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Designing (and) enabling interfaces for collaborative knowledge creation and innovation

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Abstract

This is a theoretical paper about artifacts that have been designed to enable processes of collaborative knowledge creation and innovation. We refer to these artifacts as *Enabling Spaces*, and they comprise architectural, technological (ICT), social, cognitive, organizational, cultural, as well as emotional dimensions.

The paper claims that innovation is a *highly challenging social and epistemological process* which needs to be facilitated and enabled through *supporting (infra-)structures*. Our starting point is that innovation can no longer be understood as a mechanistic knowledge creation process. The process of *enabling* is introduced as an alternative to such traditional approaches of innovation. Enabling is the main design principle that underpins Enabling Spaces and ICT plays an important role in it. These concepts will be illustrated by a case study and concrete examples. The paper culminates in the derivation of a set of design principles, ICT based and otherwise, for Enabling Spaces.

Keywords: artifact, design, enabling space, extended cognition, innovation, meaning, situated cognition, space

1 Introduction

Innovation is intrinsically *social* and *epistemological*. As many examples impressively show (e.g., O'Connor & McDermott, 2004; Fagerberg & Verspagen, 2009; Dodgson & Gann, 2010) innovation is *not*—and, as it seems, never has been—something that is accomplished by an individual or a *maverick*. Contrary to classical myths, innovation is *social*: in most cases it is the result of well-orchestrated team work, formal and mostly informal social networks, as well as processes of intense collaboration and a tradition of prior knowledge (Weisberg, 1993)

In addition to this *social* dimension, one needs to study *knowledge* processes when studying innovation. Apart from exploiting and implementing ideas, the core activity of innovation teams is the creation of *new knowledge* (compare the polarities between exploitation and exploration in innovation processes; e.g., Corso, Martini, & Pellegrini, 2009).

Take the example of the *IBM innovation jam*: IBM was confronted with a number of challenges in the area of innovation a couple of years ago (cf. Bjelland and Chapman Wood 2008): (i) how could IBM commercialize and capitalize on this huge pool of ideas and potential innovations? (ii) How is it possible to make all these ideas and knowledge known to and fertile for a larger community inside the global organization of IBM? (iii) How can the remaining 300,000+ employees of IBM (plus its systemic environment) be involved and their huge knowledge and creative resources be tapped and related to the research results? It is clear that we are talking about social, epistemological, as well as technological (in the sense of ICT) issues and challenges here. Hence, it is necessary to find both a conceptual and an operational answer to such challenges; an answer integrating all these dimensions into a unified and coherent innovation process. Although not explicitly designed as an Enabling Space the *IBM innovation jam* illustrates many of the principles of the Enabling Spaces approach which will be discussed in this paper.

The starting point of this paper is that innovation is a *highly challenging social and epistemological process*, which is in need of *supporting structures* which *facilitate and enable* these *processes* on various levels and domains. But why is that so?

Even before Schumpeter (1947) put innovation center stage in our economy, innovation has fascinated a wide range of people. What is it that makes innovation so interesting for individuals, for teams, companies, for economies, for society (e.g., social innovation; Thackara, 2005), or for science? Besides an increase in productivity, quality, growth or some other factors which seem—at least for the moment—to be a change for the “better”, there is the fascination of *newness* which is key to almost any form of innovation (e.g., Arthur, 2007; Johannessen, Olsen, & Lumpkin, 2001; Müller, 2000). Innovation has something to do with coping with *future* events and challenges in an adequate and sustainable manner.

Predicting the future has always fascinated humans. It meant to be prepared for the unexpected, to protect oneself from possible future dangers, to make use of the unforeseen, to react to possible changes. However, “coping with future events” must *not* be reduced to the notion of reacting to future changes and challenges, but—and that is the even more interesting and challenging part of innovation—also includes *actively shaping* the future structures and dynamics, to shape a new and unpredictable world, society, market, or a (collective) way of looking at and understanding things.

Looking more closely and investigating the causes behind innovations, highly complex *knowledge processes* prove to lie at the root of every innovation. Such processes lead to “new” insights that are the foundation for a particular innovation, for a new product, service, business model, social innovation, cultural development, scientific model, etc.

The big challenge is to figure out how these “new insights” that underpin innovation processes, come about. This prompts us to ask such questions as: What do innovation processes look like and how can they be *designed*? What are the conditions and contexts that facilitate them? Which role does technology, and more specifically, information and communication technologies (ICT) or web 2.0 technologies, play? Which design principles apply when constructing an environment that enables processes of knowledge creation and innovation? What are the enabling factors on an epistemological, social, technological, as well as cognitive and emotional level? These questions we will address in the present paper. Our objective is to develop a conceptual and theoretical framework that should provide a

basic understanding of the process and design principles, of a theoretically informed and practically functioning innovation environment.

Our discussion is built up as follows. First, we will take a closer look at what today's innovations are about (Section 2). We will discover that they are a special form of artifacts that cover a wide range of dimensions, from physical, via processual, symbolic/cognitive, and interface-bound, to cultural. We will argue that innovations are mainly about creating new (systems of) *meaning*. Therefore, the processes and technologies leading to such comprehensive artifacts also should comprise the dimensions just mentioned. This discussion will result in the development of a typology of innovation processes. We will then show that innovation processes are not “purely cognitive” processes, but are always embedded in a specific physical, social, and technological context (extended or situated approach to cognition) (Section 3). In doing so, we adopt Krippendorff's “ecology of artifacts” (Krippendorff, 2006; Krippendorff & Butter, 2007). We will also show that innovation cannot be brought about in a mechanistic manner. This prompts us to develop the paradigm of *enabling*, as an alternative approach to mechanistic accounts of innovation (Section 3.2f). On this theoretical basis then the concept of *Enabling Spaces* is built: multidimensional spaces enabling processes of knowledge creation while integrating the architectural, technological (ICT), social, cognitive, as well as emotional dimension (Section 4). Subsequently, a case study is presented to undergird the plausibility of our arguments and approach (Section 5). In a concluding section, we summarize our arguments. We present our conclusions in the form of a set of design principles for spaces that should enable innovation as an ICT-infused yet thoroughly social and epistemic process (Section 6).

2 What are today's innovations about?

To inform our analysis of innovation and how it can be supported we will take a closer look at what innovation actually is about. So (a) what is the context of innovation processes and (b) what are their objects?

2.1 Innovation in context

To examine the context of innovation we make a *distinction* between *creativity* and *innovation*. According to Amabile (1996) creativity is composed of such domain specific traits as (a) expertise, (b) creative thinking skills, and (c) motivation (see also Schmid, 1996).

Innovation, however, is a more general concept, emphasizing not only the processes of creation, but also of its successful application and implementation in the market.

Innovation, therefore, is not a one-dimensional phenomenon, but emerges always as a result of a highly complex network of interacting actors, dynamics, and constraints. Reframing these issues one could summarize them in the question: what are the (interacting) *sources* leading to new knowledge and innovations (e.g., Hippel, 1988, 2005; Dodgson & Gann, 2010; Dönitz et al., 2010)? In the following paragraphs we will give a very brief overview of these “ingredients” of innovation so that the framework we are working in becomes clear (see also Figure 1).

- *Object of innovation* refers to the object, phenomenon, process, etc. to be innovated or to be created. For further details see Section 3. The interesting point is that this object of innovation is a potential, it only comes into being when the innovation bears fruit.
- *Users & market* Users play many roles in the process of innovation: (i) they have implicit or explicit needs, (ii) however, at the same time they are not experts in the technological possibilities for new solutions, (iii) they may provide ideas and inspiration for creating innovations, (iv) they are testing the innovations (e.g. as lead-users; Hippel, 1988; Sanders & Stappers, 2008), and (v) finally they are using these innovations as everyday products or services. Diffusion of innovations (e.g., Rogers, 2003; Christakis & Fowler, 2009) plays a critical role here as it determines if ideas will become innovations (by their successful usage).
- *Society* provides the context within which innovation happens. In essence, the innovation-object interacts with society on value systems, cultural issues, etc. (leading question: “what are emergent patterns within society?”).
- *Technology* is often seen as a source of innovation. However, in our view it is not so much a source, but rather an *enabler* of innovation.

- Organization(s): (a) the internal view: organizations are the “structural container” in which most of (industrial) innovations come about. Of course, in most cases it is the individual cognitive system or a group of interacting cognitive systems, which is the source of a particular innovation. However, these cognitive systems are always embedded in a social and/or structural context, which we refer to as *organization*. By providing the necessary stability and “protection” an organization may carry the risk of entering the domain of the newness and unexplored. (b) the external view, innovation as the eco-system in which a singular organization is embedded. As literature shows, much innovation happens between organizations or industries (“cross-innovation”) or by networks of organizations (reaching out and including their users, other organizations, etc.) intermediated by different agents (e.g., Chesbrough, 2003a, 2003b; Hippel, 2005; Howells, 2006).

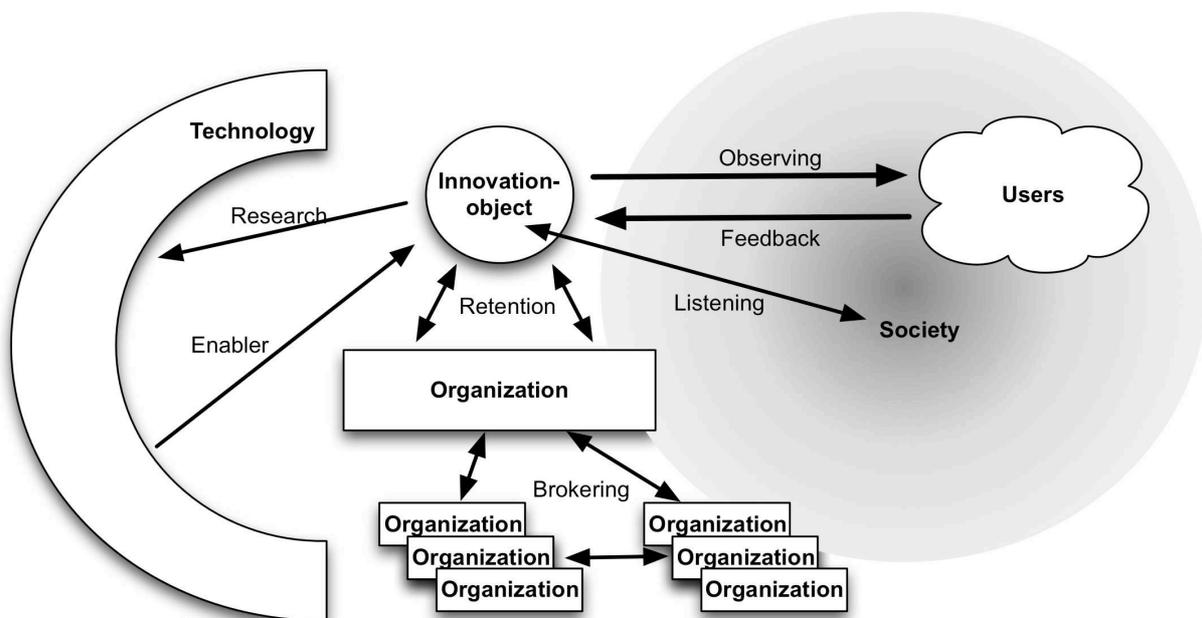


Figure 1: The domains of innovation and how they interact with each other.

The source of innovation

Crucially, this perspective of innovation does not allow the identification of a single system (person, etc.) as being responsible for bringing about an innovation. Rather it is the *interaction between these domains and between the actors in these domains which are the source of innovation*. Hence, we suggest understanding innovation as an *emergent phenomenon*: it is the result of a highly complex social and epistemological process with a meandering and serendipitous interaction history; it therefore is not a deterministic process.

2.2 On the object(s) of innovation

Unlike classical accounts of innovation (e.g., Fagerberg & Verspagen, 2009) we perceive innovations as *artifacts* that result from a cognitive and social process of collectively creating new knowledge. That is, innovation is not limited to the process of knowledge (creation).

Rather—in order to be a “real” innovation—the newly created knowledge has to be *brought into reality* as a concrete “new” artifact that needs to be accepted in its usage (such as in the market; compare also Drucker, 1985; Garcia & Calatone, 2002; Rogers, 2003; Schumpeter, 1934). This implies that, in the final analysis, innovation is about creating new artifacts:

innovation artifacts.

This leads to the question of (a) how we may generate “new” knowledge, ideas, or insights (and how we may support these processes); and b) what kinds or types of “innovation artifacts” we aim at or, which dimensions do these artifacts comprise? We will first address question (b) later on to tackle question (a). Together, this will give us the kind of understanding of the objects of innovation that we need to be able to develop the means and tools for enabling and supporting the *processes* that lead to innovation.

Artifacts, innovation, and design

Our starting point is the relationship between innovation and design. The process of design shows impressively how new artifacts are generated (more details later). Like design, innovation is about *creation*, bringing something new to the world. Innovation, however, emphasizes newness more strongly. There is a tradition to reflect both theoretically and practically on the design of artifacts (such as design research/theory, design thinking, etc.; e.g., Glanville, 1998, 2006; Laurel, 2003; Brown, 2008, 2009; Krippendorff, 2006). D. Norman is one of the most important proponents of and forerunners in this field (Norman 1991, 1993) with his radically user-centered and systemic approach. His concept of “cognitive artifacts” is one of the foundations for our innovation artifacts. On a more theoretical level we will also follow the lines of a 2nd-order cybernetic and systems theory approach to design (e.g., Glanville, 1998, 2007; Krippendorff, 2006, 2011; Krippendorff & Butter, 2007). This takes into consideration the whole context of design, its relation to artifacts, as well as innovation.

“...an artifact is an aspect of the material world that has been modified over the history of its incorporation into goal-directed human action. By virtue of the changes wrought in the processes of their creation and use, artifacts are simultaneously ideal (conceptual) and material. They are material in that they have been created by modifying physical material in the process of goal-directed human actions. They are ideal in that their material form has been shaped to fulfill the human intentions underpinning those earlier goals; these modified material forms exist in the present precisely because they successfully aided those human intentional goal-directed actions in the past, which is why they continue to be present for incorporation into human action. The core of this idea was expressed by Dewey in the following terms: Tools and works of art, he wrote, “are simply prior natural things reshaped for the sake of entering effectively into some type of [human] behavior”.” (Cole & Derry, 2005, p. 212)

This short characterization brings up a couple of issues which are important in our context:

- Artifacts are the result of a process of creation: some kind of cognitive process is responsible for creating the “plan”, goal, intention, meaning, etc. of this artifact.
- The material world is shaped according to this knowledge/cognitive process. This idea is closely related to the classical understanding of work as a process bringing an idea or plan into the concrete world by giving it its form.
- This work process has both a material and a non-physical (mental, semantic, etc.) dimension. We will elaborate especially on the semantic dimension of artifacts by stretching their notion.
- Artifacts are always about being embedded in a meaningful pattern of usage.

From designing product innovations to designing meaning

Krippendorff's (2006, 2011) “trajectory of artificiality” helps us to further detail our view, in particular, that innovations are not primarily about material things or products, but about *meaning* (see also Cole et al. 2005). Artifacts may be understood by looking at them under the perspective of the following dimensions:

1. *Material artifacts* and *products* In line with the classical perspective on design results and innovations respectively, they are concrete physical objects or products that have a certain form and serve a particular purpose which depends on the context—be it

the context of the designer or of different users. Think of household appliances, a new car, etc.

2. *Processes (i.e. services, business models, etc.)* Artifacts as processes are the result of cognitive (design) processes and are not restricted to physical objects. This implies a shift from tangible artifacts to non-material procedures, rule-systems, enabling structures/processes, etc., which in turn may lead to certain (material) results. In this view then, what we are innovating are relationships between input-output systems. However, these systems must not be reduced to simple deterministic linear systems (e.g., in the sense of Foerster's [1972] trivial machines). Rather, we are dealing with highly complex dynamical systems which have been designed to fulfill tasks in a highly complex and unstable environment. In the context of innovation, these processes translate into concrete new services, business models, or organizational processes, changes, strategies, and structures. Take for example Starbucks' open innovation initiative "betacup": The design challenge was announced as intending "... to reduce the number of non-recyclable cups that are thrown away every year by creating a more convenient alternative to the reusable coffee cup". The jury awarded the project "karma cup", as it transcends a typical product-based thinking (another paper cup or a reusable cup) by proposing a community-rewarding system: on a simple chalkboard placed by the register every guest that uses a reusable mug will be noted; every 10th guest receives a free item. So, it is up to the people themselves to decide which mug they prefer to use, as long as it is reusable and thus triggers a behavioral change through an incentive¹.
3. *Artifacts as cognitive and symbolic items.* This dimension introduces the *symbolic or the representational quality* to artifacts. Simply speaking, in this sense artifacts act as symbols, substituting the real phenomenon (e.g., Cole & Derry, 2005). Besides substituting a "real" phenomenon artifacts with cognitive and symbolic qualities play a crucial role in the context of communication, coordination as well as "transmission"/diffusion of knowledge (compare also the notion of inscriptions in Actor-Network Theory (e.g., Callon, 1986; Latour, 1987; House, 2003). Symbolic artifacts are not limited to linguistic symbols, but comprise all kinds of representational systems; i.e., each system which can be ascribed or attributed a representational value or function by a user of this artifact—and this applies to almost any artifact as there is at least the "original/intended meaning" of its creator embodied in its structure. Acknowledging that artifacts have a symbolic dimension implies that: (a) there does *not* exist a single fixed "meaning" of an artifact—it always depends on

¹ See: <http://www.thebetacup.com/>

the context and its user (see, for instance, constructivist approaches; e.g., Glasersfeld, 1989, 1995; or philosophy of technology studies, Pinch & Bijker, 1984)); (b) the physical world becomes almost irrelevant in the realm of symbols; it plays only the role of carrier triggering potential interpretations/meanings in its users (e.g., Borgmann, 1999); (c) if one introduces a dynamic dimension to symbols and, by that, extends the concept of symbolic artifacts to machines one ends up with “symbol manipulating machines”; they are also referred to as computers or even “artificial cognitive system/machines” as suggested by cognitive science (e.g., Clark, 2001; Friedenbergr & Silverman, 2006). So, from an innovation perspective, what we are talking about here, is the design of semantic systems, creating new meaning(s), identities, brands, or whole hypertext-like representational systems.

An example may clarify our point. Back in 2008, Asus’ Eee PC 700 started to create meaning for small subnotebooks (with screens varying from 7 to 11,6 inch), called “netbooks”. Netbooks’ meaning can be summarized as very small, light and mobile computers (being a replacement of a bigger computer). Sales rose sharply until 2010. Then, with the introduction of the iPad in 2010, sales dropped by 40% in the first quarter of 2011. What happened? The iPad created a completely new meaning, rendering the netbook almost redundant. Many commentators at that time criticized the iPad as nothing but a large iPhone, that it is technologically inferior, or just a hype. However, since then, the iPad proved Stephen Fry right, when he wrote about the totally new experience and ways of using such a device in a wide variety of contexts; it actually created completely new contexts for its usage which have not been present before². So, Apple created a game-changing and new meaning for a highly mobile device, a cognitive artifact: it is not a small laptop, it is not a large smart/i-Phone, it is something that has revolutionized our working and leisure habits. It is a cognitive artifact in the sense of D.Norman (1991, 1993) which did not just extend our cognitive abilities, but also changed the whole meaning and context of tasks to be accomplished.

4. *Interfaces*: As we primarily experience artifacts by *interacting* with them we have to focus on interfaces. They imply a shift of perspective from tangible artifacts or processes to “a concern of how people interact with them, from what things

² “This is the first time I've joined the congregation at the Church of Apple for a new product launch... The moment you experience it in your hands, you know this is class. This is a different order of experience... it is a whole new kind of device. And it will change so much. Newspapers, magazines, literature, academic textbooks, brochures, fliers and pamphlets are going to be transformed (poor Kindle)... But believe me the iPad is here to stay and nothing will be quite the same again”. See <http://www.guardian.co.uk/technology/2010/jan/29/stephen-fry-apple-ipad>

objectively *are* to *processes* through which they are created and experienced, and from *ontology* to *ontogenesis*.” (Krippendorff & Butter, 2007, p. 6). This dimension is about designing and innovating ways of interacting and interfacing with the world/artifacts as well as new ways of having an impact on users. Human-computer interfaces are the most prominent example, but the same also applies to such simple things as a steering wheel or a dashboard of a car. The important point for the context of innovation is to learn to see a particular innovation-task in terms of designing and innovating the patterns of *interaction* between the human and an artifact (in order to reach some goal). Consider an every-day situation: eating. The interface between food and technological tools (cutlery) has a historic and mutual relationship which is expressed differently in various cultures: spoon, fork and knife in the western culture, chopsticks in Japan (imagine eating a chop of meat with chopsticks).

5. *Discourses and cultural artifacts (e.g., social innovation)*: Pushing the notion of artifacts one step further, one ends up at designing and innovating whole systems of *discourses* or even *cultural and social systems*. Paradigmatic shifts in science (*sensu*, Kuhn 1962), culture or art are examples of these kinds of innovations. Krippendorff summarizes the goals of creating innovations in the realm of discourses as follows: “The design of discourses... focuses on their *generativity* (their capacity to bring forth novel practices), their *rearticulability* (their ability to provide understanding), and on the *solidarity* they create within a community.” (Krippendorff, 2011, p. 412). A good example is Alessi’s approach to shape the design discourse together with architects and designers for a time-span of 10 years to come (Verganti, 2006). These are “social engineering projects” with an impact on cultural processes.

Clearly these dimensions may be distinguished but not separated from each other. The dimensions overlap and build on each other. For instance, the material dimension plays a crucial role in most cases: it is the physical carrier of, say, the symbolic dimension. A good example is IBM’s Innovation Jam, in which IBM organized a kind of crowd sourcing initiative. It shows nicely how the above-mentioned dimensions and their integration are crucial for bringing forth innovations: it is not only based on material artifacts, but also on processes, symbolic interaction as well as discourses. It socially shapes discourses between a huge number of participants by applying web 2.0 technologies and social engineering approaches. For further details see the case study in Section 5.

What is happening in social networks nowadays is another good example of how all these dimensions function as an integrated whole. They are innovations designed with the purpose to change the ways we interface and interact with each other, with our world, the way how social (and even political) systems function, and perhaps how our culture functions (we will be able to fully understand and evaluate these changes only in a couple of decades from now). From such a perspective it becomes clear what kind of impact certain innovations may have on a larger scale even though they are “only technological” innovations on the material or process level (in the scheme of the categorization of above). Hence, if one wants to bring about game-changing innovations one should consider and explore all dimensions jointly, but especially the dimension of *meaning*.

Krippendorff puts it most succinctly: “Meaning is the only reality that matters. ... people never respond to what things are but act according to what they mean to them. ...No artifact can survive within a culture without being meaningful to those that can move it through its defining process” (Krippendorff, 2011, p. 413).

2.3 Innovation as strategy for dealing with shaping the unforeseen

The above inventory of the context and objects of innovation, has brought us one step closer to addressing our main question of how innovation can be facilitated. However, a proper understanding of this question requires one more preliminary step, looking at innovation strategies.

Coping with change is at the heart of any innovation process. In most cases the challenge is how to react to this change with a strategy that is based on new knowledge or—even better—to anticipate this change and proactively shape the future with new knowledge. From a knowledge perspective this is a triple challenge: one has not only to react to a change which has occurred already; rather, (a) one has to anticipate this change and (b) to relate it to a possible future state of one’s own knowledge (be it in one’s own business, human resources, technology, etc.). (c) Over and above that, one has to shape a whole future scenario which integrates these domains in a (radical) innovation. Of course, this is the most

sophisticated form of dealing with the challenge of change. In the present we will elaborate different levels and strategies of how to deal with change (see also Scharmer [2007]).

1| Reacting and downloading

This is the simplest way of responding to change. Already existing and well established cognitive, behavioral, perceptual, or organizational patterns are applied to solve the problem or the learning/adaptation task. This is the most convenient and most economic way of reacting to change, because it requires only 'downloading' of prefabricated solutions, knowledge, patterns, etc. The price of this simple response is quite high: (i) the reactions are rigid and (ii) the resulting solutions or changes do not even touch the underlying issues of the problem. However, this mode of dealing with change is what many cognitive systems and organizations do most of their time as it helps maintain the functioning of an organization.

2| Restructuring and adaptation

This approach goes one step further by not only applying already existing knowledge patterns, but to use these patterns as a blueprint which is to be adapted to the current situation. From a cognitive perspective this is a highly efficient learning strategy, because it is not as rigid as downloading, yet can be done with minimal cognitive effort. These processes of optimization normally lead to *incremental innovations* (e.g., Ettlie, Bridges, & O'Keefe, 1984).

3| Redesigning and redirecting

The focus of this strategy to cope with change is to primarily explore one's own *patterns of perception and thinking* in order to be able to assume new perspectives. In that process the focus of attention shifts from the external object to the source of one's cognitive and perceptual activities—this shift is referred to as *redirection* (Depraz, Varela, & Vermersch, 2003). This can be done individually, however, it is done much more effectively in a collective setting. The goal is to arrive at a position from which it is possible to take different standpoints and to understand what one's own patterns of perception and thinking are—these insights act as a starting point for creating new knowledge and for the following level of reframing.

4| Reframing

Fundamental change is always connected with reflection of deep assumptions and stepping out of the—more or less consciously—chosen framework of reference, i.e., going beyond the boundaries of the pre-structured space of knowledge and “reframe” it in the sense of constructing and establishing new dimensions and new semantic categories. This process concerns the level of mental models, premises, deep assumptions and their change. In dialogue-like settings (e.g., Bohm, 1996) these assumptions are explored in a *double-loop learning* manner (Argyris & Schön, 1996). Going one step further, this process of reflection leads to the construction of completely new conceptual frameworks enabling the reframing of already well-established cognitive structures. These are the basis for *radical innovations*.

5| Re-generating, profound existential change, and “presencing”

On an even more fundamental level, change goes beyond reframing. Change is not any more concerned with intellectual or cognitive matters and modifying assumptions only. Questions of finality, purpose, heart, will, etc. come to the fore, that all concern an *existential* level rather than only the cognitive level. From a learning perspective these processes are realized in the *triple-loop learning* strategy (Peschl, 2007a). The goal is to bring the existential level of the person and the social system/organization (i.e., its acting as well as its core) into a status of inner unity/alignment with itself and with its future potentials as well as with future requirements. What might sound esoteric is in fact a very old theme and philosophical issue, at least dating back to Aristotle’s philosophy. Very often these questions concern the domain of the core/substance of the innovation object and of wisdom. Because of its existential character Scharmer (2007) refers to this mode of knowledge creation and change/learning as “presencing”. It represents an approach to innovation which does not primarily learn from the past, but which shifts its focus towards “learning from the future as it emerges”. The goal is to be very close to the innovation object and at the same time completely open to “what wants to emerge” (out of the surrounding, out of the organization, its humans and its knowledge). The difficult part in this approach is (a) to profoundly understand the situation (i.e., the core of the innovation object) plus its context,

(b) to match these insights with the potentials which want to emerge, and (c) to bring them into a consistent and integrated picture.

In short, the process of presencing is about a fundamental examination of the core of the innovation object leading to a profound, holistic, and integrated understanding of this object including its context—only a highly nurturing environment for generating profoundly new knowledge may give rise to radical innovations which are not only fundamentally new (in the sense of radically changing the rules of the game), but which are also fitting organically into what is already there and what emerges in society, in the organization, and in culture in general.

As can be seen these five strategies of coping with change reflect most of the dimensions of the typology of artifacts presented above. In the end, they go far beyond the material level and dive deeply into the existential and discursive dimension.

3 Enabling innovation as a process of extended cognition

3.1 Extended cognition as foundation for innovation processes

As we saw, the strategies for creating new knowledge just discussed all build on cognitive abilities. However, it is necessary to rethink our traditional notion of cognition, particularly if we want to understand the role ICT plays in innovation processes. While classical approaches in cognitive science (e.g., Friedenbergr & Silverman, 2006; Stillings, 1995; Varela, Thompson, & Rosch, 1991) focus on the cognitive processes *inside* the brain, the *situated* or *extended* approach to *cognition* does not only take into account the *embedding* of the cognitive system into its *environment* (e.g., Clark, 1999, 2001, 2008; Hutchins, 1995; Menary, 2010; Suchman, 1987), but includes it as an *inherent part* of cognition.

“...the actual local operations that realize certain forms of human cognizing include... loops that promiscuously criss-cross the boundaries of brain, body, and world. The local mechanisms of mind... are not all in the head. Cognition leaks out into body and world...”

This matters because it drives home the degree to which environmental engineering is also self-engineering. In building our physical and social worlds, we build (or rather, we massively reconfigure) our minds and our capacities of thought and reason.”

(Clark, 2008, p. xxviii)

At this point the concept of *Enabling Spaces* comes in: innovation is *not* only a cognitive activity taking place *inside* the brain, but it is *intrinsically coupled with the environment*.

Innovation is heavily dependent on the interaction with and immersion in the environment, be it in the process of close observation, of interaction with other persons of the innovation team, in the processes of (jointly) using ICT, or in the process of fast-cycle learning through prototyping, which is a kind of “thinking-with-the-object”-process.

Hence, here we are confronted with the question of how *environmental structures* can act as *enablers* for processes of profound innovation. The situated and embodied cognition approach in cognitive science, which Clark (2008) also refers to as “extended cognition” (see also Menary [2010]), represents the foundation for designing innovation processes as being situated in Enabling Spaces.

3.2 Enabling or on the importance of giving up control

When it comes to organizations and output-oriented efficient action we love predictable, repeatable, and stable processes. Innovation seems to be an enemy of such processes as it aims at destroying or destabilizing established routines. This is also one reason why so many innovation initiatives are doomed to fail in organizations; innovation is change and implies giving up near and dear routines and processes. In most cases this is something that is not really appreciated by employees. Putting ourselves in the role of a manager, our desire concerning innovation is that it is a controllable process which leads to new products or services in a deterministic and almost mechanistic manner, i.e., there are rules, algorithms, or mechanisms describing the process of successfully producing new knowledge and innovations.

Which attitudes and values hide behind such an approach to innovation? There is clearly an attitude of *making* (“*facere*”) and *controlling*: the assumption is that innovation can be

produced or controlled as any other process, such as production processes. It is clear from experience that even less complex processes can be controlled only to a certain extent: Reality always has unpredictable surprises and is always more complex and richer than the knowledge about it. Hence, it is always “one step ahead” and—in spite of all our attempts of cognitive or scientific domestication—will always surprise us with its unpredictable dynamics. This applies even more to innovation processes. Controlling, making, or “managing” innovation by applying rules or recipes turns out to be a *contradiction in itself*. Looking more closely from the perspective of logic reveals that knowledge resulting from a process of applying rules cannot be really new in a more profound sense. (In a formal system) applying rules (which is more or less equivalent to running an algorithm) just makes explicit what is implicitly given in this set of rules. Consequently, the resulting knowledge is not really new, as the structure of the knowledge space is already implicitly given by the rules. It just gets explored in the process of applying these rules. That makes certain points and trajectories explicit in the knowledge space; it is only due to the complexity of the rule system and its implicit character that they appear to be “new”.

Enabling as an alternative paradigm

So, are there no rules at all for structuring and organizing innovation processes? As will be shown the difference lies in the *attitude* towards the role of these rules and towards how they are applied. Essentially, as already indicated, we suggest to replace the classical attitude of control and making with one of *enabling*.

In the context of generating new knowledge and innovation, enabling means that we (i) have to give up the regime of control, determinism, and mechanistic making; (ii) and instead *provide a set of constraints or a facilitating framework* that supports the *processes of generating new knowledge*. This can be best thought of using the metaphor of a (force) field. The constraints are attractors and repellers. They are responsible for modulating the knowledge dynamics, which is driven both by its internal dynamics and is constrained by the forces of the attractors/repellents. Beyond that, the knowledge dynamics may themselves influence the structure of the framework of constraints (i.e., the attractors/repellents). This is

a typical structure of a “design problem” (e.g., Dorst, 2003, 2006): as opposed to a well-structured problem/solution space (see above) the knowledge creation space itself may be changed during the process of navigating it.

This approach is based on the premise that there is something *latent* in reality/knowledge which wants to *break out*. Metaphorically speaking, it is something that wants to *break out*, but typically is *highly fragile* and too weak to break out by itself. This portrayal is also closely related to what C.O.Scharmer refers to as *self-transcending knowledge* (e.g., Scharmer, 2001, 2007; Senge, Scharmer, Jaworski, & Flowers, 2004; Kaiser & Fordinal, 2010).

Following the metaphor, it is therefore, necessary to *facilitate* this process of moving this object/phenomenon from a state of potentiality into a state of realization. This is what we refer to as *enabling*: facilitating the process of breaking forth of (new) latent qualities and dynamics, facilitating to “give birth“ to a new form, new knowledge, etc.

It is clear that this approach to innovation and knowledge creation goes far beyond classical “out-of-the-box thinking” or creative tools (Kelley, 2004; DTI, 2005). Peschl and Fundneider have developed an entire innovation paradigm and a systematic innovation process around this approach, which they call *Emergent Innovation* (e.g., Peschl & Fundneider, 2008, 2008; Peschl, Raffl, Fundneider, & Blachfellner, 2010).

Enabling as attitude and foundation for innovation

As indicated, this approach of enabling for innovation and knowledge creation is not only an abstract and cognitive concept, but is a question of *attitude*, it is a *habitus* or a paradigm of thinking and acting. Unfortunately, the enabling paradigm is a rather “*poor*” and *weak* concept in the following sense: one has to give up control and let things go and let things develop. “Reality does a large part of the job for you.” Of course, this is not a very comfortable position—especially in a business environment where everything has to be determined, calculable, “managed”, and predictable. However, the enabling attitude is a consequence of having to admit that we are not in (total) control when being engaged in innovation activities. It seems to be more sensible to “surrender” than to invest energy and resources into an epistemological battle, which we will never be able to win. Table 1 gives a

summary of the changes of the most important attitudes from the regime of controlling innovation to enabling innovation.

Enabling attitude	Control, managing, “making“ attitude
Enabling, facilitation	Planned, rule oriented, algorithmic, „making“ („facere“)
Providing supporting environment & enabling constraints	Following rules & „recipes“, (mechanistic) execution of routines
Primacy of openness, listening, and (passively) observing	Primacy of projecting one’s own ideas
Letting things go, go with/ follow the flow, emergence, “surrender” to reality”	Trying to keep things under control
Patience, Waiting for the right moment (kairos καιρός)	Pushing things and getting things done
Problem setting & paradigm setting	Problem solving & „puzzle solving“ (Kuhn, 1962), paradigm accepting
Questioning assumptions and methods, open ended	Staying within the predetermined problem/knowledge/search space
Design (-thinking) based / „artistic“	Analytical, „science like“
Starting with blank sheet, taking the large perspective	Starting with already existing solutions, concerned with details

Table 1: Opposing the attitudes of enabling and the regime of control, managing, and making.

However, the notion of enabling does not imply that we are only passively sitting and waiting for an innovation to emerge; quite to the contrary: the real challenge is to create *enabling structures* in the form of constraints, which support these highly fragile processes. In this sense managerial abilities in the *enabling attitudes* do not really contradict each other.

3.3 Artifacts as socio-epistemological technology enabling knowledge creation

Artifacts as technology

The “enabling structures” mentioned above are enabling artifacts, that facilitate the creation of new knowledge and lead to innovation artifacts. They are essentially artifacts playing the role of a *technology*. Hence, we are not only considering innovations to be artifacts, *but also the innovation processes themselves*. What we are looking for is *artifacts as enablers* for processes of knowledge creation and innovation. It is clear that technology, and more specifically ICT, plays an important role in this context.

Theoretical foundations from the field of science and technology studies (STS)

As has been discussed already any kind of knowledge creation process is always embedded into a social context as well as in a technological/artifact environment. Knowledge creation is a socially and technologically mediated construction process, which can be described as a *socio-epistemological technology*. Having its roots in the works of Callon (1986), Law (1992), or Latour (1987) the *Actor-Network Theory (ANT)* approach provides a framework from the field of science and technology studies/social sciences which tries to describe such socio-epistemological processes of knowledge production in a broader context including a wide variety of actors by (originally in the field of science).

“The basic ontological unit of ANT is the *actor-network*, a heterogeneous collection of human, non-human, and hybrid human/non-human actors participating in some collective activity for a period of time. Networks may be composed of people, machines, animals, texts, money, and other elements. ANT is concerned with how these pieces are held together, as agents, organizations, devices, machines, texts, social institutions, social technologies, organizational forms, boundary protocols, and many other things.” (House, 2003, p. 14)

Some interesting insights for the concept of Enabling Spaces can be gained from the ANT approach. (a) Organizationally speaking, knowledge creation processes are never linear processes, but always follow networked patterns and heavily depend on interaction between actors. (b) It is necessary to explicitly design these networks and to channel their dynamics, although it is clear that the outcome has to be open. (c) From an epistemological perspective knowledge creation always goes through phases of epistemological opening up and closure/stabilization processes. (d) Symbolic artifacts (“inscriptions”; Latour, 1987; House, 2003) are key players for providing a “knowledge eco-system/landscape” in and through which new knowledge can emerge. (e) Embodiment, context, inclusion of stakeholders and the systemic environment, both human and non-human, all matter.

Implications for innovation: innovation as socio-epistemological technology

As has been discussed in Section 2.2, artifacts always involve a wide range of dimensions which have to be considered when designing and applying them. And this is especially

relevant in the context of innovation processes. The innovation process itself has to be seen as an artifact and it is not enough to reduce the artifact “innovation process” to either purely ICT or cognitive processes. As an implication of the typology of artifacts presented in Section 2.2, it becomes clear that *innovation is mainly about creation of new meaning* (systems) which always involves epistemological as well as social processes and interactions.

Think, for instance, of the different phases of an innovation process: there is a huge difference in the qualities of knowledge being involved in the processes of idea generation, of listening and observing, of identifying potentialities, of prototyping, or of implementing.

Besides this *epistemological* perspective these processes are always embedded in a *social* dynamics, which has to be considered as well.

We are searching for a *technology* that comprises all these dimensions in order to come up with comprehensive innovation artifacts. Normally the term technology triggers the connotation of information technology (ICT). In our context of innovation processes the concept of technology has to be used in a much broader sense, namely in the sense of an *enabling artifact*. As Arthur (2007) puts it, we „will define a technology... quite simply as a means to fulfill a human purpose... A technology is built around the reliable exploitation of some effect, as envisaged through some principle of use...“ (p. 276). Thus conceived, technology is rather a well-defined and structured practice, process, or procedure which itself might involve other technologies. Philosophically speaking, technology plays the role of a *tool* or an instrument in order to achieve or enable some desired state or goal. It does so by mediating between cognitive activities, such as planning, or realizing some internal mental model and the object (in the outer world) by making use of some effect—i.e., it supports and facilitates the process of transferring the “*causa formalis*” into the world. The problem in the context of innovation is that the “goal” is not really clear as it comprises something which is not known yet. That, indeed, is why we have to put our focus on enabling rather than following some rules in order to achieve a well-defined goal.

From ICT to Enabling Spaces for knowledge creation and innovation

“Essential to this broader notion of technology is that although tools are constituents of a technology, it is the way in which tools are deployed as part of a social practice that is crucial. ...the study of technology must focus on behavior and artifacts in the context of activities. Our emphasis on technologies as forms of tool-mediated social practices also inclines us to adopt a broader notion of intelligence than that adopted in most contemporary theorizing on the subject.” (Cole & Derry, 2005, p. 211)

This suggests to comprehend innovation processes as *socio-epistemological technology* (see also Peschl, 2006a, 2006b). The concept of innovation cannot be limited to mere knowledge processes, to ICT, or to waiting until some brilliant idea emerges somewhere and at some unknown moment. Rather, the *whole facilitating context* has to be taken into account: in that sense an innovation process is a form of *tool-mediated enabling social practice* that creates new knowledge leading to an innovation. It is necessary to provide structures which are facilitating these highly fragile and complex knowledge processes which we refer to as *Enabling Spaces* (e.g., Peschl, 2006a, 2007d; Peschl & Fundneider, 2012; Peschl & Wiltschnig, 2008; Wiltschnig & Peschl, 2008).

Enabling and artifacts

Artifacts play a crucial role in the context of innovation, both as *means* for and *results* of innovation processes. As was stressed by Norman (1991) already, designing artifacts that support cognitive processes in general, demands us not to see *enablers* primarily as tools that amplify already existing cognitive abilities but as tools that change the whole context: “Artifacts may enhance performance, but as a rule they do not do so by enhancing or amplifying individual abilities. There are artifacts that really do amplify. A megaphone amplifies voice intensity to allow a person's voice to be heard for a greater distance than otherwise possible. This is amplification: The voice is unchanged in form and content but increased in quantity (intensity). But when written language and mathematics enable different performance than possible without their use, they do not do so by amplification: They change

the nature of the task being done by the person and, in this way, enhance the overall performance.” (Norman, 1991, p. 19)

This implies that Enabling Spaces (as cognitive artifacts) must not be thought of as primarily enhancing and supporting already existing creative cognitive abilities; rather, they have to open up new spaces of knowledge creation by offering completely new and unexpected patterns of interaction between the participating cognitive systems and these enabling artifacts. Hence, we should not start our design process only investigating existing creative cognitive abilities, we also need to take into consideration the *interaction perspective* that is suggested by the extended cognition approach (e.g., Clark, 2008; Menary, 2010). Ultimately, the goal is a smooth coupling between cognitive dynamics and the dynamics of the enabling artifacts forming a new unity—a joint process enabling and bringing about the creation of new knowledge. Enabling Spaces are like an ecosystem, providing exactly such a context of smooth and fertile interaction between cognitive and artifact dynamics.

4 Enabling spaces

Enabling Spaces act as containers, holding innovation processes and activities. An Enabling Space is designed as a multi-dimensional space, in which architectural/physical, social, cognitive, technological, epistemological, cultural, intellectual, emotional and other dimensions are considered and *integrated*. These dimensions must not be seen as separated from each other; rather, all dimensions are heavily dependent on each other and only enable sense making, if they are related to each other. It is the big challenge to develop a well-orchestrated design that integrates these dimensions into an unified enabling framework. This cannot be achieved in a mechanistic manner, because one always needs to take into account the particular organizational context, its environment, as well as the particular task. Hence, developing an Enabling Space is—besides its foundation in epistemological and scientific findings—a *design* task, one which does not have a “single best solution” (e.g., Peschl, 2007d; Peschl & Fundneider, 2012). To argue this case, we will discuss in turn the dimensions and then their integration.

4.1 Dimensions of an Enabling Space

Architectural and physical space

The dimension of physical space, or Euclidean space, refers to the intentionally designed and built physical environment that surrounds the innovating user with concrete physical structure(s). It comprises elements such as walls, furniture, windows, etc. Examples of architectural spaces are offices, spaces for creative and knowledge work, houses, urban places, or urban settlements, etc.

The challenge is to design this space in such a way that the flow of knowledge and social interaction is supported in the best possible way for the specific (knowledge or innovation) task at stake. In most cases today's architecture leads to "disabling spaces" rather than enabling or even actively supporting knowledge and innovation processes. Allen and Henn (2007), Krogh et al. (2000), Nonaka et al. (1998) (concept of "ba"), and others give good examples of how to solve this architectural design challenge.

Social, cultural, and organizational space

Knowledge (creation) processes are always embedded in social processes as social interaction is a *conditio sine qua non* for the emergence of (radically) new knowledge in a collaborative setting. As Kelley (2004) and many others show, social groups are essential for bringing about innovation and new knowledge. From an epistemological perspective we know that the knowledge processes, which are involved in the course of radical/game-changing innovation are highly fragile—the new is unknown, it cannot be planned, there is lot of intuitive knowledge involved, in many cases one expresses very personal and existential thoughts and intuitions during such a process. Therefore, there has to be a "social container", a (social) atmosphere, in which these processes are allowed to develop their own dynamics and gain their own strength. Apart from other aspects, *trust* and openness are key social enablers, which have to be established before any kind of innovation work can start (see also Rusman et al., 2010). That is why it is necessary to spend much energy in selecting the "right" members of an "innovation team" and to find a socially as well as functionally well-balanced constellation (see, for instance, Sie, Bitter-Rijkema, & Sloep, 2011).

Above that, innovation is always embedded into the culture and organizational structures of an organization. They heavily influence the enabling or disabling effects on innovation- and knowledge creation processes and have to be considered and designed accordingly.

Cognitive space

Although innovation is the result of a collective effort in most cases, every innovation has its origin in one or more individual brains and in *cognitive processes*. The relationship between individual and collective creative activity can be thought of best in terms of an emergent phenomenon (e.g., Stephan, 2006; Corning, 2002). In any case, cognition (and its interaction with the environment; cf. Clark's (2008) extended cognition approach) is the source of new knowledge. Hence, it is the cognitive space and its relation and interaction with the remaining enabling dimensions which have to be taken into account when designing Enabling Spaces. What are the key cognitive enablers among the cognitive activities which are provided by our brain? The capability to observe closely, to "listen to what wants to emerge" (cf. Scharmer, 2007), to reflect on one's premises, to sense and to understand one's own patterns of thinking and perception, to enter into a "real" dialogue (e.g., Bohm, 1996), practical intelligence/phronesis (φρόνησις) (e.g., Nonaka, Toyama, & Hirata, 2008), learning processes in a prototyping setting, etc.

Emotional space

Cognition is always embedded into emotional states. An Enabling Space therefore has to take into consideration emotions and offer features that trigger emotional states that support processes of knowledge creation, such as security, protection, openness, etc. However, the emotional dimension of Enabling Spaces is not only about "feeling well". In some cases it is necessary to push oneself into an emotionally uncomfortable situation in order to leave behind one's well-established and dear patterns of thought and perception.

Epistemological space

Besides behavioral action cognitive processes generate knowledge: both internal and external knowledge (i.e., in the form of artifacts). Dealing with innovation processes always involves a wide spectrum of different types, categories, styles, or genres of knowledge

processes: there is a huge difference between the knowledge involved and created in a process of ideation, of close observation, of intuitive reasoning, of deep understanding, of sense making, of prototyping, of letting-come, of reflecting, of implementing, of executing a routine, etc.

Hence, in order to establish an epistemologically enabling space, one has to first identify the knowledge processes which are relevant for the particular (phase of the) innovation process. One has to understand the very nature of these processes. Then it is necessary to create an enabling environment (in the sense of boundary conditions, constraints, attractors, etc.) in which this knowledge dynamics can develop, grow and flow. From these considerations it becomes clear that the resulting spaces will look very different and depend on the supported knowledge process and organizational culture and social setting.

Technological and virtual space

Innovation processes are always embedded in a technological environment. This comprises a wide range of technological means ranging from “low-tech” tools, such as white boards, flip charts, light ambiences, etc., to high-tech tools such as computers, the internet, social media, visualization tools, complex software, knowledge displays, etc.

In (virtual) collaborative innovation settings ICT plays a special role as it integrates the above domains. The most important and difficult challenge is to design an interface between the diversity of knowledge processes and knowledge spaces and to integrate them with the social structures and dynamics.

4.2 Integrating enabling dimensions

As argued, these dimensions may be seen separately but cannot be separated from each other. Indeed, the very goal of Enabling Spaces consists in integrating these aspects in a radically interdisciplinary manner into an integrated design, into a whole, like a composition, a piece of art (“Gesamtkunstwerk” in German). Krippendorf’s (2007, p. 5) “*ecology of artifacts*” follows a similar notion. There, complementary enabling artifacts work together by supporting their users in their cooperative knowledge processes in order to develop joint meaning systems. The success of such enabling artifacts heavily depends on how mutually

supportive, cooperative, and efficient the integration of these artifacts is designed. In a nutshell, that is what the real challenge in the design of Enabling Spaces is about.

Take the example of the process of knowledge creation. Here we see the necessity of integrating social, cultural, emotional, physical/architectural, as well as epistemological issues: generating new knowledge is a highly fragile process, which is about intuition, listening to weak signals, deep thinking and understanding, incubating vague knowledge, etc.

Due to the fragility and vulnerability of these processes it is necessary to create a kind of container, i.e. an Enabling Space, which provides qualities such as offering an environment of protection, of being able to hold and cultivate epistemological and social fragility, of enabling the free flow of knowledge, of silence, of openness for error, openness for change, as well as of collecting results in an unobtrusive manner, etc.

These design qualities have to be translated into integrated and interdisciplinary concepts, which—in their wholeness—form the concrete Enabling Space. In them, trust is a major issue, not only between the team members (i.e., in the concrete social domain), but also as a cultural value in the organization, which does not only exist on paper, but is practiced in every routine and social interaction. Furthermore, the (epistemological) understanding has to be established that the knowledge and processes with which the team is dealing are highly fragile and need completely novel mindsets and attitudes. Such an understanding implies a different mode of operating, of talking and interacting with each other, novel criteria of evaluating and judging, etc. The (interior) design of this space has to reflect these qualities: vulnerability, fragility, openness, trust, amicable dialogues, non-hierarchical, building up on each others' ideas, etc. This design challenge can be solved by situating the process mainly outside the company's walls, since—according to experience from many projects—this allows for leaving behind the usual “business-like”-attitudes and patterns (hierarchy-based, not invented here syndrome, etc.). The quality of the Enabling Space (and, hence the process of knowledge creation) is enhanced by carefully choosing the parameters of such a space: (scenic) location, almost no tables (acting as barriers for talking), different seating scenarios (including a private situation for individual thinking, as well as a more public setting

for negotiating knowledge, etc.), mobile ICT-infrastructure (e.g., knowledge visualization and semantic techniques can be employed for documenting this process), a “research booth” for inquiries (telephone, Skype-meetings), lots of space for presenting things, workshop equipment facilitating the transformation of ideas into tangible prototypes (“interface”), etc. Further, and equally important, is the considering of how to integrate the results of this extra-territorial space back into the organization.

Apart from these elements one has to consider the corporate/organizational culture as a key constraint. Enabling Spaces receive their “flavor” by the organization’s culture and might differ considerably according to these constraints. One can see clearly that the creation of Enabling Spaces is a real design challenge; it has to be done for each organization individually and no standard solutions and simple rules exist which one just has to follow in order to come up with a ready-made and fully functioning Enabling Space fitting organically into the organization. Hence, it is necessary to develop a design process that translates these rather abstract innovation-, knowledge-, and core processes of an organization along with its culture into design qualities and patterns and which, in a next step, into concrete elements that integrate the above dimensions into an Enabling Space.

5 Case study: the IBM innovation jam—massively parallel knowledge creation

IBM, more specifically its research division, counts among the largest corporate research organizations worldwide: it comprises eight labs with about 3,200 researchers (being part of the 346,000 employees in total) in six countries. It is clear that there is a huge potential for a wide variety of innovations in such a highly research driven global organization. As has been described above IBM was struggling with capitalizing on this huge innovation potential.

Compared to classical companies IBM was facing a rather different scale (concerning the number of people involved, the global dimension, the organizational structure, the high diversity of fields of innovation/products/services, etc.).

That is why IBM developed the idea of a “*jam*” to promote innovation on a broad scale already in 2001. In 2006 it organized the big “*IBM Innovation Jam*”. IBM set up an ICT infrastructure comprising a group of bulletin boards, discussion forums, interlinked web pages displaying and explaining IBM’s research results, etc. The goal was to trigger a *massively parallel worldwide virtual bottom-up brainstorming process* in which all employees were invited to participate and to collectively create new ideas. The process was not limited to IBM’s employees, but involved also their relatives, invited external experts, users, customers, suppliers, etc. (Helander, Lawrence, & others, 2007); it was designed as a truly crowd-sourcing and *open innovation* process (e.g., Chesbrough, 2003a, 2003b).

5.1 The IBM innovation jam set-up

The idea is rather simple—it is a huge challenge and has huge potential, however, if it is seen in the context of the organizational, cultural, as well as socio-epistemological interventions that took place in a well orchestrated manner. This exemplifies, what an Enabling Space is about: it is the *socio-epistemic* and *socio-technological process* that are important in this context (see also our considerations above on innovation artifacts and on artifacts themselves being enablers for knowledge creation). The innovation jam processes comprised several phases and steps (Bjelland & Wood, 2008; Helander et al., 2007):

1. Identification of “seed areas”: these are strategic fields which were assumed to be essential for IBM (e.g., “Going places”, “Staying Healthy”, “A better planet”, etc.). As can be seen these areas are very broad and general; this is intentional as they should act both as inspirations and constraints for the brainstorming process. These seed areas were the result of IBM’s Global Innovation Outlook, opinions of thought leaders, high-ranking managers, scientists, etc.
2. These seed areas were developed further, correlated with existing research, fields of competence, products, and services at IBM, etc. Web sites were built up for these fields, explaining them, making them more graspable by mini-lectures, by interviews and (online-) discussions with experts, etc.
3. Jam Phase 1 (July 24–27, 2006): the primary focus of this 3-day phase was *ideation*, the generation of a vast number of ideas. These ideas were posted in forums,

discussion boards, wikis, etc. About 37,000 messages were posted in about 8,600 threads in these 72 hours (Helander et al., 2007, p. 68).

4. Post Jam Phase 1: review and develop “big ideas”. About 50 senior executives looked through the postings to identify the most promising ideas and suggestions. In this phase both technological means (e.g., automatic clustering and semantic analysis) and massive human processing was involved in order to identify the “golden nuggets” in this vast amount of data and conversations. This process resulted in 31 “big ideas” such as “big green” services, intelligent utility grids, branchless banking for the masses, remote health link, real markets for virtual worlds, cellular wallets, etc.
5. Jam Phase 2 (September 12–14, 2006): the focus of this phase was to transform these “big ideas” into real products, services, business scenarios, solutions that benefit business and society. Wikis were provided to develop these business solutions in a more structured co-creation process. The sessions of this phase were more focused than in phase 1 although experience showed that people could not stay focused on the given fields, but went on in developing new ideas (Bjelland & Wood, 2008, p. 35). This shows the limitation of these “online-only tools” in such processes which require a high level of interaction, epistemic discipline, and epistemic awareness.
6. Post Jam Phase 2: Review of the postings and wikis of Jam Phase 2 again using methods of e-clustering and human intelligence. The most promising ideas were correlated with the IBM overall strategy and portfolio, checked with Market intelligence, etc.
7. Proposing new businesses: 10 final project were chosen; the winner projects of this innovation jam received all together \$100 million funding for launching their businesses, such as Integrated Mass Transit Systems, 3-D Internet, Smart Health Care Payment Systems, etc.

According to IBM executives, none of the major ideas were completely new, as they have been uttered in one way or the other already before the innovation jam. However, the whole process was important, because so many people were involved in a joint innovation effort, they were part of it, they were listened to, they developed an understanding and culture of creative thinking, and many small ideas complemented very well with others so that new perspectives could be generated by correlating them. Feedback from IBM executives indicates that some of the businesses will be substantial success (e.g., the Big Green unit) (cf. Bjelland & Wood, 2008).

5.2 Learnings, limitations, and potentials for improvements from an Enabling Space perspective

“Idea generation is in some ways the ‘easy’ part—and darling star child—of innovation, whereas advancing, refining and building support for those ideas is the really tough part...

The online portion of the Jam is the rather large tip of an iceberg.” (Feedback on the innovation jam from an IBM executive; Bjelland & Wood, 2008, p. 40; compare also Denning, 2012)

What are some of the implications which can be derived from this case with respect to the concepts of enabling and Enabling Spaces presented above? First of all, one has to be clear that the IBM innovation jam was not explicitly designed as an Enabling Space although it shares some of its characteristics. Here are some major points, implications, and suggestions for improvement:

- It is the innovation *process* standing behind the whole project that is the interesting and essential element, not so much the (information- and communication-)technology. It is the *epistemic* as well as *social processes* which are vital and which get complemented and supported by technology. The innovation jam has shown that in some cases these processes have not been taken seriously enough and that there was too much emphasize on the technology perspective (e.g., the question of moderation of discussions, the focusing of fields, etc.)
- Even at IBM innovations are not necessarily highly sophisticated technological devices, but are rather *surprising and original business fields* which emerged out of a clever combination of social, political, or ecological needs and already existing products/services. By that, they open up a completely new perspective on a whole organization’s business operations. IBM is seen now in a completely new light compared to 15 years ago: i.e. the change from a technology producer to a user centered and service oriented consulting business with a technology portfolio in its backhand (compare IBM’s “Smart Planet Strategy” or its “Smart Cities” concepts which have partly emerged out of the described innovation jam processes).
- Innovations do not necessarily depend on highly sophisticated research labs, although they are necessary for developing the adequate technology for realizing the elsewhere created business innovations. The “real research labs” are the employees’

brains which, in a bottom-up co-creation process, bring about the relevant insights and ideas.

- What is interesting in the context of the IBM innovation jam is that it shows nicely how a combination of *bottom-up and top-down* processes can be realized: it is a permanent interplay between “normal employees” and strategic decision makers, between listening to the basis and setting up constraints. It remains a question how narrow or wide these semantic constraints/containers should be...
- The IBM innovation jam implicitly follows a *stage gate strategy*: a huge number of ideas is generated and then reviewed, evaluated, ranked, and selected. The first phase (broad idea generation) worked fairly well with the help of the online platform: it generated a huge number of rather low quality ideas which in most cases did neither fit the market nor the company portfolio and competences. However, as the results have shown, the following phases (translating the reviewed ideas and topics into concrete solutions) require other settings and tools than a virtual IT-infrastructure (e.g., face-to-face workshop settings supported by “low-tech technology” (flipcharts, pen, etc.)). The interesting question here is—and this should be clarified right at the beginning of such an activity—when to integrate which socio-epistemological technology.
- From an epistemic perspective it is questionable whether this stage-gate based strategy is the most advanced approach, because of the relatively low quality in the high quantity of ideas. Instead of pushing high numbers of low quality ideas it could be an alternative strategy to focus on the development of a lower number of high quality ideas by providing a more sophisticated epistemic path than wild brainstorming sessions in which nobody really listens to the other person, but wants to put forth his/her own projections and wishes instead of trying to understand what wants to emerge from real future needs. From an enabling perspective this would imply more investment in epistemic skills—this leads to more satisfactory innovation results and knowledge skills both for the employees and for the whole organization (compare also the emergent innovation approach; Peschl & Fundneider, 2008a)
- The previous point is related to an epistemic problem: IBM’s innovation jam follows a *rather limited epistemological variation*. Brainstorming process plus discussions are regarded as the primary sources for generating new knowledge. These discussions did not really go very deep and it was rare to find discussions whose postings would relate to each other. (cf. Bjelland & Wood, 2008, p. 37). From an epistemic perspective this would be the important part and the real added value for bringing

forth something new. Neither technology nor some kind of social or epistemic rules supported this important epistemic process.

- “Epistemic discipline”: as an implication of the points above we have to differentiate clearly between the type of knowledge processes taking place in the different phases of the innovation process. Accordingly it is necessary to provide constraints in the form technological support/tools, rules, social interaction patterns, epistemic awareness, etc. that drive and facilitate these knowledge creation processes
- The interesting, challenging, as well as very important parts of the innovation process were almost not technology-driven: identification of the seed areas, selection and construction of “relevant/big” ideas, correlating ideas which are semantically far apart and developing synergies out of them, etc. (see also Bjelland et al. 2008, p33, 38, 40). They are the result of face-2-face socio-epistemological as well as individual cognitive knowledge creation/negotiation processes. As an implication one can identify that there is a truly huge field having high potential for further development in the domain of knowledge technologies for creative processes.

6 Conclusions

Starting off with the question about the role of technology for innovation (processes) we have arrived at a more comprehensive understanding of what ICT and technology in general could mean in the context innovation. In summary, we made the following points:

- Innovation processes create artifacts: we have to start understanding innovations as result of a process leading to artifacts. I.e., innovations are based on new knowledge (an “idea”) which gets translated into an artifact. We refer to these artifacts as innovation artifacts.
- These artifacts have a wide range of dimensions which have to be considered both in the process of designing and applying them.
- Innovation artifacts are mostly about *meaning*: in other words, innovation basically creates new meaning or meaning systems.
- Design processes and innovation processes are structurally similar.
- The innovation process needs to be designed and thus itself is an artifact: as artifacts cannot be reduced to physical objects we can consider the innovation process itself to be an artifact leading to innovation artifacts.

- We came to see that this innovation process itself comprises more than just ICT tools or cognitive aspects. Innovation is a *socio-epistemological technology* (e.g., Peschl, 2006a, 2006b; Peschl & Fundneider, 2008b).
- Innovation is a process of creating new meaning which essentially is a “cultural” process. Such processes are always embedded in social, epistemological, cognitive, emotional, physical, etc. contexts.
- Furthermore, we have come to see that innovation and knowledge creation cannot be brought about by mechanistic and deterministic processes. If we want to increase the quality of innovation processes we have to shift our focus from a regime of control and managing to an attitude of *enabling*.
- We have seen that cognitive processes, and especially innovation processes, are always embodied and situated in the real world (cf. extended cognition approach; Clark, 2008; Menary, 2010). Hence, if we want to successfully implement innovation processes, we have to take this into account.
- Putting all these things together we came up with the concept of *Enabling Spaces* aiming at integrating these considerations and dimensions in an “ecology of artifacts” (Krippendorff & Butter, 2007) mutually supporting and complementing each other.
- In such an ecology of artifacts enabling innovation processes ICT plays an important role as it is very good at integrating these dimensions.
- However: as we know from (philosophy of) cognitive science (e.g., Boden, 1990; Clark, 2001) ICT only offers *syntactical* means supporting semantic processes. Hence, we cannot expect to tap into the semantic domain with these tools. As this semantic dimension has turned out to be crucial for any artifact we have to see that the any ICT is confronted with a clear limitation here.

Design principles for Enabling Spaces

As an implication of these insights we can derive the following design principles that should be considered when designing Enabling Spaces, and more specifically, ICT systems supporting innovation processes:

- *Attitude of enabling and emergence*: Instead of designing systems which try to mechanically create new knowledge it is necessary to think about such systems in terms of a set of constraints facilitating and supporting the cognitive processes of knowledge creation. They can be thought of as a structured container providing the necessary conditions for emergent processes of knowledge creation. They leave room for and trust in the emerging knowledge dynamics and in the processes of

social interaction. This attitude of enabling is probably the most important principle which should be present in every design decision as it gives the innovation process a whole new character and dynamics.

- *Interdisciplinary integration*: Innovation processes are not one-dimensional; they are one of the most complex and sophisticated cognitive, epistemological, as well as social processes we know of. As we have seen in our discussion about artifacts we have to consider a multitude of dimensions not only for the product (i.e., the innovation [artifact]), but also for the processes leading to such artifacts. Therefore, designing innovation processes should always involve expertise from various disciplines which get integrated in an Enabling Space like ecology of artifacts.
- *Meaning is the only reality that matters*: Designing such an innovation ecology of artifacts (including the processes as well) has to be directed into one direction: the *creation of new meaning* (systems). As Krippendorff (2006, 2011) has shown the only thing which users respond to and act on is what these innovation artifacts mean to them. And this does not only apply to the resulting innovations, but also to the tools and technologies leading to these innovations.
- *Primacy of interactivity & interface*: Following Norman's (1991) focus on stressing that we must not misunderstand (cognitive) artifacts as tools primarily amplifying already existing cognitive (creative) abilities, we have to start understanding Enabling Spaces as spaces facilitating a change in the mode of knowledge creation: it is the *interaction* between the enabling artifacts and the participating cognitive systems that give rise to a change in the way of bringing forth new knowledge. Furthermore, it is not primarily the materiality of Enabling Spaces (including ICT tools) but its *social utilization* by *interacting* with them that is of importance (e.g., Krippendorff, 2011). We have to focus on the process and the functionality of an *interface* which is offered by this integration of (ICT) tools forming an Enabling Space. They act as an *interface enabling a smooth interaction with the potential object of innovation*. Therefore, it is not only about an interface in the sense of a human-computer interface, but we have to start thinking about the *whole Enabling Space as an interface* coupling the users, technology, physical and non-physical structures of the Enabling Space with the object of innovation.
- *Primacy of exploration*: Enabling Spaces (including ICT tools) have to support processes that "explore the present for what is variable, combinable into new artifacts, fusible into new technologies in order to reach desirable futures for targeted communities". (Krippendorff, 2011, p. 416) These goals cannot be achieved by classical tools of re-search and analysis. In most cases re-search is rather oriented

towards the past and does not allow for “learning from the future (e.g., Scharmer, 2007; Peschl & Fundneider, 2008e). This orientation towards re-search applies especially to ICT as they have—in most cases—a strong focus on analytical and quantitative tools. Hence, there is a real challenge in this field to open up to more exploration based tools and processes. Recent developments in social technologies (WWW, socio-epistemological approaches, etc.) or design-thinking (e.g., Brown, 2008, 2009) point into that direction.

- *“Invisible” Enabling Spaces*: Considering the different stages and qualities how an artifact is experienced (e.g., Krippendorff 2006[p89ff], 2007[p8ff]), from recognition, over exploration, to reliance, the latter is of high importance for our context. In this stage of reliance the interaction with the whole Enabling Space (understood as an artifact) or a part of it (e.g., an ICT tool) is mastered and moves to the background. The users interact with it seamlessly and naturally and can focus on what they actually want to accomplish. This quality of reliance is one more aspect of “enabling”—the Enabling Space becomes “invisible” for the user. It has changed into “natural environment” for knowledge creation and innovation processes.

Future research

The above account is a first attempt to understand and detail the notion of innovation in enabling spaces. Future research should be directed towards an even more profound understanding of this concept of enabling and put it in a transdisciplinary context (e.g., from educational sciences, systems theory, human-computer interface design, design thinking, etc.). Among other things, this should allow for a better understanding of domain-specific characteristics of the design process, for instance in multi-cultural urban planning and housing, settlements implementing new ways of working and co-creating knowledge, etc. Crucially, we have come to see that we are involved in a design process in a twofold manner when we think about innovation processes: (a) the innovation process itself is a design process and (b) designing the innovation process is a design process that aims at creating an Enabling Space. Thus we understand enabling in the context of innovation processes both as a quality and as an activity.

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