Please refer to this text as follows:

Verdonschot, S.G.M., & Keursten, P. (2011). Learning with the intention of innovating: eleven design principles for knowledge productivity. In R.F. Poell & M. Van Woerkom (Eds.), *Supporting workplace learning: Towards evidence-based practice* (pp.183-203). London: Springer.

Learning with the intention of innovating: 11 design principles for knowledge productivity

S.G.M. VERDONSCHOT
P. KEURSTEN

Our society is gradually becoming a knowledge society. Peter Drucker (1993) speaks of a revolution that is comparable to the industrial revolution that started in the 18th Century. This means that the traditional factors of production, labour, land and capital, make way for the factor of the production of 'knowledge'. By applying knowledge, people develop gradual improvement and radical innovations that lead to new products and services which provide for economic growth. This shift from an industrial society towards a knowledge society requires a change in the focus of learning in the context of work. In order to be successful in a knowledge economy learning with the intention of innovating becomes increasingly important.

Learning with the intention of innovating is a special form of learning. For a long time, learning in the context of work was organized serially (Nieuwenhuis & Van Woerkom, 2007) first learning, and then the application of this learning at the workplace. However, the effects of these training programmes in terms of the transfer of what had been learned to the workplace was disappointing (see: Baldwin & Ford, 1988; Burke & Baldwin, 1999). This was one of the reasons why the focus shifted from a training orientation to a learning orientation (Marsick & Watkins, 1990). Notions such as work-based learning, work-related learning and workplace learning emerged. Many of the learning processes that take place at work focus on helping employees to become better at their work. For instance, by observing a more experienced colleague at work, one can learn the intricacies of the profession. However, learning with the intention of innovating refers to another form of learning. It is not so much initiated from the perspective of learning (how can I become better at this task?), but rather from the perspective of work (how could we solve this problem?). This is the kind of learning that takes place when a difficult question or problematic situation arises for which no solution has been found yet. Then, learning and working coincide. To enable this process, the work environment should be a rich learning environment (Kessels & Van der Werff, 2002). In this case, learning is not seen as a means to support the work, but rather as something which itself adds value to the work by improving and innovating it. The concept of knowledge productivity (Kessels, 2001) integrates the notions of learning and innovating. Knowledge productivity refers to the processes through which new knowledge is developed, contributing to the gradual improvements and radical innovations of products, services and operating procedures.

In environments in which the desired outcome is to achieve standardisation, repetitive routines and fixed procedures, the desired level of performance can be clearly described. In these environments a gap analysis helps to identify the required learning interventions. However, when the desired situation cannot be defined clearly, which is the case with questions whose answers are aimed at leading to innovative solutions, a clear path of interventions cannot be defined. Then, the desired situation cannot be defined clearly and a clear path of interventions cannot be defined in advance. It is not possible to systematically design a learning process that analyses the actual and the desired situation and to design a learning process to overcome the gap (Keursten, 1999). Learning with the intention of innovating is a process that happens in practice and that is about creating a context in which people participate and thereby acquire the abilities needed (Brown & Duguid, 1991).
This process of learning in practice for innovation cannot be managed systematically (Harkema, 2004; Van de Ven, Angle, & Poole, 1989). The term management implies control of processes that may be inherently uncontrollable (Von Krogh, Ichijo, & Nonaka, 2000). It is a learning process that takes place while working, driven by people who are motivated to find answers to the intriguing questions they encounter.
The aim of this research is to better understand the learning processes undertaken by employees with the intention of gradual improving or radically innovating their organisations' products, processes and services.

2. Problem statement

The idea that people and learning processes are the only true source of competitive advantage in a world where products can so easily be replicated (Walton, 1999) and the fact that high levels of success can only be achieved in organisations that are able to develop creativity and innovation (Majaro, in: Walton, 1999) caused this study. The learning processes necessary for innovation cannot take place through training, nor can they occur through systematic management. Rather they are part of the daily work, during innovation and improvement processes. They are seldom deliberately planned as learning activities, but arise by organising the work environment as a learning environment in which new knowledge can be developed and used. This makes it important to learn more about the characteristics of a work environment in which learning with the intention of innovating is supported. The central question of our study, therefore, is:

What are characteristics of a work environment in which learning for knowledge productivity is stimulated and supported?

3. Relevance

The present study aims to contribute to the existing knowledge about innovation and the related learning processes taking place in work environments. From the perspective of learning in the context of work, the present study builds on previous research that considered the work environment as a learning environment. These researches mainly focused on what and how people learn (e.g. Eraut, Alderton, Cole, & Senker, 1998), and on how to guide learning in the workplace (e.g. Billet, 2001). The present study aims to elaborate on these insights by exploring the specific learning processes that lead to gradual improvements and radical innovations in the workplace.
For a long time, research on innovation presented innovation as a linear process of design, development and implementation. Movement, interaction, and feedback did not have a prominent place in the underpinning theories. If knowledge was acknowledged, the emphasis was on learning from external knowledge sources (Harkema, 2004). Currently, innovation is seen increasingly as a cyclical, interactive process in which learning plays an important role

(Tidd, Bessant, & Pavitt, 2005). This requires a better understanding of the concept of innovation by conceiving it as a learning process, which the present study aims to contribute to.
For organizations, this research is relevant since the R&D departments are not the only - and maybe not even the main - places and sources for improvements and innovations. All departments, including marketing or finance contribute to the process of innovation (Kanter, 2006), and besides product innovation, also process innovations are acknowledged as an important source for innovation (Volberda, Van den Bosch, & Jansen, 2006). Indeed, in a knowledge economy all members of an organization contribute to the necessary and continuous process of improvement and innovation. This makes it increasingly important for organisations to know more about stimulating and facilitating these learning processes that lead to lasting success.

4. Theoretical basis

A prominent concept in the theoretical basis that underlies the present research is that of knowledge productivity. This section explains this concept, and describes the learning processes related to knowledge productivity. Furthermore, the concept of breakthrough that we used to focus our data gathering, is introduced.

4.1 Knowledge productivity

Kessels (1995) introduced the concept of knowledge productivity and described it as the process by which new knowledge is created in order to contribute to innovation in the workplace. Knowledge productivity refers to the process of tracing relevant information, using this information to develop new abilities, and applying these abilities to the gradual improvement and radical innovation of products, services, and work processes. The concept is inspired by the work of Drucker (1993). Drucker describes the important role of knowledge in the knowledge economy and the challenge for employees to become knowledge workers in their organization (Drucker, 1999). These knowledge workers should contribute to the organization's processes by developing gradual improvements and radical innovations. From this perspective the work environment is actually the learning environment in which employees develop the necessary abilities for the improvement and innovation of products, services and their working processes. Work processes then take on the characteristics of learning processes (Dixon, 1999; Kessels & Van der Werff, 2002).

4.2 Learning processes related to knowledge productivity

The process of knowledge productivity manifests itself in learning that can be characterised as developmental learning (Ellström, 2002) or double loop learning (Argyris & Schön, 1978). Ellström describes developmental learning as opposed to adaptive learning. Adaptive learning refers to learning processes that cause changes within a given framework or a given organizational structure, whereas developmental learning causes changes "that represent a break with the past and go beyond the given" (Ellström, 2002, p. 423). The difference between adaptive and developmental learning may be compared to the distinction made by Argyris and Schön (1978) between single loop learning and double loop learning. Argyris and Schön regard learning as the detection and correction of errors. Single loop learning takes place when, in an attempt to correct an error, given goals, values and plans are operationalised rather than questioned. In double loop learning, learners follow a different strategy. They question the governing variables, which may result in changing the goals, values and existing plans.
Knowledge productivity refers to learning processes in which learners break with the past, and develop new approaches. Within this form of 'breakthrough' learning, another distinction

can be made, namely between the type of learning processes that precede the development of gradual improvements, and the learning processes that precede the development of radical innovations. Following Ellström (2002), the first might be characterised as productive learning, and the second as creative learning. Productive learning is required when employees encounter novel situations for which no knowledge is available from previous experience. Learners then engage in a process of problem solving through experimentation in which they invent and test solutions (Ellström, 2002). Creative learning takes place when the learner comes across an unclear and puzzling situation. To develop a satisfactory way of dealing with this situation, it is necessary to question implicit taken-for-granted premises, and established definitions of problems, and then transform these.

4.3 Breakthroughs as critical learning moments in innovation processes

In order to examine the learning processes undertaken by employees with the intention of innovating, it is necessary to take a closer look at those learning processes. Moments in which the learning process becomes visible are actually the breakthroughs in the innovation process. Breakthroughs are moments in an innovation process in which people break with their present way of working and start to think and act differently (Op de Weegh, 2004). Breakthroughs are conceptualized as a change in both 'thinking' and 'acting' leading to a step forward in the innovation process. The change in 'thinking' refers to the breaking of frames, which is necessary for innovation. Argyris and Schön (1978) describe how people have two choices, when the outcome of their work processes is not satisfactory. Either, they work with given or chosen goals, values, or plans, or they question these governing variables. The authors refer to the first option as single-loop learning, and to the second as double-loop learning. Double-loop learning may lead to an alteration in the governing variables and, therefore, to a shift in the way in which strategies and consequences are framed. As described in section 4.2, double-loop learning is the kind of learning associated with innovation (both the development of gradual improvements and of radical innovations). Senge (2000) refers to this process as the change of mental models, which is required for innovation. It is essential that innovation combines a change of governing variables (Argyris & Schön, 1978), mental models (Senge, 2000), or frames of reference (Hedberg & Wolff, 2001), with a change in behaviour. One must act based on these new ways of thinking (Hedberg & Wolff, 2001). This is the change in 'acting' that breakthroughs consist of.

5. Research method

An inductive parallel study was carried out to learn more about the learning processes in ongoing innovation processes. Parallel research can be characterized as a prospective case study design (Bitektine, 2008). It is a form of case study research that studies ongoing processes. Along with the parallel study, an extensive literature review was conducted. The literature research was conducted in the fields of innovation, learning, and more specifically in the domain of learning to solve problems.

Context of the parallel study

The research took place at Habiforum (www.habiforum.nl), a network organisation that works on innovative solutions for land use in the Netherlands. An examples of a pilot projects that the organization initiated is the restructuring of an open and green area between two municipalities. Another example consists of local authorities of three big cities and three villages who want to develop and carry out a joint vision. In a pilot project stakeholders who are directly involved with the problem are invited to join (e.g. statesmen, inhabitants, shop owners). They meet regularly and are facilitated by someone from Habiforum's network.

Selection of pilot projects
In total, 10 pilot projects were part of the present study. The pilot projects were all characterized by a strong desire of the people involved to find an innovative solution for an intricate question or a solution for a long-standing issue. Since the study comprises an analysis of ongoing innovation processes, it was not known in advance whether these pilot projects would indeed come up with innovative solutions and ways of working.

Search for breakthroughs
The most difficult aspect of a parallel study is determining what events to focus on in the data-gathering phase. How can one determine whether a situation occurring in the pilot project will turn out to be crucial for its success later on? In other words, how can these crucial situations be recognised at an early stage? In order to trace crucial moments in the innovation process, the data gathering in the parallel study was guided by the search for breakthroughs. Patriotta (2003) stressed that disruptions in the form of discontinuities are important indicators in innovation processes: "in order to empirically observe how organizations create, use and disseminate knowledge, we have to look for disruptive events conceived as turning points in an ongoing flow of activities" (p.69). The approach of tracing breakthroughs has similarities with the critical incidents technique as developed by Flanagan (1954) and Zemke & Kramlinger (1991). It was left up to the participants in the pilot projects to pass judgement on the extent to which a situation would qualify as a breakthrough.

Data gathering
Table 1 presents an overview of the cases and the data-collection methods that were applied. With the collection of breakthroughs as the primary focus of data gathering, there is a risk of treating incidents as isolated episodes occurring at specific points in time (Patriotta, 2003). To prevent this from happening, 4 of the 10 cases were studied intensively and the events in these pilot projects were documented in a thick description (Geertz, 1973). Thick descriptions capture various aspects of the case and its context, aiming to give a rich description of the field that is examined, whereas thin descriptions only describe the aspects one is interested in.

Table 1
An overview of the cases that were part of the study

Case	**Goal**	**Methods used for data gathering**
Post-war district	To restructure a specific quarter in a city in the North of The Netherlands	Start-off face-to-face interviews with the facilitators of the pilot projects Attending meetings of the pilot project Face-to-face interviews and telephone interviews with facilitators of pilot projects Face-to-face interviews with other participants in the pilot project
Rhombus	To abolish the barrier in this area in order to give an impulse to the social development of this part of the city	
Industrial area	To restructure an industrial area in order to bring about economic dynamics and sustainable planning	
Multi-layered area	To realise a multi-layered industrial area	
Mounds	To develop 'mounds' to be safe for the rising water	

City harbour	To restructure the banks of the city harbour	Start-off face-to-face interview with the facilitators of the pilot projects Regular short interviews via telephone with facilitators of the pilot projects to keep track of the process and to trace breakthroughs
Hinge	To create a 'city-on-top-of-a-city'	
Health boulevard	To restructure the area between two municipalities	
Triangle	To make a joint vision - by six municipalities - and carry this out	
Polder	To find a sustainable solution to keep the polder dry	

Data analysis

The breakthroughs that occurred in the pilot projects were input for the phase of analysis. In this phase an inductive analysis (Patton, 1990) was conducted. This is a process in which categories of analysis come from the data: they emerge out of the data rather than being imposed on them prior to data collection and analysis. Besides the breakthroughs, moments in which the process got stuck were used in the analysis of the data. These moments contributed to a better understanding of the themes that were related to the breakthroughs. The data emerged around 11 themes. These themes were compared with literature in order to better understand and interpret them. For an elaborate overview of the findings from literature see Verdonschot (2009). The result of the analysis was a description of the themes in the form of design principles for knowledge productivity. The choice for design principles as a format to present the outcomes of a descriptive study is not self-evident. Indeed, design principles are usually seen as a yield of design research (Van den Akker, 1999). The reasons to choose for design principles as the format to present the results of the analysis of the present study, are twofold. First, the choice was made in anticipation of next research phases. The aim was to follow up the present study with a design study to find out the extent to which the factors identified in the present study could help participants in innovation processes to actively design their work environment to enhance innovation. The expectation was that by formulating the outcome of the present study in design principles, it would be easier to collect at an earlier stage reactions of possible future users with respect to the design principles. Second, design principles seemed especially suitable to do justice to the variation and complexity that was found in the themes.

These design principles aimed to express the effective aspects underlying the breakthrough moments in the pilot projects. Each breakthrough seemed to contain more than one of these effective aspects. This means that the success of each of the breakthroughs could be explained by more than one (often two or three) design principles.

5. Design principles for knowledge productivity

This section presents the 11 design principles for knowledge productive work environments that emerged from the breakthroughs that were found in the pilot projects combined with the findings from literature.

5.1 Typical questions that form the starting point for innovation

The breakthroughs in the cases showed that the formulation of the central question in the pilot project influences the outcome. Participants in the pilot projects formulated and reformulated the central problem. Breakthroughs occurred when they managed to formulate a question that somehow *worked*. Whether a question *worked*, was related to the extent to which it was intriguing for the people involved. In the pilot projects, questions became intriguing when:

- Participants formulated the question in terms of an appealing concept (e.g. a city-above-a-city, or a multi-layered industrial area). Unusual concepts triggered their creativity;
- Participants formulated the question in the form of a complex problem they experienced and that triggered them and that left enough space for various perspectives and directions (e.g. how can this water be stored even though the country is so full already?; how can we prevent this neighbourhood from becoming neglected?);
- Participants had questions that evoked their curiosity (e.g. an official who knew many people in a particular neighbourhood experienced that the beauty of the neighbourhood had died, and his personal involvement made him curious to find new perspectives on this problematic situation).

Besides the necessity of the question being *intriguing* for the people involved, the extent to which a question was experienced as *urgent*, seemed also relevant. In the Industrial area case the urgency of the question the pilot project worked on, remained unclear during the whole process. In the particular pilot project this led to long conversations, little activity in between meetings, participants who awaited developments and who asked many questions. Instances in which the urgency was clearly there, the process got an impulse and could go on.
Literature in the field of cognition affirms that the outcome of a problem-solving process is defined by the definition of the problem (Benjafield, 1997). Innovation can be seen as a special kind of problem solving that could also be referred to as problem finding (Getzels, 1979; Mackworth, 1965).

Design Principle 1: Formulate an urgent and intriguing question
Developing an urgent and intriguing question is necessary for innovation. Such a question is not a given, it needs active development in interaction with key players and stakeholders. Urgency refers not only to a rational urge but also to the personal feeling that there is an urge. This means that the question must be formulated in such a way that the people who work on it have the feeling that the question cannot remain unanswered. An intriguing question refers to a question that entices people to develop new perspectives. A question can become intriguing when an unusual combination of concepts is made.

5.2 New ways of working that deviate from the traditional approach

Many breakthroughs were characterised by a new way of working. Traditional meetings with agendas were traded off against open conversations with the individual involvement as the main topic of conversation. Information was not gathered by large-scale surveys with truth-finding as the main goal but rather by small-scale excursions by the people who joined the pilot project to understand the different perspectives from people involved in the area the pilot project was occupied with.
Theoretically, this can be explained by the idea that all learning integrates thinking and doing (Senge, Scharmer, Jaworski, & Flowers, 2005). Innovative solutions often require breaking with the actual way of thinking, and adopting a new frame of reference. The cases revealed that this new way of thinking can be stimulated by new ways of doing. Some ‘old ways of working’ provoke ‘old behaviour’. They will not lead to solutions that break with the existing way of thinking. An official meeting with a chairperson, a secretary and an agenda that defines the procedure is not a setting that easily evokes new ways of thinking. In the pilot projects these ways of working were often traded off against forms in which individuals and their perspectives played an important role.

Example from the Polder case
Participants in this pilot project experienced difficulties in explaining each other their interest in the pilot project. To overcome this, they hired a minivan and with a small group of people (each belonging to one of the stakeholder groups that had an interest in the polder environment) and they made a tour through the polder. There were inhabitants, farmers, environmentalists and people who represented the group of visitors who visited the polder for recreation. Each of these stakeholders got the key of the bus for one hour. Within that hour they were free to show the others whatever they wanted. The idea was that everyone would guide the others through the polder, showing them what they found so attractive. The inhabitants for instance chose to have a coffee at a certain café in the polder where the view was exceptionally beautiful. In the afternoon they sat together and talked about the meaning of the polder to each of them. The outcome of this outing was that the various perspectives and interests became clear to everyone. This enabled them to facilitate their own process. The external facilitator was not needed as much as before.

Design principle 2: Create a new approach
To find new solutions ('thinking new'), a new way of working ('acting new') is necessary. Such a new approach can be realised by breaking with hindering structures (e.g. instead of talking about the problem in a formal meeting, making an excursion and showing each other what bothers you), and by designing an overall approach. The overall approach is characterised by a developmental approach: step-by-step designing of a process that deviates from existing routines.

5.3 Individual motivation as the basis for creativity
The cases reveal that individual motivation is a powerful engine for innovation. Breakthroughs in the pilot projects were often preceded by a discussion of the participants' individual motivation. When the individual interests of the people involved were discussed, participants asked each other questions such as: 'what do you dream of?'; 'what are you enthusiastic for?'; 'what is your interest in this project?'; and 'what do you want to realise?' See the example of the Industrial area case:

Example from the Industrial area case
An important milestone in this pilot project was the moment that the facilitator asked all of the attendants in the meeting to share what their personal stake in the project was. This conversation offered an attractive alternative for the behaviour that hadn't helped them until now. Instead of a formal meeting it became a personal conversation that stimulated the process. Not the formal positions of the people involved determined the agenda. Rather, the personal involvement determined the conversation. This led to a breakthrough in this pilot project.

Individuals are capable of special achievements when they work from individual motivation. This is confirmed by various authors. Authors refer to this kind of personal involvement with different concepts, such as intrinsic motivation (Deci & Ryan, 1985), flow (Csikszentmihalyi, 1997), engagement (Nahapiet & Ghoshal, 1998) and passion (Amabile, 2000; Kessels, 2001).

Design principle 3: Work from individual motivation
Individual motivation is a powerful engine for creativity and innovation. When people have the opportunity to work on things they find important, their creativity is stimulated. Therefore, it is important, in pilot projects, to explore and use the personal incentives of all

participants and to allow them to formulate a personal goal. The personal incentives can be of an intrinsic nature (e.g. a passion for a specific theme) but they may also be of an extrinsic nature (e.g. recognition).

5.4 Novel combinations as a trigger for innovation

According to Nahapiet and Ghoshal (1998) the creation of new knowledge, a process relevant for innovation, occurs by two processes: combination and exchange. These two processes can be recognised in the breakthroughs that were collected in the pilot projects that were part of the study.

Combination is a process that consists of combining elements previously unconnected or developing novel ways of combining elements previously associated (Nahapiet & Ghoshal, 1998). In the pilot projects this is recognised in the act of separating the main problem or sub-problem in different themes or perspectives that each offer a different perspective on the question at hand. For instance in the Post-war district case, in which the problems in a neighbourhood in the north of The Netherlands are central, the pilot project chose different perspectives to approach the question: economy and self-help among the inhabitants; cultural identity; social cohesion and initiatives of inhabitants. These perspectives all helped to take a different perspective on the situation. It showed that a new perspective on the situation leads to new ideas for the solution.

Exchange is a necessary process for knowledge creation when resources are held by different parties (Nahapiet & Ghoshal, 1998). The process of exchange occurs through social interaction and coactivity. This process is recognised in the pilot projects as well. In the pilot projects breakthroughs occurred when experts, invited by participants of the pilot project, gave their perspective on the problem at hand. Often, unusual combinations of subject matter expertise were made that contributed to the breakthrough: artists or architects were invited to give their perspective. See this example from the Post-war district case:

> *Example from the Post-war district case:*
> This pilot project is concerned with restructuring a quarter in a city in the North of The Netherlands that is mainly inhabited by citizens originating from the Antilles. The participants in this pilot project invited an architect. This architect, who'd lived in The Netherlands Antilles, developed new ways to design the quarter. He used the Antillean culture as a starting point and came up with 12 concepts for the redesign of the quarter. He had ideas such as transforming the neighbourhood into a street theatre, making a compound and a cruise quay. He used the Antillean culture and linked elements of that culture to ways of using the neighbourhood for living, recreating and working. Normally, the homogenous group of inhabitants was seen as the main problem, but the approach of the architect used a completely different starting point. The architect's proposals inspired the participants in the pilot project to take a new perspective on this 'problematic neighbourhood'. Participants could use this new perspective and add on their own expertise.

Design principle 4: Make unusual combinations of subject matter expertise

A surprising or not obvious admixture of different kinds of knowledge can help to establish new connections between elements that were not linked before. These new connections are necessary for innovation. A fruitful way to establish new connections is by choosing new or uncommon perspectives or metaphors to look at the question at hand, or by inviting experts who have new or uncommon perspectives.

5.5 Connecting different interests by working from mutual attractiveness

Typical for innovation processes are the different, and often opposite, interests at stake. In order to develop an innovative solution it seems necessary to combine these opposite interests. Imagine a municipality that wants to arrange more parking spaces whereas the inhabitants wish to preserve the green park. A solution, in which these different stakes are successfully combined, is the development of an underground parking lot. The search for a solution that meets varying stakes is an important aspect of innovation.

In the pilot projects that were part of the present study, breakthroughs occurred at moments in which participants succeeded in combining different interests. For instance by collaborating with a party with which they previously didn't want to collaborate because of their competing activities. They realised that collaboration was necessary, and instead of seeing them as competitors they worked as partners. Kessels (2001) previously referred to this principle as mutual attractiveness.

The principle of mutual attractiveness is considered to help participants in pilot projects to design a collaboration in which each of them can hold on to their own interests, and in which they use the varying interests to come up with new solutions for the problematic situation at hand. This is expressed in the fifth design principle.

Design principle 5: Work from mutual attractiveness

Typical for innovation is that different and often opposite interests are at stake. To develop an innovative solution it is necessary to combine these opposite interests. In a pilot project the personal interests must be central, and not a general goal or an abstract organizational goal. When everybody holds on to their own interests, and when people actively seek for ways to collaborate on a basis of reciprocity, breakthroughs are likely to occur.

5.6 A positive approach

Breakthroughs in the pilot projects were caused by what could be called a 'positive approach'. Not failures, shortcomings or gaps were central to the breakthroughs, but rather qualities, achieved successes and positive attention. In literature, this positive approach can be related to positive psychology (Seligman, 2005). The three ways in which this 'positive approach' was recognised in the breakthroughs include:

- Using qualities as a starting point. Various pilot projects explicitly used the qualities of the area the pilot project was working on. See for instance the example below, taken from the City harbour case:

  Example from the City harbour case

  The participants made a presentation of 'lost and found objects' from the banks of the city-harbour. The inhabitants collected beautiful pieces of nature but also some rusty objects. This made both the inhabitants and the market parties aware of how much the area actually had to offer. They realised that the area was not a blank field, but rather that there is much that is worth to protect. The perspective of the area as a 'problem' was changed into a perspective of the harbour as a promising area with various qualities. The facilitator of this pilot project described this as a breakthrough.

- Reflection on previously achieved successes led to a lot of energy and at the same time it helped the group to learn more about their own abilities.

- Working with the qualities of the context. In various cases the qualities of the context (e.g. the rare plants growing in the old city harbour) were taken as a starting point for new developments.

Design principle 6: Build on strengths
People's talents, successes achieved by the group, and the qualities of a context provide a valuable starting point for the pilot projects. Paying attention to the strengths of individuals, the group, and the context offers an attractive starting point for reflection and for the design of follow-up steps. Furthermore it is likely to contribute to the self-efficacy of participants, which may enhance their performance.

5.7 Beyond a polite conversation by creating something

In the pilot projects that were part of the study, there were groups that experienced difficulties in interacting with each other in such a way that it would help them to develop new perspectives. They kept having polite conversations, agitated discussions and reflections. The kind of conversation observed in the pilot projects is related to the type of communication that Scharmer (2007) refers to as 'downloading'. Operating effectively in such conversation requires the participants to exchange polite phrases with one another, not telling one other what is really on their mind. These kinds of conversations reproduce existing rules and phrases and do not help to create something new.
In the pilot projects in which groups started to make things, for instance concrete products or prototypes, they succeeded in going beyond these polite conversations. They were then able to move from ongoing analysis and reflection to a phase of design. Instead of explaining why things are as they are, they started to inquire each other's perspectives and connected them to each other. Examples of products that were made in the pilot projects are a model, a map for the area they were working in, and a flyer that announces a gathering they organized for inhabitants in the area. See the example of the Industrial area case:

Design principle 7: Create something together
In pilot projects participants often spend quite a lot of time exchanging their points of view and discussing them. However, polite conversations or agitated discussions alone do not lead to innovation. For innovation it is necessary to examine each other's perspectives and to find out the points on which the various perspectives differ. Creating something together supports this process. Examples of products include a workshop, a photo-exhibition, a scale model or a poster.

5.8 Sensitivity for weak signals

Sensitivity (Walz & Bertels, 1995) and sagacity (James, in:Benjafield, 1997) refer to the ability to become aware of signals or information that people previously didn't see but that could offer relevant clues for the problem to solve. Mindfulness (Langer, 2005) refers to the ability to play with context and interpretation in order to change the meaning of situations, people's actions, and things. These two abilities, as became clear from literature that was reviewed, are relevant to innovation. In the pilot projects participants used these abilities as well. Participants used and developed their sensitivity by doing interviews with people whom they would normally not have involved (e.g. interviewing a group of inhabitants). Using their genuine curiosity in an interview provided the opportunity to imagine other people's perspective. This helped them to become aware of new information or new signals. Mindfulness is also recognised in the pilot projects. Participants searched for new words and metaphors in order to play with interpretation and to switch contexts. See for instance the example from the Rhombus case:

Example from the Rhombus case
This pilot project deals with restructuring a region in order to improve its social development. The region had always been labelled as 'messy'. The highway that crossed this region was seen as something that stands in the way of innovating the area. As soon as people in this pilot project labelled the highway as a "gateway" they started to see new perspectives. It helped them to get ideas to organize the area in a completely new way.

The eighth design principle refers to the development of sensitivity.

Design principle 8: Entice to see new signals and to give them new meaning
People interpret the world around them all the time. For innovation it is necessary to reconsider existing interpretations and to develop new ones. In order to do so, people must become sensitive to new information and clues. Furthermore, playing with the interpretation of this information and these clues is necessary in order to assign new meaning to them. The use of new words and metaphors facilitates this process of playing.

5.9 The pilot project versus the unit of adoption

In the pilot projects attention was paid not only to the development of new ideas and concepts, but also to the connection of them with the context for which they were developed. Several strategies of connecting the pilot project to the context outside led to breakthroughs:

- Involving influential people by for instance letting them judge or test the developed ideas. See the example from the Multi-layered area case :

  Example from the Multi-layered area case

  In this pilot project the participants connected their ideas with the world outside by composing an expert group consisting of experts from outside the pilot project. These experts were influential people within the context. They were asked to reflect on the vision the participants developed within the pilot project. The experts were especially interested in one of the ideas. Because of the involvement of experts in this phase, the participants in the pilot project had the opportunity to develop this idea further.

- Another strategy was the involvement of important stakeholders that were left out before (e.g. the inhabitants or the shop owners in a certain area).
- Also, positive attention from persons with a certain status, or attention from media, helped to establish a connection with the world 'outside'. In the pilot projects articles in newspapers, a visit from the royal family and radio interviews offered the participants the opportunity to connect the two worlds.

To be successful, it is necessary to establish a connection between the world inside the pilot project and the world outside. The ninth design principle refers to the connection that must be established between the pilot project and the organizations, groups or individuals for whom the innovation could mean a substantial benefit.

Design principle 9: Connect the world inside the pilot project to the world outside
Participants in pilot projects must establish a connection with the organizations, groups or individuals for whom the innovation they are working on could mean a substantial benefit. Indeed this supports the implementation of the proposed innovation. Such a connection can be

established by involving influential people (e.g. experts) or important stakeholders (e.g. inhabitants or users) in the pilot project.

5.10 The innovation process as a social process

The facilitators do show awareness for the social and communicative process in the pilot project. One of them said: "When participants talk a lot about the minutes, for me that is a clear sign that things are not going well. And I want things to go well. A lot of fuss about minutes means that something else is going on. Let's talk about that then". The facilitators also mention interventions that they initiated with respect to the social and communicative process:

- Putting the process on hold and check: are we all talking about the same thing, do we understand each other?
- Acknowledging the input of a group of participants who did not have the feeling being taken seriously.

Interventions concerning the social and communicative process seem to be conditional for breakthroughs, rather than directly causing breakthroughs. In literature, the importance of conversations for innovation processes is stressed as well (Scharmer, 2007; Steyaert, Bouwen, & Van Looy, 1996; Von Krogh et al., 2000).

Design principle 10: Pay attention to the social and communicative process

Innovation is a social process. Social and communicative skills are the vehicle for this process. Therefore, it is important that participants in pilot projects pay attention to the quality of the interactions.

5.11 The innovation process as a learning process

The facilitators in the pilot projects that were part of the study, had sometimes explicit attention for the development of competences that they needed in the innovation process. See for instance the example taken from the Hinge case:

> *Example from the Hinge case*
> In a meeting with an important politician and the director of the development company the participants of the pilot project did not want to use a PowerPoint presentation. They were decisive to use the opportunity to start the conversation differently, unconventional. They didn't want the politician and the director to lean backwards with an attitude of 'please convince me'. This motive created the urge to learn and practice a new technique. They practiced the 2x2 technique (a way of asking questions) in advance and then they used it in the meeting. Their motive for doing it like this was their desire to organize a new kind of conversation that would have a new outcome.

At the same time, participants in the pilot project found it difficult to facilitate their own learning and that of others. Some participants and facilitators found it easier to take over a specific activity than to help others to learn it themselves. Design principles 1-10 are pointed towards the innovation process itself. The eleventh design principle focuses on the crucial and lasting role of learning in this process.

Design principle 11: Actively support the development of competences

The learning processes undertaken with the intention of innovating are primarily focused on the improvements and innovations that the people involved aim to bring about. However, participants in pilot projects must pay explicit attention to the learning processes as well.

They could do this by defining the competences that they need to develop and by developing approaches that stimulate learning in that direction. They should regularly reflect on these learning processes since that could enhance learning.

6. Conclusion and discussion

This section circles back to the research question and discusses the practical implications of the study at hand. A reflection is offered on the generalisability of the findings.

What are characteristics of a work environment in which learning for knowledge productivity is stimulated and supported?

The parallel study in 10 ongoing pilot projects tracked down breakthroughs. These breakthroughs were expected to represent the 'critical learning moments' of these pilot projects. The analysis of these breakthroughs led to 11 recurring themes. These themes were compared with literature in order to better understand and interpret them. Literature in the fields of innovation and learning, and more specifically the problem-solving field of learning was used for this purpose. This resulted in a description of the themes in the form of design principles for knowledge productivity. These design principles represent the factors that were found to underlie the learning processes leading to gradual improvements and radical innovations. The design principles tended to be present in various combinations in the breakthroughs that were observed or reported by the participants.

The definition of knowledge productivity distinguishes between gradual improvements and radical innovations as results of the process of knowledge productivity. All pilot projects that were part of the present study had the intention to come up with innovative solutions, but the actual outcome was not part of the study. The parallel study followed ongoing innovation processes for which the outcome was yet unknown. The choice not to concentrate on the outcome of the process but rather on the breakthroughs that happen along the way made it impossible to reflect on the different learning processes that precede the development of both gradual improvements and radical innovations. A provisional conclusion is that the intention to find a solution for a difficult question accounts for the characteristics of the learning process more than the intention to develop either a gradual improvement or a radical innovation. In all cases the intention was to come up with an innovative solution for an intricate question or a long-standing issue. Participants never deliberately aimed at developing gradual improvements or radical innovations.

Practical implications

The study aimed to contribute to practice by providing guidelines which could help organizations in the design of learning environments that support employees in the process of learning with the intention of innovating. The results of the research are useful for practitioners. The design principles clarify the factors that matter in the creation of breakthroughs in innovation practices. These principles might be used in daily practice as a means to reflect upon or analyze innovation projects. Furthermore the cases studied provide examples of interventions that were carried out by participants in the pilot projects, and that contributed to the creation of breakthroughs. Although these principles and the concrete examples do not tell people exactly what they need to do, they do contribute to practice by showing underlying principles that can serve as examples (Wardekker, 1999). This can be helpful for participants who are occupied with innovation projects in practice.

Generalisability of the findings

The results of this study are not simply generalisable to all organizations since the cases that were studied were not part of a random selection. The 10 case studies that were included in the parallel study took place in pilot projects which were initiated by a Dutch organization that promotes innovative urban planning processes in The Netherlands. Different people, related to both public and private organizations, took part in these pilot projects.

An observation that could be made is that the type of work environment that was central in this study had typical characteristics, such as the type of problems that were central in the pilot projects, the motivation of the people involved for solving this problem, and the fact that these problems were never theoretical, but always real. If these characteristics are translated to the kind of work environment to which the results of this study could be applied, the findings could be applied in a context in which the following three elements are present: 1) an intricate question, problematic situation or long-standing issue that requires an innovative solution, 2) a group of people from one or more organizations, all of whom are committed to solving the problem, and 3) a concrete manifestation of the problem that is dealt with.

Situations in which the findings of the present research are not applicable include situations in which individuals did not choose to participate, situations in which individuals have no interest in solving the problem at hand, and situations in which the group that aims to find an innovative solution does not have the freedom to experiment with new approaches. If groups need to comply with the rigid structures and procedures that organizations often deploy, the findings from the present research will not be easy to apply.

References

Amabile, T. M. (2000). Stimulate creativity by fueling passion. In E. A. Locke (Ed.), *The blackwell handbook of principles of organizational behavior* (pp. 331-341). Malden, MA: Blackwell Publishers.

Argyris, C., & Schön, D. (1978). *Organizational learning: A theory of action perspective*. Reading, Mass: Addison Wesley.

Baldwin, T. T., & Ford, J. K. (1988). Transfer of training: A review and directions for future research. *Personnel psychology, 41*(1), 63-105.

Benjafield, J. G. (1997). *Cognition* (2nd ed.). New Jersey: Prentice-Hall, Inc.

Billet, S. (2001). *Learning in the workplace: Strategies for effective practice*. Crows Nest: Allen&Unwin.

Bitektine, A. (2008). Prospective case study design, qualitative method for deductive theory testing. *Organizational Research Methods, 11*(1), 160-180.

Brown, J. S., & Duguid, P. (1991). Organizational learning and communities-of-practice: Toward a unified view of working, learning and innovation. *Organization Science, 2*(1), 40-57.

Burke, L. A., & Baldwin, T. T. (1999). Workforce training transfer: A study of the effect of relapse prevention training and transfer climate -. *Human resource management, 38*(3), 227-241.

Csikszentmihalyi, M. (1997). *Finding flow. The psychology of engagement with everyday life*. New York: Basic Books.

Deci, E. L., & Ryan, R. M. (1985). *Intrinsic motivation and self-determination in human behavior*. New York: Plenum.

Dixon, N. M. (1999). *The organizational learning cycle: How we can learn collectively* (2nd ed.). Hampshire: Gower Publishing Limited.

Drucker, P. F. (1993). *The post-capitalist society*. Oxford: Butterworth Heinemann.
Eraut, M., Alderton, J., Cole, G., & Senker, P. (1998). *Development of knowledge and skills in employment.* Sussex: University of Sussex.
Flanagan, J. C. (1954). The critical incident technique. *Psychological bulletin, 51*, 327-358.
Geertz, C. (1973). *The interpretation of cultures*. New York: Basic Books.
Getzels, J. W. (1979). Problem finding: A theoretical note. *Cognitive science, 3*(2), 167-171.
Harkema, S. J. M. (2004). *Complexity and emergent learning in innovation projects, an application of complex adaptive systems theory.* Universiteit Nyenrode, Breukelen.
Hedberg, B., & Wolff, R. (2001). Organizing, learning, and strategizing: From construction to discovery. In M. Dierkes, A. Berthoin Antal, J. Child & I. Nonaka (Eds.), *Handbook of organizational learning and knowledge* (pp. 535-556). New York: Oxford University Press.
Kanter, R. M. (2006). Innovation, the classic traps. *Harvard business review, 84*(11), 72-83.
Kessels, J. W. M. (1995). Opleiden in arbeidsorganisaties. Het ambivalente perspectief van de kennisproductiviteit. *Comenius, 15*(2), 179-193.
Kessels, J. W. M. (2001). *Verleiden tot kennisproductiviteit [tempting towards knowledge productivity]*. Inaugural Lecture University of Twente, Enschede.
Kessels, J. W. M., & Van der Werff, P. (2002). What is beyond knowledge productivity. In T. Van Aken & T. M. Van Engers (Eds.), *Beyond knowledge productivity, report of a quest* (pp. 19-28). Utrecht: Lemma.
Keursten, P. (1999). Het einde van strategisch opleiden? *Opleiding&Ontwikkeling, 10*), 27-33.
Langer, E. (2005). Well-being: Mindfulness versus positive evaluation. In C. R. Snyder & S. J. Lopez (Eds.), *Handbook of positive psychology* (pp. 214-230). New York: Oxford University Press.
Mackworth, N. H. (1965). Originality. *American Psychologist, 20*(1), 51-66.
Marsick, V. J., & Watkins, K. E. (1990). *Informal and incidental learning at the workplace.* London: Routledge.
Nahapiet, J., & Ghoshal, S. (1998). Social capital, intellectual capital and the organizational advantage. *Academy of Management Review, 23*(2), 242-266.
Nieuwenhuis, L., & Van Woerkom, M. (2007). Goal rationalities in work-related learning. *Human Resources Development Review, 6*(1), 64-83.
Op de Weegh, S. (2004). *How to break through, a research on knowledge productivity focussing on breakthroughs at habiforum innovation projects.* University of Twente, Enschede.
Patriotta, G. (2003). *Organizational knowledge in the making: How firms create, use, and institutionalize knowledge*. New York: Oxford University Press.
Patton, M. Q. (1990). *Qualitative evaluation and research methods* (2nd ed.). California: Sage.
Scharmer, C. O. (2007). *Theory u, leading from the future as it emerges*. Cambridge, MA: SoL.
Seligman, M. E. P. (2005). Positive psychology: Positive prevention, and positive therapy. In C. R. Snyder & S. J. Lopez (Eds.), *Handbook of positive psychology*. New York: Oxford university press.
Senge, P. (2000). *The fifth discipline: The art and practice of the learning organization*. New York: Doubleday.
Senge, P., Scharmer, C. O., Jaworski, J., & Flowers, B. S. (2005). *Presence: Exploring profound change in people, organizations and society.* London: Nicholas Brealey Publishing.

Steyaert, C., Bouwen, R., & Van Looy, B. (1996). Conversational construction of new meaning configurations in organizational innovation: A generative approach. *European Journal of Work and Organizational Psychology, 5*(1), 67-89.

Tidd, J., Bessant, J., & Pavitt, K. (2005). *Managing innovation, integrating technological, market and organizational change* (3rd ed.). West Sussex: John Wiley & Sons.

Van de Ven, A. H., Angle, H. L., & Poole, M. S. (1989). *Research on the management of innovation, the minnesota studies*. New York: Harper & Row.

Van den Akker, J. (1999). Principles and methods of development research. In J. Van den Akker, R. M. Branch, K. L. Gustafson, N. Nieveen & T. T. Plomp (Eds.), *Design approaches and tools in education and training* (pp. 1-14). Dordrecht: Kluwer Academic.

Verdonschot, S. G. M. (2009). *Learning to innovate: A series of sudies to explore and enable learning in innovation practices.* Doctoral dissertation, University of Twente: Enschede.

Volberda, H. W., Van den Bosch, F. A. J., & Jansen, J. J. P. (2006). *Slim managen en innovatief organiseren*. Rotterdam: Erasmus Universiteit.

Von Krogh, G., Ichijo, K., & Nonaka, I. (2000). *Enabling knowledge creation, how to unlock the mystery of tacit knowledge and release the power of innovation.* New York: Oxford University Press.

Walton, J. (1999). *Strategic human resource development*. Harlow: Pearson Education.

Walz, H., & Bertels, T. (1995). *Das intelligente unternehmen: Schneller lernen als der wettbewerb*. Landsberg: Moderne Industrie Verlag.

Wardekker, W. (1999). Criteria voor de kwaliteit van onderzoek. In B. Levering & P. Smeyers (Eds.), *Opvoeding en onderwijs leren zien, een inleiding in interpretatief onderzoek* (pp. 50-67). Amsterdam: Boom.

Zemke, R., & Kramlinger, T. (1991). De critical incidents methode [the critical-incidents technique]. *Opleiders in Organisaties/Capita Selecta*(8), 69-80.