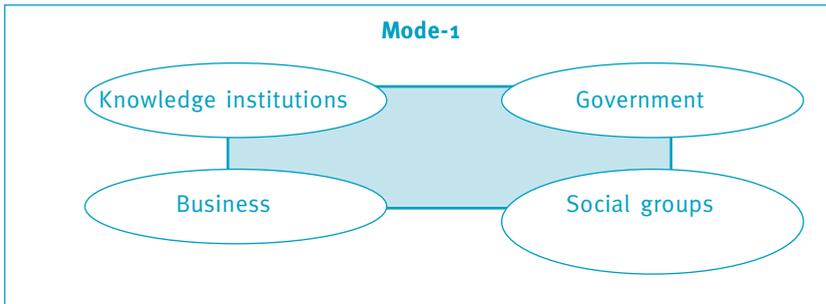


Figure 1.2 Relationships in mode-1

In recent decades scholars have sketched the contours of changes in our Western society, in which old institutional borders between science, industry and government have been overridden. (See, for example, Nowotny et al. 2001, Jasanoff 2004, who specifically describe these changes with respect to the nature of science and technology). So, in science we see

that knowledge production currently takes place not only in traditional knowledge institutions such as universities and

research institutions, but also in consultancies, government laboratories, thinktanks, NGOs, etc. (See Gibbons et al. 1994). In addition, the visible negative effects of science and technology

and public scientific controversies lead to an erosion of the knowledge monopoly of science. Both citizens and NGOs react to this by organising (scientific) knowledge acquisition themselves, either by building up expertise themselves or by introducing counter-expertise.

Scientific controversies also bring to light the fact that other actors contribute equally relevant practical knowledge (and sometimes scientific knowledge as well) which can contribute to the resolution of problems. In the underlying knowledge-philosophical area, we see a shift from an

Gertjan Fonk (Project Leader, Innovation Network): "On the DTO project Novel Protein Food it was apparent how separate the worlds of product developers and consumers are. You expect the professionals to be knowledgeable about their consumers and the expectations and trends for the future. Marketing people do have the knowledge; they are used to working with the consumers in mind. But the R&D people told us: 'You tell us, you know what the consumers want, don't you?' "

epistemology of realism to an epistemology of constructivism; the idea that knowledge is objective and technology brings progress in competition with the idea that borders between nature and culture and between facts and values are socially constructed. Thus, two destabilising changes are taking place simultaneously in the way in which we regard the world: a cognitive one and a political one (see also Jasanoff 2005: 13).

We indicate all these notions in this publication with the prefix ‘mode-2’: so we are talking about mode-2 knowledge production, mode-2 methodology, mode-2 epistemology, etc. All these are consistent with the idea of an intrinsic interwovenness or co-evolution of science and society. This interwovenness implies that the focus on differences, lines of separation and demarcation should be supplemented with attention to interaction, contextualisation and co-evolution. A strategy for approaching unstructured problems in this manner is one based on a de facto interweaving of domains. Knowledge development and problem-solving are not clearly distinguishable from each other and the primacy for solving unstructured problems does not therefore lie clearly with one of the domains.⁸ Both practice and research groups are actively seeking the best way of interpreting and managing the change processes. This notion of co-production fits with the idea that it is not only scientific knowledge that is relevant for the resolution of unstructured, social problems but also social or experiential knowledge. The mode-2 approach therefore also implies a different vision of (relevant) knowledge and knowledge integration. In mode-2, the demarcations between the different actors are much less clear; actors merge and are closely interwoven in a network. Responsibilities differ, but the modus operandi of different actors and their institutions start to look very alike. A statement by a project director of one of the BSIK programmes^V, that his organisation is

Annette de Vries (Real Prosperity Foundation):

8

"Depending on the subject, we bring different people together who really want to do something – actors who normally would not come together. In this way a problem acquires new meanings, leading to unexpected solutions. One such case was the litter issue, which in a meeting with Unilever and the Police Federation quickly became broadened to the theme of "city degeneration". We designed the project 'Wenswijk' [area of wishes] to experiment with a positive approach. The police encouraged local co-operation aimed at the realisation of wishes concerning livability and Unilever persuaded 'problem owner' Nederland Schoon to supplement the traditional information campaign with the 'empowerment-project'".

9 Jeroen Bordewijk (Senior Vice President Supply Chain Excellence, Unilever): "In the agrarian raw materials chain we try to develop other concepts in which aspects of sustainability are considered. Our challenge is how to ensure a very different kind of system, in which principles of both sustainability and market forces go hand in hand. We do projects in which technical solutions emerge, as well as value chain adaptations. However, changes in environmental legislation are also necessary."

not just a financier, but an active 'partner in crime' is a striking example of this. In mode-2, the contacts between actors are many and informal, with many intermediaries (knowledge brokers) actively attempting to create knowledge integration and commitment for a problem solving process. This can even lead to new institutional arrangements.⁹ Integration, participation, innovation and long term objectives (sustainability) are key words in the mode-2 approach to problems.

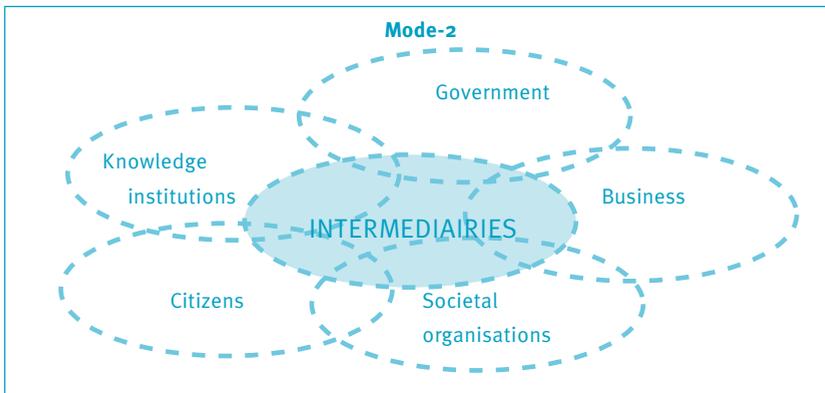


Figure 1.3 Relationships in mode-2

1.3 FROM ANALYSIS TO APPEAL

Although the mode-1 approach has proven its success, and to date is the predominant norm towards methods of knowledge processing and problem solving, and for the relationship between science and society, it is clear that mode-1 has reached its limits. Years of effort spent applying the mode-1 approach have not been able to resolve persistent environmental problems. In addition, the mode-1 approach has not been able to prevent the lack of coordination between knowledge production and societal issues such as, for example, in the controversy surrounding genetically modified food products. Other forms of knowledge production are therefore being proposed.

An important consequence of a mode-2 perspective on our society is that the distinction between (scientific) knowledge production and the approach to unstructured problems is difficult to make. We also see that accounts of changes in knowledge production and societal relations are at the same time descriptive and prescriptive. Thus, Nowotny et al. (2001) not only describe the changes in the production of knowledge, they also argue in favour of a new contract between science and society in which socially robust knowledge is developed in heterogeneous partnerships. Funtowitz and Ravetz (1993) also describe the development of ‘post normal science’ and they propose involving the expertise of several stakeholders in unstructured problems. We can find points of contact for a different approach to knowledge production with the authors mentioned. Characteristics of other forms of knowledge production are indicated in table 1.2:

Main characteristics of a transdisciplinary strategy

- holistic and integral approach
- acknowledgement of complex context and set of actors (scientific and societal)
- orientation on societal perspectives and problem-solving capability in the context of application
- integration of explicit and implicit knowledge from various scientific and non-scientific sources
- direct and personal involvement of relevant stakeholders in participatory processes
- evaluation on the basis of different validation criteria, such as consistency, empirical adequacy, applicability, and contextual adequacy
- dynamic, complex process with iterative feedback loops

Table 1.2 (from Flinterman et al. 2001: 259)

The characteristics in this table relate to several aspects of a transdisciplinary or mode-2 strategy; it is about the approach and nature of knowledge, the epistemology, but also the approach and methodology for approaching unstructured problems. In this publication we will further develop this summary of characteristics. We do this using the typology of relations between science and society outlined in this first chapter (see table 1.1). Not only does this tripartite division provide tools for thinking about the interpretation of new methods of knowledge production (both relating to epistemology and methodology), the thinking about

intransigencies can be better understood from tensions which occur between different modes.

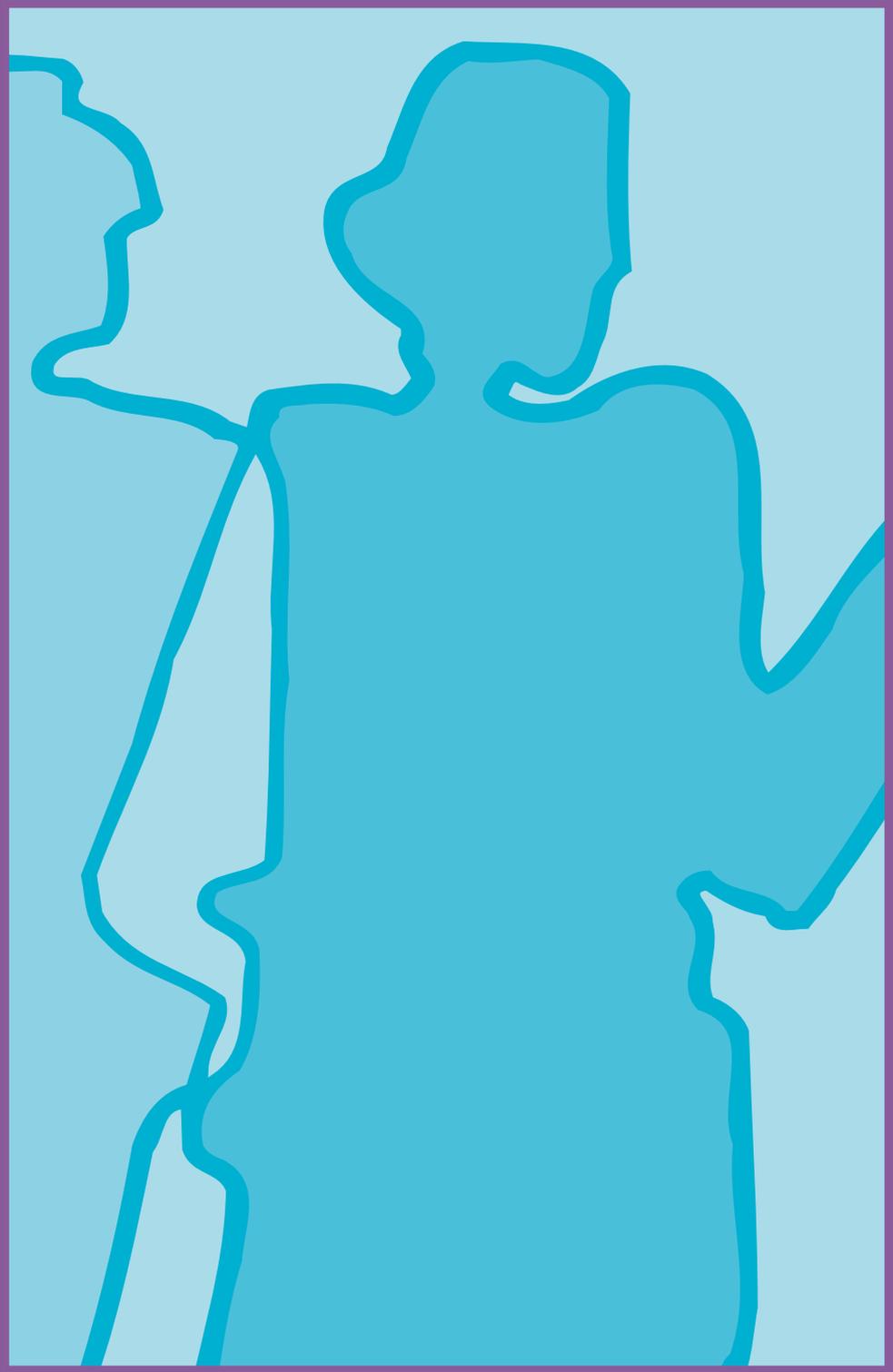
1.4 OBJECTIVE AND STRUCTURE OF THE PUBLICATION

The following chapters are explorations of the epistemological and methodological aspects of the approach to unstructured problems from the perspective of the mode-0, mode-1 and mode-2 relations between science and society outlined in this chapter. At the same time these explorations give us the opportunity to devise a more in-depth interpretation of the characteristics of mode-0, mode-1 and mode-2. It is an interpretative and conceptual exercise using illustrative examples from diverse mode-2 knowledge production projects.

In the light of the above analysis, in this publication, we focus on the questions indicated below:

- What does the co-production of science and society mean for the changing role of scientific knowledge production? (Chapter 2)
- What does this new form of knowledge production mean for our understanding of knowledge? What are the differences in epistemological principles between mode-1 and mode-2 knowledge production? (Chapter 3)
- What different methodological principles can we distinguish in approaching knowledge development for unstructured problems in mode-1 and mode-2? (Chapter 4)
- Can we use the modus typology to indicate intransigencies which become apparent in the practice of these new approaches? Can we offer tools for how to handle these intransigencies? (Chapter 5)

In ‘Knowledge co-creation; interaction between science and society’, we argue that for the implementation of transdisciplinary research it may be helpful to have a number of principles which can form the key themes in considerations and choices. The different epistemological and methodological principles which arise from Chapters 2, 3 and 4, seem in Chapter 5 to be helpful in handling intransigencies. The publication thus provides a way of thinking about shaping mode-2 interfaces between science and society in real-life practice. We hope that we inspire the reader to expand and further develop the range of aspects which play a role in co-production activities; whether these are visions on communication strategies or further developing the competences of scientists and other actors.



Chapter 2 The role of scientific knowledge development

In this chapter we will examine in more depth the assumed role of scientific knowledge production in the three modes. The relation between mono-, multi-, inter- and transdisciplinary research will be addressed. In the previous chapter we saw implicit changes in the assumed role of scientific knowledge development with the approach to various types of problems. Before we take a deeper look at epistemological issues, we will further clarify the role of scientific knowledge in different modes. Does the professed transition described in Chapter 1 from an image of separate societal institutions with divergent role assumptions, to an image of a network of people and institutions with converging aims and working methods mean that scientific knowledge development in mode-2 has lost its significance? Does the proposed strategy, in which the problem is approached holistically and integrally mean that monodisciplinary knowledge development plays no role in mode-2? We will shed light on these questions by looking at the parallels between different perceptions of the relationship between science and society on the one side, and the assumed role of scientific knowledge development on the other.

2.1 MODE-0: AUTONOMOUS

As we saw in Chapter 1, in mode-0 the main societal institutions are considered to operate independently of one another. For scientific knowledge development, this means that it is largely an autonomous process in relation to other societal institutional domains. Scientists do their work in research centres and at universities, after which their findings seep through to society via science popularisation or specialist journals (so-called “knowledge creep”) (Hoppe et al. 2003:13). For their research questions, scientists derive inspiration from physical reality. The epistemological principle on which this is founded is that of realism: it is possible to develop universal knowledge and to know the truth. The scientific method is aimed at revealing this truth about the physical reality. Different

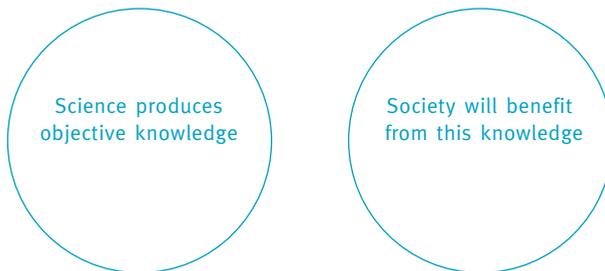


Figure 2.1 The role of scientific knowledge development in mode-0

10 André van der Zande (DG, Ministry of LNV): "We can, of course, opt for what I call the Osterhaus variant; the unspoken scientist, the virologist who simply says how things are and that is the last word on the subject. There is no interaction and no debate about the validity, let alone the legitimacy, of this knowledge. That's applying normal science straightforwardly. Sometimes it works, with fast progress as a result. Moreover, you can then stay within your own field, in your own area, and say: 'We are responsible for policy and science is responsible for science, and then we keep everything in the garden neat and tidy, and all the fences are in place'."

aspects of the physical reality are examined by different scientific disciplines. The emphasis lies on the monodisciplinary development and specialisation of, in particular, natural sciences. The assumption with regard to the role of scientific knowledge in the relationship between science and society is that scientific progress also engenders societal and economic progress. *How* scientific knowledge is used in the societal domain is the responsibility of societal actors. Scientists are only responsible for the production of objective, true knowledge.¹⁰

In summary, scientific knowledge development in mode-0 can be described as the autonomous development (in relation to other societal processes) of monodisciplinary knowledge, as represented in figure 2.1.

2.2 MODE-1: INSTRUMENTAL

In Chapter 1 we characterised mode-1 as a simultaneous specialisation and coordination of different social domains. With regard to the role of scientific knowledge, we see two developments here that can be seen as concrete manifestations of the mode-1 image. On the one hand, the development within scientific knowledge development of monodisciplinary research to multi-, inter- or transdisciplinary research. On the other hand the development within science policy towards better correlation between societal issues and research. We will describe both these developments in more depth.

Bridging the gap between science and society

The so-called 'myth of infinite benefit' (Sarewitz 1996), that is the theory that more science and more technology *automatically* lead to more prosperity and progress, became subject to doubt in the second half of the twentieth century, as the negative consequences of science and technology became apparent. New questions were raised, such as: what sort of knowledge do we as a society need? How can we make choices in terms of knowledge production? And who is responsible for making these choices? How can we translate society's need for knowledge into scientifically relevant questions? These are questions which relate to the directing of science and technology.

Knowledge and technology development, therefore, should be influenced via policy and financing structures, so that the output of science and technology better meets the needs of society. Thus, the strategic research programmes of the 1970s were focused on the contribution of science and technology to societal issues, such as environmental pollution and energy provisions. In the 1980s, research into potentially beneficial new technologies such as ICT, synthetic materials and biotechnology was encouraged (Rip 2005). Other examples for promoting the coordination between science and society are the development of the sector councils (in 1987), the NWO (The Netherlands Organisation for Scientific Research) incentive programmes for policy-oriented, socially relevant research programmes, the BSIK (a scheme to subsidise investments in knowledge infrastructure) investment scheme (formerly ICES-KIS), and the establishment of various knowledge centres and knowledge networks.¹¹ The development of instruments to anticipate the direct consequences and further implications of new technologies, under the common denominator of Technology Assessment (TA), also fits within this context. In the first years of TA (in the 1970s and 1980s), the emphasis was on the objective, scientific analysis of possible subsidiary effects of technology for the benefit of decision-makers^{vi}. In the next section, when we discuss mode-2, we will come back to other forms of TA which were developed in subsequent years.

11
André van der Zande (DG, Ministry of LNV): "The BSIK funds are so important because they are a binding agent. They seduce the practical world and the university community into entering this new kind of working structure. And - something I consider very important - they are grouped around 'burning issues'."

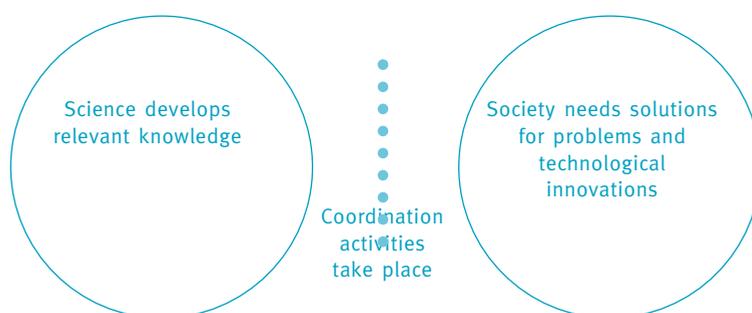


Figure 2.2 The role of scientific knowledge development in mode-1

"There is a growing need for multidisciplinary research. Scientific, social and technological issues have become so complex that they cannot be answered from a single perspective. [...] Only by drawing diverse perspectives together do the contours of societal issues in their complexity emerge."

AWT (Advisory Council of Science and Technology Policy report no. 54, 2003: 11

12

Peter Nijkamp (Chairman NWO): 'Money talks. This has purposely been a reason for us to set funds apart specifically for multi-, inter- and transdisciplinary research initiatives. If we didn't do this, we would have to resolve all these issues within the monodisciplinary areas. From the moment we started allocating funds for this purpose, it had an effect. You can see this with Genomics and with Aids research. A lot of projects become successful because of money and also because people from different disciplines are encouraged through funding initiatives to work together to address concrete questions. The medical sector is part of this, as is the societal sector, the political sector, and so on.'

The assumed role of scientific knowledge development in mode-1 is instrumental in resolving societal problems and stimulating the economy. To promote this, coordination activities are developed in mode-1 which set the direction for scientific knowledge development, for example by stimulating particular research directions financially¹², but which do not influence the structure and implementation of scientific research. Research proposals are assessed in advance on their quality, indeed the societal relevance of research has become an additional assessment criterion for proposals, but they are still rarely evaluated retrospectively (Rip 2005). There is scarcely any interaction between financiers (steering groups, programme commissioners) and researchers during the course of the research, as is apparent from an interim evaluation of the NWO Incentive Programme on Biodiversity (De Wit 2005). So, scientists have a high degree of autonomy in terms of designing and executing their research. At the same time, co-operation between scientists from different disciplines is promoted through financing programmes which actively encourage multi- and inter-disciplinary research, such as, for example, with the Incentive Programme on Biodiversity. Here, too, we see that the scope of co-operation depends on the individual scientists; even in the assessment stage of research proposals there is a lack of any criteria for interdisciplinarity (De Wit 2005).

In its advice regarding the promotion of multidisciplinary research, the AWT stresses its importance, both from the perspective of society, and from the perspective of the scientific world, because, "multidisciplinary research is not just necessary, it is also exciting" (AWT 2003: 14). In the next paragraph we will address the development of multi-, inter- and transdisciplinary research from the viewpoint of the scientific world.

Multi-, inter- and transdisciplinary research

In 1970, the OECD organised an international seminar in Paris on 'Inter-disciplinarity in Universities'. The seminar was a response to the growing awareness that the monodisciplinary nature of scientific education and research was not adequate for the changing needs of science and society. There was a requirement for holistic knowledge about real life and for the

integration of disciplinary knowledge resulting from scientific analysis. Universities should teach disciplinary knowledge in relation to other disciplines and in the context of societal issues. (Apostel et al. 1972: 10) Apostel argued that what was needed was more than research whereby different disciplines work side by side on aspects of the same issue, which he referred to as pluridisciplinarity. (What used to be referred to as pluridisciplinarity is now generally referred to as multidisciplinary.) What was most needed was the combination and integration of methods, concepts and axioms of a group of related disciplines: this was referred to as interdisciplinarity.

A number of participants in the seminar, including Professor Jean Piaget and Andre Lichnerowicz, went further and argued that the development and maturation of (interdisciplinary) science would eventually lead to one general scientific theory of systems and structures. They saw the convergence of all disciplinary knowledge to one united body of knowledge as the end result of the interdisciplinary approach. This higher stage with a shared basis and terminology for all sciences was referred to as transdisciplinarity (Apostel et al. 1970: 284). See table 2.1 below taken from the report of the seminar for a summary of the different gradations in the integration of disciplines.

Definition of Transdisciplinarity I

Pluridisciplinarity:	Juxtaposition of disciplines
Interdisciplinarity:	Integration of concepts, methods and axioms of several disciplines
Transdisciplinarity:	Total integration of concepts, methods and axioms

Table 2.1 Definition of transdisciplinarity (From Apostel et al. 1972: 106)

In subsequent years, the ‘unity of knowledge’ perspective on transdisciplinarity was further developed by other people such as Nicolescu (see insert). A second perspective on transdisciplinarity also originated in this seminar, but only became predominant some years later. In this perspective,

“As the prefix “trans” indicates, transdisciplinarity concerns that which is at once between the disciplines, across the different disciplines, and beyond all disciplines. Its goal is the understanding of the present world, of which one of the imperatives is the unity of knowledge.”

Basarab Nicolescu (2002)

transdisciplinarity was not only about the internal dynamics of science moving towards an overall framework, towards a unity within science, but it was also related to the external aim of science. Erich Jantch argued during the seminar in 1970 that the world is constantly changing and that restructuring the overall system of society, science and nature is necessary in order to safeguard the survival of mankind. (He is referring here to such comparative phenomena as Ulrich Beck mentioned more than ten

years later in 'The Risk Society'). Since this second perspective on transdisciplinarity assumes a far-reaching intertwining of science and society, we will discuss this in depth in the upcoming section on mode-2.

2.3 MODE-2: TRANSDISCIPLINARITY

Thirty years after the OECD seminar in Paris, eight hundred people came together in Zürich for the conference on 'Transdisciplinarity: Joint problem-solving among Science, Technology and Society'. The discussions were not about the unity of knowledge, but about solving persistent, societal problems, such as the world's decreasing energy supplies, shortage of space, transportation, environment, climate-change, all grouped under the common theme of sustainability. The definition which was applied during the conference was thus quite different from the aim established in 1970 ("To establish a common system of axioms for a set of disciplines"), namely: "Transdisciplinarity is a new form of learning and solving problems whereby different parts of science and society co-operate to meet the complex challenges of society." (Klein et al. 2001: 7). With regard to the assumed role of science, two things in particular stand out. First, there is no mention of research, but rather of learning and solving problems, suggesting that the linear innovation model of mode-1 has been laid aside. Knowledge development and problem-solving do not run sequentially. Second, the definition of transdisciplinarity refers to co-operation between science and society, implying that the primacy of science has been abandoned: scientists cannot solve these problems alone,¹³ even if the university education and research systems have developed a co-ordinated set of terms, concepts and aims, as was advocated thirty years earlier (Apostel et al. 1972: 104).

According to the second, newer definition of transdisciplinarity, the primacy for resolving persistent societal problems does not lie with one of the established institutions. Different societal actors, including scientists, search in a joint deliberative process to find solutions to complex problems.¹⁴ The knowledge which scientists contribute to this process complements the knowledge which other participants contribute on the basis of their experience. The different perspectives on the issue are combined in a learning

Marga Kool (Water Board): **"Climate change requires that water authorities store large quantities of water on the land if there is a lot of rainfall. We involve science in this, in the sense that scientists make models for us in which they calculate how much water we can expect in the future with a climate rise of x degrees. Then we have to meet with farmers and nature conservators to see where the water can best be stored. We have to look for locations, the municipality and the land owners have to agree to it, there has to be a claim settlement, and all this has to be included in the sector plan. It is, therefore, a combination of residents, other governmental bodies and scientists, that make a solution possible."**

13

process, whereby in the course of the interaction, implicit knowledge is made explicit and new knowledge is construed, shared and tested. In this kind of process, 'socially robust knowledge' can be generated, which Nowotny et al. (2001) indicate is not only scientifically reliable, but is also accepted and applicable in the societal contexts of the issue at hand.¹⁵

The later initiatives of Technology Assessment can also be seen in the same context. Constructive Technology Assessment (CTA) was developed in the 1980s based on the idea that technology development is not an autonomous process separate from the societal side effects. CTA looks at technology development as a social process, within which choices will continually have to be made about the form and usage of the technology. Because producers and end users of technologies often have completely different assumptions about the desired form and use of a technology, end-users have to be involved in the development process, as do actors who influence regulation, such as government bodies, NGOs, and unions. With this focus on interaction, other TA instruments are developed, under the term Participative Technology Assessment (PTA). PTA stands for a diversity of methods and instruments which promotes better stakeholder and public participation in TA exercises, such

15

André van der Zande
(DG, Ministry of LNV):

"Our slogan is 'working together on policies that work.' This means that at the end of the project, it is noticeable that the manure problem has been resolved. You can probably measure the output relatively easily, but increasingly we want to know what the outcome is. This approach is more effective on a number of societal objectives. But then you have to be prepared to define these societal aims more broadly than just in scientific terms, otherwise the research becomes a goal in itself."

Jeroen Bordewijk
(Senior Vice President Supply

Chain Excellence, Unilever): "When we started to work with sustainable agricultural materials, we first went to Wageningen because we thought that was where all the available knowledge about agriculture and sustainability could be found. But that didn't work because, in my opinion, it was outdated information. It was about models and modeling. From our problem analysis it appeared that there were many different opinions about what the issue was and how we should handle it. So we just decided to get on with it. We organised a conference focusing on our main raw materials, with our own people present and external people from all kinds of different target groups. The question we posed was, can we create a successful approach together? We had no idea beforehand how to do it."

as citizen juries, consensus conferences and focus groups.

Finally, Interactive Technology Assessment (ITA) distinguishes itself from other forms of TA because participants themselves contribute to shaping and completing the exercise; both in terms of process design and choices about content.

16

Frans Evers (Member of RMNO): "Bear in mind that people are all too well aware of the values which they consider important and that an insight into these values is sometimes lacking in scientists. The discussion about Brent Spar was by no means about the danger of oil rigs and storage facilities, but about whether or not you should be allowed to continue to dump these structures in the sea. At that time I myself tried to instigate a discussion about drilling in the Waddenzee. The question of whether gas excavation in the Waddenzee is damaging is completely irrelevant if you agree among yourselves that you should keep your hands off the last bit of 'real nature' in the Netherlands (quote Hans Pont)."

In addition, ITA not only focuses on possible solutions, but also on the underlying values and world views of the different participants, in order to seek overlap or congruence.¹⁶

These prescriptive interpretations of transdisciplinary knowledge development, namely how to develop socially robust knowledge (and which instruments and interfaces can

we develop for it), arise from the much broader descriptive studies of the relationship between science and society. The co-evolution of science and society is emphasised here: scientific and societal developments are mutually dependent processes in which they are each the environment for one another and produce one another. Or, as Sheila Jasanoff (2004: 3) expresses it: "Knowledge and its material embodiments are at once products of social work and constitutive forms of social life." And from the perspective of society: "Society cannot function without knowledge any more than knowledge can exist without appropriate social support." The epistemological principle implied here is that scientific knowledge does not mirror reality. "It, [scientific knowledge], both embeds and is embedded in social practices, identities, normal, conventions, discourse, instruments and institutions – in short the social." Thus, the social and the scientific are two sides of the same coin.

Correspondingly, other authors have proposed that the classical contract between science and society is in need of renewal and that new interfaces have to be developed, described above under the name of transdisciplinarity, and referred to by Arie Rip as 'attempts at reflexive co-evolution' (Rip 2005). Before we deal with this issue in more depth, we would like to emphasise what this means from the perspective of knowledge development. In mode-2, there is a shift of focus from generating scientific knowledge (based on the assumption that this will lead to progress), to resolving unstructured problems through integrated societal and scientific (technological) innovations (Grin 2004). Scientific knowledge development is not separate from the societal demand for solutions, but societal needs

above all are the basis for knowledge development.¹⁷ What this means for involving different disciplines is expressed by the sociologist Fuller as follows:

"Interdisciplinarity presupposes the existence of disciplines that between them carve up reality into distinct domains of inquiry, each governed by laws, which in some combination can be used to provide ever richer understandings of a particular phenomenon [...]"

In contrast, transdisciplinarity presupposes that reality escapes any combination of disciplinary perspectives [...] Thus, in the case of tropical disease, one may adopt either an interdisciplinary approach that brings together specialists from biomedical and environmental science and public health policy or a transdisciplinary approach that treats tropical disease as a domain of scientific inquiry in its own right that requires expertise that is not reducible to a combination of existing disciplinary practices." (Fuller 2001: 1220)

Peter Nijkamp
(Chairman NWO): "What you should not do when addressing issues such as 'transdisciplinarity' is to only talk about it. As a metaphor, love is a verb and so is transdisciplinarity: you just have to do it. You have to have a common concrete case, around which you gather people of various disciplines, on the basis of the case and the problem definition. This is the best way of getting started. Every other approach quickly leads to one discipline gaining the upper hand."

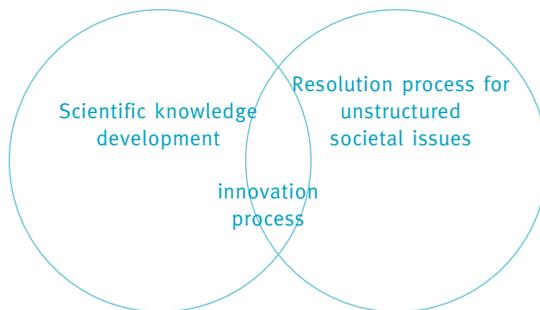


Figure 2.3 The role of scientific knowledge development in mode-2.

Issues are therefore not formulated from the viewpoint of a scientific discipline, and assessed by other researchers ('peer review') using scientific criteria which are relevant within the discipline. In a mode-2 approach, the issues, and therefore the required expertise, are formulated

18

Marga Kool (Water Board): "There are of course many knowledge institutes and universities which have to be kept going and which appeal for funds from governments and organisations. In mode-1, the initiative which a knowledge institute takes is based on its own research. It seems to me that in mode-2 the question of starting a project comes from society. Is that not a considerable difference between the two?"

from the context of the problem.¹⁸ Scientists and other societal actors can generate new knowledge in mutual exchange, which can help to clarify the problem and generate possible solutions. As can be seen in figure 2.3, it is difficult in mode-2 to make a distinction between the process of scientific knowledge development and the process of resolving unstructured societal issues.

Scientific development becomes more like socio-technological innovation. There is no question of ‘knowledge transfer’ or of applying (or making applicable) scientific knowledge in a specific problem context. The knowledge will be generated and assessed during a socio-technological innovation process, by all those involved (‘extended peer review’).

The definition of transdisciplinarity which we can deduce from the different discourses about the relation between science and society is then considerably different from 1970 as shown in table 2.1.

Definition of Transdisciplinarity II

Transdisciplinarity is an umbrella term for all kinds of efforts towards reflexive co-evolution of science, technology and society. It creates interfaces between science and society to address challenges, by generating knowledge and solutions for unstructured problems.

We want to stress here that there are gradations in the interpretation of mode-2 interfaces; some approaches are more focused on developing ‘better’ or ‘more adequate’ knowledge and technology, by involving a number of actors, while other approaches also emphasise the effects which the process has on the actions of actors beyond the exercise. So, at one end of the spectrum we see such initiatives as the more analytical forms of Technology Assessment or Integrated Assessment, which are primarily focused on knowledge and technology development and interactively using the knowledge and insights of relevant actors in order to eventually gain a better picture of the desired situation. At the other end of the spectrum we see initiatives which not only deliver socially more robust analyses of possible developments of science and technology, but which at the same time contribute to a social learning process for the actors involved and

indirectly also for their environment.¹⁹ Analysis here is linked to taking action, as was the case with the action research in the 1970s and we again see with Interactive Technology Assessment (Grin et al. 1998), the Interactive Learning and Action approach (Bunders et al. 1994), the TO3 approach for futures research (In 't Veld 2001) and initiatives in the framework of transition management.

Gertjan Fonk (Project Leader, Innovation Network): "What we do at the Innovation Network, is mainly learning-by-doing. The result of the process has to be: to achieve innovations at system level, which the parties are at least willing to support. Increasingly, we are concerned with how to interpret the process in a scientific way."

19

2.4 SUMMARY

In Chapter 1 we constructed three modes for the relationship between science and society on the basis of dominant discourses relating to the approach to unstructured problems. This tripartite approach has helped to make a number of clarifications regarding the role of scientific knowledge development in relation to societal issues and needs. These clarifications will be summarised in table 2.2 on the next page, where we will devote the right hand column to the type of role played by knowledge (see also Smits in Fonk 2002).

In mode-0, scientific knowledge development is an autonomous process in relation to other societal processes. Scientific knowledge automatically seeps through to society where it leads to more societal progress. The emphasis is on monodisciplinary knowledge development within the field of the natural sciences.

In mode-1, the focus is on consciously making use of scientific knowledge for societal and economic purposes. Objective and context-dependent knowledge has to be translated into societal practice: it has to be made applicable. Knowledge from the field of the social sciences is also important here. Monodisciplinary knowledge is not always the most suitable in societal problem contexts: multi- and interdisciplinary knowledge development often leads to new innovations and societal applications.

Finally, in mode-2 we see the need for developing interfaces that contribute to the reflexivity of society, or 'self-renewal' as Jantsch called it in 1972 (in Apostel et al. 1972). Scientific knowledge development and societal problem-solving processes are difficult to separate. Through the participation of scientists in the process, scientific knowledge is introduced

and at the same time the process contributes to the development of new knowledge.²⁰

Depending on the societal issue, mono-, multi-, inter-disciplinary or experiential knowledge will to a greater or lesser extent be introduced and created. The result of mode-2 research is not objective, real knowledge but context-related, socially robust knowledge.

Jeroen Bordewijk (Senior Vice President Supply Chain Excellence, Unilever): "An interesting question is to what extent specific knowledge questions that come from mode-2 approaches can then be followed up via a mode-1 approach. My experience with Unilever's sustainable agriculture programme is that it was set up along mode-2 lines (not that we knew it at the time!) and in each phase it gave rise to very specific knowledge questions, such as how to make biodiversity plans for specific agricultural areas, how to define soil fertility, etc."

20

Later in this publication we will argue that it can be helpful for the implementation of transdisciplinary research to have a number of key principles for making considerations and choices. The principles for mode-2 research which arise from this chapter are:

	Relationship between science and society	Assumed role of scientific knowledge (development)	Type of knowledge
Mode-0		AUTONOMOUS More scientific knowledge leads to more progress.	Monodisciplinary knowledge. Emphasis on natural sciences.
Mode-1		INSTRUMENTAL The development of policy-relevant knowledge and/or applied knowledge leads to the resolution of societal problems and the stimulation of the economy.	Mono-, multi- and interdisciplinary knowledge. Natural and social sciences.
Mode-2		TRANSDISCIPLINARY Scientific knowledge (mono-, multi-, and interdisciplinary) is part of the shared problem solving process AND the process is part of scientific knowledge development.	Mono-, multi- and interdisciplinary knowledge. Also, experiential knowledge.

Table 2.2 The role of scientific knowledge development in mode-0, mode-1 and mode-2.

MODE-2 PRINCIPLE SCIENTIFIC KNOWLEDGE DEVELOPMENT AND SOCIETAL PROCESSES (SUCH AS PROBLEM-SOLVING PROCESSES FOR UNSTRUCTURED PROBLEMS) EVOLVE TOGETHER.

MODE-2 PRINCIPLE SCIENTIFIC KNOWLEDGE AND EXPERIENTIAL KNOWLEDGE ARE INTEGRATED.

21 **Peter Nijkamp (Chairman NWO):** "What you shouldn't do is to assume that you can throw young research fellows in at the deep end with transdisciplinarity. These people first have to learn to understand their specialist field, which is difficult enough. You have to leave this approach to more senior researchers. Of course, you may from time to time need some help from this younger generation of researchers, but it is extremely difficult. It is an extremely difficult approach with a lot of intellectual effort and so I advocate that people should not be exposed to it too early, because the chance that they will slip is enormous."

As well as differences in assumptions about the stage in their careers when scientists are ready for transdisciplinary research,^{21,22} there is also often confusion about the concept of the 'transdisciplinary researcher'. We can at least identify the following interpretations.

- First, a transdisciplinary researcher can be a scientist who is taking part in a transdisciplinary project. On the basis of this chapter, we would be more likely to call this scientist a mono-, multi- or interdisciplinary scientist, who at the same time takes part in transdisciplinary research and is responsible (in the form of publications) to his own 'home base' with the assessment criteria which apply there;

- Second, there are scientists who have become specialists in the development and facilitating of transdisciplinary research;

- And finally, there are scientists who make the transdisciplinary research process the object of their research, whereby they observe, describe and explain it, whether or not they are taking part in it. In short, they describe very precisely what happens in the transdisciplinary development of knowledge.

22 **André van der Zande (DG, Ministry of LNV):** "When I was studying in Leiden, we already had action research - this was doing research from the outside inwards - on motorways, which we were protesting against. Research was externally oriented. So, in the student phase it all went very well. It only goes wrong - and I really noticed this in my time at Wageningen - when the scientific pecking order comes into play and there is a lack of prizes, reputation and prestige. You see professors, eminent scientists, who have enormous authority in the societal field, who only achieve average scores in scientific citations."

In the light of this last interpretation, in the next chapter we will look at the (implicit) perceptions of knowledge in the practice of transdisciplinary research. In the subsequent chapters, we will pay greater attention to the second interpretation of 'transdisciplinary researcher' by describing the methodological aspects of transdisciplinary research. In all cases, the scientist who participates in the transdisciplinary research plays an important role.

Chapter 3 Epistemology

In the previous chapter we looked at the role of scientific knowledge development from a broad perspective. Transdisciplinarity was defined as an umbrella term for interfaces in which different actors generate socially robust knowledge in meaningful interactions in order to contribute to solving unstructured problems. In this section we leave the broad perspective and look at the practice of actual interfaces. Perceptions about (relevant) knowledge and knowledge bearers are implicitly present in every participative or interactive project. In this section we will use a number of examples to make explicit the way in which knowledge is handled. We hereby aim to gain insight into the differences between mode-0, mode-1 and mode-2 approaches to knowledge, and contribute to developing a mode-2 approach.

We want to emphasise that for this publication the chosen examples have not been subjected to a detailed case study, nor have they been evaluated on mode-0, -1 or -2 characteristics. Rather, these examples are illustrative for many transdisciplinary initiatives, and serve as material from which different aspects of knowledge can be construed. The right-hand column of table 2.2 will be further specified. We therefore offer an interpretation, from a different direction, of different perceptions of knowledge in the different modes ('What is knowledge?', 'Who has knowledge?'). This results in principles (and their characteristics) that can be a guide to developing and implementing a transdisciplinary research project (which will be further explored in the chapter on methodology).

In the second part of this chapter we will address in depth the issues relating to the validity of transdisciplinary research: once more we see a distinction between a mode-1 and a mode-2 perspective which can be helpful with the further development of transdisciplinary research.

3.1 CHARACTERISTICS OF KNOWLEDGE IN INTERFACE PRACTICE

One of the main aspects of knowledge development that we consider in this publication is the claim that an effective strategy must involve different actors from an early stage. Mainly normative arguments are cited to support this: stakeholders are those who will experience the effects of particular decisions and therefore should be involved in the decision-making (according to the definition of the World Bank 1996). At the same time, stakeholders are those who can have an effect on the outcome of the decision-making process and therefore on its successful implementation: a licence to develop goes hand in hand with the early involvement of different stakeholders. Including stakeholders therefore has both an ethical aspect (right) and a pragmatic aspect (support).

In addition to normative arguments, substantive arguments are increasingly being put forward for involving more actors in approaches to unstructured problems. In the sociological study of science and technology since Kuhn's groundbreaking study (1970), the idea that scientists possess knowledge which is more 'true' than that of other parties has come under pressure. This is most apparent in instances of scientific controversies, but also becomes obvious when you look at the many decrees and decisions which are taken daily in a laboratory environment. The image of science as a finder of truth has become a myth (e.g. Latour and Woolgar 1979).

Thus, substantive arguments for involving a number of stakeholders are increasingly used, particularly in the case of unstructured or moderately structured problems.^{vii} For instance, in the field of Integrated Assessment, there is a movement towards 'stakeholder participation in integrated assessment' (see for example Van Asselt et al. 2002). Introducing the viewpoints of stakeholders can provide new, valuable perspectives on the problem, but also new relevant information that is relevant to finding solutions.²³ The definition of stakeholders is extended here from actors with a 'stake' to actors with a 'stake' and 'knowledge'. The Deliberative Mapping trial of the British Committee for Radioactive Waste Management serves as an example of this. We will discuss this example below, with particular respect to the different views on knowledge.

Marga Kool 23
(Water Board): "Participants often contribute knowledge of the area. It has always been common knowledge that the expertise which is needed lies with those in the region, but people don't always want to hear it. And so public servants considered that they themselves had the knowledge, and that they knew better than the inhabitants of the area. People have now become very open to involving the local people through developments such as area-focused policy."

Deliberative Mapping

The British Committee for Radioactive Waste Management (CoRWM) was installed by the British government to assess solutions for the radioactive waste problem. The explicit assignment to the CoRWM was to make public recommendations for the government in 2006 after working with the public and other stakeholder groups.

In the summer of 2004 a 'trial' was conducted of Deliberative Mapping – a method for assessing different options, which has been developed and implemented earlier in the area of organ transplantation. The basic principle of the method is that specialists and citizens go through the *same* assessment process; a characteristic which is praised by its developers as distinguishing it from other participative methods, such as citizen juries and consensus conferences (see Burgess et al. 2004: 66). In short, the process consists of two parallel assessment paths: one consisting of citizens and one of specialists, with exchanges between both groups at several points in time. Both groups develop criteria on the basis of which the options should be assessed and they apply these criteria. The whole process takes two long weekends, with a month in between (Burgess et al. 2004).

This project starts from the notion that assessing technological options is not reserved for scientists in ivory towers. Quite the contrary, certainly with respect to socially controversial issues, such as radioactive waste, which moreover contains many scientific uncertainties, a transdisciplinary approach seems appropriate. The method of Deliberative Mapping appears to lend itself well to this. Let us look then in more detail at the method in order to bring to light different (potential) assumptions with regard to the nature of knowledge and the holders of knowledge.

3.1.1 WHO HAS KNOWLEDGE?

In the invitation to potential participating citizens, three aims for the meetings were mentioned. First, to *learn* more about the issues relating to the management of radioactive waste. Second, to discuss the best options, and third to inform the ministry about which issues people considered important. Different activities were organised by the facilitating team in order to achieve the first objective, learning. An information pack was put together to prepare for the first weekend in which the different options for waste management were objectively explained for the non-expert public.^{viii} Sessions were organised during which the specialists provided additional information to the participating citizens. And during other sessions citizens interviewed the specialists in pairs about the options for managing radioactive waste.

What perspectives on relevant expertise does this represent? We see in this example two possible scenarios: on the one hand the obvious one which can be deduced from the brief description of the aims (namely lay-people versus experts); on the other hand, on further examination of the detailed description of the process, a second perspective on the division of roles arises, whereby both citizens and experts have relevant expertise.

Perspective 1: Experts versus laypeople

One perspective on the ‘Who has knowledge?’ question which emerges from this example is that specialists have the knowledge (in this case it was the university scientists, consultants and representatives of the nuclear industry), while the citizens had to be educated before they could make any statement about the best options. The fact that citizens are not experts in the area of radioactive waste management is explicitly mentioned as an advantage. "While one of the citizens had worked at Sellafield in the past, none of the other citizens were in any way experts on the subject." (Burgess et al. 2004: 9)

24

**Gertjan Fonk
(Project Leader,
Innovation Network):**

"The parties who were involved in the "Novel Protein Food" project committed themselves to the principles of the project – talking about a consumer perspective for Novel Protein Foods. We included the different opinions in the final report. There were parties who considered that we should not have got involved with Novel Protein Food, but with biological agriculture. Also, the idea that the need for protein was a key consideration was disputed. We didn't do this within the project. In that sense, it wasn't an interactive process. Power already played a role in agenda-setting."

This division of roles is also expressed in the degree of influence which the different parties involved had in framing the problem²⁴ at the start of the process.

Specialists received the information package with a number of options, including the question of whether they wanted to add any further options. Citizens were not given this option; they started with the discussion of the options as described in the information package.

Independent assessors who were present during both weekends remarked that in spite of the possibility that the experts, too, might learn from the citizens it was primarily the citizens who learned from the experts. This is particularly due to the fact that "the specialist contribution to the citizen's strand is much more structured than the other way around." (Collier 2004: 3). The interviews which citizens had with different specialists in the second weekend are an example of the structured contribution of the specialists to the knowledge development of citizens. The aim of these short interviews was to give citizens the opportunity to put to the specialists any technical questions which they had with regard to the different options for waste management. There was time beforehand to prepare the questions well, and 15-minute interviews were planned. One of the facilitators who observed the interviews made the following remark: "Citizens remained task-centred and did not digress into expressing their own opinions or responses – so what the specialists learned about what the citizens were making of all this was limited." (Burgess et al. 2004: 44).

Returning to the remark by David Collier, we may conclude that the *design* of these interactions lent itself primarily to learning on the part of the citizens and less on the part of the specialists. It was the task of the citizens to learn about radioactive waste management, and it was the task of the specialists to provide information on this subject.

The image which arises from this about who possesses relevant information is asymmetric: the design of the process is focused on knowledge transfer from specialists to citizens.²⁵ In the evaluation, the citizens are roundly praised for absorbing the knowledge so quickly and for having a good understanding of the technical aspects. The assumption that citizens first have to learn before they can take part in discussions in the science and society literature is known as the deficit model: there is a knowledge

deficit (among citizens) and that deficiency should be made good before citizens can participate in discussions. The NWO's head of Information and Communication said in an interview that: "It is difficult, as NWO, to consult the *man in the street*. [...] Ideally, you first have to inform the people before they can form an opinion." (Da Vinci Newsletter, February 2006).



Figure 3.1 Division of relevant expertise

From this perspective, the actors involved will be divided into two groups: those with knowledge and those who could benefit from the knowledge. We also see this image with other 'transdisciplinary' processes. For example, the International Institute for Urban Environment (IIUE) conducted an extensive European project for restructuring post-war residential areas, in which knowledge institutions and practice parties were separated explicitly (in rhetorical, organisational and process terms) from one another, and the knowledge institutions were at the service of the practice parties. Many knowledge centres and networks are designed on the same principles. The asymmetry of those possessing knowledge is emphasised by the way in which the process is organised and what terminology is used. Citizens and stakeholders who participate in this type of interactive process are primarily asked because of their right to be consulted, and because of the desire to gain their support for the final decision which will be created, rather than because of any expertise they may have.

25

Frans Evers (Member of RMNO): "Policy-makers too easily think they have enough information to make decisions about, for example, the routes of roadways. They are satisfied with model research, groundwater models, etc. But there are so many differences in what is meant by knowledge, and how this should be generated, that in the coming years we will have more fights about this with the Council of State. This could have been prevented with mode-2 research. The State did produce products and let people respond, but then it drew its own conclusions."

At the same time, a second image emerges from the Deliberative Mapping trial with regard to who has knowledge, when we look at the *content* of the discussions held in spite of the asymmetrical design of the process.

Perspective 2: All experts

The citizens did apparently make a considerable contribution, even though there may have been less encouragement

within the process for them to do so. Both panels (specialists and citizens) contribute to one another's analyses; the specialists gave citizens technical information, and the citizens gave the specialists a broader perspective on the matter, insights into ethical issues and the way in which issues which seemed to the specialists to be unrelated, were in fact related to one another from the perspective of the citizens. "Specialists reported that new points had been raised for them." (Burgess et al. 2004: 46)

During the programme it also appeared that citizens had difficulty with the way in which the problem was framed. "Citizens repeatedly returned to the question of future production of wastes in relation to future energy production scenarios, and the separation of this from the management of radioactive waste was uncomfortable." (Burgess et al. 2004: 63)

Citizens repeatedly indicated that they wanted to explore different combinations of options and wanted to look at waste flows in different ways. The process offered no opportunity to do this²⁶ because the options were set in advance, in consultation with only the experts, but it shows that on this point, too, citizens could have played a more equal role.²⁷ Interestingly enough, the citizens also introduced a further idea about who are relevant specialists. At the end of the first weekend citizens were able to indicate their information needs, so that the team of specialists could be broadened for the second weekend. "The citizens requested access to local people who could talk to them about living and working near a nuclear facility." (Burgess et al. 2004: 41) By so doing, the citizens indicated that they considered the experiential knowledge of residents who lived in the vicinity of storage locations to be very important. This request supports the assumption that relevant knowledge is not limited to scientific knowledge. Let us take a minor detour to further explore this assumption.

A research field in which epistemological questions such as 'What is knowledge?'

26

Frans Evers (Member of RMNO): "If you then see that people say: 'We want to talk about future energy policy' and the supervisors who design the process say: 'Yes, but that's not possible in this process, because that question isn't under discussion' I would have left. And in all honesty, this process which you describe here happens all the time, even in the Netherlands. It really happens, that is what people do. Then they just say: "No, this is the process; it is designed in this way, you as a participant have to keep to it. At the National Convention, for example, very expensive advisers were contracted for the supervision of a starting conference, who had made a very precise design for a process, which they had given considerable thought to, in line with an internationally recognized method. However, half way through the afternoon people rebelled against it. And people did actually leave. Because the method became so dominant that there was no opportunity for people to have their say."

Jeroen Bordewijk (Senior Vice President Supply Chain Excellence, Unilever): "If we are involved in a programme about sustainable agriculture, with all kinds of actors, nature organisations, but also with other companies and advisers, then it should be clear to them that our intention as a company is to eventually make choices for raw materials on the basis of sustainability criteria. You have to be completely clear about your goals. You can say: 'I want a particular focus in the process because eventually for me these goals have to be met.' If some of the actors then say: 'Well, we have a problem with that,' of course, then you will talk about it. But you also have to be clear about where your paths diverge."

and 'Who has knowledge?' are studied is that of science studies (science and technology studies, or STS). In a review article, sociologists of science Collins and Evans (2002) sketched the study of science along three lines, or waves. In the First Wave, knowledge and truth were regarded as logical outcomes of scientific procedures. Sociologists studied the scientific working methods in the 1950s and 1960s in order to understand and explain the success of science, and thereby also to support and strengthen it. Scientists had obvious authority to make choices in the areas of science and technology, in their own field and often beyond this.

With Kuhn's study of the sociology of scientific knowledge (*The structure of scientific revolution*) the image of science as objective, independent and a producer of truth was called into question. The idea that scientific knowledge is embedded in paradigms, and should therefore be socially understood, has shifted the attention from the content of scientific knowledge to the structure and organisation of it. The borders between what

THREE WAVES OF SCIENCE STUDIES

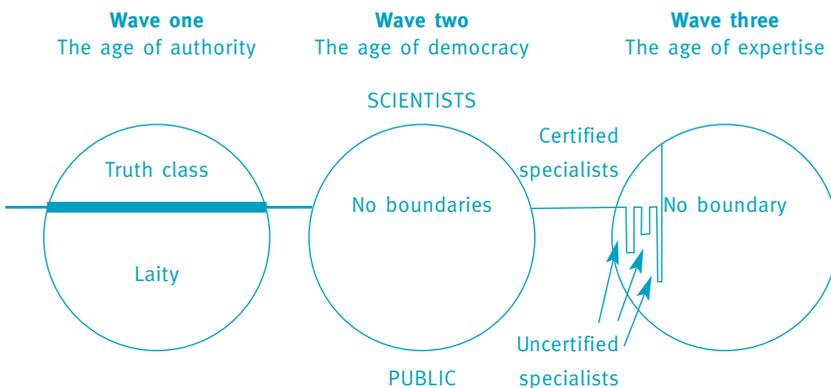


Figure 3.2 Three Waves of Science Studies (adopted from Collins and Evans. 2002)

does and what does not belong to scientific knowledge were problematised, and studying these borders became relevant. In the past three decades this has led to a stream of research into ‘science in action’, the so-called Second Wave of science studies (see figure 3.2 on page 53).

28

Roel in 't Veld (Policy Adviser): "The methodology, the standard criteria, of mode-1 research completely differs from the mode-2 method. However, this proves nothing about the similarities and differences between mode-1 and mode-2 in practice. Because, in a mode-1 approach too, people consider the problem definition in the final stage, nor is there a clear starting point or end."

While science in the First Wave was legitimised by referencing to an independent reality, with its own logic and momentum, in the Second Wave, the ‘certainties’ which science produces by no means appear to be certain, independent and free from specific value considerations (e.g. Edge 1995).²⁸ The very idea that the borders between scientists and lay people and between facts and values seem to be socially constructed, has motivated the Second Wave of sociologists of scientific knowledge to call for the democratisation of science and technology. Because, if scientists are not able to lay claim to an independent reality on which they base their facts, then they also do not have the sole right to decision-making within science and technology.

Nevertheless, Collins and Evans (2002) draw a different conclusion from the research of Second Wave science studies. They place the emphasis on the fact that scientists do not have the sole right to knowledge. A well known study that supports this position is that of Brian Wynne (1996) into the reaction of sheep farmers to the danger of contamination of their sheep as a result of the nuclear disaster in Chernobyl.

The case of the Cumbrian Sheep Farmers

After the Chernobyl fallout, farmers at great distance from the disaster location had to take action to minimise the impact of the contamination. Wynne (1996) studied the way sheep farmers in Cumbria responded to this challenge. He found that the sheep farmers knew a great deal about the ecology of sheep, and about their behaviour (and that of rainwater) on the fells. Due to the proximity of the Windscale-Sellafield plant, the farmers in the local area had long experience of the ecology of sheep exposed to (radioactive) waste. They treated the sheep and the fells on the basis of their own experiential knowledge.

Wynne (1996) studied the relationship between scientists and sheep farmers, and saw that the local knowledge of the farmers, about the effects of raised radioactivity on the fields and sheep, was not recognised by the environmental specialists. The farmers threw out the official advice they were given which was seen as naïve behaviour based on ignorance of the basic scientific facts. The experts acted from a First Wave perspective (knowledge is localised within the scientific community), while Wynne

showed that ‘lay-people’ also have knowledge. The borders between scientists and non-scientists are blurring.

On the basis of this type of research, Collins and Evans (2002) introduced a Third Wave of science studies, whereby actors are brought together; not on the basis of their democratic right, but on the basis of their relevant expertise. Some of those involved will have certified knowledge, other uncertified knowledge, but all are experts.²⁹ From this perspective, the case of the Cumbrian sheep farmers can be seen as the interaction between two groups of experts (who may dispute one another’s expertise), instead of as the interaction between a group of lay people and a group of scientists. The Deliberative Mapping case can also be interpreted as a meeting of different experts: scientists, industrialists, consultants, and citizens (who were not consulted about their expertise). Other examples of projects where different experts meet are those such as when poor farmers co-operate in the development of new agricultural innovations by using their local knowledge (Zweekhorst 2004) and patients who participate in assessments of research priorities by bringing in their experiential knowledge (Caron-Flinterman 2005). The second aspect which we want to explore using the above example relates to the nature of knowledge.

29
Gertjan Fonk (Project Leader, Innovation Network): "Our working method makes use of people’s knowledge; experiential knowledge which they bring in and exchange with others. It is important to remember this. Whether it is experiential knowledge or scientific knowledge makes no difference, as long as the parties are willing to invest in problem-solving, or in seizing opportunities (as we prefer to call it nowadays)."

3.1.2 WHAT IS KNOWLEDGE?

The Second Wave of science studies has not only demonstrated that knowledge is not the prerogative of ‘scientists’, but also that knowledge is socially constructed. Latour and Woolgar (1979), for example, describe the process in which facts and machines (the products of science and technology) are divested of any trace of fabrication, construction, place and time. Facts are, as it were, ‘black-boxed’, after which they appear in manuals, study books and newspapers, without reference to the actors involved in the construction and the environment in which the construction took place. It is a process whereby context and content are separated from one another, until the context is dissolved in a history which has become invisible (Latour 1987). Particularly in the case of controversies, whereby the black-box has not yet been closed, it becomes clear that scientific knowledge is not unequivocal, but that there are many different perspectives, each of which is supported by different facts, opinions and values.

Both the *design* of the Deliberative Mapping trial on radioactive waste management and the *content* of the process illustrate this image of knowledge as person-related and context-dependent. In the first place, the organisers took care that specialists and citizens had many moments of informal interaction: in the coffee breaks, during the dinners, in the bar and at the kitchen tables in the accommodation. Moreover, there were discussion sessions where citizens and specialists sat in mixed groups. "Specialists were not accorded any special status in these discussions, which helped familiarise the citizens with them as people as well as information providers." (Burgess et al. 2004: 42)

What image of knowledge does this generate? Knowledge was passed on to citizens not only in a depersonalised form (information packs, videos and presentations), that could give an impression of knowledge being unequivocal and factual as if the black-box was already closed. On the contrary, knowledge was assumed to be something held by people: geologists, environmentalists, safety experts, representatives of industry and consultants. Interestingly, the citizens were very much aware that knowledge in this phase of a decision-making process was strongly linked to people and that it was also important who these people were and what their personal view of the issue was. Therefore, they made the point that not all perspectives were represented (such as environment, economy and local residents). Moreover, in the their interviews with specialists, the citizens asked not only for factual information, but also asked explicitly for the individual perspectives and opinions of the specialists.³⁰

The reactions of the specialists to this were very diverse; from 'discomfort with the questions which asked for a personal opinion' to 'liberating, as it did not require speaking for the organisation.' (Burgess et al. 2004: 43).

A final important observation with regard to knowledge, which arises from the Deliberative Mapping trial, is that specialists at times not only had different ideas and opinions about the waste issue, but they also introduced contradictory 'facts'. According to some participants, it appeared from the individual interviews that 'the science of underground phased disposal is sufficiently well developed to proceed' while according to others, 'the science was currently inadequate and there are no indications for longer term safety.' (Burgess et al. 2004: 43). During the discussion of

30

**Frans Evers
(Member of
RMNO): "I see it
often at meetings.
Scientists are there,
eagerly telling everyone
what they know, but the
people in the room are
just not interested. They
want to know what scien-
tists consider important and
whether that ties in with
what they themselves con-
sider important; that is, the
whole value system on which
their views are based. Dealing
with this should be considered
an equal, or maybe even top
priority in these kinds of
mode-2 processes."**

this last issue in a plenary session, the differences were directly diminished by the specialists involved. In the evaluation therefore, arguments were put forward for the inclusion of a programme element where discussions could be held with specialists on an individual basis, such as the interviews that were held in this case, so that the individual views of the specialists could actually emerge. Other possibilities lie in a different design and facilitation of the plenary session.

3.1.3 DIFFERENT PERSPECTIVES ON KNOWLEDGE

What is the significance of the examples and observations mentioned above for different perceptions of knowledge in mode-0, -1 and -2?

As we outlined in Chapter 1, in mode-0 there is a divergence in the division of roles; the primacy of knowledge development and the authority for taking knowledge-related decisions lies with the scientists. In the case of the sheep farmers, from a mode-0 perspective the experts were right when they considered the farmers to be naïve, and the CoRWM should not have allowed citizens to participate in the decision-making on radioactive waste management.

From a mode-1 perspective there is clearly an exchange between science and society. Strategies are focused on the exchange of knowledge (via knowledge networks, databases, conferences) or coordination of the demand for and supply of knowledge (demand-driven research, policy relevant research). However, citizens are primarily involved in decision-making for political reasons and not for reasons of knowledge. Because CoRWM involves citizens in decision-making, there is more likelihood that solutions for waste management will develop in acceptable directions; there is a better correlation between technological developments and their societal environment. Nevertheless, in view of the nature of knowledge, we see in mode-1 major similarities with mode-0: the knowledge which is introduced in interactive processes comes from scientists.

In the mode-2 situation, roles converge and there is no hierarchical relation between scientific knowledge and societal knowledge, or experiential expertise. Moreover, knowledge can be contradictory. Knowledge is also seen as person- and context-related. With controversial or unstructured issues, it is not always possible to separate opinions, ideas and facts from one another. Or, as the citizens indicated in the Deliberate Mapping trial: "Different experts could have gone a different way." (Burgess et al. 2004: 47).

As we indicated earlier, there is a spectrum of mode-2 initiatives which stretches from interactive knowledge development (for example for the benefit of decision-makers) on the one hand to co-production of knowledge and solution on the other hand. In the case of the CoRWM, we see on the one hand an image of knowledge development for the benefit of decision-makers, in which the knowledge development focuses mainly on knowledge about the wishes and concerns of citizens. On the other hand, the image of the co-production of knowledge and solutions has also become apparent, whereby the joint knowledge development is also focused on the technical and organisational aspects of waste management. Discussions took place regularly on other possible solutions and combinations of options: "The specification of the options was seen to be unclear in some cases, and the inability of the process, as it stands, to deal with interacting options and to encompass different waste streams requires some revision of the process. From early in the process, citizens were raising these considerations." (Burgess et al. 2004: 62-63). It is quite conceivable that deliberation about these aspects of waste management could have had an effect on the technology development by the specialists involved after the exercise.

3.2 THE VALIDITY OF TRANSDISCIPLINARY KNOWLEDGE

So far, in this chapter we have looked at different perceptions of the assumed role of scientific knowledge development and at who has relevant knowledge and what knowledge is. A mode-2 perspective on societal issues implies the broadening of the knowledge basis by involving more actors beside the scientists.³¹

	Who has knowledge?	What is knowledge?
Mode-0	Scientists have knowledge	Knowledge is objective and can be generalised Internally driven
Mode-1	Scientists have knowledge Society has questions	Knowledge is objective or subjective (explicit) Sometimes internally and sometimes externally driven
Mode-2	Different scientists have different knowledge Both scientific knowledge and experiential knowledge are relevant	Knowledge is context- and person-related (implicit and explicit) Knowledge is inter-subjective Opinions, ideas and facts are difficult to distinguish Combination of internal and external drive

Table 3.1 Perspectives on knowledge

For the scientists involved and for the transdisciplinary researchers who are organising the process, epistemological questions will arise, such as ‘What is the nature of the knowledge derived from transdisciplinary research’ and ‘How can this knowledge be regarded as objective and correct’ (Burger 2000: 104). In sum, these are questions about the validity of the knowledge which is developed in the heterogeneous co-operation process. Partly based on a previous article (Regeer and Bunders 2003), we address these questions by looking at the nature of knowledge creation and the implications of this for knowledge integration. We also hope in this way to explain the remarkable phenomenon that whereas in table 2.2 mode-1 and mode-2 show similarities (namely co-operation between scientists and other societal actors) in table 3.1 the opposite is true: mode-1 perspectives on knowledge appear to have more in common with those in mode-0 than with those in mode-2.

We start with the dominant vision on knowledge integration because the above questions arise from and are significant in this context. In addition to the examples described earlier in this chapter, we will also refer to the Osdorp Complex 50 case (see frame): a multi-actor process in the area of urban renewal, where the knowledge of all the participants is integrated for the joint development of context-specific socio-technical solutions.

André van de Zande (DG, Ministry of LNW): "We are now again facing a manure dilemma. The agricultural organisations have decided the measurement depth is not correct and that if that is put right, the whole manure problem will be solved. The new legitimacy question is then the measurement depth, and no matter what Van Egmond (Director of the Netherlands Environmental Assessment Agency) says about it, it is disregarded. We will therefore have to find a new, transdisciplinary measurement depth, together with the farmers."

Osdorp Complex 50

The housing supply in the post-war urban area to the west of Amsterdam (Osdorp) due for renovation and modernisation. The housing corporation which owns Complex 50 decided from the outset to substantially improve the quality of the residences, and at the same time to give the residents the opportunity to return to their own houses. The main actors who were involved in this process were the architect, the housing corporation (project leader and participating staff member), the environmental adviser and the residents with their coach. More than thirty

meetings were organised in which all the actors co-operated in a joint solution-oriented process. Their aim was to find integral solutions for a variety of problems: from social conflicts in the staircases to the poor technical quality of the houses. The challenge for the project team can in this sense be seen as the development of social-technical innovations whereby the knowledge of all the relevant participants will be integrated in a process which recognises the local quality and possibilities of the environment.

(Regeer and Bunders 2003)

3.2.1 PERSPECTIVE 1: KNOWLEDGE INTEGRATION

In the predominant vision on bringing together knowledge which we frequently come across, such as in the literature about transdisciplinary research, the differences between different kinds of knowledge and the related challenge to integrate these types of knowledge successfully were emphasised. A distinction was made between knowledge of natural sciences, and social sciences and humanities, between scientific knowledge and intuitive (informal) knowledge, between knowledge held by laypersons and expert knowledge, and between knowledge ‘originating from multiple sub-spheres of science, politics, market and civil society’ (Klein et al. 2001: 231). By emphasising differences, borders are drawn which are difficult to bridge. We argued in the article mentioned (Regeer and Bunders 2003) that this interpretation has the inherent risk that the use of knowledge will be seen as separate from the creation of knowledge, the people who have the knowledge and the context in which the knowledge is valid. Knowledge integration is then too readily assumed to be the combining of different separate ‘pieces’ of explicit knowledge.³²

32

Marga Kool (Water Board):
"With regionally-focused policy, scientists are often involved on a piecemeal basis. You need scientists for archaeological research, for water modeling, and landscape experts who investigate, for example, how things used to be and how they should become."

inherent risk that the use of knowledge will be seen as separate from the creation of knowledge, the people who have the knowledge and the context in which the knowledge is valid. Knowledge integration is then too readily assumed to be the combining of different separate ‘pieces’ of explicit knowledge.³²

To explain this view and to relate it to the epistemological questions, we use Osdorp Complex 50 as an illustration for the knowledge integration process as indicated in figure 3.3.

<p>The architect, tenants, representatives of housing association and environmental expert all have their own type of knowledge. Some types are justified by an objective reality through science.</p> <p style="text-align: right;">1</p>	<p>The types of knowledge are brought together and methods are applied to integrate the different types of knowledge.</p> <p style="text-align: right;">2</p>	<p>The end result of this process is new knowledge, manifested as a solution to the problem, or a socio-technical innovation.</p> <p style="text-align: right;">3</p>

Figure 3.3 The process of knowledge integration (from Regeer and Bunders 2003)

As can be seen in the left-hand column of figure 3.3, the knowledge of all the participants is regarded as relevant, and is included in the process. The difference between scientific knowledge and the knowledge of the residents is, however, seen as problematic: how can the experiential knowledge of residents be reconciled with the knowledge of the environmental adviser, which has been gained through scientific training? Scientific knowledge reflects an objective reality and can be generalised to supercede its specificity, while the experiential knowledge of residents is specific, personal and context-related. Also, even if the knowledge of residents is seen as equally *valuable*, from this dominant perspective it is not seen as equally *true* (because it is not 'objective').

In the literature about transdisciplinarity, considerably more attention is paid to the *process* of knowledge integration in the central column of figure 3.3. Transdisciplinary researchers are again confronted with the epistemological question in the last phase of the process: in what sense can the end result be seen as scientific?³³

The frequently expressed concern that the results of transdisciplinary research are not easily publishable in the scientific journals which are based on monodisciplines is an example of this.³⁴

3.2.2 THE NATURE OF KNOWLEDGE CREATION

34

Peter Nijkamp (Chairman NWO):
"Faculties have, of course, also developed decentralised competence arrangements on the basis of which its people are judged. Therefore often, academics who are carrying out transdisciplinary research are not evaluated on that basis, but often solely on whether they are successful in publishing in highly qualified monodisciplinary journals. I consider this an impoverishment of the scientific enterprise. Probably, faculties, even more than universities, are their own worst enemy."

In the reasoning based on this dominant perspective of knowledge integration, classical epistemological principles (such as correspondence with an objective reality) are tacitly used as a reference framework. However, as we have seen earlier in this chapter, insights from the philosophy and sociology of science teach us that the claim that scientific knowledge reflects the objective reality is a construction as well. The fact-value, subjective-objective, dichotomy which science seems to aspire to does not appear to be tenable. The distinction between scientific and non-scientific is then in some cases less relevant than it appears at first sight. Studies into the differences between, but especially within, scientific disciplines illustrate this.

André van der Zande (DG, Ministry of LNV): **"People who venture into transdisciplinary research are without exception enthusiastic about it. A friend from university works in the field on the relationship between farmers and manure, and is wildly enthusiastic. His eyes shine, and he feels that the work he does there with his students is the pinnacle of his work. But he does not get the best publications out of it."**

33

Talking about disciplines, which is inherent to all discussions about multi-, inter- or transdisciplinary research, is less unequivocal than it at first appears. Some approaches within disciplines differ more from one another than those between more distant disciplines. Philosopher Marjolijn Februari, for example, argues that it is 'completely misplaced' to equate the difference between qualitatively and interpretatively oriented scientists and quantitatively and empirically oriented scientists with the distinction between humanities and natural sciences (see frame).

Northern and Southern scientists

"In all countries of the world, the population in the North is rational and the population in the South is emotional. It is common knowledge that all people from Groningen are just as hard-working, sober and boring as the North Italians – while all people from Limburg are just as warm, Burgundian and carnal as the Southern Italians. And this phenomenon occurs in exactly the same way in the scientific world. Every area of science has on the one hand its northern, rational and calculating population – and on the other hand its southern, creative and empathetic inhabitants. Once you realise this phenomenon, then you need no longer be surprised when you notice that some psychologists can operate just as objectively and logically as physicists, while some physicists can be just as creative and imaginative as psychologists.

Marjolijn Februari, de Volkskrant, 13 August 2005

Instead of disciplines, the sociologist of science Knorr-Cetina introduced the term 'epistemic cultures' within which knowledge is created and validated. Epistemic cultures are "those amalgams of arrangements and mechanisms [...] which, in a given field, make up how we know what we know." (Knorr-Cetina 1999: 1). Through detailed study of two research groups (a group of microbiologists and a group of high energy physicists), she demonstrates the remarkable differences in epistemic culture.

The two cultures differ in how authorship is handled, what the role of technological instruments is, what the processes of symbolic classifications are, and what the position of individual scientists is in the whole knowledge creation process.

Also studies into publication behaviour, and particularly into the way in which academic discourses of scientific communities differ from one another underline the image that knowledge gains its status as 'true' knowledge within epistemic cultures. From another perspective, the nature of scientific knowledge production ('how we know what we know') is described in terms of different 'styles' of research: deduction, experiment, hypothesis, taxonomy, statistics and evolution (Kwa 2005), or different modalities: 'controlled circumstances' such as in a laboratory, 'natural

history' such as structuring and pattern recognition, and 'exchange' of local personal knowledge, as in communities of professionals (Rip 2002: 119)^{ix}.

3.2.3 PERSPECTIVE 2: KNOWLEDGE CO-CREATION

We now come to a second perspective on knowledge integration, which assumes that we acquire knowledge, and assign meaning to this knowledge, through participation in social practices, such as epistemic cultures. Wenger's concept of Community of Practice (1998) is analogous to this. We therefore prefer the term knowledge creation (or co-creation) to knowledge integration. According to Wenger, a Community of Practice is characterised first by mutual commitment on the part of the participants (as opposed to the formal structure of a project team), by a common goal which is decided upon by all the participants, and finally by a shared repertoire of resources which are developed during the course of the project to give meaning (or to create knowledge), such as routines, words, instruments, ways of acting, stories, symbols and gestures (Wenger 1998). The second perspective then assumes a vision of knowledge development as a communicative process which takes place within a shared practice. Moreover, knowledge, communication and behaviour are inseparably linked; they create one another. "Discourse is socially constitutive rather than simply socially shapen; writing is not just another aspect of what goes on in the disciplines^x, it is seen as *producing* them." (Hyland 2000: 3, cited in Cronin 2003)

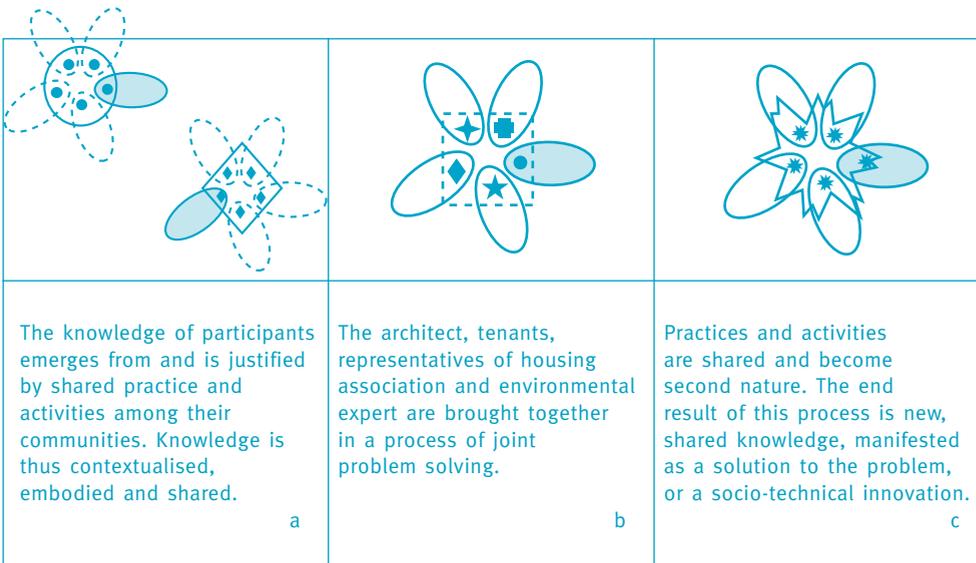


Figure 3.4 The process of knowledge co-creation (Regeer and Bunders 2003)

From this perspective, knowledge cannot be seen as separate from practice or context, but is acquired or gains meaning within a shared practice, Community of Practice or epistemic culture.

The development of Osdorp Complex 50 can be seen as a process which integrates the know-

ledge which the different actors already have, but it can also be seen as a Community of Practice in which different experts take part (residents, architect, housing corporation, environment expert) and where new knowledge and innovations are created in a shared and intensive process (see figure 3.4). This knowledge creation process is at the same time the process through which the knowledge is validated.³⁵

Roel in 't Veld (Policy Adviser): "In my role as adviser my prime focus is on a process design which in a particular set of circumstances can lead to Pareto Optimal perspectives for action. This means that I may produce knowledge, but this knowledge is not to be assessed on reality criteria, but on plausibility criteria. Is what we are doing here plausible? Is it credible? These are characteristics which lead to robust perspectives for action."

35

3.3 SUMMARY

In this chapter the key question was what new types of knowledge production imply for our understanding of knowledge. We have described how in mode-0 and mode-1 science has the primacy for knowledge development, whereas in mode-2 other actors also contribute relevant knowledge to the process of solving unstructured problems. At the basis of this is the epistemological principle that knowledge is socially constructed and that truth is based on inter-

subjectivity. In addition, we have emphasised

the importance of intensive interaction between actors in exchanging explicit as well as implicit knowledge.

36 Gertjan Fonk (Project Leader, Innovation Network): "Sometimes you need disciplinary knowledge. You take the research questions, for example, from the interactive process. Then, the role of the interactive process is to put research questions on the agenda. Next you implement applied scientific research to these questions. This forms the input for subsequent actions."

The concept of 'Community of Practice' was introduced to indicate how new knowledge and innovations can be created in a shared practice.³⁶

In summary, this gives a different perspective on the relationship between ourselves, the world around us and the knowledge claims that we make: in short, on the epistemological issues relating to transdisciplinary research.

An epistemology of transdisciplinary research

- The grounds for knowledge claims in an epistemology of transdisciplinary research do not lie in their reference to an objective reality, nor do they exist solely in the subjects mind. Knowledge, objects and people do not exist in separate realms. Rather we conceive of knowledge as embedded in our (communicative) practices, activities and uses.
- Hence, we should resist the temptation to think of transdisciplinary research in terms of the integration of different bits and types of knowledge and reject the visualisation of the process of knowledge integration as presented in figure 3.3.
- The epistemology of transdisciplinary research is not a relativistic one when we recognise the inseparability of knowledge, their grounds and ourselves. We are the glasses we look through; they cannot be replaced by an equally valid frame of reference.
- Recognising that knowing is being part of a community (in that language, action, experience and knowledge are inseparable) is our answer to the critique that transdisciplinary research is all about process. Context and content merge when we look at science in action, or knowing at work. Separating epistemological issues from methodological ones is misunderstanding the relationship between the nature of knowledge and the process by which it is acquired and shared.

(Regeer and Bunders 2003)

In the Osdorp Complex 50 article mentioned above we emphasised that the inseparability of knowledge and action also implies an inseparable link between epistemology and methodology (see last bullet point above). Whereas in figure 3.3 methodology is seen as a separate element, in figure 3.4 methodology and epistemology are part of the same process. The following chapter, about methodology, can thus be seen as shedding light on the transdisciplinary research process from a different perspective. But before we continue, we will formulate the mode-2 principles which have been put forward in the context of this chapter.

MODE-2 PRINCIPLE OPINIONS, IDEAS AND FACTS ARE DIFFICULT TO DISTINGUISH
IN THE CASE OF UNSTRUCTURED PROBLEMS

MODE-2 PRINCIPLE KNOWLEDGE CO-CREATION IS A COMMUNICATIVE PROCESS WHICH
TAKES PLACE WITHIN A SHARED PRACTICE

Chapter 4 Methodology

How can joint learning processes be organised in which different actors can develop new knowledge and solutions through the exchange of implicit and explicit knowledge? How can a mode-2 process be fashioned? These questions form the core of this chapter.

In Chapter 1 and 2 several aspects of a methodology were discussed. First, we described transdisciplinarity as an umbrella term for a broad range of different initiatives and methods for structuring the interface between science and society. On the website of the ‘network for transdisciplinarity in sciences and humanities’ (www.transdisciplinarity.ch), a distinction is made between transdisciplinary ‘Approaches’ and ‘Tools’. According to this network, examples of transdisciplinary approaches are: action research, case study method, ecological economics, integrated assessment, real world experiments, systems analysis & modelling, and (interactive/constructive) technology assessment and examples of instruments which are mentioned on the website are: evaluation tools, knowledge management tools, participation tools, problem framing tools, project management tools, and system analysis tools. Second, we argued

	Relationship science-practice	Strategy
Mode-0	SEPARATE Knowledge development and practice are (rather) separate from one another. It is unclear whether they can benefit from one another.	DEMAND-DRIVEN Transfer of explicit knowledge and technology.
Mode-1	CO-OPERATION Co-operation between research and practice. No changes in the modus operandi of either party.	BROKERING Agreement between supply and demand (articulation of demand, selection of supply), development of training and skills, financial support, information and communication, advice on the development and implementation of new strategies.
Mode-2	CO-PRODUCTION Practice and research are both actively seeking the best way of structuring and supervising complex change processes.	SYSTEMIC Content and process role: custom-work, support demand articulation, strategy development, development of instruments for transition management. Network role: identify, mobilise and involve players. Management of complex innovative projects.

*Table 4.1 Strategies in Mode-0, -1 and -2
Based on Smits in Fonk (2002), see also Smits and Kuhlmann (2004)*

that from the different relationships between science and society in mode-0, mode-1 and mode-2 we can infer differences in the design of the interface. In a mode-1 situation, so-called coordination activities take place to bridge the gap between two different worlds, while in mode-2 an environment is created in which actors fashion mutual relations and meaning.

On the basis of the difference in strategy between mode-1 and mode-2, how can we understand the broad range of methods, approaches and tools? With regard to the changing ideas on innovation processes (from a linear model to co-production), Smits and Kuhlmann (2004) identify three forms of intervention strategies for structuring the interconnection between supply and demand. The table above outlines these strategies in terms of the different relationships between science and society from table 1 on page 12.

The types of instruments used in mode-2 are referred to by Smits and Kuhlmann as systemic instruments: they are aimed at facilitating change in complex systems, such as the actor networks around such unstructured societal challenges as sustainable development. Systemic instruments focus simultaneously on the content, the process and the network.

Similarly, the approaches and instruments cited by the Transdisciplinarity Network (www.transdisciplinarity.ch) also focus on the content, the process and the network. It mentions methods frequently used in social sciences, such as surveys, interviews and questionnaires, and all kinds of group discussion methods such as focus groups and consensus conference. But social marketing and economic instruments and visualisations of future developments are also examples of methods in transdisciplinary research. (Klein 2001: 108) In addition, there are methods of participation and instruments for system analysis. Because transdisciplinary research is generally carried out in teams, managers of teams working with transdisciplinary research

Marga Kool (Water Board): "You look for people who have certain skills. You need process knowledge: how does this work, what are the pitfalls, how should you do it? You have to acquire this process knowledge. But it is also a matter of personalities. You have to be able to see things from the point of view of the other person; you have to be a bridge-builder by nature and not someone who likes polarisation and conflict; you have to be a good chairperson to be able to get to the essence of things and then take things a step further. I don't think that these are skills you can teach everyone. You have to look for people who have it in them, and then give them the opportunity to develop their skills."

37

have to have experience with teamwork (Martinez and Schreier 2000), conflict management and facilitating communication (Hirsch 2000). Furthermore, it is important that they can quickly familiarise themselves with new subjects (Martinez and Schreier 2000) and that their management style is suited to coaching (Defila et al. 2000). The importance of the management and facilitative skills of project leaders is also borne out in the research of Hollaender (in Tress et al. 2002: 94) among participants in transdisciplinary research projects.³⁷

It is, however, unclear which method should be applied and when the methods can be used effectively together and precisely how each separate method should be used. The conference book by Klein et al. (2001) argues that precisely defining the way in which methods are used can make an enormous contribution to improving the quality of transdisciplinary research. In this chapter therefore we will first discuss the structure of the research process (the process design) that is, how phases are used, and the way a diverse range of instruments is employed. This will give insights into the underlying mode-2 way of thinking – the principles. We will then discuss a number of success factors which can enhance the effectiveness of a transdisciplinary research process. Finally, we will look in more depth at two crucial sub-processes: involving actors and structuring the ‘problem’. Here, too, a number of principles for transdisciplinary research can be deduced. At the end of the chapter a summary will be given of the principles identified.

4.1 PROCESS DESIGN

Since transdisciplinary research aims to achieve several goals simultaneously, the approach taken in transdisciplinary research will often be a combination of methods. The individual methods are

38

Roel in 't Veld (Policy Adviser): "The mode-2 approach fundamentally differs from the mode-1 approach, just as monocentric decision making theories differ from pluricentric theories. Of course you use small mode-1 cycles in that process. However, they cannot conceal the totally deviating requirements in the process design between the two approaches. In the mode-2 approach, for example, there is no clear starting point or end."

also used in mode-1 endeavours, but it is the combination of these activities which make it a mode-2 project.³⁸ We indicate in this section a number of guidelines for which instruments we can apply, and when.

Phasing

In spite of the inherent problem of translating the lack of an unambiguous method for transdisciplinary research into an action plan, an instruction or a checklist, we want to address the need

for more knowledge about mode-2 approaches by showing how to phase a transdisciplinary research project in which activities can take place in the different phases. In the table below, we have placed the different phases of transdisciplinary research in a form which is recognisable for monodisciplinary research.

Phasing	Activities
Preparation phase	Definition of research area Appoint research team (stakeholders and researchers) Exploration of problem context (INSTRUMENTS: LITERATURE STUDY, INTERVIEWS, ACTOR MAPPING)
Definition phase (observation)	Joint problem exploration What is the problem? Who defines it as a problem? (INSTRUMENTS: FOCUS GROUP, VISUALISATION TECHNIQUES, SCENARIO ANALYSIS, MIND-MAPPING)
Analysis phase (reflection)	Development of a shared and integral vision (INSTRUMENTS: SCENARIO ANALYSIS, DIALOGUE MEETING, INTEGRATION WORKSHOP, BACKCASTING)
Design phase (plan)	Joint determination of the actions required (INSTRUMENTS: DELPHI METHOD, GROUP DECISION ROOM, SURVEY, CARD TECHNIQUES, ACTION PLANNING)
Implementation phase (action)	Implementation of the plan (INSTRUMENTS: PROJECT & PROCESS MANAGEMENT, (VIRTUAL) COMMUNITY, TEAM COACHING, SKILLS TRAINING)
Evaluation phase (observation)	Evaluation of actions in relation to the problem (INSTRUMENTS: LEARNING HISTORY, REFLEXIVE EVALUATION, INTERVIEWS, PARTICIPATIVE OBSERVATION)

Table 4.2 Phasing and activities

Even if a transdisciplinary research project appears to consist of almost all the same steps as monodisciplinary research (problem exploration, hypothesis formation, research design, data collection, analysis, reporting, evaluation), in reality there are substantial differences between a mode-1 and a mode-2 research methodology. These differences are primarily in the degree of emphasis on the different phases, the number of actors involved, the diversity of their backgrounds, and the type of activities that take place in the different phases. In a transdisciplinary project, for example, considerable attention is paid to the preparatory and problem definition phase. As the research team consists of people with different backgrounds, considerable attention will be devoted at the beginning to defining the problem jointly,³⁹ whereby all those involved will have to

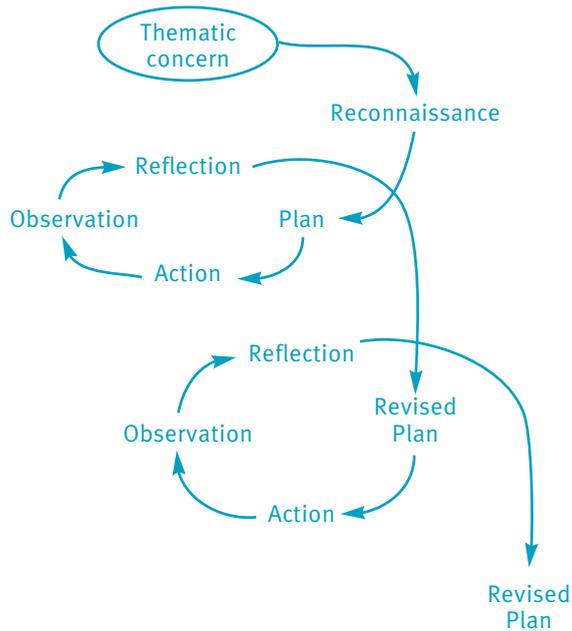


Figure 4.1 'Action Research Spiral', (from Kemmis and McTaggart 1988)

39 Marga Kool (Water Board): "It is important to have a mutually agreed definition of the problem. This starts with discussions around the kitchen table, but I also like to have the problem definition as a plenary activity, when the group is together, to prevent a situation in which you discover that people have made different assumptions once you are already deep into the project. Or, that, once you have reached the stage of deciding which grounds will be used for waterstorage, people still want to raise the issue of climate change."

operate outside the substantive frameworks within which they view the problem from their professional background. In addition, in the starting phase, attention will have to be paid to building up a research team which can function on the basis of constructive co-operation, for example, by dealing with any hidden agendas at the outset.

Another important difference between mode-1 and mode-2 research is that in mode-2 it is emphasised that the different phases should be repeated and we should imagine the whole process as a continuous cycle of observation – reflection – planning – action, as indicated, in figure 4.1 (also see Guba & Lincoln 1989, Stringer 1996, Zweekhorst 2004).^{xi} In table 4.2 we see that the different phases can be related to the elements of the action learning spiral.

Transdisciplinary research is in this sense a form of action research, wherein the primary goal is not (only) to increase the scientific knowledge basis, but where changes actually take place in the actual environment of the problem. The process of passing through several cycles, whereby stakeholders are actively involved

40

Jeroen Bordewijk (Senior Vice President Supply Chain Excellence, Unilever): "In our sustainable agriculture programme we decided to just get started. We agreed on an approach, and tested it first – just like in your spiral. Together, with all the actors; people from Wageningen and people from the World Wide Fund for Nature, we carried out projects to learn what the issues were. Anything that worked, we made available to others; what didn't work, we did more research on. And so on."

throughout, is indispensable.⁴⁰ The role of stakeholders will shift in the course of the process from participating in the problem analysis to making and implementing plans for interventions.

On the subject of designing knowledge-rich processes, Wenger (1998: 233) says that the process can *respond* to design; it is not the *result* of the design. Interventions and instruments therefore acquire significance within the context in which they are placed; they have no inherent significance which can be transferred to the participating actors. A mode-2 intermediary is therefore involved in a combination of making interventions and looking at how these interventions acquire significance within the project.⁴¹ Transdisciplinary

research is characterised by an explicit 'emergent design'. At the start the process is described in global terms, with only the subsequent phase being planned in more detail. On the basis of observation and reflection (in the form of self-evaluation or learning evaluation) the subsequent phases acquire structure and meaning. For those who are not directly involved in it, describing this process makes it clear and transparent under what circumstances the knowledge is being developed.

Frans Evers (Member of RMNO): "If you want to bring these kinds of things together in a mode-2 process in which you continuously allow policy and science to interact with one another, then the professional facilitator will have to use very open processes, and be able to handle this openness in such a way that they are able to switch to another process, even if they are already half-way through."

41

The main MODE-2 PRINCIPLES for successful transdisciplinary research with regard to phasing can be summarised as follows:

- DURING THE WHOLE PROCESS RESEARCHERS AND STAKEHOLDERS WORK ACTIVELY TOGETHER
- THE DIFFERENT PHASES REPEAT THEMSELVES IN A CYCLIC PROCESS
- MONITORING AND REFLECTION PROMOTE LEARNING WITHIN THE PROCESS

Instruments

An essential requisite for interactive approaches is a well filled ‘toolbox’ with instruments and methods for different activities (Swaans 2004, Leeuwis 2004, Broerse 2000). In the right hand column of table 4.2 we see different possible activities which could make up the elements of a mode-2 approach. More detailed descriptions of instruments and techniques for interactive approaches are given elsewhere. Rowe and Frewer (2005), for example, have devised a list of more than a hundred instruments which they have encountered in the literature and reports. Their alphabetical list of instruments is reproduced in appendix 1 and illustrates the multiplicity of available techniques and tools (see also Klein et al. 2001: 108, fig 3, Methods and Tools). On the basis of ‘degree of participation’, Rowe and Frewer have classified the different instruments into a typology of what they call ‘public engagement mechanisms’ (2005: 276-282). Summaries of various interactive methods and their characteristics can be found in other places too. In Appendix II different participative methods are classified according to their envisaged aim (Honingh 2006).^{xii} On the Wageningen portal for multi-stakeholder processes (<http://portals.wi.wur.nl/msp/>), the different instruments are classified according to the point in the learning cycle when the instrument is applicable (see Appendix III). The abundance of different summaries and classifications shows that it is complicated to create a generic

42

Annette

de Vries (Real

Prosperity Foundation):

There is often a tension

between the demands or requests
a tension imposed by the outside
world or the principal on the process
and how things actually proceed. We

have a toolbox of methods and a vision of
the direction in which we want to go with a
process, but then it becomes custom-work
which gains shape as we go along. You cannot
determine in advance what results you are
going to achieve, only what the effort will be
and what quality conditions you will place
on the process. Then you trust that it will
generate meaningful results. This also means
that you should not drive it towards some-
thing which will be ‘scaleable’ – the
experiment is worthwhile in itself."

methodology for a mode-2 approach for unstruc-

tured problems. All the authors mentioned,

emphasise that the choice of instruments,
the actors to be involved, the sequence
of activities etc. is dependent on the

problem in question, the aim of the
exercise and the available resources
and time. Therefore, descriptions of
phasings, action plans and proce-
dures should be taken as guidelines,
not as blueprints.⁴² Also, the instru-
ments and techniques to be applied
will have to be modified to suit the
local context and dynamics; a
mode-2 approach is tailor-made.
(See, for example, Swaans, 2005)

MODE-2 PRINCIPLE
APPLYING INSTRUMENTS
IS TAILOR-MADE

4.2 SUCCESS FACTORS

The literature on interactive methods includes an outline of different (partly overlapping and recurring) phases; it provides a broad range of instruments which can be applied, and emphasises the context and problem-dependent nature of interactive methods and ‘emergent design’.

In our opinion, this does not provide sufficient structure for applying a mode-2 method for approaching

43

Frans Evers

(Member of RMNO):

"Mode-2 processes cannot be achieved by training intermediaries so that they know

precisely how they should approach them. It is about keeping processes open and being able to modify them, depending on what problems the participants have to deal with. It is also about the continual switch between content and process. That's very difficult. And it's why it so often goes wrong."

an unstructured problem. Phasing and toolboxes do give us insight into the what and when of the approach, but they offer no guarantee of success.^{43, 44}

It therefore seems useful to describe success factors, at four levels:

- At the level of the broader context
- At the level of institutional setting(s)
- At project level
- At the level of the participants

Research in the area of system innovations teaches us that interventions at several levels are necessary to achieve the desired change. Mode-2

‘projects’ aim to provide more than just results. It is the anchoring of the results in existing structures over the longer term that is the objective of the present endeavours. In recent years, the Athena

Institute has experimented with a framework for institutionalising a demand-driven and transdisciplinary approach (Broerse et al. 2000;

Zweekhorst 2004). The idea of this framework is to create the conditions for a successful mode-2 approach at four levels. First the ongoing acquisition of relevant competences by individuals; the development of methodological principles at project or implementation level; optimal conditions in the institutional context; and finally, a correlation with the broader social context. These four elements are indispensable ingredients for the desired changes. and their relation to one another is reproduced in figure 4.3.

Roel in 't Veld

(Policy Adviser):

"You can go a long way with a good design, but if you want to develop a balanced perspective, then you also have to pay necessary attention to people's fixations and deep core beliefs. These can engender a huge amount of resistance to accepting knowledge even if they don't dispute the knowledge itself. You can say fine things about processes, but you will be confronted by the raw reality. There are a number of dominant expressions present. You have to have stature – and, moreover, influence - to be able to refute these."

44

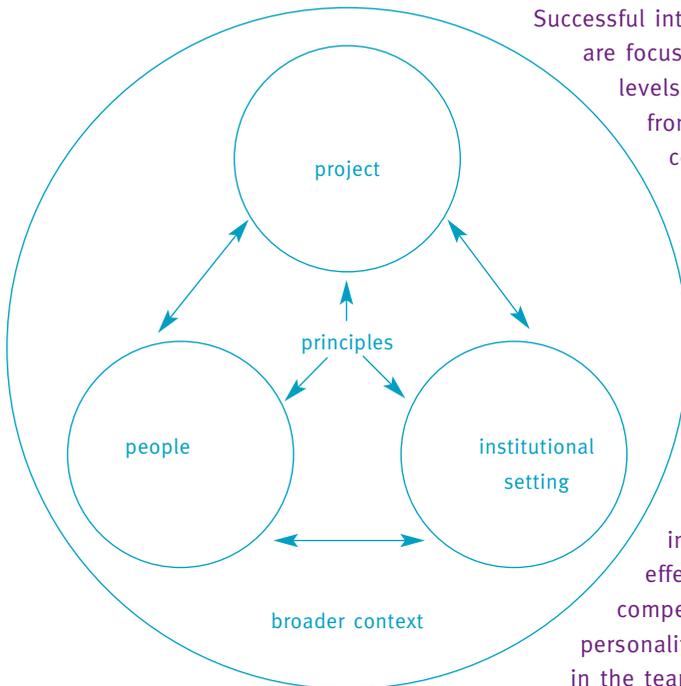


Figure 4.3 Framework for mode-2 methodology (Broerse et al. 2000: 289)

Successful intervention strategies are focused on these four levels simultaneously: from the broader context at the macro level, via the institutional context, to the projects and activity level, and then to the competencies of people at the micro level. Applying the right instruments is ineffective if the required competences and personalities are not present in the team. And a 'successful' project which is separate from the context(s) in which it is implemented will become isolated, will not be understood,

and will have little success and minimal duplication.⁴⁵

The framework clarifies why systemic instruments should play a network role in addition to a substantive, process role; depending on the aim of the project, the network role focuses on the institutional setting(s) and on the broader context.

A (not exhaustive) summary of the success factors which are mentioned in the literature (Caron-Flinterman 2005, Swaans et al. 2004, Klein et al. 2001, Broerse 1998, De Bruijn et al. 1998) relating to interactive approaches is given in table 4.3, organised into four (interacting) levels, namely: success factors at project level, at individual level, at institutional level and at the level of the broader context.

Roel in 't Veld (Policy Adviser): "You can regard it as a landscape with areas through which you can pass. In general, everything is shut tight, and sometimes there is a limited window when mode-2 is briefly possible. And then it closes up again, and there are no more opportunities for a while. Making good use of these 'windows of opportunity' for mode-2 is an art, or a skill."

45

Success factors for interactive approaches at four levels	
<p>Broader context (system level) Network is adaptive (neither too strong nor too weak) and provides learning opportunities</p>	<ul style="list-style-type: none"> • Believes in the project • Able to handle obstacles and implicit assumptions • Preferably an interdisciplinary team
<p>Institutional level <i>Organisational embedding</i></p> <ul style="list-style-type: none"> • Support from the home bases of parties for co-operation • Possibility for changes in the process 	<p><i>Process management</i></p> <ul style="list-style-type: none"> • Mutual trust • Secure atmosphere • Attention to whom to involve and when • Equal role for all participants • Iterative phasing, open process architecture • Well-oiled communication and documentation
<p><i>Stimuli</i></p> <ul style="list-style-type: none"> • Financing • Adequate assessment criteria 	
<p>Project level <i>Project leader / core team</i></p> <ul style="list-style-type: none"> • Drives the project • Social, communication and management skills 	<p>Individual level <i>Participants</i></p> <ul style="list-style-type: none"> • Committed to the shared objective • Open, listening, curious, empathetic • Skills for joint learning, reflective

Table 4.3 Success factors

Before explaining this table, we will make an important comment on the list relating to the nature of the success factors mentioned. People sometimes interpret success factors as ‘conditions for success’. A popular comment at ‘science and society’ conferences or meetings is, for example: “If there were a Nobel Prize for interdisciplinary research, then scientists would really be encouraged to look beyond their own discipline.” It is our belief that these conditions will never (all) be present and also that they do not need to be (Broerse 1998). In a mode-2 approach, creating the necessary conditions at the different levels is part of the process. In order to focus attention explicitly on how to create these conditions, we distinguish between two related dynamics in a mode-2 approach:

- The *boundary dynamics* for (working on) conditions at the borders of the project (institutional and broader context, participants)
- The *internal dynamics* for (working on) conditions within the project

With the *internal dynamics* it is a matter of creating an environment which optimally supports the basic principles of a mode-2 approach (knowledge co-creation, joint problem-solving, mutual learning, etc.). Intermediaries supervise the process of communicating, co-operating, learning and building up a network between the different participants by anticipating problems which can arise as a result of differences in vision, language and

Marga Kool (Water Board): "What is most difficult is to get people to be prepared to relinquish their own interests. You can first define the problem with them very clearly. And then there has to be an atmosphere in that process where people are willing to relinquish their own direct interests, or the interests of their environment, and to participate in thinking about and searching for a solution. You have to take the time for this, but it is also a matter of inspiration, that is, inspiring leadership. You have to keep coming back, keep getting together on a regular basis. Meeting once at the beginning is not enough."

46

power.⁴⁶ These tasks can better be carried out by a team of people rather than by one individual. It is for this reason that an interdisciplinary team is put together for the implementation of a mode-2 approach .

An important aspect of the approach is promoting mutual trust between the participants.⁴⁷ A certain degree of trust is crucial in order to gain access to sensitive information and implicit knowledge. Implicit knowledge is very personal and difficult to formalise. This makes it difficult to communicate such knowledge or to share it with others, while at the same time this knowledge is important in the case of unstructured problems. Creating a secure environment is therefore essential.

47

Frans Evers (Member of RMNO): "You have to build up belief in the process and trust in the intermediary. That takes a lot of time. The participants must trust that what is laid on the table is not a lie, but the reality. People must not think that you have a hidden agenda, because then you'll never get anywhere."

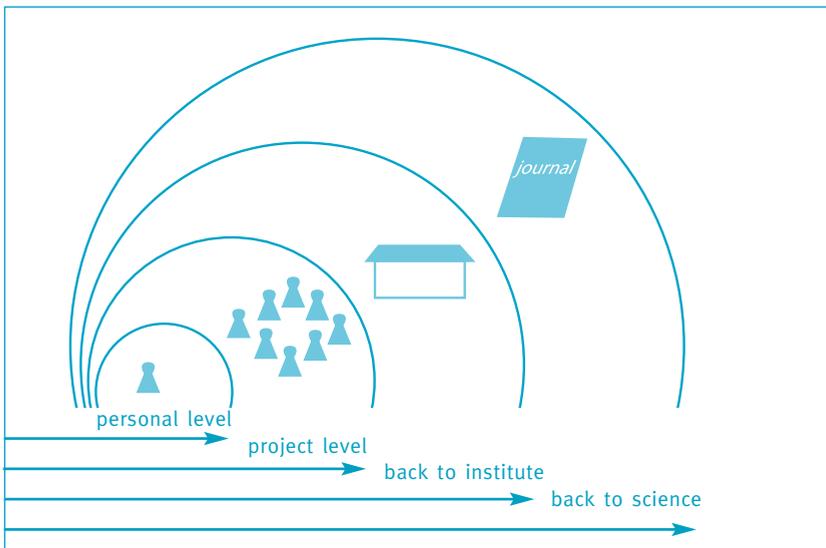


Figure 4.4 An illustration of the institutional environment and networks of a participant from science (from Tress et al. 2003)

Marga Kool (Water Board): "If you really want to be effective, there has to be enough feedback, because otherwise there is a risk that participants wholeheartedly take part in the process and distance themselves from their home-base colleagues, which results in a lack of support ."

48

Whether this is successful depends, among other things, on a number of other, external factors, including the institutional background of the participants. Or what 'task' people participating in a transdisciplinary research process take with them from their home organisation.⁴⁸ The illustration in figure 4.4 shows an example of the institutional environment and networks that a participant from science might face (Tress et al. 2003: 21).

Similar illustrations can be constructed for participants with different 'home bases'. For a mode-2 project to succeed, attention has to be paid during the process to the boundary dynamics. The root of boundary dynamics lies in the relationship between the actions of an actor in a mode-2 project and the framework on which his actions is based, that is, his professional and cultural background and the corresponding values, quality criteria and working method. The degree to which actors are able to participate openly, creatively and co-productively in a mode-2 project is dependent on the degrees of freedom which are offered by the other networks of which the actor is a member, which in their turn are dependent on the way in which these networks are organised and the level of inclusion of this actor in the different networks (Elzen et al. 1996). Research has been conducted from various perspectives into these correlations and the factors which can influence them.

Bunders (1987) for example, has studied the interaction between the macroscopic mechanisms of the scientific field of biology and the microscopic mechanisms of partnerships between biologists and non-scientists, and the limitations and opportunities which biologists encounter on the basis of their professional background (or macroscopic mechanisms).

Personal characteristics and capacities also play a role: for example, the degree to which a person is able to handle the dominant culture.⁴⁹ This means that it has to be clear what internal conflicts the participants have

Peter Nijkamp (Chairman NWO): "Older researchers are often not capable of this, because they are so attached to monodisciplinary research. I believe that a culture change is needed, and in my opinion we have to fight for this. Nonetheless, I have the impression that, after a long struggle, we have made some progress. In recent times I have seen increasingly that many panels are put together along broad lines and that nobody in these panels can play a dominant role. But it is difficult because transdisciplinarity in a monodisciplinary world is simply a hard task."

49

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Frans Evers (Member of RMNO):

"Someone might say: 'I consider this personally, as a representative of the environmental organisations, to be a good and achievable solution, which I should support, but, well, I have a couple of people at my home base who wouldn't agree.' The whole group then says: 'How can we help you?' From then on, it is no longer your problem. If you as the process facilitator have reached this point, then you know that the group has won. As process facilitator you have to be constantly alert to people's experiences of the project: 'I see you're doing that; maybe you have some problem with colleagues from your home base? Should we approach them together?'"

to deal with, and how to handle such conflicts.⁵⁰ For example, by training participants (at the project level) to act bi-culturally so that people (at the personal level) are able to translate the mode-2 working method (at the project level) into the modus of their home bases (institutional level). In addition, building a network is crucial for the success of a transdisciplinary research project. A network of different actors from the institutional settings can ensure balance and adequate support and resources to maintain the project and to ensure its implementation. It is also important to make visible to actors outside the project what the process is expected to produce.⁵¹

MODE-2 PRINCIPLE A MODE-2 APPROACH OPERATES AT SEVERAL LEVELS SIMULTANEOUSLY

So what does interaction between two different levels, or between participants with different Communities of Practice, mean for the role of an intermediary, or 'interactional expert' as Collins and Evans (2002) call it? To answer this question we return to the example of the Osdorp Complex 50. We see here two groups participating in the process as stated by the residents' adviser: "Actually, you had two parties during the design teams. The residents and myself on one side, and the corporation, the architect and the environmental adviser (the project team) on the other side." (Regeer and Bunders 2003). In spite of the large number of meetings in which a practice was shared, we cannot talk of a shared Community of Practice between the project

Jeroen Bordewijk (Senior Vice President Supply Chain Excellence, Unilever): "A long-term vision and leadership which supports the process are not enough. You also must have a view of what it delivers in concrete terms. My experience is that you have to be able to extract even small things from the process time and again, to create little products. We have done this consciously in our projects, each time ensuring that there is something to celebrate. Every year you have to make sure you have some 'positive stories', so that people can talk about what they are proud of in this project this year, and so they feel they have something to celebrate together."

51

team and the residents. The question then becomes; 'How can the project team and the residents interact in a meaningful way if they do not share a Community of Practice?'

To understand the co-operation and interaction between the residents and the others, we use the concept of *alignment*, which is used by Wenger as a way of becoming part of a 'community' without a shared involvement in daily practice.

"The process of alignment bridges time and space to form broader enterprises so that participants become connected through the coordination of their energies, actions and practices." (Wenger 1998: 179)

Scientists for example, bring their energy and activities in line with the practice of the production of scientific journals; they meet deadlines and comply with the expectations of peer reviewers without actually being involved in making the journal. Metze shows good examples of participants' alignment activities with interactive policy processes in the fields of agriculture and spatial planning in the United States and the Netherlands (Metze 2005). In the case of Osdorp Complex 50, the residents had to bring their activities in line with the working structure and expectations of the project team. Conversely, the project team had to give the residents' input a valid place in their Community of Practice.

In the case of the residents, the residents' adviser served as an intermediary who could facilitate the necessary alignment. An intermediary (or broker in Wenger's terms) is someone who creates different forms of continuity between several Communities of Practice. The residents' adviser did this by preparing meetings together with the residents ("I asked them to draw it as they would like to have it."), by accompanying them, by helping them during the design team meetings ("If it wasn't going well during the meeting, now and again I said: 'Time for a break.'") and by sending them to committees and council members ("Of course, I didn't go myself. If the voters are sitting on the bench it's different"). The residents themselves were those who actually took part in other practices, but the adviser ensured that the activities were 'in line' with the decision-making process and with the policy procedures.

An important characteristic of a Community of Practice is that meaning is created in the process together and is confirmed time and again.⁵² It is a dynamic process in which new knowledge and insights arise, instead of a static event where new knowledge may or may not gain acceptance. The members of the Osdorp Complex 50 project team also

talked about progressive insight, the gradual development of ambitions and the organisation of a collective exploratory process.

"This way of working is above all about organising a joint exploration. Of course, we have ideas, but we also have an open mind." (Architect).

"We started the discussion with what people believed to be the problems in the complex. There was already a general urban development plan in circulation, but what was important was that it should be the residents' renovation plan. So we just had to forget about the plan that was already there." (Corporation project leader).

"A success factor in this project was that people did not hesitate to call in third parties at an early stage." (Residents' adviser).

The importance of listening to one another was stressed.

"The main thing is that you listen. For example, there was a man who was very difficult to deal with, but if you really listened to him, you could pick up his points." (Environmental adviser)

In short, this dynamic process, in which listening to one another was an important aspect, meant that the *knowledge of the residents* came to be regarded as significant within the project team.

"A total ignorance of the residents' knowledge is a misjudgement of the knowledge that is available." (Project leader)

"The architect, project leader and I sometimes come up with things that are not very clever, and then it's a good thing if the residents are critical and point this out." (Corporation staff member)

"The development process was cyclic and iterative. As a result of the contribution of the residents, the design became significantly different from that which the architect would have designed by sitting at his drawing board." (Environmental adviser)

52

Roel in 't Veld (Policy Adviser): "If you apply configuration theories, then you see profound circles of social and cognitive dimensions of configuration. But the reality is not so fluent. Gradually things start to firm up. It is a good idea to stop such reflection. Just like in a marriage – we love one another and we know that. But at the same time, fixation can take place and then it's damaging."

In mode-2, the intermediary applies his interactional expertise, that is, his knowledge and skills in interacting bi-culturally, not so much in order to 'broker' agreement between the parties but much more to bring several different communities in line with one another. Thus, the intermediary creates continuity or congruency between Communities of Practice, or between certified and uncertified experts. This substantiates one of the recommendations made in the AWT report on multidisciplinary research (2003): namely the organisation of more interaction between

53 **Marga Kool (Water Board): "You have to remind participants that they have to stay in touch with their home base communities. You can facilitate this by providing time and also by supplying reports, so that they don't all have to repeat verbally what they themselves have understood."**

different disciplines and society. Organising interaction means bringing different worlds in line with one another: creating continuity between different epistemic cultures.⁵³

MODE 2 PRINCIPLE

A MODE 2 INTERMEDIARY CREATES DIFFERENT FORMS OF CONTINUITY (ALIGNMENT) BETWEEN SEVERAL EPISTEMIC CULTURES.

In Chapter 5 we use the concept of ‘alignment’ to handle potential pitfalls and intransigencies. In the final part of the present chapter on methodology we will take a closer look at a number of important aspects of the approach of transdisciplinary research. In paragraph 4.3 we describe the difference between participants in mode-1 and participants in mode-2 processes. In paragraph 4.4 we describe the mode-2 characteristics of exploring and structuring the unstructured problem.

4.3 ACTOR INVOLVEMENT

The essence of transdisciplinary research, as we have defined in Chapter 2, is the interaction between actors from different societal domains in order to reach a process of knowledge co-creation in the context of unstructured societal problems.⁵⁴ From this we can infer that the role perceptions of actors in mode-1 are different from those in mode-2. In mode-0 there is no involvement of actors, with the exception of ‘peers’.

Mode-1: Representation

In mode-1, knowledge demand and supply are brought together in a coordinated process. The emphasis here is often on clarifying the demand side so that the supply side can be combined with it. For structured problems the supply side does not need to be problematised: science can supply knowledge to resolve societal problems.

54 **Jeroen Bordewijk (Senior Vice President Supply Chain Excellence, Unilever): "We entered the process of sustainable agriculture from the view that something had to be done with agricultural production to avoid long-term problems. If you want to change something in a major system, for example palm oil, then you have to negotiate this with all the major actors. This is a totally new concept in this industry – that parties sit around the table together who previously would have been at one another's throats."**

Consequently, in mode-1, a logical distinction can be made between the parties doing the consulting on the one hand and the parties being consulted on the other. To legitimise the process, the consulting parties in mode-1 apply three different criteria to ensure that the parties consulted represent as broad a cross-section as possible. When citizens are allowed to participate, in mode-1 it is important that they form a reflection of the so-called 'general public', or that they are *represented* by societal organisations.⁵⁵ Moreover, when different sectors take part in the participative process, people are sought who *represent* their sector.

Annette de Vries (Real Prosperity Foundation): "When a Dutch Ministry started involving citizens in its policy-making, we at the Real Prosperity Foundation were called in. We were asked whether we could help think about which organisations to involve. Our advice was to think more in terms of people than in terms of organisations. After all, they wanted to involve the citizens."

55

Mode-2: the individual actor

The use of the 'model of representation' (whether in the form of a 'broad cross-section' or in the form of 'representation') for selecting participants for an interactive process is by no means a given in mode-2.⁵⁶ Political scientists have shown the growing influence of civil society on the legitimacy and the effectiveness of policy-making processes. Whereas in the classical-modern institutions legitimacy is obtained via a representative democracy, and via formal consultative procedures and

56

Marga Kool (Water Board): "In the past a representative of the actors' interests was always appointed, but he or she was more likely to represent a sectoral interest than the interests of individual farmers. The individual farmer might be prepared to sell land, if he could get a good price for it, that we could use to create water storage, while the representative for the sector might oppose the sale because he or she has to ensure that agriculture as a whole does not suffer. So the sector representatives are against anything that might weaken agriculture. Therefore we increasingly involve the affected farmers in important issues."

professionalised lobby organisations, in the new political arena it is necessary to re-shape the legitimisation of agenda-setting and policy-making processes, such as those surrounding biotechnology and food. (De Cock Buning et al. COS, RMNO, 2008, with reference to Hajer 2003) In particular with controversial issues, such as biotechnology and food, the positions of societal organisations are not representative of the concerns of society at large.

It may well be that it is not always desirable to strive for 'representativity', but rather to strive for a diversity of values, ideas and opinions, particularly for unstructured problems. In their work for the 'Public Conversations Project', in which dialogues are organised with a

Participants in debates	Participants in dialogues
Participants are generally 'known' opinion leaders.	Participants are generally not opinion leaders. They are people who speak as individuals, whose unique experiences differ from others on their side of the debate.
The behaviour of the participants tends toward 'stereotypes'.	The behaviour of the participants varies somewhat and does not wholly reflect the stereotypical images that others may have of them.
Participants speak as representatives of groups.	Participants speak as individuals based on their own unique experiences.
Participants talk with their own home base colleagues, and probably with the public at large.	Participants speak with one another.

Table 4.4 Participants in a debate versus dialogue based on Becker et al. (1992)

view to breaking through polarised debates, Becker et al. (1992) make a distinction between participants in debates and participants in dialogues (see table 4.4). People who take part in dialogues do not speak on behalf of a group of colleagues, but on their own behalf. These are people who are prepared to explore the nuances and uncertainties of a controversial subject from their personal experiences, instead of expressing and defending as strongly as possible the viewpoints of the people they represent.

Also, the authors of the RMNO report '*Biotechnology and Food*' (De Cock Buning et al. 2008) argue that by approaching people from society as individuals it is possible to go beyond the polarisation which is characteristic of societal and political discussions about biotechnology and food.

"While the ideas and opinions of important stakeholders (government, industry, NGOs, the scientific community) have largely been shaped and even institutionalised, the body of ideas held by society is generally under-articulated. So, although the institutional agenda includes inputs from society (via NGOs, but also via ministries), we hypothesised that these may differ considerably from the societal agenda. In order to go beyond already well-known opinions, professional societal spokesmen are not consulted in this research, but a societal agenda is constructed together with interested, but not professionally involved citizens. The construction of a societal agenda might provide options to overcome the vested polarisation between the institutional agendas."

De Cock Buning et al. 2008: 11-12

Annette de Vries (Real Prosperity Foundation): "In our methodology we focus on values in order to go beyond the individual interests. Otherwise you're playing a game of chess or monopoly: 'I'll give you this, if you give me that.' We have to come to understand the meaning of a certain objective to those involved, so that the values behind the interests will be connected."

57

In mode-2, participants are not regarded as people who speak on behalf of others or on behalf of a particular interest, but as individuals who speak from their own knowledge and experience. Thus, replacing a participant with a colleague or demographically comparable citizen will probably give a different result. The process is aimed not at uncovering the already formulated viewpoints of the different parties, but on developing and making explicit the as yet unarticulated ideas, value conflicts and uncertainties.⁵⁷ The intermediary or facilitator also plays a role in this process.⁵⁸ Participants are people who listen to and learn from one another. As the actors who participate in a mode-2 process have different Communities of Practice, they can be addressed on the basis of these roles, so that the process of knowledge co-creation does not become separated from the different practices of the participants. Bringing together those requiring knowledge and those offering knowledge is also important. As a mode-2 intermediary has said: "Now we have brought the people wanting knowledge and those supplying it into contact with one another, they know one another and also know where to find one another. They can now telephone one another if they have a question." Participants cannot be replaced arbitrarily. (current research Athena Institute, april 2006).

Different 'constructions' of the actors to be involved

In mode-1 we see that the processes are focused on bringing parties together by means of their representatives, while in mode-2 people are regarded as actors who participate in several overlapping Communities of Practice (see table 4.5). According to Wijffels, in an industrial society you have to ignore your personal interests and "do what is expected of you, [while] the network society demands a leadership that motivates and inspires people and gives them opportunities. You now have to take yourself to work." (Wijffels in Trouw, 5 January 2005). This also has consequences for the role of scientists and for the way in which scientists are approached.

58

Roel in 't Veld (Policy Adviser):

"Advisers often say: 'Look how independent I am.' I always dispute this because I think that it denies that you are in a relationship as an adviser which involves a particular bond. You shouldn't try to deny that bond. The relationship means that there is a kind of multiplicity of rationalities, but there are also many orientations on that relationship. The adviser who disregards the nature of the relationship because he is unable to be empathetic and does not have any feeling for what the rationality of the client demands, will not be a good adviser."

	WHOM TO INVOLVE	CHARACTERISTICS
Mode-0	DELEGATES AND REPRESENTATIVES  INDIVIDUAL ACTORS	'Peers'
Mode-1		Whom to involve is determined at institutional level Representation: - Representatives, (opinion) leaders - Representative citizens The individual can be replaced by a colleague or a demographically equal citizen The intermediary is neutral
Mode-2		Whom to involve is determined on a case by case basis Participant is held accountable as an individual The individual participates based on his personal and unique experience; he is not replaceable. Intermediary also plays a role

Table 4.5 Perspectives on participants

First, it is important that the participants, including the scientists, have an open attitude towards the subject and the other participants, and are willing to learn. Participants must also support the essential principles of the project; such as, for example, involving stakeholders in technology development and decision-making. There has to be a shared sense of urgency (see also De Bruijn et al. 1998: 86). As we saw with the Deliberative Mapping trial, scientists and specialists were selected for their capabilities and enthusiasm for interacting with citizens. It is, therefore, usually the case with transdisciplinary research that you first interview the participants who might be involved.⁵⁹

**Gertjan
Fonk (Project Leader,
Innovation Network): "In the
original ideal-typical model which
I developed – the system for Future
Images of Consumers – there was first a
solid stakeholder analysis. You need to
analyse not only the substantive perspective,
(that is, what someone's position is to a
problem), but also whether a person could be
a suitable candidate to take part in that type
of collaborative meeting. At DTO there was no
time or opportunity for interviews, and people
held different ideas about it internally.
You can't be too critical about a person's
suitability though, otherwise you'd be
left with nobody. Willingness is also
very important."**

59

60

**Gertjan
Fonk (Project**

Leader, Innovation

Network): "My impression of the commitment of societal organisations is that participating in interactive processes is not their core business; their mission is to lobby for particular interests. Therefore, they either don't participate at all or they send someone who is only there to represent a particular interest and participates mainly on the basis of a short-term vision. They don't want to commit themselves to considering the future, especially if it concerns possible developments whose effects are still unclear."

Second, it is not always possible to detach people from their institutional context in order to stimulate the creative process. This is partly dependent on the character of the individual person (their flexibility and willingness to stick their neck out and to tread new paths), but it also depends in part on the characteristics of the institutional context.^{60, 61}

It is often said that the scientific system hampers co-operation with others because scientists are judged on their publications in specialist journals. But additionally, the possibility of participation in heterogeneous partnership processes depends on the characteristics of a specific specialist field. The research described in Chapter 2 about the differences between the epistemic cultures of high energy physicists and micro-biologists, for example, demonstrates that some fields are more open to collaboration than others. Nowotny et al. (2001) interpret the collectivist culture of the high energy physicists as mode-1 and the more individualistic culture of microbiologists as mode-2. Based on this argument it would be safe to assume that it would be easier for microbiologists to take part in interactive processes.

Transdisciplinary research also offers opportunities for as yet undeveloped scientific areas such as ecogenomics. Current research in the context of the social aspects of ecogenomics has shown that there is a great deal of preparedness among scientists in this area to cooperate and involve other people. An interesting point to note is that the scientists who are involved in developing ecogenomics further, do not yet have a clear understanding of which stakeholders should be involved. Brainstorming in joint workshops on the question of who will benefit and who will lose from the development of ecogenomics, has resulted in the identification of possible stakeholders (Roelofsen et al. 2007).

**Annette
de Vries (Real
Prosperity**

Foundation): "When looking for key figures for the Real Prosperity campaign, we were pleasantly surprised by a number of entrepreneurs. They had more of an eye for the future and for what was happening in their social environment than some of the societal organisations, and they were much more curious about innovations."

61

Finally, we want to emphasise that in a mode-2 process, it is not only people who are selected according to mode-2 characteristics. As we have already seen, for a mode-2 process to work it is important that there are simultaneous efforts towards a creative and innovative process at project level and the embedding and securing of support at institutional level. The challenge for the core team of a mode-2 process is to have a clear view of when a mode-1 approach is suitable and when a mode-2 one is the right choice.

MODE-2 PRINCIPLE

PARTICIPANTS ARE INDIVIDUAL ACTORS

4.4 STRUCTURING THE PROBLEM

As we saw in Chapter 2, ‘real world, tangible problems’ are the starting point for transdisciplinary research. The assumption is that with this type of problem different perspectives which all define and structure the problem in a different way are possible; the vision of the problems and what knowledge is relevant will be different for each of the actors involved. It is the many uncertainties that surround major, persistent problems that have led to the need for a different, mode-2 approach. Science does not play the role of problem-solver, but rather works with others to structure the problems (Hisschemöller 1993: 170, 2005: 200). Whereas in mode-0 and mode-1 approaches the scientific knowledge development process starts with structured problems and generates solutions for these problems, in mode-2 the focus is more on the learning process.⁶²

Marga Kool (Water Board): "With mode-2 there is no discussion about science but about learning and research. That is also what administrators are talking about. They don't talk about knowledge, but they want to have things researched." 62

As a comparison, in the framework of strategies for sustainable development a distinction is frequently made between two ways of looking at challenges:

1. First, there is the view that sustainability is a goal in itself and that you can attain it: "moving toward sustainability [...by promoting] measures that undertake the technologically easiest, economically least expensive and politically most palatable activities." (Yanarella 2000: 132).
2. Second, there is the view that sustainability is a constant search for balance: "Sustainability as balance-seeking process. [...] Sustainability [...] becomes not a distant goal to be striven for, but a complex and dynamic process to be maintained in the face of continuing change and tendencies toward imbalance." (Yanarella 2000: 132).

Two opposing perceptions of problem definitions become visible: either problem definitions are fixed and unproblematic, or the problem is seen as changeable, subjective, context-dependent, etc.

Using examples, we will try below to fashion and substantiate different perceptions of problem structuring. That this is important is demonstrated by the analysis of the English stem cell debate of Nelis and Hagendijk (2005). (See insert). In a debate apparently about one subject, the two main actors apply a different problem definition.

The problem definitions conceal implicit assumptions about the conditions and subjects of the debate and about possible responses or directions for solutions. For a mode-2 process where a common direction for a solution is sought but in which participants do not share a Community of Practice and therefore do not share the problem definition, more insight into the construction of problem definitions is of great importance. In the example of the Osdorp Complex 50 project discussed in the previous chapter, there were several different problem definitions: residents wanted to have their houses and living environments improved; the project team wanted to meet the challenge of achieving a sustainable renovation project; and the local politicians were struggling with an outdated supply

"In the discussions between supporters of stem cell research and Pro-Life, both parties represent a different problem. Pro-Life represents the values of human embryos. The pro-research lobby represents serious untreatable disorders."

Nelis and Hagendijk 2005: 244

68

Marga Kool (Water Board): "It may be that someone says: 'Water storage does not have to be on land, just build a big pump.' This is not what we, in the Netherlands, think at the moment, but it might be that this comes out of the group. I believe that as a public administrator you must be able to re-consider the problem and the possible solution. It's different in practice. I have become rather cynical about this. I often have the impression that public administrators think largely in terms of their political convictions or interests; they already have particular ideas in mind and that such a process is supposed to fulfill their assumptions or wishes. Then people are not searching for the best solution."

of homes and had to compete with a new residential area which was being built in the neighbourhood. In an intensive joint process the problem definitions of different actors were brought in line with one another.

Mode-1: Institutionally determined

In the above example of the stem cell debate, the problem definitions of the two main lobby groups follow from what their organisation represents; they are institutionally determined.⁶³

Both within policy sciences and science studies, the institutional

64

Annette de Vries (Real Prosperity Foundation): "During a field trip about new Dutch environmental quality legislation, organised by Real Prosperity and the Netherlands Society for Nature and Environment, a member of the municipal staff indicated that if a person complains about noise nuisance, he sends someone to visit the location with a decibel meter. "If the noise is under the norm, I write a letter to this effect to the complainant. My task is then over." From his policy position noise nuisance was a problem of exceeding the norms: therefore the solution lies in measuring the number of decibels at a set distance from the accommodation. During the field trip the group passed through a number of noisy places. The civil servant in question was very surprised about what he himself experienced when he, as a 'resident', cycled through the neighbourhood. 'It is acceptable, but what a racket.' Noise nuisance was no longer a question of exceeding the norms, but of experience."

determination of problem definitions was described years ago.⁶⁴ In the area of science studies, Whitley (1984) writes that as an outsider, the possibility of exercising influence on knowledge development within a particular discipline is dependent on the degree to which the discipline is organised (see also Bunders 1987). Each scientific field has a so-called 'reputational (or appreciative) system' which consists of a particular degree of mutual dependence between scientists and a degree of uncertainty about the position and tasks of the discipline. If for example, there is a lot of discussion about what precisely the scientific discipline researches and what its intention is, there is task uncertainty. The possibility of influencing knowledge development is greatest when the mutual dependence is small and the uncertainty about the position and tasks of scientists within the specific field is great. Conversely, when a discipline is strongly 'institutionalised', and when the challenges of the discipline are clear and the relations between researchers are more stable, problems do not have to be continually redefined. The differences between the epistemic cultures which Knorr-Cretina (1999) has researched can also be understood in this way. With high energy physicists, the mutual dependence is very great and the position and tasks of this specialist field are clear; co-operation with others outside this field is almost impossible.

It is precisely this mechanism that encourages thinkers about transdisciplinary research to postulate that with unstructured problems the issue has to be defined on the basis of the problem situation, and not from existing disciplines. "Transdisciplinarity presupposes that reality escapes any combination of disciplinary perspectives, which are themselves treated as little more than an artefact of the last 150 years of the history of the Euro-American university system." (Fuller 2001) The research field does not determine what the problem is, but the problem defines the field.^{xiii}

The NIDO transition programme Sustainable Urban Renewal also started with a clear definition of what Sustainable Urban Renewal is and structured the programme on the basis of this (in terms of intervention activities and goals). However, this changed in the course of time: NIDO-DSV set the problem definition in motion. In the following paragraph we will give a sketch of the way in which NIDO's Sustainable Urban Renewal programme team handled defining the challenge which the programme sought to address.^{xiv}

Mode-2: A problem-definition in motion

The final report of the NIDO programme on Sustainable Urban Renewal gives a detailed description of how the 'challenge' which faced them was analysed and defined (see Van Twillert et al. 2004: 3.2.1). Initially, the choice was made to have an external bureau (Bureau Ruim and DHV) carry out an analysis to define and specify the programme. This analysis produced a number of specific issues (reducing mobility, pressure on space, etc.) and definitions (a sustainable environment = an area which facilitates the residents' needs). In a number of discussions with stakeholders and during three workshops, the analysis and the focal points were tested and confirmed. So far, this was a relatively standard way of establishing the 'challenge' and the problem areas.

However, with the arrival of the process manager a new situation developed. The focal points appeared not to meet the demand from the work field sufficiently. The process manager wanted to concentrate more on the conceptual framework and the related urban planning aspects for sustainable urban renewal. During round table discussions with experts from the field, the decision was taken to regard the substantive themes as questions which would have to be answered in the course of the programme. The central question was: "What is sustainable urban renewal about?"

The above description of problem structuring demonstrates an interesting dichotomy. In the first instance the aim was to achieve a definition and specification of the issue. Bureau Ruim and DHV defined the objectives and a number of related focal points. This generated the key features for a programme plan on which NIDO could make a start. However, the strategy of starting out with a well-defined vision of sustainable urban development was gradually relinquished. The question: 'What is sustainable urban renewal about?' did not have to be answered at the start of the programme, but was formative in shaping the programme.⁶⁵

Annette de Vries (Real Prosperity Foundation): "In 1999, the Real Prosperity Foundation started the campaign: 'And now: real prosperity!' The opening statement of the campaign was that in our striving for quantitative and material prosperity we neglect values and needs which are crucial for a sustainable society. To gain greater awareness of these values, a large scale publicity campaign was planned. Over time we became convinced that we ourselves should not determine what real prosperity is, but that we should discuss this with people in organisations and networks; the decision-makers, the opinion leaders, the key figures within organisations, politics and business. By discussing what real prosperity is by organising meetings, initiating projects and encouraging co-operation. The initial plan for an inspiring but lightly moralising broad publicity campaign was turned into a network approach: the big story became a lot of smaller stories."

65

In part this was related to the fact that there did not seem to be any shared problem definition. When the (new) programme manager checked what assumptions of the 'sustainability paradigm' were at that moment prevalent within the work field, sustainability seemed to relate to material use and energy savings or not to be on the agenda at all. Moreover, it appeared from interactions with people from practice (in seeking local projects) that it was not useful for the programme manager to enter the field with set goals and expect them to be implemented. "Speeding up substantive renewal (sustainable social approach) is something you do by joining in, not by adding something (work)."

The programme team therefore made a conscious choice not to establish in advance the concept of 'sustainability' in relation to urban renewal. Depending on the local demand and the predominant assumption about sustainability, the choice would be made as to which side the concept needed to be expanded. In practice this meant that the process or programme manager joined a local project and helped shape the discussion and articulation relating to sustainability. In short, the NIDO-DSV programme team applied a 'problem definition in motion'. What constituted sustainable urban development was continuously being reestablished. This contextual approach generated a pluriform collection of interpretations of sustainable urban renewal. In Den Helder, for example, the emphasis was on the local area economy, while in Vlaardingen social sustainability came into the picture via a video 'Well-loved and Sustainable.'

Structuring a problem in mode-2 is not an activity which precedes the process, rather it is part of the process. Sometimes an entire transdisciplinary research project can be about the structuring of the problem. Hisschemöller (2005), for example, describes the main characteristics of a participative learning process as:

1. facilitating the interactive *articulation* of conflicting perspectives
2. facilitating the interactive *evaluation* of conflicting lines of argument

3. facilitating the formation of a *conclusion* in the form of a consensus or competing policy options

Smits and Kuhlmann (2004) also underline the role of systemic instruments in the articulation of the demand (for innovations) and therefore also in the structuring of the issue.

This can be done, for example, by an intermediary joining in with the project in practice and expanding the problem definition on the spot (as in the example of NIDO-DSV). This stimulates the articulation of knowledge, concerns, insights and visions by people in practice (see also Loeber 2004). As people who are not professionally involved in the work of articulation are at a disadvantage in comparison to many scientists and policy-makers, it is often necessary to organise a separate process in which their articulation is facilitated, as in the case of the study into the societal agenda of biotechnology and food (De Cock Buning et al. 2008). In other cases it is the scientists who have also not articulated the issue such as in the case of the societal aspects of ecogenomics. By holding a joint workshop in which the scientists create an image of the possible contribution of ecogenomics to societal issues, a temporary structuring of the problem comes about. By involving societal stakeholders (the identified winners and losers of ecogenomics) in the subsequent phase, the problem is re-structured: a problem definition in motion (Roelofsen et al. 2007).⁶⁶

Finally there are problems where the established problem definitions conflict with one another, as in the case of the English stem cell debate (Nelis 2005). Bringing together these conflicting perspectives in order to redefine the problem can be a goal of transdisciplinary research. De Cock Buning and Cohen (2003), for example, brought together stakeholders involved in the use of small apes for research to jointly structure the problem. To minimise the influence of the participants' current interests, the discussion was placed in the future, by means of the question: 'What would you want to see changed by 2025 in small ape research?' The animal protection faction, primate researchers, laboratory animal experts, inspectors and policy-makers each wrote on paper the problems with small age research as they saw them and passed them to their neighbour on the right, who in turn wrote down what

66

Gertjan Fonk
(Project Leader,
Innovation Network):
"At SWOKA we did a project about transport for the disabled: this problem has been stuck for twenty years. The accepted thinking was that the problem was really with the taxi companies. Our solution focused on a joint approach by involving different actors who were relevant to the issue, not just the taxi drivers. We had three meetings with those different actors and we formulated an action plan. Eventually, this resulted in a covenant with a code of conduct for the different parties."

they thought the causes were of the problems presented (the so-called 'write and shift' technique). Subsequently the analyses were integrated into one problem description of the barriers and their deeper causes that have to be faced in order to reach a better solution in 2025.

Problem perceptions

Can we derive from these various examples any characteristics for handling problem-structuring in mode-1 and mode-2? The following different aspects of structuring the problem arise from the examples described (see also table 4.6):

We saw that there are mechanisms (epistemic cultures, such as a stable discipline) which determine how a problem is perceived (often implicitly). This can stimulate knowledge development for structured problems. At the same time it can be a hindrance for a mode-2 approach.

In mode-2 we see the idea that a problem is defined in its own context, by people and not based on the fixed problem perceptions of a policy field, an interest group or an academic discipline. Moreover, the problem definition is continuously in motion, and is never finished; the situation is regularly analysed in a cyclic process while seeking solutions, as outlined in figure 4.1.

The two definitions of sustainability/sustainable development mentioned earlier lead to the important insight that whether or not a problem is structured is not so much a characteristic of the problem, but rather a (sometimes unconscious) choice of the problem-owner. This is made very clear in the problem perception of different intermediaries working in the area of sustainable urban renewal we looked at (Regeer 2004). In some cases intermediaries approach sustainable urban renewal as a structured problem with sustainability as the goal. If an intermediary interprets his role as translating policy themes into knowledge programmes, he assumes that there is consensus about the values; it is after all a politically defined problem. In this case knowledge shortfalls can become apparent. If the problem is assumed to be structured, the knowledge gaps do not need to be problematised but the intermediary will present knowledge and information to reach a clear solution. Making information sheets available about the sustainable use of materials, is an example of this. Other intermediaries regard sustainable urban renewal as an unstructured problem and together with their environment engage in a search for the meaning of sustainable urban renewal in different contexts. Organising learning processes,

whereby people in the practical situation and researchers both learn from each other is an obvious method. For example, one can involve the residents' perspective in the development of sustainable neighbourhoods, not only in order to create support, but also because of their expertise.

	Problem definition	Characteristics
Mode-0	Sustainability is an objective Structured problem  Unstructured problem Sustainable development is an ongoing inquiry	Knowledge development is not problem-driven
Mode-1		Problem is structured: scientific knowledge development from discipline
Mode-2		Problem is dynamic: move with it Problem is context-dependent: facilitate local definition

Table 4.6 Perspectives on problem definition

The Osdorp Complex 50 example also demonstrates that problem conception is not so much a characteristic of the problem, but a choice of the problem owner. As the environmental adviser involved with that project stated: "In fact, you have four choices: patching things up, renovating, restructuring and repositioning, and demolition/rebuilding. The architect and the corporation made this project into a reality in spite of the objections which favoured demolition and rebuilding. The power is in the hands of people with conviction, who see the potential of the existing town, the existing housing and work from this." From the perspective of regular building practice, the choice for demolition would have been more obvious; it would then be a structured problem. Nevertheless, the client decided to approach the process in an interactive, learning way, which has doubtless produced a different result than if the project had been approached from a mode-1 perspective.

MODE-2 PRINCIPLE

PROBLEMS ARE DYNAMIC AND CONTEXT-DEPENDENT

4.5 SUMMARY

In this chapter we looked at the method of transdisciplinary research. We saw that designing a mode-2 approach is an interactive and iterative process in which the intermediary is continually making decisions about the interventions and instruments to be applied. For mode-1 problems, it is often sufficient to apply individual instruments, such as case studies (to show how things have gone), interviews (to show how particular things are going now), focus groups or opinion polls (to determine what opinions people hold), and classical forms of TA, such as life-cycle analysis, impact studies (to find out about the effects of particular technologies). The aim of mode-2 methodologies is to bring people into contact with one another and thereby to achieve a change in the research process. Transdisciplinary research methods are in fact always applied to achieve several goals simultaneously. The use of triangulation (a combination of methods) also has the aim of valuating the knowledge acquired from different perspectives and making it more robust. Describing this process makes clear and transparent to those who are not directly involved in the process, how the acquired knowledge has been developed.

In this chapter we have seen that paying attention to the environmental conditions of a project is also part of the research. The use of particular instruments therefore cannot be standardised, but rather must be tailor-made, and mode-2 principles are key in making those decisions. The focus is on processes, people and their networks. In a mode-2 situation, an instrument is never in isolation. The use of such an instrument is embedded in an analysis-intervention-output cycle in which interventions are related to one another at different levels. Moreover, the decision to apply a particular instrument is determined on a case by case basis. In each situation particular things occur and other things go wrong, sometimes it goes quickly, sometimes it takes longer and sometimes the whole process has to be adjusted.

MODE-2 PRINCIPLE **A MODE-2 INTERMEDIARY DETERMINES THE INTERVENTIONS ON THE BASIS OF INTERACTIONS**

Chapter 5 Intransigences

In the previous chapter we argued that a choice of suitable instruments (applied in the right sequence) in no way guarantees that these will support and stimulate the basic principles of the mode-2 approach. Rowe and Frewer posited that: "Although it is true that much of the success or failure of a particular exercise will stem from how the particular exercise is applied, we suggest that it is also true that structural features of the general mechanism will limit or enhance the chances of effectiveness." (2005: 264) Since recognising these structural (mode-2) characteristics of the method is related to a particular (mode-2) fundamental attitude which also penetrates through into the (mode-2) implementation of the method, we have formulated a number of characteristics, or principles, of a mode-2 approach. The MODE-2 PRINCIPLES described in this publication both with regard to epistemological and methodological aspects of transdisciplinary research are summarised in table 5.1 below.

Mode-2 principles
<i>Epistemology</i>
Scientific knowledge development and societal processes (such as processes for solving unstructured problems) co-evolve.
Scientific knowledge and experiential knowledge are integrated.
Opinions, ideas and facts are difficult to separate in the case of unstructured problems.
Knowledge co-creation is a communicative process which takes place within a shared practice.
<i>Methodology</i>
During the whole process, researchers and stakeholders work actively together.
The different phases are repeated in a cyclic process.
Monitoring and reflection promote learning within the process.
Applying instruments is on a case by case basis.
A mode-2 approach is focused on several levels simultaneously.
An intermediary creates different forms of continuity (alignment) between several epistemic cultures.
Participants are individual actors.
Problems are dynamic and context-dependent.
A mode-2 intermediary determines interventions on the basis of interactions.

Table 5.1 Mode-2 principles

In this chapter we describe the role of mode-2 principles in anticipating, recognising and handling potential pitfalls and bottlenecks. As we have constantly put mode-1 and mode-2 interfaces between science and society side by side in this publication, we have developed a sense of the intransigencies which occur with putting a mode-2 working method into practice. We will clarify these problems in this chapter and hope in this way to provide tools for mode-2 intermediaries.

5.1 PITFALLS AND BOTTLENECKS

Let us look at a practical example and the points it generates. The objective of the research programme 'New Cattle-breeding Systems' financed by the Ministry of LNV was to transition to a socially desirable and sustainable cattle-breeding industry in an interactive, interdisciplinary and innovative way (Bos and Wolleswinkel 2002: 2). The programme had all kinds of characteristics of a mode-2 approach as described in this publication. During a workshop in the course of the programme, the researchers involved were asked about the most important benefits and the main frustrations of working in interactive, interdisciplinary and innovative ways. The following conclusions emerged (Bos and Wolleswinkel 2002):

- The difference in time horizon between researchers (longer) and stakeholders (shorter) seemed problematic.⁶⁷
- Active stakeholders and researchers tended to move too far ahead, with the consequence that at later stages the communication and interaction with a broader public was more difficult.
- The group of stakeholders who were involved appeared one-sided.
- Processes were overly planned in advance.
- Interests and expectations should have been declared much earlier and much more clearly. This requires a dialogue.
- People have to make decisions more quickly based on their gut feelings, and dare to handle uncertainty.
- The consensus culture prevalent in Dutch society meant that in a number of project groups dissensions, dilemmas and conflicts were not addressed, but rather swept under the table.

It is interesting that the above observations and recommendations are not so different from the factors we have identified as being needed to make transdisciplinary research a success. In short, regarding the methodology of transdisciplinary research we can draw the following conclusions:

Gertjan Fonk (Project Leader, Innovation Network): "With the DTO project Vervoer Vraagsysteem (Transport Demand System), we brought together professionals from the areas of knowledge infrastructure, business, NGOs and government. It was difficult to keep the business participants involved. They felt that it was progressing too slowly. The process started from scratch, while they wanted to start further down the road."

67

1. Success factors are described extensively in the literature;
2. Experiences in practice provide points of attention which are apparently difficult to achieve.

Can we say anything more about the type of issues that people come across in practice? In Chapter 4 we emphasised the importance of the various contexts of a transdisciplinary research project. We have seen that a mode-2 approach has to bring four elements (or levels) in line with one another:

- the wider context with its set patterns and paradigms;
- the institutional settings with their own rules, procedures, cultures;
- the project with its particular ambitions and basic assumptions; and
- the participants with their values, interests, expertise.

As figure 5.1 below demonstrates, the issues which arose from the workshop on New Cattle-breeding systems all lie on the border between two levels (for example between a mode-2 project and a mode-1 context), or at project level (for example as a result of a difference between mode-2 intention and mode-1 implementation).

Issues in practice	Modus conflicts
<ul style="list-style-type: none"> • The difference in time horizon between researchers and stakeholders seemed problematic. 	<p>A conflict on the border between institutional and project level.</p>
<ul style="list-style-type: none"> • Active stakeholders and researchers tended to advance too quickly, with the result that in a later stage the communication and interaction with a broader public was more difficult. 	<p>Conflict on the border between project level and wider context.</p>
<ul style="list-style-type: none"> • Processes are overly planned in advance. 	<p>Conflict at project level between what people want and what they do; i.e. people want to work without a blueprint but don't do so.</p>
<ul style="list-style-type: none"> • Interests and expectations have to be declared much earlier. Dialogue is needed. 	<p>Conflict at project level between desires and actions.</p>
<ul style="list-style-type: none"> • The Dutch consensus culture meant that in a number of project groups, disagreements, dilemmas and conflicts were not addressed, but were swept under the table. 	<p>Conflict on the border between project level and personal (or institutional) level.</p>

Figure 5.1 Modus conflicts in two variants

We see, then, that with a mode-2 approach potential bottlenecks and pitfalls can be found in:

- A. *Boundary dynamics* (bottlenecks on the border between two levels)

B. Internal dynamics (pitfalls at project level which are related to the difference between intention and implementation)

Both cases relate to a modus conflict between mode-1 and mode-2. So when the consensus culture prevalent in Dutch society causes dilemmas, and conflicts are swept under the table, then this constitutes a conflict between the mode-1 attitude of participants and the mode-2 intentions of the project. Similarly, when processes are overly planned in advance, the conflict is between a mode-2 intention on the part of the project team and a mode-1 implementation.

68

Peter Nijkamp (Chairman NWO):
"We have at times, in the face of criticism, including from the field, said that we have to handle things differently, that we have to address knowledge via a thematic perspective and international partnership arrangements. Now and then, we have had conflicts with people who considered that the best way to see is through expensive monodisciplinary glasses."

The bottlenecks that become visible in the boundary dynamics, and the pitfalls in the internal dynamics, can be seen as intransigencies.⁶⁸ By this we mean the tendency of people and systems to continue to think and do what they have always done.⁶⁹ From the perspective of this publication we can understand such intransigencies as the manifestation of mode-0 or mode-1 thinking and behaviour patterns. We have regarded mode-0, -1 and -2 as explorative concepts, with which we could clarify and further develop methodological and epistemological aspects of transdisciplinary research. But at the same time we have also seen in Chapter 1 that appeals for transdisciplinary research are closely related to a changing vision of society; from an industrial mode-1 society to a mode-2 'network society'. Our society really cannot be described as mode-2 or as mode-1: we see both perspectives in all kinds of places side by side and simultaneously. For many problems, mode-1 institutions and working methods are very suitable. These do, however, often constitute a challenge when used for unstructured problems. When one wants to address an unstructured problem and apply transdisciplinary research, one comes up against mode-1 institutions, rules, working methods and assumptions which are not congruent with a mode-2 approach. Society is beset with intransigencies. This applies both for the environment (boundary dynamics) and for the working method and approach to the problem (internal dynamics).

69

Jeroen Bordewijk (Senior Vice President Supply Chain Excellence, Unilever):
"What stands out is that if you want to achieve a transition and you look at the issue, there are always institutions that say they have the solution. You should then say: 'That isn't what we ought to do.' We really have to try a different approach and distance ourselves from the straitjacket of established patterns. Then you have to involve parties both new and existing ones, to reach different constructions from those you already have or ones which you might never have thought of."

It is in fact possible, therefore, to anticipate modus conflicts; they are almost unavoidable. In an analysis of an interactive policy process in the Bijlmer Area, Metze (2006) shows how, by using language, participants drew the line between a new working method and an institutionally accepted approach.

Returning to the examples of the cattle-breeding system, it was not surprising that participants in projects tried to ignore the issues (or conflicts) because we live largely in a mode-1 consensus culture. The MODE-2 PRINCIPLE that people will be approached as individuals, with attention given to their individual concerns, expectations, wishes (and therefore also their differences, conflicts, underlying values, etc.) is directly opposed to the MODE-1 PRINCIPLE that participants represent their colleagues from their home organisations or can only participate in their roles as employees.⁷⁰ It is also possible to anticipate the second problem that arose in the cattle-breeding project namely, that people did more planning than intended. For professionals who are used to mode-1 project-style methods it is not easy to implement a MODE-2 PRINCIPLE of iterative and process-style working.

We see then that the strength of the modus typology lies not only in distinguishing different principles and characteristics inherent in transdisciplinary research, but also in better understanding the intransigencies which occur in practice.

Gertjan Fonk (Project Leader, Innovation Network): "During meetings we distanced people from their constituents by explicitly saying: 'you come from the ... group, but you don't need to side with them now.' Later on, there comes a point when you ask: 'are you prepared to commit yourself to this? If so, go back to your constituents'."

70

Bottlenecks and pitfalls can be understood as intransigence in boundary dynamics (a difference in modus between different levels) and the internal dynamics (a difference in modus between intention and implementation).

In current practice in Western society (which cannot be fully described as either mode-1 or mode-2), dealing with the interaction between mode-1 and mode-2 is inevitable. We will demonstrate below using a number of examples how the MODE 2 PRINCIPLES and the concept of alignment help to anticipate and deal with this.

5.2 BOUNDARY DYNAMICS

A very common bottleneck in transdisciplinary research is the modus conflict between the perceptions about knowledge in the project and of the potential participating scientists.⁷¹ At project level, the idea is that in order to be able to make a contribution to resolving unstructured problems, different types of knowledge have to be integrated. The AWT advice on multidisciplinary research states that: "In many, if not all, cases it will appear that the traditional borders between disciplines, and also between science and society, have to be crossed." (AWT 2003: 47) The MODE- 2 PRINCIPLE is that, as well as scientific knowledge, experiential expertise and practical knowledge are important.

Many people realise that this is easier said than done. As an example, during the research by Caron-Flinterman (2005) into opportunities for involving patient knowledge in biomedical research, it appeared that many biomedical researchers were very sceptical about patients' knowledge.⁷² There is a modus conflict between the mode-2 ambitions of the project and the mode-1 perceptions of a potential participant in the project. This conflict also played a part in the case of the Cumbrian sheep-farmers: the experts saw the farmers as lay-people as far as the dangers of radioactive contamination were concerned, while the sheep-farmers clearly had the necessary knowledge to discuss the dangers at local level. Both had what Collins and Evans call 'contributory' expertise, but it may be that the absence of 'interactional' expertise meant that there was no constructive interaction between the sheep-farmers and the scientists. It may be that an intermediary with 'interactional' expertise could have made a difference here; "Cumbrian

André van de Zande (DG, Ministry of LNV): "Who exactly are the peers? Who have the authority over these kinds of enterprising new forms of knowledge and knowledge businesses? That is difficult to answer. You quickly see among the better scientists a fear of being tainted, of: 'I am not going to get involved in social sciences, let alone experiential knowledge. It's not possible for me to make a good impression doing something like that.' So you have to include in people's career paths and their prestige development checks, balances and rewards."

71

72 Gertjan Fonk (Project Leader, Innovation Network): "At SWOKA (a scientifically oriented environment), I organised interactive processes and involved citizens in constructing images of the future. The reaction was: 'this isn't our style, this isn't 'scientific'."

farmers might well have had more success in their dealing with the scientists from the UK Ministry of Agriculture, Fisheries and Food (MAFF) and from the British Nuclear Fuels Ltd (BNFL), if their concerns were mediated by a Greenpeace scientist, a Brian Wynne, or the like." (Collins and Evans 2002: 256)

What then is the role of the intermediary with ‘interactional’ expertise? In Chapter 4 we introduced the concept of *alignment*. An understanding of the concept itself can help in taking a step further from simply observing or recognising the friction between the two levels. With the concept of *alignment* in mind, the awareness of a modus conflict may raise the question of whether and how the two modes can be brought in line with one another.

In the case of the biomedical researchers and patient participation, several alignment strategies were followed. First, on the basis of in-dept preliminary interviews, the intermediary^{xv} observed that it was not wise to put patients and sceptical biomedical researchers directly together in an interactive workshop. There was thought to be little likelihood of alignment. Instead, patients were encouraged to express their wishes, concerns and questions through focus groups. Subsequently, the intermediary created⁷³ a boundary object^{xvi}: the results of the focus groups were re-formulated into the form of research questions. Using the boundary object, the intermediary created alignment with the epistemic culture of the biomedical scientists^{xvi}. One biomedical researcher expressed his concern in the exploratory phase of the project as follows: "Patients usually lack the detailed professional knowledge to put their question in a relevant scientific context." (Caron-Flinterman 2005: 57) With the boundary-object, researchers could now better comprehend the ideas, wishes and knowledge of the patients and it was possible to organise an integration meeting (dialogue) between the parties. In an interactive workshop, researchers and patients agreed on a research agenda.

At a different system level we see another alignment strategy in this project. At the start of the research into the possibilities for patient participation in biomedical research, it appeared that scepticism among scientists was high and the interest in taking part in participation projects was low. The MODE-1 PRINCIPLE of participation (patients can probably discuss policy issues but cannot contribute knowledge) in the scientific field was too far removed from the MODE-2 PRINCIPLE of the intermediary (patients have knowledge which can be relevant for biomedical research), with the result that it was decided for the time being not to carry out transdisciplinary research projects. A number of years later there was the opportunity to implement the above-mentioned project with the Asthma Foundation. A culture change seemed in sight among biomedical researchers. There were now scientists who wanted to take part in the project and this example, meanwhile, has been followed by others:

**Roel in 't Veld
(Policy Adviser):**
"As an adviser I have to use my powers of empathy to understand what the client means by 'laying a foundation stone'. Only then can I construct a foundation stone."

73

at the moment in the Netherlands there is a broad range of projects in which patient knowledge is involved in biomedical research. In the second instance, more biomedical researchers seem to be willing to commit to the MODE-2 PRINCIPLE of participation. It is important to raise awareness of these kinds of initiatives and role models.⁷⁴ The example below is a good indication that personal experience is also often the deciding factor:

André van der Zande (DG, Ministry of LNV): "Research is people work. It is about education, but also about role models. I believe firmly in pointing out people and saying, 'wow, that's great, what you are achieving.' People who dare to do something at the interface and have gained prestige by doing so. I think it is very inspiring for young people who are starting a study or a research project. In the policy world we are looking at the 500 best policy programmes for 'the other government'. There will be a top 10 and eventually someone will win the prize. Then there will be a presentation in The Hague full of people, and that will give everyone a great boost. The person who won a prize there a number of years ago is now Secretary of State, so there is definitely prestige attached to finding different ways of developing policy. Of course, this should also be true in the scientific world, because there are successful people there. We have to dare to praise them and to point them out as role models."

74

Experience with experiential knowledge

There are many researchers who do acknowledge experiential knowledge in their scientific work. Often this is based on a very explicit experience which has opened their eyes. A worker in erosion and soil and water conservation can remember vividly the moment when he realised that it is important to catalogue and use local knowledge in his research. "In the Sahara I discovered that farmers know perfectly well what the cause of wind erosion is, why it gets worse and what happens. They explained it in qualitative terms and then I did some quantitative research, and found it to be exactly right. My eyes were often opened by those farmers. I generally advise PhD students to start by talking to the farmers close to the problem where they are going to be doing their research. You can learn such a lot from them. When doing my PhD, I did it the other way round. I first did my research and then at the end went and talked to the farmers. Then I discovered that they could tell me almost perfectly what I already knew. I thought, goodness, I should have started with them."

(Quoted in Zwaan and Mur, 2003: 38)

The alignment strategy which was chosen, when the time appeared ripe, was to focus intervention on the level of the participating biomedical researchers, and in so doing at the (institutional) level of the biomedical field. They started with minor interactions and experiments. A large scale patient participation programme would have had little chance of success in the starting phase because analysis of the knowledge assumption in the

network had shown there was a high degree of scepticism. Instead, personal experiences are created and people can be brought in line with one another. The intermediary learns from this (such as about the culture of biomedical scientists and possible changes to this) and at the same time it has an effect on the participants and their environments. The lesson learned here is that transition experiments at a niche level can lead to changes at regime level (Caron-Flinterman 2005: 82).⁷⁵

Modus conflicts in the area of boundary dynamics can be recognised with the help of MODE-2 PRINCIPLES: one has to look at the intended participants, the institutional settings and the broader context. On the basis of this an assessment can be made as to whether and how alignment can be created between the different levels. We therefore need to add to figure 3.2 from Chapter 2 the concept of alignment and how it can be used to enable the dynamics indicated to actually take place.

Jeroen

Bordewijk (Senior Vice

President Supply Chain Excellence,

Unilever): "We have started all kinds of projects within the sustainable agriculture programme in cooperation with other actors. We now see that very distinct processes and activities have developed from the projects, which lie outside our direct sphere of influence, but where we often still participate. You see a spin-off towards all kinds of other activities which lie outside our control. Other actors pick things up and create developments which contribute to sustainable agriculture."

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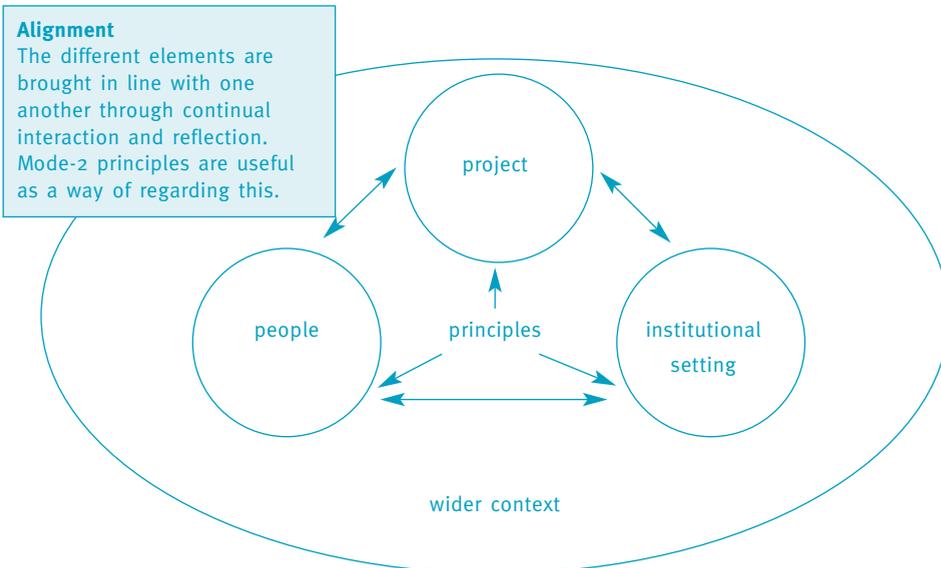


Figure 5.2 Framework for mode-2 methodology

5.3 INTERNAL DYNAMICS

Just as with boundary dynamics, the key to preventing pitfalls arising due to internal dynamics is that they first must be anticipated and recognised. We believe that the principles which we have formulated in the course of this publication can be useful here. Pitfalls become visible as the difference in *modi* between the intention of the project and the actual implementation of it.

A very common pitfall with transdisciplinary research is that during implementation knowledge integration is interpreted as combining pieces of knowledge from different disciplines and practices (essentially, a mode-1 principle of knowledge integration). This is also a pitfall with interdisciplinary research. A researcher who was involved in an interdisciplinary research project, that featured a partnership between anthropologists, geographers and economists, described that at the start of the project too little attention was paid to integration (in the sense of knowledge co-creation):

"In the first phase the researchers had to come to a common understanding. This was achieved through a number of discussions. The first discussions, of which there were too few, took place in 1996. You have to reach a common set of principles. It is not possible to combine two proposals by scrapping a few things here and there and integrating what is left over. You have to set up such a project completely from scratch. There was not enough time to do this, because such a process would take years." (quoted in Van Horsen 2002)

A researcher who took part in a European project with six partners had a similar experience. She emphasises that it doesn't necessarily have to take years, but that better process management would have helped.

"A first consequence of a lack of process management was that the project had a bad start. This was not due to a lack of time (because the start up lasted two days), but due to a lack of process management in an earlier phase during which the project proposal was written. Only a small part of the project group wrote the proposal and sent it to the rest of the partners asking for comments. Few of the partners reacted with comments because of lack of time and interest. Therefore, the proposal was biased by the ideas of the small groups and most of the partners were not aware of the content of either the proposal or their tasks. Consequently the partners were not committed to the proposal." (quoted in Tress 2003: 49)

Knowledge integration is approached from the perspective of coordinating knowledge instead of from the perspective of co-creation of knowledge.

Because the two days together were not used to create something collectively, using instruments for knowledge co-creation, professional process facilitation and a well thought out process design, people were not committed, to the project or to the concept of the co-operation.⁷⁶ Based on the MODE-2 PRINCIPLE that knowledge co-creation is a process which requires a safe environment, deliberation, dialogue, making explicit implicit knowledge, assumptions, wishes and concerns, etc., the start-up of the process should be structured differently by the project leader. This principle can be a guideline for reflecting on the process requirements. A good example would be an interactive workshop in which the definition of the problem is revised by the participants through dialogue after which they can establish where original research projects intervene, how they stand in relation to one another, what additional research is necessary, etc. However, often it appears that recognising mode-1 patterns in one's own behaviour (of the intermediary: in this case the project leader) is more difficult

than recognising mode-1 patterns in the environment.⁷⁷

Reflection by a researcher who is monitoring the project can be a solution here.⁷⁸

77 Annette de Vries (Real Prosperity Foundation): "Following field trips which we organised together with the Netherlands Society for Nature and Environment, we realised that it is not so much about discussing the questions of the citizens, but rather acquiring knowledge and gaining an understanding of the realities of citizens. You can only do this if you are aware of your own reality."

The following example shows how difficult it is to implement a mode-2 approach if you are a scientist trained in mode-1. The MODE-2 PRINCIPLE that you should involve end-users from the start to bring the demand for knowledge and the supply of knowledge in line with one another in a process of co-creation, was not internalised by the researcher. Many scientists feel safer in the role of expert as they have more experience with this role.

76 André van der Zande (DG, Ministry of LNV): "I see that researchers are very clever when they make proposals, whether it is for Brussels or for NWO or for a faculty. But I get complaints from the field, from entrepreneurs who feel misused. Not the major 'food industries' because they can look after themselves, but in particular the individual, innovative entrepreneurs. They say: 'It was very interesting to fill in the proposal, but after that I felt sidelined.' I am putting it rather dramatically, but it has to do with treating one another with respect. If you say: 'I will accept the knowledge from practitioners; the actors with the problems are a crucial element of transdisciplinarity,' then you have to follow through on this and really implement these actors in your project."

78 Roel in 't Veld (Policy Adviser): "Routine becomes obsolete if you don't engage in reflection. But reflection is also tiring. There is little time for it. The whole day you are busy with other things. It is a matter of setting priorities."

Entering into a discussion with those seeking knowledge and tailoring the research accordingly does not come naturally to them.

A researcher:

"The biggest mistake that I can recall from my time as a supervisor of the Costa Rica project; at one point someone said: 'that's a fantastic model with fantastic results, but it gives answers to questions which nobody has asked.' By then, it's too late to do the questioning phase. The problem happens because you think that you can only start talking with policy workers when you think that your system works." (quoted in Zwaan and Mur 2003: 33)

The reflection by this researcher (maybe induced by the interview) is a way of learning to recognise this pitfall. Training and gaining experience with other working methods can also make a contribution to the implementation of the mode-2 problem structuring process. That training alone is not always enough is demonstrated by the following example. The researcher from VU University Amsterdam hardly required any knowledge of the Bengali language to be able to observe the following.

"The Bengali agricultural researcher who was trained in the framework of a participative project to develop a problem construction with the farmers, using visualisation techniques, talked *himself* for two hours in the interaction with the farmers. During the interaction he explained the problems which the farmers had, used the visualisation techniques by outlining the situation, and explained again to the farmers what their problems were. He ended the two hour 'interaction' with *his* summary of the farmers' problem."
(Zweekhorst personal communication 2005)

In this case, too, there was reflection, by means of the observations and feedback of the researcher. Training and other interventions were determined on the basis of these kinds of observations.

Role monitor: contextualising principles

In this chapter we have re-formulated the MODE-2 PRINCIPLES for each example. Precisely because the principles in this publication are constructed with the help of the three ideal-typical modes, this offers possibilities to define other principles also, to formulate the principles differently or to recognise and place other characteristics (or manifestations of principles). Principles can thus be formulated, refined and clarified during a transdisciplinary research process.⁷⁹

Roel in 't Veld
(Policy Adviser):
"Take care with checklists. You have to watch out, because these checklists have to be adaptable."

79

CIS [Communication and Innovation Studies] is involved as a research partner in the health promotion project in an asylum seekers centre. The coordinator of the project, an employee of the GGD [Area Health Authority] sees the role of research in this project as reflective. 'As it is a pilot programme', we want to chart the whole process from start to finish. So the research serves to help us talk with the stakeholders and clarify the starting situation. The research is supportive, it serves the project. It is not the most important aspect. The research has to give the project, the groups, the participants and the coordinator, the inhabitants enough tools to be able to go further."

Quoted in Zwaan and Mur, 2003: 44

André van der Zande (DG, Ministry of LNV): "Who is going to peer review the BSIK foundations? I think a number of people should get together and say that they're going to take care of the peer reviews. Because sooner or later the question will arise 'what is the point?' Everyone is really enthusiastic right now because that's often inherent in these new processes, but does it have any substance, and will it stand up to criticism? That's what worries me, and you can't expect the ministry to organise the peer review. The most you can do is to invite the knowledge community to organise it themselves."

80

They are in this way contextualised: brought in line with the words, language and activities of the project (and vice versa). One way of doing this is by explicitly organising reflection, for example, by allowing a researcher to take part in the process and to reflect on it (see insert). By explicitly organising an action learning spiral, as indicated in figure 4.1, the reflection becomes part of the process. Methodologies such as 'learning histories', in which the lessons learned, or the formulation of principles, are drawn from what occurs during the process with the participants are suitable here. It is the stories of the participants, not of the researchers, which are fed back in the process. Even when the process is supervised by a professional, experienced intermediary, reflection is essential. In some cases an interdisciplinary research team gives both coaching, training and advice to the transdisciplinary intermediary, and reflection and feedback via monitoring (see Zweekhorst 2004, Caron-Flinterman 2005, Swaans et al. 2005, Broerse et al. 2005). Monitoring and reflection can be helpful with small projects, such as using a series of focus groups, but also with major programmes such as, for example, BSIK programmes,⁸⁰ which function as intermediaries forging links between science and society and creating new meanings to stimulate change.⁸¹ The question is both, how does the intermediary interpret mode-2 and how can we

Jeroen Bordewijk (Senior Vice President Supply Chain Excellence, Unilever): "Do transition programmes meet the basic criteria for the mode-2 approach? If I look at the transition programme which I am involved in, then I think it tends too much towards mode-1. Control is completely in the hands of the educational institutions who will write the knowledge agenda, instead of creating a dynamic situation where all kinds of connections are made between markets, but also with knowledge institutions."

81

use the concept of ‘mode-2 intermediary’ to reflect on the actions of the intermediary.

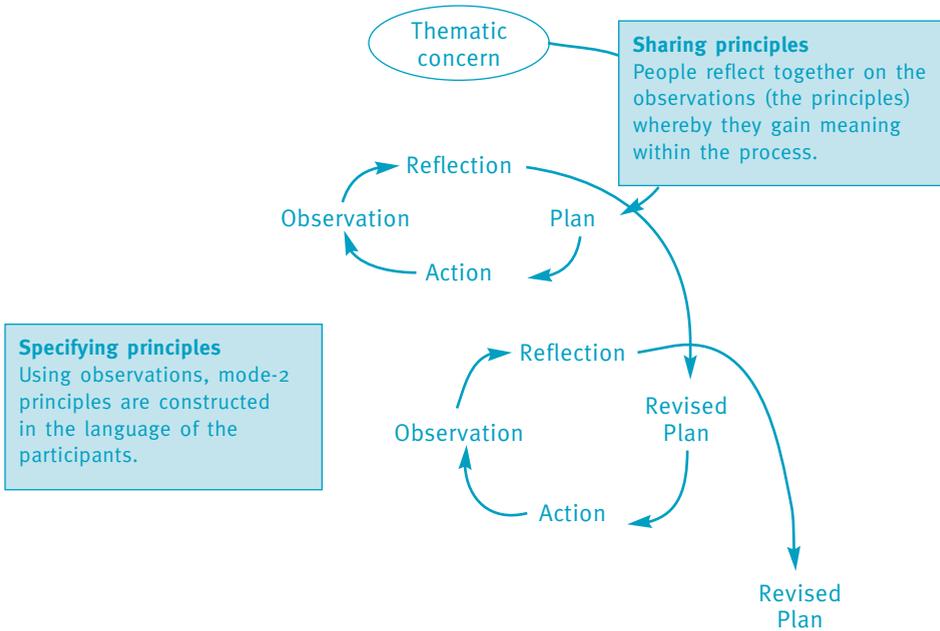


Figure 5.3 Principles in the action learning spiral

In the practice of present-day Western society, which cannot be fully described as mode-1 or mode-2, the dynamics between mode-1 and mode-2 and how they are resolved are the reality. Handling these differences is an inherent aspect of the objectives, tasks and skills of a mode-2 working method, project leader and/or participant. In mode-2 one has to be bi-cultural, as it were.

The degree of success of a transdisciplinary, or mode-2 approach, lies in the way in which the internal dynamics and the boundary dynamics are managed. The instruments and interventions applied focus on knowledge enhancing interactions within the process and alignment with the different (institutional) contexts.

5.4 SUMMARY

We have tried in this chapter to demonstrate the different types of intransigencies that can arise in a mode-2 project, because recognising them and reflecting on one’s own behaviour, is an essential aspect

of learning.⁸² Additionally, we have made a number of suggestions for handling potential intransigencies.

In the first place we have introduced the concept of *alignment*. The concept itself can help us go further than simply observing or realising that there is friction between two levels. The observation of the modus conflict can, with the concept of alignment in mind, lead to the question whether and how the two modi can be brought in line with one another. A number of possible methods have been mentioned: a particular context can be avoided for a time, an intermediary can bring two cultures in line with each other, two cultures can work together and bring themselves into alignment, or boundary objects can be created.

In the second place we have suggested that in order to prevent pitfalls, such pitfalls first have to be recognised.⁸³ It often happens that the intermediary had mode-2 intentions, but interprets

83

Roel in 't Veld
(Policy Adviser): "It

depends very much on the observational capability of the outsider. If you are very sensitive to this, then you see those fixations."

transdisciplinary research according to mode-1 norms.

It is important here that reflection and feedback take place with regard to the jointly established principles.

Gertjan Fonk
(Project Leader,
Innovation Network):

"Too little attention is paid to establishing the results of interactive processes, both in terms of form and content. This means that knowledge and experience are thrown away. What is most important is to hold on to the knowledge acquired in the process. For this you have to organise a research process, for instance, by formulating research questions with regard to the process. For example: 'Which actors are relevant for a certain issue to involve in an interactive process?' 'Can the parties change their existing behaviour?' 'Is the composition of the group important in order to break through firmly established institutional barriers?' I see this as an important step."



Chapter 6 Conclusions

Scientific knowledge development has brought us a great deal in past centuries. At the same time, in the 21st century we are being faced on all fronts with persistent problems for which scientific knowledge development has no direct solution. The problems are too complex for this: they are present at several system levels, different societal actors are involved, and there is neither consensus about the problem definition nor about the most suitable direction for a solution. For this kind of problem, new approaches for resolving the issues are needed. From science studies the term mode-2 has been introduced as a different, transdisciplinary, form of knowledge development (Gibbons et al. 1994) and as an indication of the changing relationship between science and society (Nowotny et al. 2002). For some time now explicit experiments have been done with the aim of shaping relationship between science and society whereby joint knowledge development is induced through intensive co-operation (e.g. Bunders 1990). In this publication different epistemological and methodological aspects of these forms of joint knowledge development are developed further.

6.1 RESULTS

What does co-production by science and society mean for the changing role of scientific knowledge production?

In the first two chapters of this publication we explored the basic traits of mode-2 (or transdisciplinary) research by setting it beside two other modes of knowledge development: mode-0, in which scientific knowledge development is considered an autonomous process, and mode-1, in which scientific knowledge development is coordinated with societal issues. Mode-2, or transdisciplinary, knowledge development implies an intensive co-operation between science and society. In mode-2 knowledge development and problem-solving can no longer be clearly distinguished and the primacy for solving unstructured problems therefore does not clearly lie with one of the domains concerned. Science and society are both actively seeking the best way of organising and facilitating change processes. This notion of co-production is consistent with the idea that it is not only scientific knowledge that is relevant for solving unstructured societal problems, but also societal knowledge or experiential expertise. It is difficult in mode-2 to make a distinction between the scientific process of innovation and the process of resolving unstructured societal issues. Instead, scientific development acquires the form of socio-technological innovation processes, in which new knowledge is generated and assessed by all those involved (extended peer review). Through the participation of scientists in the process, scientific knowledge is introduced and at the

same time the process contributes to the development of new hypotheses, questions and knowledge. Depending on the societal issue in question, mono-, multi-, interdisciplinary or experiential knowledge will be introduced and created to a greater or lesser extent.

What does this new form of knowledge production mean for our understanding of knowledge? What are the differences in epistemological principles between mode-1 and mode-2 knowledge production?

Chapter 3 focused on the question of what this new form of knowledge production implies for our understanding of knowledge. We described that whereas in mode-0 and mode-1, science has the primacy for knowledge development, in mode-2 other actors also introduce relevant knowledge which is essential for solving unstructured problems. This is founded on the epistemological principle that knowledge is socially constructed and reality is based on intersubjectivity. In addition, the importance of intensive interaction between actors for exchanging explicit and implicit knowledge is emphasised. We introduced the concept ‘Community of Practice’ to indicate how in a shared practice new knowledge and innovations are created. This perspective assumes that we acquire knowledge and ascribe meaning to this knowledge through participation in social practices, also called Communities of Practice. According to Wenger (1998) a Community of Practice is characterised by the mutual involvement of participants (instead of the formal structure of a project team), in a shared goal which is determined by all the participants together, and finally through a shared repertoire of resources which are developed in the course of time to develop meaning (or to create knowledge), such as routines, words, instruments, ways of behaving, stories, symbols and gestures. Knowledge development is then a communicative process which takes place within a shared practice. Moreover, knowledge, communication and behaviour are inseparably linked with one another; they create one another. From this perspective knowledge cannot be seen as separate from practice or context, but rather it is acquired or gains meaning within a shared practice, Community of Practice or epistemic culture. In this way the difference between knowledge integration and knowledge co-creation is clear. The knowledge co-creation process is at the same time the process within which the knowledge is safeguarded – through the intensive involvement of relevant actors in the process of knowledge co-creation, and thus ‘extended peer review’ takes place at the same time.

What are the different methodological principles that we can distinguish in the approach to knowledge development for unstructured problems in mode-1 and mode-2

In Chapter 4 we established that the development of a mode-2 approach is an interactive and iterative process in which the intermediary continually has to consider which interventions and instruments should be applied. In a mode-1 situation coordination activities take place to build bridges between two different worlds, while in mode-2 an environment is created in which actors shape mutual relations and together determine what is significant. In mode-1 the focus is on seeking solutions according to long established methodologies for relatively concrete problems, while in mode-2 the emphasis is on creating the conditions for structuring problems and supporting the search for possible directions for solutions.

We have described the transdisciplinary, or mode-2, approach as a cyclic process of planning, taking action, observing and reflecting. The overall process design consists of a number of phases or cycles. The choice for individual interventions and instruments is determined each time on the basis of interactions in practice. Transdisciplinary research is then tailor-made and a professional interdisciplinary team plays an initiating and facilitating role. Since transdisciplinary research aims to achieve several goals simultaneously, the approach used in transdisciplinary research will always be a combination of methods. It is this combination of activities which makes it a mode-2 project; the separate instruments are also often applied in mode-1. The use of a combination of methods (triangulation) has the explicit aim of evaluating the knowledge acquired from different perspectives and in so doing making it more robust.

Because transdisciplinary research focuses on unstructured, societal problems, it cannot be implemented in isolation from different contexts. In addition to internal dynamics (relating to the project team and the process design), a transdisciplinary project also involves boundary dynamics (relating to the participants involved, their institutional settings and the broader context). Working on conditions in the environment of the project is thus also an element of the research approach. It is not possible to standardise the application of particular instruments; instead it must be done on a case by case basis in a very precise manner, whereby mode-2 principles are key in making the decisions. In every situation particular things occur and other things go wrong. Sometimes the project progresses quickly, sometimes it takes longer, and sometimes the whole process has to be modified.

*Can we use the modus typology to point out intransigencies which become apparent in the practice of these new approaches?
Can we offer tools for handling these intransigencies?*

In Chapter 5 it was shown that the modus typology is well suited for highlighting the intransigencies which become visible in the practice of transdisciplinary research. We described the role of mode-2 principles in anticipating, recognising and handling potential pitfalls and bottlenecks by mode-2 intermediaries. Observation and reflection by an additional researcher can be helpful here. The concept of alignment clarifies how to deal with intransigence that arises as a result of a difference in modes between the transdisciplinary project on the one hand and the different participants, institutional settings and the broader context on the other hand.

The intermediary who facilitates the transdisciplinary research must therefore make sure that enough time and attention are paid to the boundary work by the participants. The intermediary should also equip them for this by, for example training the participants to act bi-culturally so that they can translate the mode-2 working method into a form recognisable to their home base. In addition, in some situations, boundary objects can be created which have significance in two different cultures or Communities of Practice. In other instances, a particular context will temporarily be avoided because the chance of alignment between the modus of that context and the ambitions of the project is considered to be small. When the opportunity for alignment appears to be present, it is crucial to seize it for the success of the mode-2 research process. A network of different actors from various institutional settings can provide balance, as well as sufficient support and resources to keep the project moving and to ensure its implementation.

6.2 PROMOTING TRANSDISCIPLINARY RESEARCH WITHIN UNIVERSITIES

In this publication we have shown that new ways of knowledge production have to be found for solving unstructured problems, but it is not that simple. Most people agree that the present disciplinary structures of universities form an important intransigence for transdisciplinary research. A number of recommendations have been made in different advisory reports, including for modifications to assessment systems, disciplinary structures, alternative career developments for scientists and new financing structures (e.g. AWT 2003, Klein 2001). These recommendations relate to changes at the institutional level that can facilitate or promote the implementation of transdisciplinary research.

In our opinion this does not imply that transdisciplinary research cannot be implemented in the context of the present scientific research structure. It does follow from this publication that monodisciplinary scientists who participate in transdisciplinary projects have to make extra efforts to achieve alignment with colleagues from their own disciplines. Scientists have to be equipped to do this. University educational programmes play an important role here. Increasingly, university education is promoting co-operation between different disciplines and between science and society, which will make participation in transdisciplinary research easier for future generations of scientific researchers. However, a condition of a successful mode-2 approach is that the intermediary who facilitates the transdisciplinary research devotes time and attention to the boundary work done by the participating scientists. These scientists do not only contribute to the process, they themselves have particular concerns and interests. For this to be possible, it is important that intermediaries have a good knowledge of scientific practices and preferably also of the relevant specialist field. Good intermediaries are competent in thinking and operating in transdisciplinary terms and usually have a background in the relevant scientific field as well. University master's programmes in which (science) students are educated to fulfil (and study the role of) intermediary in transdisciplinary research projects can play an important role in the further development and promotion of transdisciplinary research.

6.3 RECOMMENDATIONS

We conclude with a number of recommendations for intermediaries who supervise knowledge development and for those setting science policy.

Intermediaries who facilitate mode-2 knowledge development:

Opt for a transdisciplinary approach if the problem is an unstructured one. Unstructured problems are ones that occur at several system levels, with different societal actors involved, and where there is no consensus about the problem definition or about the most suitable direction for a solution. Establish at the start of a transdisciplinary research process a number of principles which suit the intended mode-2 character of the process based on the following questions:

Internal dynamics

- How do we organise interactions between science and society? How do we encourage the development of a set of shared visions, expectations, language and practices?

Conclusions

- How do we support open communication between the participants and the development of mutual trust?
- How do we ensure a flexible process design, so that the process can be adapted to changing circumstances? What mechanisms do we build into the system to accommodate this?
- How do we avoid problem perceptions becoming fixed too early, with the ‘jump to solutions’ which this may cause? What instruments can be used for articulating a shared problem definition?
- Whom do we involve in the process, on what basis and in what capacity?

Boundary dynamics

- What modus conflicts can we expect between the project objectives and the environment? What alignment strategies can we apply?
- How can we organise the transitions between knowledge co-creation and the development of support and implementation, by involving different people at different points in time?
- How do we support the participants in handling modus conflicts between the project and the participants’ home organisations?

Organise monitoring and reflection on the complete process, whereby the shared mode-2 principles are key.

Recommendations for those setting science policy

Encourage the exchange of experiences in the area of mode-2 processes. What can we learn from international programmes such as the Swiss transdisciplinary network? And what can transdisciplinary researchers, interactive policy-makers and transition managers learn from one another?

Encourage the monitoring and reflection of current transition programmes which can function as intermediaries to forge links between science and society, and create new meanings to promote change. How do they interpret a mode-2 approach to knowledge co-creation and what can we learn from this? And where and how can the transdisciplinary approach of these transition programmes be improved?

Encourage competence development in which professionals are trained to fulfill and study the role of intermediar in mode-2 research – sensitivity and experience are at least as important here as technical skills. Within universities, master’s students should be trained in the area of mode-2 research, thinking and behaving, as well as provided knowledge and skills in their specialist subject.

6.4 CONCLUDING REMARKS

A publication such as this runs the risk of suffering a lack of alignment with the different (epistemic) cultures of the readers. What is obvious for one person is an inspiring insight for another, and a question which is relevant for one person, is obsolete for another. Some readers are comfortable with the concept of alignment, others prefer to talk of congruency and still others consider contextualising a more suitable term.

Paradigms, Communities of Practice, operational theories, problem frame: do people mean the same thing by these terms, or are there real differences?

By developing other, different (intermediate) products for different target groups, we have in this project striven for alignment with diverse epistemic cultures^{xviii}. We have endeavoured through regular interaction with mode-2 intermediaries and transdisciplinary researchers through the course of this exploration to make the product more socially robust. This final publication uses the terminology of mode-0, mode-1 and mode-2 as concepts to reflect on different visions of knowledge, on the role of science, on methodology and on potential intransigencies.

We hope that we have shown that an approach to unstructured problems does not imply a naïve belief in a so-called ‘pure learning process’, in which everyone, equally free from vested interests, looks for the best solution for everyone. Also, we do not think that in solving such problems there should only be transdisciplinary knowledge co-creation; there is also a role for mono-, multi- and interdisciplinary research. Moreover, conducting a mode-2 approach also implies putting into practice mode-1 instruments for specific knowledge development and alignment with the institutional (and administrative) setting. It is for this reason that we have opted to describe not only idealistic situations for mode-2 research (that is, how it should be under ideal circumstances), but also the transitions and the continual exchanges between mode-1 and mode-2 approaches. By describing the principles of various different approaches, we hope to have provided guidelines for designers and facilitators of interactive and transdisciplinary research processes.



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Appendix I: Alphabetical list of participative methods (Rowe & Frewer 2005)

<ul style="list-style-type: none"> • Act Create Experience (ACE) (1) • Action Planning (1, 2) • Appraisal (Comm unity, Public), e.g., village/parish/ environmental. (Also "Monitoring", e.g., citizen monitors and scrutiny) (1, 2) • Arbitration (Mediation) (3, 4) • Broad-Based Organizing (1) • Cab le Television (Not Interactive) (2) • Cab le Television (Interactive) (3) • Charette (3) • Choice Methods (1, 2) • Citizens' Advisory Committee (CA C) (3, 5, 6, 7, 8, 9) • Citizen Advocacy (1) • Citizen Employment (3) • Citizen Honorary (3) • Citizens' Jury (1, 2, 6, 10, 11, 12, 13) • Citizens' Panel (Research) (2) • Citizens' Panel (Standing) e.g., Health Panel (2, 10, 14, 15) • Citizen Review Board (3) • Citizen Training (3) • Comm unity Dinners (16) • Comm unity Forum - of: Place (e.g., Neighborhood); Issues; Service Users; Shared Interest (2, 10) • Comm unity Indicators (1) • Comm unity Plans/Needs Analysis (10) • Comm unity Site Management Plans (1) • Comm unity Strategic Planning (1) • Comm unity Technical Assistance (3) • Complaints/Suggestion Schemes (10) • Computer-Based (IT) Techniques (2, 3) • Conference (generic te rm, often with qualifier e.g., "planning," "deliberative," "visualization") (3, 10, 17) • Consensus Building (1, 2) • Consensus Conference (2, 6, 18, 19, 20) • Consultation Document (Consultation) (10) • Consultative Panel (2) • Coordinator or Coordinator-Catalyst (3) • Co-option (Citiz en Represent atives on Policy making Bodies) (3, 10) • Deliberative Opinion Poll (2, 21) • Design-in (3) • Drop-In Center (also Neighbor - hood Office, One-Stop/First - stop Shop) (2, 3) • Enspir ited Envisioning (1) • "Finding Home" ("Visualizing our future by making maps") (1) • Fishbo w Planning (3) • F ocus Group (3, 6, 10) • From Vision to Action (1) • Game Si mulation (3) • Guided Visualization (1, 2) • Hotline (3) • Human Scale De velopment Initiative (1) • Initiatives (Citiz en Initiated Petition) (2, 22) • Imagine! (1) • Interactive Web-Site (10) • "Issues, Aims, Expectations , Challenges & Dialogues in a Day" (1) • Learning Service Team (2) • Local Sustainability Model (1) • Maps/Mapping (Village , Parish) (1, 2) • Media-Based Issue Balloting (3) • Meeting-Comm unity Sponsored (3) • Design-in (3) • Meeting-Neighborhood (location-based) (3) • Meeting-Pub lic ("Open Informational" generic) (3, 10, 23, 24) • Meeting-T own (New England Model) (2) • Meeting-T own (Electronic) (2) • Negotiated Rulemaking (6, 22, 25, 26) • Neighborhood Planning Council (3) • Ombudsman (3) • Open Door Policy (3) • Open House (2) • Open Space (1, 2) • Opinion Metres (2) • Opinion Polls (2, 10) • Participatory Appraisal (1) • Participatory Strategic Planning (1) • Participatory Theatre (1) • Planning Balance Sheet (3) • Planning Cell (27) • Planning For Real (1, 2) • Policy Capturing (3) • Policy Delphi (3) • Priority Search (2) • Priority Setting Committee (3) • Public Hearing (3, 6, 22) • Public Information Programs (3) • Publicity (Leaflets, Newsletters, Exhibitions) (2) • Question and Answer Session (10) • Random Selected Part icipation Groups (3) • Real Time Strategic Change (1) • (The) Recall (2) • Referendum (generic; compulsory response) (2, 3, 6, 10) • Referendum-P etition (2) • Referendum-Pref erences (Referendum) (10) • Roundtable (2) • Social Audit (1) • Study Circles (2) • Surveys (e.g., Comm unity, Tenants' (Service) Satisfaction) (2, 3, 6, 10, 16, 22) • Ta lkWorks (1) • Task Force (3, 28) • Team Syntegrity (1) • Te le-Polling (2) • Te le-Voting (2) • Time Dollars (1) • User Management of Ser vices (10) • Value Analysis (3) • Visioning Exercises(Conf erences (10) • Workshops (generic, may include: Action Planning; Design; Information Exchange) (1, 2, 3, 29, 30) • Whole System De velopment (2) 	<ul style="list-style-type: none"> • Drop-In Center (also Neighbor - hood Office, One-Stop/First - stop Shop) (2, 3) • Enspir ited Envisioning (1) • "Finding Home" ("Visualizing our future by making maps") (1) • Fishbo w Planning (3) • F ocus Group (3, 6, 10) • From Vision to Action (1) • Game Si mulation (3) • Guided Visualization (1, 2) • Hotline (3) • Human Scale De velopment Initiative (1) • Initiatives (Citiz en Initiated Petition) (2, 22) • Imagine! 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Figure 2. Alphabetical listing of "participation" mechanisms (references in parentheses).

SOURCES: (1) New Economics Foundation (1999); (2) Democracy Network (1998); (3) Rosener (1975); (4) Baughman (1995); (5) Lynn and Busenberg (1995); (6) Rowe and Frewer (2000); (7) Plumlee, Starling, and Kramer (1985); (8) Hannah and Lewis (1982); (9) Pierce and Doerksen (1976); (10) Lowndes et al. (1998); (11) Barnes (1999); (12) Cooto and Lenaghan (1997); (13) Melver (1998); (14) Downswell et al. (1997); (15) Kathlene and Martin (1991); (16) Carr and Halvorsen (2003); (17) Rowe, Marsh, and Frewer (2004); (18) Einsiedel, Jelsoe, and Breck (2003); (19) Guston (1999); (20) Joss (1998); (21) Fishkin and Luskin (1999); (22) Fiorino (1990); (23) Rosener (1982); (24) Sinclair (1977); (25) Coglianesse (1997); (26) Susskind and McMahon (1985); (27) Dielen and Renn (1995); (28) Stewart, Dennis, and Ely (1984); (29) Lundren and McLarkin (1998); and (30) Twright and Carroll (1983).

Appendix II: Framework of participative methods: objectives and related techniques & methods

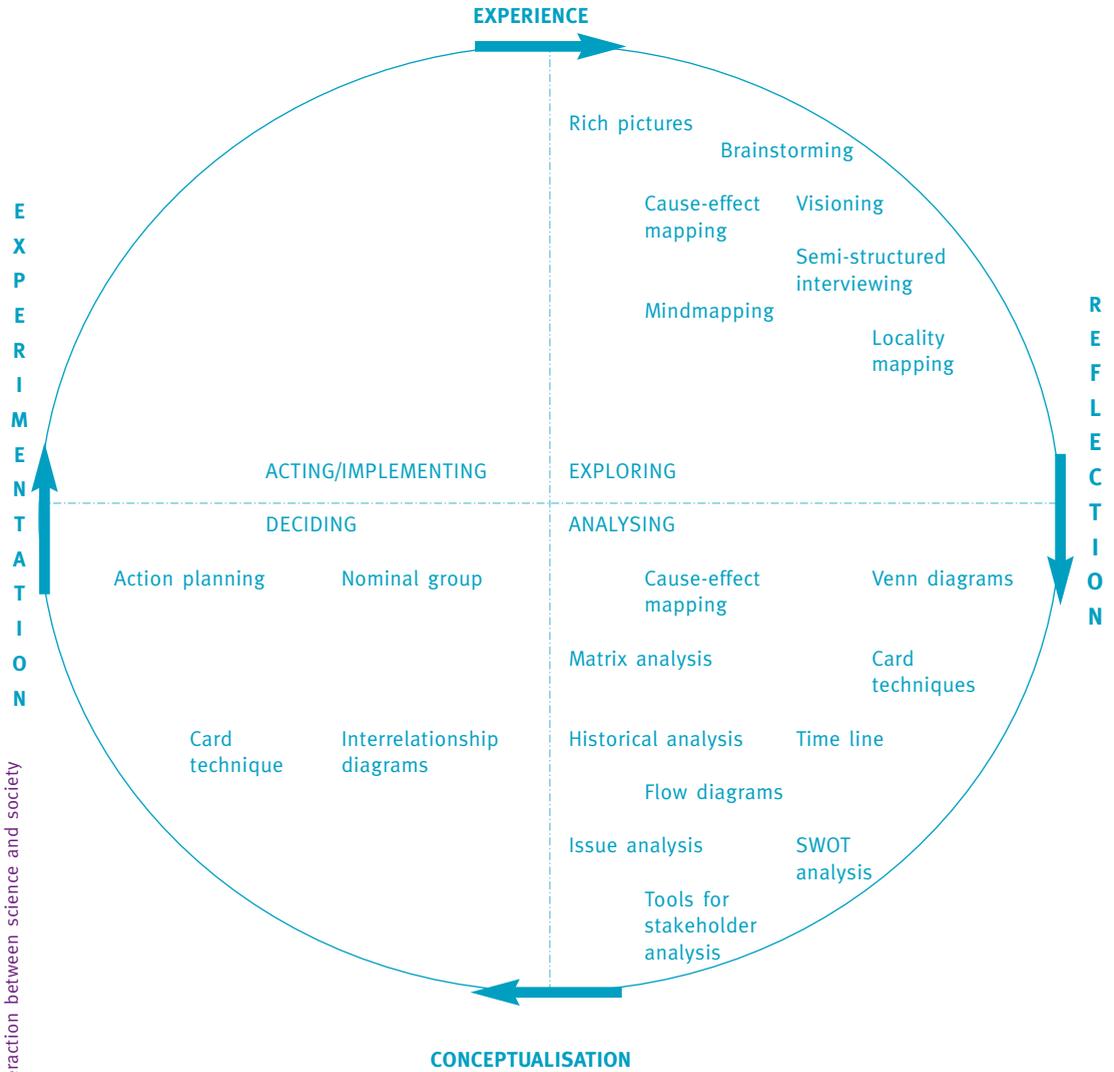
(Honingh, 2006)

	Objectives	Techniques	Methods	
Mapping out diversity	To gain diverse uninformed values, opinions, attitudes and preferences.	Focused questions, brainstorming and a planned, structured, focused discussion around the prepared open-ended questions in a safe environment.	Focusgroup	
		An iterative process of filling in questionnaires and receiving information.	Policy Delphi	
		A questionnaire with structured and standardized questions.	Survey (also opinion poll)	
	To compare representative and non-informed with representative and informed views, values and/or beliefs.	Three steps: - A survey is set out. - Informed deliberation: balanced briefing materials and afterwards randomly assigned small discussing groups. - The identical survey is again set out.	Deliberative polling (also deliberative opinion poll)	
To gain informed feedback, advise and open responses.	A small group of representatives monitor a process. Interaction with stakeholders.	Citizen (or public) advisory committee / board		
	Making a document (or website) with information on the subject, distribute this document to potentially interested people (or place it online) and inviting them to react.	Consultation document, also electronic consultation		
	Presentations are given to inform participants, on which they can respond.	Public hearings / inquiries		
Both	To exchange information (knowledge, opinions, etc) about different topics around a theme.	Several workshops / discussions around a central theme led by participants. each others experiences and	Open space	
	To educate and engage participants and gaining knowledge. (arguments)	Freedom of objective, learning from each others experiences and skills, equality among the participants.	Study circle	

Knowledge co-creation: Interaction between science and society

	Objectives	Techniques	Methods
Reaching for Convergence	To obtain an informed, recommended judgement/ consensus opinion/ advise/ solution or vision. (arguments)	Informing participants, question and answer sessions, negotiate / deliberation among participants.	Citizens' jury (also planning cell and citizens' panel)
			Consensus conferences
		Informing participants, discussion among participants	Task force
			Expert panel
		Brainstorming, developing storylines/stories, discussing the various scenario plots.	Scenario analysis (also scenario planning, scenario learning, scenario work shop)
To reach consensus between all (representatives of) stakeholder groups. (interests)	Negotiation by representatives of stakeholder groups.	Negotiated rule making (also regulatory negotiations and mediation)	
To reach the most reliable consensus of opinion. (arguments)	An iterative process of filling in questionnaires and receiving information.	Delphi also Public Delphi, Delphi Conference, Delphi face-to-face	
To obtain a democratic vote. (interests)	Voting within a fixed number of options in which all participants have equal influence.	Referendum	
	All participants can speak concerning the subject of voting. Subsequently there will be held a voting.	Town Meeting (New England model) with voting	
	A representative standing panel, which members rotate, that debates periodically on several topics and which opinion is aggregated via a vote.	Citizen panel - group based (e.g. health panel)	
To motivate and mobilise people and together prepare a concrete plan of action which spells out who will do what, when and how. (interests)	Briefings, icebreakers, topic- and design workshops.	Action Planning	

Appendix III: An example of the classification of methods



Knowledge co-creation: Interaction between science and society

Different instruments in the learning cycle (<http://portals.wi.wur.nl/mssp/>)

Endnotes

- i In 1990, Bunders et al. introduced a series of books on the 'Interactive Bottom Up Approach' (IBU), about transdisciplinary programming and conducting of biotechnology research with university researchers, farmers from developing countries, NGOs, Ministries and industry (Bunders 1990, Bunders and Broerse 1991, Bunders et al. 1996). This later led to the Interactive Learning & Action Approach (ILA).
- ii We follow here scholars who introduced this term from the perspective of changes in knowledge production: "In mode-1, problems are set and solved in a context governed by the, largely scientific, interests of a specific community. By contrast, mode-2 knowledge is carried out in a context of application. Mode-1 is disciplinary, while mode-2 is transdisciplinary. Mode-1 is characterised by homogeneity, mode-2 by heterogeneity. Organisationally, mode-1 is hierarchical and tends to preserve its form, while mode-2 is more heterarchical and transient." (Gibbons et al. 1994: 3). In the second instance, they used mode-1 and mode-2 terminology for a broader description of societal developments (Nowotny et al. 2001).
- iii The distinction frequently made between mode-1 and mode-2, whereby mode-1 refers to purely scientific and mono-disciplinary knowledge development and mode-2 to transdisciplinary knowledge development which takes place in heterogeneous networks, we expand with mode-0, in line with Vasbinder (in Fonk 2002). In our view, this tripartition sharpens our view of how mode-2 distinguishes itself from mode-1.
- iv The sector councils are independent exploration and programming colleges, with an interdisciplinary structure, consisting of representatives from society/industry, the research world and government (advisory members), who on the basis of, for example, mid and long term explorations and trends which have been signalled, carry out such activities such as formulating priorities for government-financed research with a societal focus." (<http://www.toekomstverkennen.nl/english.index.html>).
- v BSIK (Decision on subsidies for investments in the knowledge infrastructure; previously ICES-KIS 3) is a broadly structured, national research incentive programme which aims to provide Dutch society with more usable knowledge and research capacity by creating high quality networks in the knowledge infrastructure and to identify and encourage innovative research fields.
- vi "Technology Assessment is the systematic identification, analysis and evaluation of the potential secondary consequences (whether beneficial or detrimental) of technology in terms of its impacts on social, cultural, political and environmental systems and processes. Technology Assessment is intended to provide a neutral, factual input to decision-making." (Coates 1975)
- vii With moderately structured problems there is disagreement about knowledge and with unstructured problems there is disagreement about both knowledge and relevant values. (Hischemöller and Hoppe 1996).
- viii "The major challenge was to produce material that would satisfy the members of CoRWM in terms of its objectivity and technical accuracy and would be appropriate to a lay audience who did not possess technical expertise in nuclear issues generally, or radioactive waste management in particular." (Burgess et al. 2002: 9)
- ix Rip calls these modalities 'modes of knowledge production' and applies these terms, unlike us, for the internal and substantive side of knowledge production. (see Rip 2002)

Appendices

- x In the meaning of epistemic cultures.
- xi In a mode-2 approach the word ‘phases’ can therefore be replaced by ‘rounds’ or ‘cycles’. (See also de Bruijn et al. 1998: 24). Apart from that, many monodisciplinary scientists will also be more likely to describe their working process as a series of consecutive rounds/cycles, than as a linear process.
- xii Some other examples are:
Table 5.1 Methods of Public Engagement by Weldon (2004: 16-17)
Table 1: Summary of overview of participatory methods in ‘A look in the mirror: reflection on participation in Integrated Assessment from a methodological perspective’ (Van Asselt et al. 2001: 175-177)
Table 3: Summary of Techniques, Table 4: Application of techniques for different groups and Table 5: Techniques’ Scale and Costs in ‘Dialogue with the Public: Practical Guidelines’ (Research Council 2002: 31-34).
Comparative Chart in Participatory Methods Toolkit. A practitioner’s manual (Elliot, J., S. Heesterbeek et al. 2005: 27)
Schema 5.1: De methoden en hun kenmerken. In: *Innoveren in de groene ruimte: een verkenning van methoden*. (Dammers, E., J.A. Klijn, et al. 2002: 36-37)
- xiii In Albrechts et al. (1998) Kunitz’s analysis of illness and destruction of indigenous populations in the new world describes as follows: ‘he has sought to fully explore all facets of the problem by transcending traditional boundaries and allowing “the problem to define the field”’. (62)
- xiv The following paragraph is based on Regeer 2004 Chapter 2.
- xv Interdisciplinary team of the Athena Institute. In this project two of the roles of transdisciplinary researchers were interpreted which are described at the end of Chapter 2: observation and reflection on the one hand and process design and facilitation on the other.
- xvi Boundary objects are ‘scientific objects which are part of different bordering societal worlds and which meet the information requirements of each of these worlds. Boundary objects are objects which are plastic enough to be adapted to local requirements and to the limitations of the different parties who make use of them, but which are at the same time robust enough to maintain a common identity across local borders.’ (Star et al. 1989: 393). Translated according to Keulartz (2005: 22).
- xvii Biomedical expertise was present within the team.
- xviii In the context of this project, the following reports and articles appeared earlier: Regeer, B.J. (2003). *Nieuwe Tijden, Nieuwe Kennis? Een essay over kennisproductie in de risicomaatschappij*. In: *Niet bang voor onzekerheid*. M. van Asselt, A. Petersen, S. Huijs and S van ’t Klooster. The Hague, RMNO.
Regeer, B.J. and B. de Wit (2003). *Transdisciplinarity in Practice*. Innovation and knowledge-integration in Sustainable Urban Development. The Osdorp Complex 50 case. Workshop report. The Hague, RMNO, Vrije Universiteit Amsterdam, NIDO.
Regeer, B.J. and J.F. Bunders (2003). "The epistemology of transdisciplinary research: From knowledge integration to communities of practice." *Interdisciplinary Environmental Review* 5(2).
Regeer, B.J. (2004). *Tussen kennis and praktijk. De betekenis van ‘intermediair zijn’ in het veld van duurzame stedelijke vernieuwing*. Leeuwarden, NIDO.