BrainSpace: a virtual environment for collaboration and innovation

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Abstract: Innovation and problem solving processes take place more and more beyond the boundaries of the enterprise. Therefore, new methods and tools are necessary to foster multiple stakeholder relationships and manage distributed knowledge creation. This paper addresses some of the key considerations for collaboration and innovation, compares different possible approaches to support them and derives an integral internet-based platform on which a method and different communication tools are combined to a distributed cognitive system. Sustainable solutions require procedures that combine the effectiveness of a team with the creative power and the expertise of a community. *BrainSpace* fills this gap, and allows innovation to proceed in a complex environment by striking a balance between order and creative chaos.

Keywords: BrainSpace™; CSCW; CSCL; distributed cognitive system; enterprise collaboration; innovation management; knowledge communication; knowledge creation.

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1 Introduction

Progress in Information And Communication Technologies (ICT) has important consequences on the global economy. ICT is responsible for new fields of growth, drives innovation and shortens innovation cycles. To survive in efficient markets, the ability to innovate is crucial for small as well as medium-sized companies. As a result, the valuation given to enterprises is increasingly based on intangible assets and the potential to create future innovations. Therefore, it is surprising that little research has focused on innovation and its communication processes.

Often the term innovation is used in a fuzzy way for everything that is new or can be communicated as new. Even if innovation is identified as a competitive advantage (Porter, 1998), most discussion is restricted to describing knowledge as a key factor in the innovation process (Drucker, 1998).

This paper also deals with knowledge, but focuses on creating new knowledge rather than managing existing knowledge, profiting from the most recent developments in ICT. Derived from a theoretical framework for virtual collaboration, and based on the assumption that knowledge creation will take place beyond the boundaries of an enterprise, we have developed a web-based method to drive innovation in a large virtual group. By comparing alternative approaches for collaborative innovation, we will discuss the characteristics of *BrainSpace*, and show how it bridges the structural gaps of team- or community-based approaches to innovation. Finally, we describe practical experiences in a first implementation (Buesser and Ninck, 2003).

2 Fundamentals in the innovation process

Innovation is more than the ingenious flash of inspiration. In the next section we will describe our definition of innovation and discuss fundamental prerequisites for the innovation process.

2.1 Innovation: collaborative value creation

Too often innovation is confused with creativity. Innovation stems from the Latin verb *innovare*, which means to renew. Creativity is the act of generating a new idea, while innovation involves making that new idea real (Sebell, 2001). The idea itself has no intrinsic value; it is the act of turning the idea (invention) into a marketable product that creates value. Finding new ideas is easier than transferring them to products. Creativity is necessary, but not a sufficient trait in the innovation process. Also, creativity is usually contributed by an individual. Innovation is often the result of a collaborative effort. According to Schrage (2000), 'The most important raw material of innovation has always been the interplay between individuals and the expression of their ideas'. In the history of important breakthroughs, collaborative thinking and implementation has nearly always been a key factor in the process.

Innovation is more than a 'new combination of factors of production' (Schumpeter, 1983). It can also be the result of a change process, or the solution of a conflict. Innovation does not have to be a breakthrough in any case – frequently gradual and small improvements can be interpreted as an innovation. This does assume that the collaborative interaction within a group adds value to the innovation.

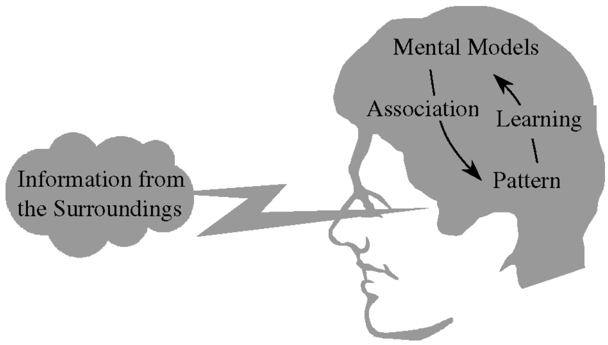
Part of the innovation process deals with complex and sometimes wicked problems that contain an evolving set of interlocking issues and constraints. Until a solution is developed, problems often must be solved without full understanding of the problem. A non-linear and complex process is necessary to find a solution. Sometimes, the requirements can even change during the process. Also, in this social process there are many stakeholders with divergent interests who care about how the problem is solved since the results affect them (shareholders, management, project teams, government, customers, employees).

As a result, generating innovation in a complex environment becomes a process of 'satisficing' (Simon, 1969), or consensus, rather than a single 'Eureka!' event. The different points of view in such multiple stakeholder interactions (Schmitt, 2003) should be merged and, as we will show later, not seen as obstacles but as an essential and important prerequisite for innovation.

2.2 Collaboration: creating shared understanding

For a better understanding of collaboration, we must first look in general at the cognitive interaction of individuals. Our basis for understanding cognitive processes comes from the concept of constructivism as described by Jean Piaget, and developed further by others (Glasersfeld, 1997; Foerster, Glasersfeld, and Hejl, 2000; Maturana and Varela, 1992; Watzlawick, 1976). According to constructivism, there is no one universal reality (objective reality), but each person has his/her own view of reality (subjective reality). When we absorb information from the outside world, only aspects that can be related to our current mental models will penetrate into our consciousness. Ideally, we can match the incoming information with our mental models (Figure 1 (Ninck *et al.*, 2002)).

Figure 1 Construction of mental models



A difference between our perception and patterns leads to perturbations, which forces us to rebuild our mental models. If the difference is too large, no association can be made, and we have no understanding of the incoming information.

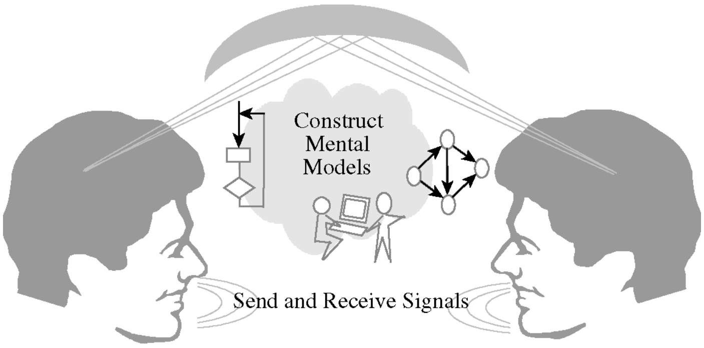
In the context of collaboration and innovation, we are particularly interested in the process where two persons (A and B) communicate in order to develop a common understanding of a topic. Communication is more than just the exchange of information. However, it is not possible to transmit information between A and B in the objective sense. That is, if A says something to B, it is not possible for B to know what is happening in A's mind, and vice versa. We feel that communication is closer to the Latin verb *communicare*, which means 'to share'. Therefore, persons A and B will start a process of sharing in order to develop this common understanding.

The concept of collaboration goes one step further: not only does A and B strive for a better understanding of each other, but they also are in a mutual social process of designing new mental models for themselves. Schrage brings up this point when he defines collaboration as, 'two or more individuals with complementary skills interacting to create a shared understanding that none had previously possessed or could have come to on their own' (Schrage, 1995).

2.3 Organising innovation: creating a common playground

Questioning the required means and conditions for mutual thinking and learning within a virtual space is important to our work. Representatives of activity theory believe that individual consciousness is shaped substantially by activities, 'Consciousness is located in everyday practice: you are what you do' (Nardi, 1996). The close connection between activity and consciousness is also emphasised by Jonassen (2000), 'The conscious understanding is an essential part of the activity that cannot be separated from it'. Activity theory asks in particular for tools, which support our activities, 'An activity always contains various artifacts (e.g. instruments, signs, procedures, machines, methods, laws, forms of work organisation). An essential feature of these artifacts is that they have a mediating role' (Kuutti, 1996). As discussed in the previous section, communication and collaboration is more than a simple exchange of information by transmitting and receiving signals – it is the common construction of mental models. During this process activities and mediating artifacts obviously play a key role, 'the use of culture specific tools shapes the way people act and think' (Jonassen, 2000). Schrage (1995) focuses on the significance of the space within the context of sharing. He assumes that in a collaborative context it is mandatory that symbols, pictures, models or concepts are processed within a shared space. Figure 2 summarises some substantial demands on an environment for collaborative activities – shared space must not only enable optimal signal transmission and reception, but should also support the cognitive process using artifacts.

Figure 2 More than information exchange – space and artifacts as mediator in the cognitive process



As a consequence of constructivism and activity theory, the potential for creativity and innovation should increase if we provoke perturbations using artifacts. Collaborative groups can represent a suitable environment for this purpose. The effect is optimal if there is a certain deviation of the mental models within the group; however, this should not be so strong that communication is blocked. The conditions are best within new groups, as older groups have the tendency to develop paradigms (Kuhn, 1991) that cannot be easily changed. Group members acknowledge themselves mutually and adapt their mental models within the group. In addition, mature cognitive systems have the tendency to homeostasis (Vicari and Troilo, 2000) so that in case of disturbance they tend to move back towards the initial state. If we intend to create a stimulating environment for innovation, we should compose heterogeneous groups that collaborate for a certain time. Nadler (1988) calls this approach 'frame breaking'.

As explained in Section 2.1, the innovation process usually deals with complex problems. The inclusion of different stakeholders with multiple perspectives is crucial in order to break deep-rooted patterns of thinking. We need organisational structures that allow autonomy, redundancy, variety and even chaos, while also needing a method to bring concerned persons together to create confidence and bind agreements under time restrictions. Therefore, collaborative groups should be free of hierarchy. We have to strive for a synergistic collaboration rather than a conflicting separation among the participants (Brown and Duguid, 1991). This concept of 'frame bending' (Nadler, 1988) is an important prerequisite for the innovation process (Hippel, 1988).

3 Approaches to support the innovation process

In the following section, we will discuss current concepts and its limitations for innovation management to derive requirements for our *BrainSpace* approach.

Research Departments are proven environments for innovation. For example, the Palo Alto Research Center (PARC) in California is often named as a model. In this kind of institution, innovations take place within clearly outlined boundaries and defined processes. There are no problems to protect intellectual property. But there are limitations concerning autonomy, perturbation and self organisation. Missing impulses from outside and thinking within the boundaries of cost and effect may inhibit the innovation process. Moreover, the approach needs a lot of resources, and can be hardly applied to small companies.

Spin-offs or Satellite Structures, which are made up by enterprises, banks, or national institutions, are often crucially involved in the economic success of a region or country. In Japan, these firms compensate for missing venture capital by building vertical structures (Gerlach and Lincoln, 2000). These networking structures can offer suitable conditions for the innovation process, assuming that there is a culture where social interactions are natural. However, this approach is often too expensive or too risky – there is a possibility of a loss of knowledge and/or intellectual property.

Knowledge Management (KM) has become one of the most important executive functions of corporations as intellectual capital has been recognised as a basis for the creation of value. However, the common recommendations and procedural instructions of best practice are mostly limited to the field of managing explicit knowledge, or are mainly focused on technical solutions. Current studies (Lucier and Torsilieri, 2001) can see no significant relation between KM and value creation in terms of bottom line results. Slowly, it becomes clear that KM can create a real increase in value only with the use of implicit knowledge, 'Tacit knowledge is the most important source of innovation, yet it is often underutilised in a firm, and difficult to separate out for productive work' (Krogh *et al.*, 2000). According to constructivism, knowledge is based on one's own experience. It is not absorbed passively, but it is constructed in an active process, and considering our collaborative approach it needs a human relationship. KM in the traditional and technical sense provides little support for knowledge construction; it is mainly an organisational tool to administer existing knowledge. This kind of explicit knowledge does not guarantee innovation, and remains ineffective unless people collaborate to adapt their mental models (see 2.2). To be innovative we need a problem-solving process where trust and social interaction play an important role.

Shared spaces (in Japanese, the concept of *ba*) are proposed by Nonaka and Konno as a solution for the above-mentioned problems with KM, '*Ba* can be thought as a shared space for emerging relationships. This space can be physical (e.g. office, dispersed business space), virtual (e.g. e-mail, teleconference), mental (e.g. shared experiences, ideas, ideals), or any other combination of them' (Nonaka and Konno, 1998). These ideas contrast with traditional KM approaches because they focus on the potential of human interaction and not on the technique. Unfortunately, this concept lacks detailed specifications concerning the interaction process, or a communication protocol. Also, we know that groups have the tendency to strengthen patterns of behaviour and world views (Kuhn, 1991), and these so-called paradigms have an inhibiting effect on innovation.

Communities of practice is another concept for organising the innovation process. It is suggested to set up such communities for breaking long-established patterns of behaviour within large organisations, 'If their internal communities have a reasonable degree of autonomy and independence from the dominant world view, large organisations might actually accelerate innovation' (Brown and Duguid, 1991). The authors state that information cannot be assumed to circulate freely just because technology to support circulation is available. However, suggestions concerning mechanisms and rules to support information exchange are missing. Alternatively, it is proposed to set up *Communities of Creation* as a kind of interface between the organisation and its surroundings (Sawhney and Prandelli, 2000). This means 'learning *with* suppliers, instead than *from* them, as well as creating value *with* customers instead than *for* them. Including customers can especially bring the above-mentioned perturbations into the system, 'the diversity of the peripheral sources' contributions can enact a creative tension, favoring continuous and diffused innovation while at the same time preserving internal cohesion and intellectual property rights' (Sawhney and Prandelli, 2000). Unfortunately, one can hardly find specifications for the 'rules of the game' for such communities.

Chaos and disorder is promoted (Vicari, Troilo, 2000) as a central prerequisite for a creative organisation. Based on cognition and system theory, the authors state, 'The existing, which is the set of cognitive schemes, routines and strategies which have proved successful, is a powerful inhibitor of change'. They suggest that 'to take the firm into a situation or creative disorder which generates new capacities'. Although we agree with the considerations for the creation of perturbations, we think the approach is somewhat risky and could endanger the assets of a company. However, if we can create and manage a situation that helps to overcome inflexible structures and patterns, this seems to us a suitable base for innovation.

As described in the two preceding sections, innovations are generated at the interface between an organisation and its stakeholders. *BrainSpace* should be suited to reveal knowledge to a large group through an active construction in which each of the participant collaborates. To gain from the interplay between the participants, the methodology *BrainSpace* is required to enable is:

- integrating heterogeneous groups with alternative world views and multiple perspectives
- creating democratic and non-hierarchical structures
- providing shared space and mediating tools for collaboration
- building trust and commitment
- provoking perturbation
- honouring temporal and financial constraints by pacing the process.

4 *BrainSpace*: knowldege creation by computer-supported collaboration

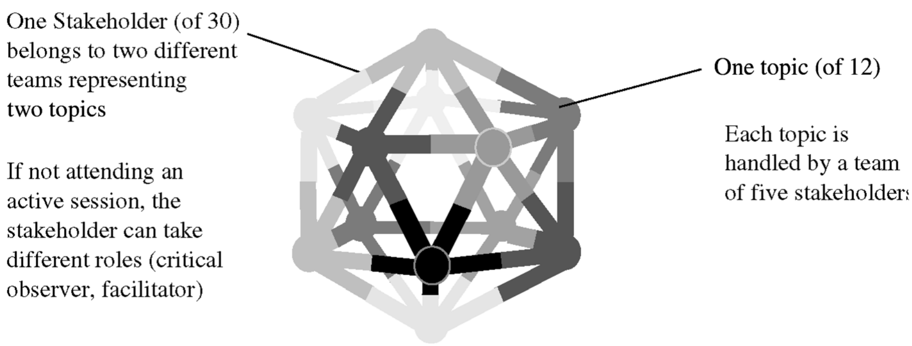
The method we propose is called *BrainSpace*, which is based on the Team Syntegrity model invented by Stafford Beer (Beer, 1994). The term Syntegrity results from a combination of synergy and tensile integrity. Synergy is due to the collaboration of actors, producing a combined effect greater than the sum of their individual effects. Tensile integrity is a structural principle according to which stability is achieved by tension, as opposed to compression (Fuller and Applewhite, 1982). While Syntegrity defines general structures for the exchange within social systems, *BrainSpace* focuses on a collaborative innovation process, enlarging the Syntegrity model regarding space and time.

4.1 Syntegrity model as a starting-point

The Syntegrity model is a holographic model for organising communication processes in a non-hierarchical style. The structural framework fosters cohesion and provides a synergetic interaction in an infoset. An infoset is a set of individuals (stakeholders) who share a common concern, who link individuals and corresponding knowledge with the issue of interest, and who wish to tackle the concern. A collaboration within an infoset leads to an integration of different points of interest (called topics). These multiple perspectives produce an environment that is rich in perturbations. Despite the diversity, the infoset remains stable because of the polyhedral structure of the Syntegrity model. This architecture can be mathematically shown to be optimal in terms of distribution and sharing information in large group settings.

In Figure 3 the architecture of the model is illustrated by using the structure of an icosahedron. Each member of the infoset is represented by one connecting edge. Each vertex corresponds to a topic. Five edges lead to each vertex, therefore, five persons constitute a team, studying one topic. Each member is an active player on two different teams, as represented by the edge connecting two vertices. In addition, the members take a role as critical observers and facilitators within two other groups. Attending different teams, a member contributes what he or she has learned in an adjacent team, and the available information is progressively distributed over the entire network.

Figure 3 Icosahedral structure of the Syntegrity model



Different polyhedra models are appropriate for different group sizes. An icosahedron with 12 vertices and 30 edges models 30 persons studying 12 topics. An octahedron with six vertices and 12 edges models 12 persons and six topics. The polyhedral structure of the Syntegrity model allows finding a balance between order and creative chaos. In addition, the process of reverberations dissolves 'the paradox of peripherality (alienation, low morale) versus centrality (effective action) of actors in an organisation' (Schwaninger, 2001).

4.2 Further development to BrainSpace

The original Syntegrity model consists of rigid protocols. For example, the length of a syntegration must be between three and five days, and during this time all members must be present. Therefore, the method requires considerable resources of time. Also innovation needs a steady process, 'Only if firms can continuously feed and renew this creative tension will they be able to catalyse innovation in a complex environment' (Sawhney and Prandelli, 2000). *BrainSpace* enables a continuous process since its protocol allows communication in a virtual environment between geographically distributed stakeholders.

The exact design of *BrainSpace* (type of polyhedron, topic definition, topic assignment, number of iteration steps, time per iteration, role combination or interpretation of the roles) is context dependant and has to be set for each case.

A typical *BrainSpace* process has the tasks described in Table 1 (simplified representation):

Tools to create a shared space (in the sense of 2.3) and to support the tasks in *BrainSpace* provide multiple asynchronous and synchronous communications among the distributed participants. Important features, such as application and file sharing, chat rooms, messaging and calendar functions, are covered by commercial products (e.g. MS Messenger, SharePoint, Groove, Centra, sWiki etc.). These products are continually being enhanced, and others are being introduced regularly. Therefore, the general functions, as opposed to the specific products, are given priority in the development of *BrainSpace*.

Table 1 Typical tasks of a *BrainSpace* process

Task		*Description*
Opening (asynchronous communication is given priority, if members don't know each other, kick-off should be local or synchronous)	Kick-off	Model explanation. Stakeholder introduction. Goal presentation. Installation and verification of the used tools
	Problem-description	Problem analysing and topic wording by stakeholders. The contributions are explicated by a superordinated opening question
	Topic-auction	Topic reduction (number depends on the type of polyhedron), and assignment of topics to stakeholders according to individual preferences (by use of an optimisation algorithm)
	Agenda-setting	The individual teams determine the dates for the meeting within a time window. Observer and moderator roles are assigned. Moderators and observers become familiar with their roles
1st Virtual Session (above all synchronous communication, asynchronous tools for documentation and planning subsequent actions)		The teams explore their respective topic. A moderator facilitates the discussion. Results and agenda are written and put in a forum, visible to everyone
		Members from non-active teams observe the discussions and give feedback
		The duration of a meeting is about 60 minutes
2nd Virtual Session		Same setting like 1st virtual session
...		According to the situation further virtual sessions may be added
Finalisation (synchronous communication is given priority)		Presentation of conclusions
		Planning for subsequent action
		Assessment

Summed up, *BrainSpace* is a model for organising processes of communication in social systems, in particular for distributed collaborative innovation. The virtual sessions happen in an environment that offers ideal prerequisites for innovation since:

- there is a fast, purposeful collaboration within a distributed setting
- the heterogeneous groups integrate individual strengths and different points of view, producing an environment rich in perturbations
- the available information is efficiently distributed and documented
- the process breaks former behaviour patterns and hierarchical decision making
- the different roles provide self-reflection and social skills
- the individual's active participation fosters personal commitment, group cohesion and a sense of responsibility.

5 *BrainSpace* in practice

We have tested the *BrainSpace* approach since 2002 with more than hundred students from two different universities and two different disciplines (business administration and information science). Compared to traditional courses the students were not working individually or in groups, but they were building a distributed cognitive system. After a half-day kick-off meeting the students began to collaborate in cyberspace. For synchronous communication and collaboration we used the conferencing tool Centra (http://www.centra.com), and for asynchronous communication, documentation and knowledge management we used a Wiki implementation called sWiki. These were the main tools for building our shared space. We have described the different steps of the process in detail (Buesser and Ninck, 2003), and the results can be found on the sWiki site, http://brainspace.isbe:8000/BrainSpace03.

Here are some of the findings of the concluding survey:

- The students found *BrainSpace* an interesting approach in comparison to traditional group and project work.
- The ability to control the technical facilities is crucial, technical problems can push the main goal into the background and reduce the motivation.
- A thorough introduction is the key for a proficient application of the method.
- The computer-mediated communication worked fine and was not seen as a barrier. On the contrary, some of the students felt less inhibited than in a face-to-face situation.
- Willingness to experiment with the features of the new technology was high, and it increased during the project.
- The get-together phase is important. Computer supported collaborative working within different groups requires a certain amount of confidence.
- The students faced a lot of difficulty to schedule the required meetings, despite the role of the administrator. But the whole process keeps on track even if there is once an incomplete group.
- The students appreciated that the teaching team facilitated the first online sessions, and some of them would have preferred to see an external facilitator during all group activities.
- It is important for the process to have a critical observer. The critical observer provides feedback to the group and helps learn about social dynamics.

Our current experience with *BrainSpace* concerns the moderation of a community of practice called ‘Forum New Learning’ (http://www.fnl.ch). This community of university teachers is part of the Swiss Virtual Campus initiative. It aims at sharing didactical knowledge on using new learning technologies. The community is almost three years old, and has about 350 members. Up to now the knowledge was mainly shared within conventional electronic discussion boards or within a knowledge sharing system, which allows partners to file and exchange didactical knowledge components, so called learning objects. This rather traditional way of knowledge sharing has the advantage that mature explicit knowledge is exchanged. The members are now starting to criticise that there is a lack of innovative new knowledge. The *BrainSpace* process, therefore, intends to start a process of knowledge construction. The experience of the first weeks gave us important insights, which are relevant to the intended future application on business settings. Although the participation is voluntary and we have no institutional incentives to stimulate the process, we have found that most of the participants are keen in starting the process; and when it happens that one person is unable to attend a group meeting, this does not stop the discussion as the other group members are able to continue the process.

6 Conclusion

We have discussed foundations and approaches for innovation management, and we propose *BrainSpace* as an alternative solution. The challenge is to enable a satisfactory balance between order and chaos, change and stability, intellectual property and the collaborative mental model development among the diversity of stakeholder relationships.

Instead of slow-acting research departments or expensive satellite structures, we are setting up a temporary organisation with a restricted amount of resources. The structures of *BrainSpace* run orthogonal to the existing organisation and allow multiple stakeholders to be involved in a virtual environment. We not only propose to share explicit knowledge, but also enforce all participants to construct tacit knowledge within a collaborative process. The costs for information technology to run *BrainSpace* are modest compared to specific knowledge management infrastructure.

Shared spaces and mediating artifacts permit a problem-oriented relationship that implies continuity and, therefore, a participative development of solutions. These relationships are the essential breeding ground for innovation. A well-specified communication protocol keeps the process on track, but the overall procedure is flexible and can be adapted to specific conditions and requirements. Finally, it becomes possible to introduce perturbations without risk to the corporation. We are convinced that *BrainSpace* solves, to some extent, the paradoxical demand to introduce disorder and to organise creative chaos.

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