A DIFFERENTIATED KNOWLEDGE CONCEPT MAKES A DIFFERENCE

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Introduction

In the knowledge based economy the human factor has been discovered as an important source of economic growth, as a source of continuous improvements in products and production processes needed for economic survival of firms (Cobbenhagen, 2000). It has been recognised that a firm’s core competence does constitute its ability to innovate rather than a specific product or technology.
Innovation is not just a technology push process, it is also a process of making new combinations of knowledge in order to solve technical, social and marketing problems in a certain context, e.g. within a production chain. It is characterised by complicated feedback mechanisms and interactive relations involving science, technology, learning, production, policy and demand (Edquist, 1997).
Kline and Rosenberg (1986) show that innovation is a complex interplay between different sources of knowledge both from the public (universities) and the private (within the firm) domain. It has been recognized increasingly that the concept of knowledge is multifaceted (see Gibbons et al., 1994; Nonaka and Takeuchi, 1995) and very likely that different types and forms of knowledge exerts quite different effects on the way economic activities are organized, on productivity and on the overall rates of technological and economic progress. Malerba and Orsenigo (2000) therefore state that we need better conceptualisations of what knowledge is, what its relevant dimensions are and through what mechanisms knowledge works.
As academic recognition of the difficulty to grasp the full complexity of the concept, in daily practice knowledge remains a blurred concept. Knowledge is associated with a lot of different meanings and connotations; for example in a ministry knowledge is research to underpin policies, in schools knowledge is the basis for competence and in firms it denotes knowledge intensive production or products. This leads to miscommunication and difficulties defining exact requirements for knowledge intensive policy issues.
In order to communicate better in practical situations Geerligs (2002) introduces a differentiated knowledge concept based on four practical questions.

Table 1

Question	Knowledge product
Is it true?	Insight
Does it work?	Design
Is it useful for a community?	Routine
Are individuals competent to do the job?	Competence

This differentiated knowledge concept is directed to the daily practice of policy makers, teachers, managers of innovative firms and project coordinators. The purpose was to develop a model and language that assists during the complicated process of innovative trajectories. With a differentiated knowledge concept it will become easier to keep track on the knowledge based change that should be the endpoint of a project and the knowledge that has to be collected or developed along the way. Being explicit in terms of knowledge products and addressing them with exclusive names in the phases of the trajectory, should limit the chance of miscommunication.

In this article we elaborate further on Geerligs’ model and show how it can be used to evaluate complicated innovative trajectories and give directions towards a better implementation of innovation, resulting in a sustainable change in society or business.

A differentiated knowledge concept

The origin of Geerligs' differentiated knowledge concept relates to the collapse of the Dutch agricultural knowledge infrastructure, the so-called OVO-triptych (*Onderzoek-Voorlichting-Onderwijs = Research-Extension-Education*). Rutten and van Oosten (1999) conclude that the OVO-triptych, the leading structure from the'50-ies until the '80-ies, was based on uniformity of targets and obviousness of policies. In the '90-ies the targets became diverse and the policy a subject for debate.
Rutten and van Oosten (1999) and Verkaik (1997) describe a 'new' knowledge infrastructure in which science, technology and innovation are the three leading elements of the innovation cycle. They propose a LAT-model; the three live apart together. Each of the three has a core competence of its own, a specific perspective, a jargon and means of communication. An essential characteristic of the LAT-model is that knowledge production takes place in each of the areas. They refer to the principles of knowledge production as described by Nonaka & Takeuchi (1995).
Gibbons et al. (1994) made a differentiation in types of knowledge, they distinguish mode I and mode II knowledge. Mode I knowledge is conventional (multi and inter) disciplinary science, exemplified by the outputs of industry research centres. In contrast, mode II knowledge is trans-disciplinary and created in the contexts where it is put to use and its results are highly contextualised (p. 19). Speaking in terms of mode I to mode II knowledge Rutten and van Oosten (1999) describe the 'old' OVO-triptych with mode I typology. The system is based on a shared perspective and has a uniform and disciplinary basis. The LAT-model however has many characteristics of the mode II knowledge production. It is diverse, has multiple actor perspectives and has a trans-disciplinary basis. Verkaik (1997) pleads for a well-balanced focus. That is the reason for the proposed LAT-relation, where all three elements keep their autonomy and nevertheless will be strongly related.

A missing element in the LAT-model is that they do not mention the school as an institution, neither competence as a knowledge product. Geerligs & le Rütte (2001; p. 58) discuss the relevance of competence for innovation: '… the core problem of innovation is acting accurately in situations where routines need to change …'. This is the operational aspect of trans-disciplinarity in the typology of Gibbons et al. (1994). Where competence applies to individuals, Geerligs & le Rütte also touch routines to address communities of practice. '… innovation and systems innovation do not apply to individuals but to groups or to interlinked groups. In that case it is important to stimulate and establish that communities of practice discuss openly their individual and collective winning or loosing, success and failure …'.

The first two elements of the LAT-model, science and technology, result in the products insights and design of the differentiation formulated by Geerligs. The third element, innovation is described as the creation of new products, services, processes and transactions, where they do refer to processes of change and useful instruments to encourage people to make this change. Especially this last part comes close to the concept of routines as Geerligs uses. Adding competences leads to four knowledge products: insight, design, routine and competence. Geerligs (2002) combines these with four practical questions that people can ask themselves during a meeting, in relation to issues involving knowledge and discussing new developments:

1. Is it true?
2. Does it work?
3. Is it useful for a community?
4. Are individuals competent to do the job?

If they are not able to answer the question they have to gain more knowledge. The way to provide this knowledge is a matter of working on information and tacit knowledge in a helix of knowledge production (Nonaka & Takuchi, 1995). According to Geerligs (2002) the questions apply in a mode I as well as a mode II context. The questions and knowledge products that give the answer to the questions are shown in table 1. The significance of the products is shown in an example of the invention of a car.
For the construction of a car it is important to know that exploding petrol produces energy. Based on this truth and many other true *insights* a car can be designed. For this car to be an

interesting *design* it is important that it works, does the combination of true insights and working designs lead to a larger design: the construction of a vehicle that runs properly? A working design only leads to an innovation, when the product is useful for at least one group of people. This means it has to be the best available solution for a problem that they perceive. The motive may be profit (taxi driver), convenience (tourist), transport (traveler), beauty (collector), etc. Consequently this group of people are willing to change their *routines*. The last crucial element is that people have to be able to drive the car, if not they have to be taught new *competences* for the innovation to be efficiently utilised. The competence can be gained at driving schools and the driving license provides an entry to the car driving community of practice.

Approach

In order to determine the usefulness of the differentiated knowledge concept, it was tested with expert panels. During two sessions with experts in the area of rural development the differentiated concept was used to evaluate a number of policy trajectories that the experts brought up. The purpose of the meetings was to test if the model is useful to support knowledge intensive businesses, public bodies or knowledge institutes by providing them better understanding of the complexity and diversity of knowledge. It should be used as mean to communicate more precise what knowledge is available, what is missing and what are the necessary next steps towards the final goal of the project or innovation.
The first expert meeting was organized with the focus group on knowledge of the Dutch Ministry of Agriculture, Nature and Food Quality. Policy makers of different departments meet together in this group to support each other with their knowledge intensive policy issues. The second meeting was held with the Innovation Network, an organization that supports innovative projects in the domain of rural development and nature conservation.

Case I
Focus group of the Dutch Ministry of Agriculture, Nature and Food Quality

Description
The main concern of the policy makers was the complexity of knowledge intensive policy issues. In contrast with, for example, legal policy interference, there is no fixed trajectory set for interference through knowledge development. Where to start, where to go and where to end is difficult to determine since the development of new knowledge is an open-end process.

Before explaining the model of differentiated knowledge products the policy makers were asked what knowledge is available already on the topic of their project and what will be the next step to be taken in their opinion. For most of the 10 participants it was difficult, at least to give a concrete answer for their case.
This was the point that we introduced our model of knowledge differentiation. Making the difference between Insight, Design, Routine and Competence appeared to be a useful concept for the participants to improve clear thinking about knowledge. During the discussion they were using the concepts immediately and expressed that they are helpful to be more precise about what knowledge is needed in the project. The discussions about the cases that the experts introduced became immediately directed towards the crucial elements of the process. What is the ultimate goal, what has to be changed, and what steps are essential to get to this change?
All project goals, when formulated in terms of desirable societal change, deal with change of routines of communities of practice. This shows that the final step in an innovative project is the change of routine of a particular group. Developing new insights or designs and improving competences of individuals are only necessary pit stops on the way to changing the necessary routines.

Example case
One of the participants wanted to get better insight in the colour perception of birds, to be able to use fishing nets that would scare birds away, instead of letting them kill themselves in the nets thinking they would find a nice supper. In his project the focus is on developing new

insights on the colour perception of birds. However, when this would be the end of the project, nothing is going to change. The new insight on colour perception of birds has to be combined with insights and designs on how to develop good fishing nets. When a new design on bird friendly fishing nets is available the routines of the fishermen have to be changed. When there is no change of routines, the fishermen will not start using the nets and all other steps have been useless.
In this case the change of routines might not be the most difficult part of the project, in most cases however this is the main bottleneck. Changing behaviour of people is in general the most difficult thing to do. Despite this (or because of this?) we see that many projects hardly pay any attention to change of routines, many projects even end before this point. The expert meeting at the focus group showed this clearly.

Analysis
The current way of thinking about knowledge intensive policy issues is that more knowledge is required to solve the policy problem X. Introduction of the differentiated knowledge concept helps the policy makers to define a knowledge intensive issue as: the solution of policy problem X requires a change of routines of community Y, from old Routine (R) to a new routine (R`), and this requires the supporting insights A, design B and competences C. This allows for better-formulated request for knowledge and consequently better-implemented and more sustainable innovations.

Case II
A workshop at Innovation Network

Description
The Innovation Network intends to support innovations in agriculture, food and land use. As the complex problems affecting rural areas and agricultural production are often interlinked, the Network aims to induce reforms, which will solve several problems at a stroke rather than focusing on a single field.
Innovation Network therefore develops wide-ranging, novel concepts to achieve goals such as optimum logistics, sustainable land-use, sound animal husbandry, and the environmental-friendly cultivation of vegetables under glass. During their five years of existence they learned that a creative concept is not enough, and they meet difficulties to pinpoint the lack in their approach.
In May a workshop was organized to evaluate a number of their projects from the perspective of the differentiated knowledge concept. The participating employees of the Innovation Network were asked to assign their projects dealing with land use issues to one of the identified knowledge products. The following table shows the result:

Project	Knowledge product
New concepts for landscape management	Design
Temporary nature	Design
Converting Grass Oil	Design
Sand Partners	Design
New Rivers	Design
Living with water	Routines
New Villages	Design & Routines
Renewal of land use	Design

The table shows the projects are focussing on the development of new designs. After this general characterization, one of these projects was discussed in more detail. This is described in the next section.

Example case
The project ‘New Villages’ is targeted at a number of interrelated problems that current Dutch villages encounter, such as a shortage of employment opportunities, a shortage of houses, an ageing population, commuting routes that taint the landscape, decreasing facilities such as shops, problems relating to care provision, a diminishing sense of community, and the

deterioration of spatial quality because the villages only expand at the periphery. Besides there is a cluster of problems that beset the direct vicinity: besides providing for living, working and recreation, rural areas must also accommodate water storage facilities, and with the gradual disappearance of agriculture, new forms of landscape management need to be embedded.
The project aims to be a refreshing inspiration to designing groundbreaking concepts, unhampered by preconceptions and unhindered by spatial restrictions and existing rules. Designs that offer a sustainable solution to the economic, spatial, social, ecological, landscape and water management problems that presently beleaguer Dutch villages; and concepts that recognize and utilize the opportunities offered, for instance by the growing interest in rural living.
'New Villages' started with an overall, nationwide exploration, followed by an elaboration on local level, and concluding with a redefinition on a general level. First, a systematic description is made of the kinds of problems faced in and around villages. In the second phase (January 2003), this overall exploration is being contrasted with the local problems faced by the municipality of Dantumadeel in the Netherlands.
At the local level, first, an inventory was made of the problems and opportunities in the municipality of Dantumadeel that a new village could solve or utilize respectively. At meetings with representatives from the region, specific problems were identified that a New Village should solve. The problem sketch was used to direct the design assignment. Three consortia of designers and other (landscape) experts created a physical and organizational design for the new village, in which at least three problems were interconnected. These designs were then presented to the population and representatives; not just to gauge their response, but also to provide such information and to garner such enthusiasm that, in time, the municipal council will decide to push forward with the plan for a new village.
Looking from a differentiated knowledge perspective it was concluded that in the first phase of the project the focus was on a new design. In the second phase an attempt was made to change the routines of important stakeholders involved, that is local administrators, designers and civilians. One of the problems they encountered was that these groups were `treated' as separate actors, but in reality the routines of the three groups interlock. For example, the Innovation Network wanted to achieve that stakeholders from the local community were involved in the designing process. For that to happen not only designers need to change their routines but also local community groups.
Although the Innovation Network has been aware of such problems, they could not easily communicate them. The distinct in different knowledge products provided them the vocabulary to express their project experiences explicitly.

Analysis
The current method of working applied by the Network focuses on developing new insights and design that need to trigger routine change. Remarkably the Networks main goal, i.e. changing routines, is not central in their method: it is a sub stage often tried to arrange at the end of their trajectories (when time and money are running out). During the discussion it became clear that the experts of the Network assume that an inspiring new design will lead automatically to routine change. The differentiated knowledge concept leads to an explication of the weak spot in this assumption and the following discussion concluded with the realisation that in many cases their new design was not followed by a change in routines.

Conclusion and Discussion

The evaluation of presented policy trajectories shows that the differentiated knowledge concept leads to a more explicated problem definition. The policy makers of the Dutch Ministry of Agriculture found it difficult to answer the question to define the knowledge aspect in their project. Only after the introduction of the differentiated knowledge concept they were able to communicate in concrete phrasing about the knowledge issues in the different trajectories. For the professionals in the Innovation Network the differentiated knowledge concept provided them with a vocabulary to make their learning experiences explicit.
A second effect is that the differentiated knowledge concept helps to specify appropriate action as can be determined whether it is a question of more research to gain insight, development of a design, the application in a user context or training of competent people.

The policy makers of the Ministry came up with another framework to specify knowledge issues in terms of: the solution of policy problem X requires a change of routines of community Y, from R to R`, and this requires the supporting insights A, design B and competences C. This enables better articulation of the necessary knowledge at all stages of the innovation process and consequently better-implemented and more sustainable innovations.
During the expert meeting with the Innovation Network it was addressed that the knowledge products are interrelated to each other. To have a successful innovation, the development of one product (a new design) should lead to developments in the other products (new routines, improved competences). The transformation from one knowledge product to another is assumed to take place automatically. After only short discussion it was agreed on that this is not the case.
The transformation between these knowledge products seems to be a crucial element of innovation. So far, not much is known about how these transformations take place. In general people tend to think about innovation as a linear process starting with the development of scientific insights (cf. Kline and Rosenberg, 1986). Kline and Rosenberg argue that innovation is a cyclic process that can start with technological design as well as in the market. Based on Geerligs' differentiation of knowledge products there are 12 possible transformations that can be distinguished during such a cyclic process. The possible transformations are shown in the matrix below.

	Public	Private (organisational)		Private (individual)
To / From	Insight	Design	Routine	Competence
Insight		1	7	11
Design	6		2	8
Routine	10	5		3
Competence	12	9	4	

The linear model of knowledge transfer includes only the three transformations (number 1 to 3), from insights to design, from design to routines and from routines to competences. The firm as knowledge producer (cf. Nonaka and Takeuchi, 1995) implies that this can also be going in the opposite direction, from competence via routine and design to insights (number 4 to 6). This can also be seen in the paradigm shift from demand to supply driven markets. Starting an innovation at the level of (competence and) routines of the users and develop new designs that match these. In his inaugural lecture Jorna (2000) gives the example of software companies. A new software program can be designed starting from the actual way people are using computers (their routines), or they can be based on the ideal way they should do this (insights about the optimal way of acting). He finds out that most program designs are based on the latter, which creates a problem implementing the software. As the users have their reasons for their existing routines, these are not going to change easily to match the new design. As a result the design has to be adjusted again. For this reason, as Jorna states, we already have a 9th version of Word and Word Perfect, even though it is only a program to facilitate a relative simple task as writing.

Additionally it is possible that some steps in this chain are jumped over (e.g. from competence directly to insight (number 7 to 12). The development of the bread machine described by by Nonaka and Takeuchi (1995) is a good example of such transformation. One of the crucial elements of this innovation was to transfer the knowledge on how to knead the dough to a design of the bread machine. For this, the individual competence of a professional baker had to be transformed into the development of a new design (number 9 of the matrix). After

externalising the art of kneading the bread dough this knowledge had to be combined with the knowledge on designing kitchen machines to come to the design of a new bread machine. After this investment of gaining knowledge on bread making a last essential transformation has to take place for the bread machine to be an innovation, the customers have to change their routines and use a bread machine instead of buying their bread at the bakery, or knead and bake their bread by hand. Matsushita did pay attention to this transfer early in the process by defining seven product specifications that had to make sure that this transformation would go easier. For example one of the specifications was that the bread had to be rectangular shaped, like a regular loaf of bread. This caused additional problems in the design process, however it is important to have fewer problems during the transformation from design to routine, since the culture gap between the old and the new routine is smaller. In general this change of cultural habits and expectations make this transformation the most difficult transformation of the innovative process (Hoeve & Nieuwenhuis, in press). Commercial companies are aware of the difficulty of this process when introducing a new product; therefore marketing is an important part of the company. In other? policy issues the focus on this last important transformation is less present for some reason. The use of the products and the transformation matrix could help to make this more apparent.

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