The Concept of Open Creativity: Collaborative Creative Problem Solving for Innovation Generation – a Systems Approach

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Collaborative creativity is a prerequisite for the generation of innovation. It is of even greater interest when attempting to move from incremental to radical innovation that aims at huge instead of incremental improvements of products, processes, services, or structures that actually changes social practices. The main objective behind this paper is to call for an extension of the creativity perspective by abandoning an exclusive focus on individual creative capabilities, and extending inner-organizational collaborative creative sources with a goal of creating an "open creativity" system by including external creative sources. In addition to a system's internal creativity (such as of an organization or a region), the synergetic interplay between internal and external sources of creativity at the individual and collaborative levels also needs to be utilized in the attempt to create innovations. In a way, what "open creativity" is for creativity, Chesbrough's "open innovation" is for innovation. This is particularly true with regards to radical innovations. Such an approach is becoming more important as environmental and system complexity increases and also as higher degrees of innovation are required. In order to understand and manage such multifacetted aspects of creativity, the "Planetary Model of Collaborative Creative Problem Solving" is introduced here as a conceptual framework and is correlated with the underlying working process oriented towards the generation of innovations.

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"I've always been an optimist and I suppose that is rooted in my belief that the power of creativity and intelligence can make the world a better place" (Gates, 2007). This statement, made by Bill Gates, appeared in *The Saturday Evening Post* in the March/April 2007 issue and illustrates a good example of what "unleashing the power of creativity" can do, not only in respect to innovation, but to the entirety of society as well. Creativity as a prerequisite for innovations certainly needs to be investigated from a broad systems perspective and from the viewpoint of various disciplines. To date, many creativity researchers have been too focused on single issues of investigation and have shown little interest in promoting interdisciplinarity with a focus towards greater real world application of innovation processes. While understanding creativity at the level of the individual – as seen in the personality traits approach – complies with the tenets of mainstream psychology (Simonton, 2003; Paulus & Nijstad, 2003), this also seems to be true for most other disciplines, including business sciences, anthropology, and sociology. The current (and relatively restrictive) perspective has only marginal implications for superordinated creativity systems such as organizations and various forms of cross-border cooperation. Although most approaches still lack an exhaustive systems perspective, environmental issues in creative problem solving have been gaining increasing attention within the business sciences, and have served to make the work environment, creative climate and innovation climate the subject of scientific discussion (Amabile & Conti, 1999; Anderson & West, 1994; Brodbeck & Maier, 2001; Ekvall, 1997; Isaksen, Lauer & Ekvall, 1999; Lapierre & Giroux, 2003; Zain, Richardson & Adam, 2002;). The same is also true for the academic relevance of specific creativity tools (Geschka & Yildiz, 1990; King, 1995; McFadzean, 2000; Schlicksupp, 1999; Smolensky & Kleiner, 1995).

Referring to the need for dealing effectively with creativity in an organizational context, Ford and Gioia stated a decade ago that although it is important as a basis for organizational learning, development, innovation and competitive advantage, there is still a lack of clear and guided instruction with respect to comprehensive creativity management (Ford & Gioia, 1996). In general, this is still true of the vast majority of today's efforts in creativity research. Still, very little effort has been placed on the management of the overall system of creative problem solving. As Simonton (2003) pointed out, comprehensive research of creativity "[…] must view it as a complex phenomenon that occurs at multiple levels, from individuals, interpersonal interactions and problem solving groups to cultures, nations, and civilizations." One reason for the lack of research effort might also be that all-embracing models of creative problem solving processes do not lend themselves readily to scientific investigation (Steiner, 2006; Woodman, Sawyer & Griffin, 1993), even though they are of obvious importance as a prerequisite for the generation of innovations. Woodman et al. (1993) pointed out the dilemma entailed in matching the need for a broad understanding of organizational creativity with the simultaneous fear of doing research on organizational creativity, since "research on organizational creativity will, by definition, cross multiple levels of analysis" and further, because a strong tendency "[…] to avoid multilevel research because of their theoretical orientations and because of methodological and conceptual problems inherent in aggregating data across different levels of analysis" (Woodman et al., 1993, p. 315). Although this thorough theoretical investigation dates from the year 1993, the tendency it describes still dominates creativity research today.

Furthermore, "open creativity" as an extended creativity system, encompasses internal and external collaborative creative sources as well, and is of an even higher complexity than group and organizational creativity. "Open creativity" also makes thorough research even more difficult because highly innovative developments require collaborative creative capabilities within organizations. In addition, research and development need to be increasingly based on cooperation, not only with other companies in the value chain, but also in terms of the development of strategic partnerships and network activities with other external players, including with so-called think tanks and even with competitors. An example of this is the joint development of new technologies within the car-manufacturing industry. Other examples are cooperation and partnership between internal and external sources within individual innovation projects. All these forms of transboundary processes of "open creativity," reveal that there is not enough research on this specific form of creativity taking place.

With regard to the major roots of creativity research, stronger interplay between sociological research related to organizational, societal, and environmental problems and psychological research that concerns both individuals and groups, is needed (Woodman et al., 1993). Greater integration of anthropology, applied business and innovation sciences, educational sciences, and design research (such as design-based communication for dealing with complex systems) might also prove fruitful in attempting to develop interdisciplinary and holistic approaches with respect to organizational and meta-organizational systems of creativity like "open creativity".

This paper aims to provide guidance to those who have to monitor creative organizational efforts in innovation development. It also aims to offer broad support for future thoughts and empirical investigations on creativity-guided innovation research. The paper is divided into several sections. In the first section, the question of how one can differentiate between problem solving processes and creative processes is posed, and what kinds of problems call for creative solutions and collaborative creativity. Creative problem solving is then considered with respect to change, innovation, knowledge, sustainability and wisdom. Subsequently, the role of creativity with respect to innovation (especially radical innovation), is briefly discussed. The linkage between various forms of creativity is then investigated, covering both individual aspects, as well as various forms of collaborative effort. In order to understand the complexity of creative problem solving, the Planetary Model of collaborative creative problem solving is introduced in order to point out the major and minor factors entailed in the collaborative creative problem solving processes. This is followed by the application of the Planetary Model to the innovation-directed working process, with a goal of explaining how prevailing shortcomings in the ability of many companies in utilizing their internal and external creative capabilities can be overcome. A brief description on future directions of innovation-relevant research on collaborative creative problem solving processes concludes the paper.

Creativity in Problem Solving

The question of whether problem solving processes and creative processes are the same cannot be answered without making further distinctions. Often used synonymously, their separation is controversial. One view is that creativity is independent of problem solving. Creativity may simply be an undirected act of self-expression also. An example of this is the process of painting of a picture. Here, there is no task in mind requiring a solution. The other view is that the mere act of self-expression and self-realization itself can be viewed as a kind of problem solving.

In terms of the mental perception of an external world, "problem solving occurs when we understand the external world by exploring an internal model of that world, instead of poking around in the external world directly" (Hunt, 1994, p. 216). That means the mental anticipation of a given state of a system, together with the task of generating potential solutions for the further development of the system by simultaneously considering its objectives, becomes a crucial part of problem solving. Furthermore, the distinction between routine problem solving and creative problem solving seems to become useful.

There is reasonable agreement that the essential features of a problem are given when there is a goal (namely to generate a solution for the problem), but there is a lack of a clear or well-learned route to that goal (Dominowski & Bourne, 1994). In a similar way, Treffinger, Isaksen and Dorval (1994, p. 226) define a problem as "[…] any important, open-ended, and ambiguous situation for which one wants and needs new options and a plan for carrying a solution successfully." In terms of the degree of complexity, problems can be divided into the categories of simple, complicated, and complex (Probst & Gomez, 1991).

Simple problems consist of a small amount of elements which exhibit relatively little interaction. They also show a strong tendency towards stability over time (Probst & Gomez, 1991). This is also true for complicated problems that are similar to simple problems, but consist of comparatively more elements and exhibit more interaction. In contrast to complex problems, the patterns here are still relatively stable over time. Of course, in order to solve complicated problems, more sophisticated methods are needed. Although in contrast to complex problems, the simple problem still tends to be of a deterministic nature (Probst & Gomez, 1991). Consequently, simple and complicated problems can be solved mainly by applying standard methods of reproductive thinking based on routine problem solving, and without a special need for creative problem solving processes.

Complex problems cannot usually be solved by routine problem solving, but instead require solutions that are not yet available and are dependent on novel connections of the various aspects of the problem in linkage to prior knowledge (Lubart, 1994). Such problems may also relate to situations for which there is no current awareness. Generally speaking, complex problems can be characterized by certain system peculiarities. It is typical that the features that characterize a good target state of the problem solving process are unknown, or at least ambiguous, and that the system's initial state often cannot precisely be described either (Scholz & Tietje, 2002; Lubart, 1994). As an example, the attempt to accurately explain the success factors of product innovation are not only an ex ante problem, but also an ex post problem because they pose the question: Are the set of responsible factors comprehensive and the interactions among them really understood? Furthermore, characteristics of complex problems make up a large amount of interacting elements and subsystems in conjunction with high system dynamics. This leads to changes in patterns, structures and related intensities over time (Probst & Gomez, 1991). They also prevent the applicability of many deterministic problem solving methods, like those used in routine problem solving. Divergent thinking and more creative approaches are needed because, the more complex the problem, the harder it will be for an individual to creatively develop solutions and make use of the collaborative creativity of several interacting individuals. The higher the innovativeness of new product development is, the more complex the system usually gets as a result of the higher uncertainties regarding future effects.

Although all problem solving processes (routine and creative), involve certain common fundamental steps, such as finding and defining a problem solving goal, scanning and generating relevant information, deriving suitable solutions from this information and evaluating and refining the proposed solutions (Lubart, 1994; Weisberg, 1993), they still differ with respect to their peculiarities. A creative problem solving process is not actually equivalent to a creative process. Therefore, distinctions between creative processes, routine problem solving processes and creative problem solving processes can be made based on the following criteria:

(1) *Initial event:* The starting point of the underlying process can either be based on a problem such as the need for new product development (applicable on routine problem solving processes and creative problem solving processes) or without a problem context (i.e. non-goal oriented activity such as the painting of a picture as a kind of self-expression). Within creative problem solving in a real-world context, the initial problem is more of a starting point where the problem needs to be recursively identified, revised and redefined in order to approach the "real" underlying problem.

(2) *Process characteristics:* Though the fundamental process steps are the same as above, the difference between routine and creative problem solving lies in the quality with which the process steps are performed (Lubart, 1994). For example, when identifying the underlying system as the basis for the generation of solutions, creativity will probably lead to more complex and novel connections concerning the various aspects of the initial problem. Such creativity may also lead to insights behind the initial problem. Furthermore, flexible and creative working processes usually require more time for individual working steps, and involve the redundancy of several steps based on recursive feedback loops. In many cases this is needed in order to find the "real" problem behind an initial problem, and often occurs within the generation of innovation. In contrast, routine working procedures based on approved sequences will not find novel system connections but will consume less time since repetition of single steps is mostly unnecessary. Creative problem solving requires both divergent and convergent thinking modes,

whereas problem solving does not need divergent thinking since neither novel procedures nor novel outcomes are needed. Lubart (1994, p. 314-316) states that "psychoanalytic theorists have proposed that regression to primary-process material (unmodulated thought) is a central feature of the creative process that the routine problem-solving process does not involve." This state of the unknown characterizes most attempts to generate innovations, especially where a higher degree of innovativeness is required. The third phase of the popular four-stage creative process consisting of preparation, incubation, illumination and verification, is similar (Poincaré, 1924; Wallas, 1926). Here the problem solver is often not consciously engaged with the problem. It acts as a kind of "preconscious information processing" (Runco, 1994).

(3 *Novelty of the outcome:* Creative problem solving processes and creative processes lead to solutions with a higher degree of novelty compared to routine problem solving processes. Hence, the outcome of creative problem solving goes beyond what can deterministically be predicted and provokes surprise "because it is more than the logical next step" (Lubart, 1994, p. 290).

Based on this distinction, many problem solving processes refer to a specific problem, whereas routine problem solving requires neither a creative working process, nor novelty of outcome. In sum, problems do not necessarily require creative procedures or creative solutions, since simple and complicated problems can usually be solved by applying standard procedures in a more or less sophisticated manner. However, complex problems usually call for solutions based on creative problem solving. Conversely, creativity does not necessarily call for a problem, but it can be a driving force behind the development of solutions to complex problems.

Creative Problem Solving in a Broader Context: from Innovation, Knowledge, and Sustainability to Wisdom

This paper is not directed at collaborative creative problem solving and open creativity (as a specific form of collaborative creativity) as ends in themselves. Instead, the focus lies on the more general question of how creativity depends and/or interacts with innovation and knowledge, and on meta-concepts such as sustainable development and the need for wisdom within creative endeavors.

Change has become the determining factor of most facets of life. To deal with change, concepts such as restructuring, downsizing, and reengineering can be useful to some degree, but are limited because they adopt an inward-looking perspective and tend to be inherently negative. This is not very useful for future-oriented companies who depend on innovation (Kalthoff, Nonaka & Nueno, 1997). Creativity is the basis of every successful innovation since it provides companies with a means of coping with change in an increasingly complex world (Amabile, 1997; Ford & Gioia, 1996; Lubart, 1994; Peters, 1993; Ulrich, 1994; Utterback, 1994). Here, increasing complexity is not only related to products and services, but also to organizational systems, most business sectors and society as a whole. This calls for creativity at both the individual and societal levels (Lubart, 1994). With regard to the degree of innovativeness, the more creativity that is needed, the higher the degree of innovativeness necessary. In other words, radical respectively disruptive or breakthrough innovations improve a certain system and can lead to changes in application and social practices. Consequently, they may also require more creativity to encompass the whole innovation systems rather than incremental ones (Hauschildt & Salomo, 2007; Christensen, 2000; Christensen & Overdorf, 2001). With respect to the generation of innovation, creativity is a fruitful strategy in attaining new knowledge. As Nonaka, Konno and Toyama (2001) pointed out, knowledge itself is dynamic and therefore, cannot be defined based on a traditional epistemological view that sees knowledge as "justified true belief." Rejecting this "absolute, static, and nonhuman view of knowledge," they maintain that knowledge is of either an explicit or implicit kind, context-specific, relational, humanistic and dynamically created in social interactions (Nonaka et al., 2001). Knowledge is also distinct from information. While the latter can be considered as a flow of messages, the former is "created by that very flow of information and is anchored in the beliefs and commitment of its holder" and can be defined as "a dynamic human process of justifying personal belief toward the truth." It needs to be stressed that this paper is based on a constructivist point of view and consequently does not consider truth as an ontological reality, but as a reflection of individual cognition and experience.

With respect to the utilization of a system's creative capabilities and particularly to mechanisms based on "open creativity," the dynamic nature of knowledge is amplified by the relative magnitude of the innovation effort and by the peculiarities of complex collaborative efforts in the context of inter and transdisciplinarity (Steiner & Posch, 2006; Steiner & Laws, 2006; Scholz & Tietje, 2002), heterogeneous teams, networking, integration of contingent work, etc. Furthermore, when it comes to the direction of influence, there is a twofold relation between creativity and knowledge. On the one hand, a certain degree of basic knowledge of the underlying subject matter is a prerequisite in order to make sense of the creative outcome while, on the other hand, creativity itself leads to an extension of the knowledge base. This means that creativity and knowledge are part of a double-loop system.

Since innovation is not an end in itself, but rather a means of coping with change and future development, the question arises of how sustainable an innovation and its preceding creative processes are in terms of economic, ecological and social perspectives. The more radical an innovation is, the higher its potential influence on the future development of related systems. Consequently, it is of interest how sustainable the innovation is. Although it is widely known that knowledge is a prerequisite for many sustainable competitive advantages (Drucker, 2006; Nonaka et al., 2001; Teece, Pisano & Shuen, 1997). In most cases, a limited understanding of the potential implications of an extended sustainability orientation, with regards to the creation and the management of knowledge and innovation, seems to exist. Generally speaking, innovation that contributes to sustainable development from an economic, ecological, and social point of view will be considered in the following as sustainable innovation. For more on questions of sustainability see Edwards, 2006; Laws et al., 2002; Perman, 1997; Posch & Steiner, 2006; Strebel, 2002; U.N., 1992; WCED, 1987.

The attainment of economically sustainable innovation and/or sustainable competitiveness seems to be obvious for most companies as a prerequisite for their survival, while the other facets of sustainability seem to be much more critical. There has been extensive research on ecological sustainable development (e.g., Strebel, 2002; Posch & Steiner, 2006), but its integration within companies' everyday business processes seems to be far more sensitive. Research shows that ecological concerns only find consideration if economically sustainable development can be ensured (e.g., Strebel, 1997). Within creative problem solving processes, it is clear that people play a crucial role as well. This concerns both those people involved in the problem solving process, and those who are affected by the innovation. However, the related research regarding socially sustainable development remains far from adequate. In contrast, collaborative creativity is characterized by dynamic patterns and becomes even more complex with regard to the development of sustainable innovations. Innovation not only entails the development of new and more appropriate solutions, but also–to some degree–the destruction of former solutions (Schumpeter, 1980). However, these former solutions stand in close relation to people, such as users and/or creators. Therefore, it is necessary to generate awareness of these diverse effects on different stakeholder groups and not merely make decisions based on a majority principle. Where possible, decision making needs to be based on intense communication and interaction in order to attain consensus. An extensive stakeholder analysis is therefore, a necessary prerequisite (Steiner, 2008). Examples of crucial questions that need to be considered are:

- Who is affected by the specific form of innovation (internal and external stakeholders)?
- What are the value systems and expectations of the stakeholders?
- What might the roles and the creative potential of the stakeholders be within the innovation process?

Further far reaching but also controversial exemplary questions are:

- What might the specific role played by future generations be?
- What about animals as an additional stakeholder group?
- What about rights for the comprehensive "spaceship" earth itself?

The question of how creativity can be utilized without sacrificing one's own values and principles and those of other stakeholders is closely connected with the implementation of sustainability. Creativity has not only led to beneficial developments, but at times, has proven to be disastrous. This calls for an extended perspective of creative performance, which takes into account social and ethical considerations and a revised definition of creativity. If creativity is understood as the ability to produce an outcome that is both novel and appropriate (Lubart, 1994; Barron, 1988; Ochse, 1990), this needs to also call for an outcome that is not only novel and appropriate, but wise as well. Since he has made major contributions in the field of creativity and intelligence research, Sternberg (2003) points out that some of the world's cruelest despots and greediest business tycoons can still be considered successful and intelligent, even though they have acted at the expense of many other people. Therefore, in addition to intelligence and creativity, wisdom also needs particular consideration. Wisdom can be understood as "the value-laden application of tacit knowledge not only for one's own benefit but also for the benefit of others, in order to attain a common good" (Stenberg, 2003). Sternberg (2003) further states that, "The wise person realizes that what matters is not just knowledge, or the intellectual skills one applies to this knowledge, but how the knowledge is used." For a detailed review of the major approaches to wisdom see Baltes and Staudinger (2000), Sternberg (2003), and Sternberg and Jordan (2005). With creativity as a prerequisite for innovations, this implies taking such considerations into account immediately prior to market implementation, and also at the earliest stages of the innovation process (e.g.,, within the definitional and modeling phases). This allows for not only having a broader view of creativity and its impact, but also for the integration of a truly holistic approach to sustainability. As a complex problem, the development of innovations (i.e., particular sustainable innovations) needs creative solutions and therefore, the utilization of available internal and external creative capabilities.

The development of an innovation is always heavily influenced by a wide variety of impact factors that the innovator cannot completely control and may not even be aware of in some cases. For instance, when developing a radical innovation, uncertainty becomes the determining factor of the system's future. The innovator might have the most expertise within the target market, but relying on experience gained with former products in previous markets is no longer possible since the more radical an innovation is, the higher the uncertainty concerning the reaction of the marketplace is. Traditional means of marketing have very limited success in predicting future market behavior with regard to radical innovations. At best, the observation of lead users (von Hippel, 1986) and the use of future-oriented procedures such as the Delphi-method, and various forms of scenario-analysis (Reibnitz, 1992; Scholz & Tietje, 2002), can support the attempt to depict potential future scenarios. However, they certainly cannot provide a reliable forecast of the future states of a particular system. Future developments of radical innovations cannot be accurately predicted and at most, only relatively rough patterns of development can be discovered. In particular, the overall target of an economically, ecologically and socially sustainable innovation is quite vague. Thus, there is no clear target state to aim at. We are confronted with a highly complex situation with dynamic and non-linear phenomena.

Understanding the complex relations between humankind and nature becomes a prerequisite for overcoming cognitive barriers (Scholz et al., 1998). Because of their specific characteristics, complex problems cannot usually be solved by applying routine problem solving processes and standard solutions, no matter how useful these may be for simple and complicated problems. Instead, complex problems demand innovative solutions, which require creative problem solving capabilities on the part of the problem solving agents. To further clarify the potential of creative problem solving processes below, creativity is discussed in terms of the individualistic and collaborative creativity perspective. Based on a systems approach, it can be said that open creativity is one of the most complex forms of collaborative activity.

Systems of Creativity

Individual Creativity to Open Creativity

In order to generate creative solutions for complex systems, instead of specializing in smaller units of investigation, a more holistic view is required (Mulej, 2007). Authors such as Probst, Raub and Romhardt (1999) stress that complex problems cannot be solved by monocausal thinking within linear cause-effect relations but instead, require holistic systems thinking, or a socio-cybernetics point of view (von Bertalanffy, 1998; von Foerster & von Glasersfeld, 1999; Forrester, 1961; Gomez & Probst, 1999; Probst & Gomez, 1991; Ulrich, 1968; Wiener, 1948). In addition to rational and convergent thinking, the dynamics of systems exhibiting permanently changing patterns require the development of new and creative approaches for solving complex problems. This entails extending standard approaches in order to encompass collaborative problem solving processes at various system levels (i.e., both at a content level so as to cover various disciplines and areas of expertise), and also at the level of organizational design. This includes the system's internal and external potential for creativity (e.g., the use of external creativity professionals in industrial design companies or the use of users and non-users). By directing participants' attention to the most essential system mechanisms, and by preventing an excessively restrictive focus when dealing with highly complex problems, informal systems thinking, and the dialectical systems theory proposed by Mulej (2007) can be very useful (Mulej et al., 2003). These systems provide for the structure and flexibility needed to handle complex innovation systems in an uncertain future.

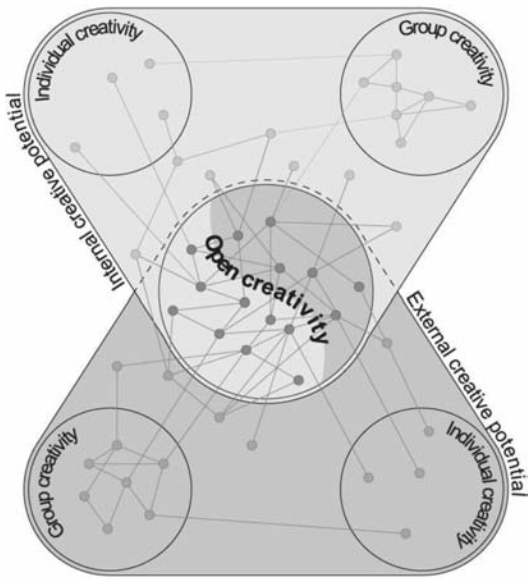
In order to enhance the overall creative capability for generating innovations, the interplay among creative systems of various scales becomes of special interest for releasing and making available the highest possible creative potential. Figure 1 shows that the various scales of creative systems can be roughly divided according to:

- their system affiliation, either the internal or external creative potential of a system (such as an organization), and
- their personal dynamics, either on an individual basis or in interaction with other individuals or groups.

Collaborative creative sources (such as groups, organizations, cooperative activities, and networks), show increasingly higher dynamics compared to individual creative sources. Along with changing behavior patterns, the more stakeholders that are involved (including internal and external creative sources) and the more interaction occurs among them, the higher the system complexity is.

Figure 1 shows that open creativity takes into account the internal and external creative potential of a system (i.e., individuals and groups). Individual creativity is an important ingredient for group creativity and for the overall system's creativity, like that of the organization. When a highly creative and strong individual becomes a driving force for collaboration, it further stimulates the creativity of others. In order to be understood and utilized properly, the single dimensions of creativity are explained in more detail below.

Figure 1: *Sources of Open Creativity*



Individual creativity

Individual creativity is crucial for all other forms of creativity that are needed at the group or organizational level. By focusing on the creative person as an individual, the creative performance can be understood as a function of a person's behavioral style, attention, motivation, specific context (e.g., peculiarities of the problem), knowledge, skills, process expertise, emotional intelligence, the given work environment and the available time (Steiner, 2004). Hence, the creative performance of the individual depends on the individual's competences in the underlying environment, and the time available for the creative problem solving process. The objective is to attain a "competence congruence," required by the creative problem solving process and the individual's competences.

$CP_{Ind} = f(Style, A, M_{I,E}, Cont, K, Sk, Exp, EI, Env, T,)$ **(1)**

CP_{Ind} .... "Creative performance" of the individual at a specific task

Style .... "Behavioral style" of the individual (Czichos, 2001)

A.............................. "Attention" encompasses "focused attention" as well as "broad attention deployment" (Runco, 1994)

$M_{I,E}$ .... "Intrinsic motivation" as a driving force combined with a sufficient "extrinsic motivation" (Amabile, 1997).

Cont .... "Context" of the task and the problem solving process (= relevant domain)

K.............................. "Knowledge" includes explicit and implicit knowledge with respect to the relevant fields of expertise and the design and management of the creative problem solving process.

Sk	"Skills" encompass context (domain) relevant skills and creativity relevant skills as well (Amabile, 1996, p. 93-95)
Exp..........................	Process "expertise" related to the creative problem solving process
EI............................	"Emotional" intelligence as the ability to perceive, assess and manage the emotions of one's self and of others (this includes the relation to superordinated positions within the firm such as the principal of the firm, who might not be involved in the process, but who nevertheless has a high impact on the project)
Env..........................	"Work environment" including organizational culture, leadership behavior, management practices, available resources, affect of colleagues and the physical environment of the organization (this is mostly neglected) (Steiner, 2006, 2004)
T.............................	"Time" there is available for the problem solving process. This is not always a question of providing more time for the creative performance, but rather a question of determining what an appropriate amount of time is. Too much time may lend to a loss of focus.

The interplay between single factors forms the basis for the potential creative performance of the individual. Hence, the underlying assumption is that there is not a single typical set of personality traits that characterizes the creative person, but that the interplay between the single variables of CP_{Ind} is more responsible in determining how creative a person can be. Thus, in a complex system, many different factor combinations can lead to creative success.

The creative performance of an individual (CP_{Ind}) is also not constant over time since the variables, including a person's behavioral style, are volatile themselves. While a personality style is typically understood as a constant factor (such as described by the Myers-Briggs Personality Type Indicator (MBTI)), the behavioral style as described by the Life Orientations Method developed by Katcher and Atkins (LIFO-Methodology), describes behavioral preferences and not behavioral competences. An exhaustive overview of diverse typologies on behavioral styles (including the Life Orientations Methodology), as well as personality styles, is given by Czichos (2001). This approach proves especially useful when applied to creative processes. It provides those involved with greater scope for developing effective forms of collaboration, allows for behavioral change and avoids typecasting of people. Something that may have negative influences on attitudes, motivation, and creative climate can lead to substandard performance.

Going a step further, several crucial questions need to be considered when extending the individual creativity perspective. How does the creative performance of an individual person differ from the creative performance within collaboration? How do individual and collaborative creativity influence each other? What are the specifics of collaborative creativity seen from the perspective of open creativity?

Collaborative creativity

The term "collaborative creativity" is a rather confusing one. It begs the question: why can't the expression "group creativity" be used instead of "collaborative creativity?" Although they have a very similar meaning, from a system's perspective, "group" is commonly used with a stronger inward looking perspective, such as a group within a corporation. Collaborative creativity leaves more possibilities for border-crossing creative cooperation. In order to avoid seeing a group as a more stable formation, the term collaboration leaves more space, allows for greater flexibility with regard to team formation over the phases of the innovation process and in terms of the need for different constellations of individuals in different projects. A crucial difference between group creativity and collaborative creativity is that the first implies a more segmented work processes based on the division of single obligations without necessarily having strong interaction between single participants. The latter is more inherently concerned with the mutual processes of creativity. Also, while collaborative creativity captures a large focus, group creativity has a much smaller focus.

Creative collaboration is a crucial process for finding solutions to the complex problem of generating innovations, especially with respect to radical innovation. It is the characteristic of a collaborative entity that the "joint creative problem solving process" takes places in an ongoing interactive process between various units working towards a common goal (such as the development of a new product, a new service, or a new strategy). In this context, the collaborative entity might be a group of interacting individuals, but it might also consist of interacting groups, a group interacting with a professional individual within or outside the own organization, a network of interacting organizations, or even an organization interacting with a heterogeneous external group of professionals and users/non-users. When the collaborative process involves external sources in interplay with the system's internal creative sources, this is considered to be "open creativity" (Figure 1). Collaborative creativity, especially open creativity, calls for considering the impact and creating awareness of the possible diversity of participants engaged in the collaborative process as a result (Steiner, 2008).

Within a collaborative creative problem solving process such as a group or an organization (Amabile et al., 2005; Fay et al., 2006; Ford & Gioia, 1996; Nemeth et al., 2004; Paulus & Nijstad, 2003; West, 2004; Woodman et al., 1993), overall creativity is much harder to determine, since it cannot be assumed that it is just the sum of the single individual performances. It is also much harder to determine because synergies might allow creative solutions to emerge as a result of associative thinking among different people with different backgrounds, different experiences, different value systems and different expectations (Steiner, 2008; Risopoulos, Posch & Steiner, 2004). In addition to their positive effects, collaborative processes can also have considerable drawbacks when process complexity is not considered appropriately. The creative performance of collaboration can be described as a function of the creative performance of the individual(s), the composition of the group, prevailing rules of collaboration, the set of objectives of the underlying project, group productivity, communication peculiarities of participants and the prevailing group climate.

$$CP_{Coll} = f(CP_{Ind,}\ Compo, Ru, Obj, Prod, Comm, Clim) \qquad (2)$$

CP_{Coll} .... "Creative performance of the collaborative entity" (such as a group)

$CP_{Ind.}$ .... "Creative performance of the individual"

Compo...................... "Composition" and diversity of the group with regard to disciplines and hierarchies and with respect to system's internal and potential external creative sources

Ru............................. Group "rules" (e.g., participative or hierarchical)

Obj .... Set of stakeholder "objectives" for the project

Prod.......................... "Group productivity" (Steiner, 1972) within the creative problem solving process implies that process losses can reduce the overall productivity of the group. Group productivity also depends on the type of problem at hand; some call for sharing of the task within a group, others do not.

Comm .... "Communication" (including the provision of appropriate means of communication for the respective problem solvers)

Clim .... Group "climate" "[…] affects organizational and psychological processes such as communication, problem solving, decision making, conflict handling, learning and motivation, and thus exerts an influence on the efficiency and productivity of the organization, on its ability to innovate, and on the job satisfaction and well-being that its members can enjoy." (Ekvall, 1987, p. 183). Climate dimensions might encompass empathy, freedom, positive challenge and involvement, supervisory and organizational encouragement, work group support, sufficient resources, idea time, playfulness and humor, debate and conflict, and risk-taking (Ekvall, 1997; Amabile & Conti, 1999; Steiner, 2004)

With regard to the elements of equation (2), there is no ideal extent or domain for any one element since every element has to be seen with respect to its interplay with the other elements in a specific situation. Innovation processes hardly ever repeat themselves in the same manner, even though a highly sophisticated methodological framework for their generation may exist.

As an illustration, we can consider the effect of "diversity" on creative performance during collaboration. Diversity among the participants engaged in the creative problem solving process is not automatically fruitful (e.g., Williams & O'Reilly, 1998). In fact, it may even be destructive when incompatibilities among those collaborating are too powerful. Diversity can also hamper the creative process if the other constituting factors of creative performance are not aligned appropriately (see equation (2)). That also poses a great challenge for designing the appropriate environment because the more diverse people are with regard to their values and preferences, including perceived image norms (e.g., Giannantonio & Hurley-Hanson, 2006), behavioral styles, backgrounds and demographic characteristics, the more difficult it is to create an environment that best fits the individual needs. A collaborative entity such as a group that is incorporating different disciplines or individuals from different hierarchical levels of a corporation, will only be able to effectively generate a fruitful creative outcome when the appropriate communication is provided (i.e., a common language basis). If the single behavioral styles of the individuals are mutually complementary, the participants share a common vision for the overall project success. If participants jointly collaborate (i.e., avoid purely segmented individual work in isolation that then is finally brought together), and if groupthink phenomena, polarization and process loss are not overwhelming, the potential positive synergies of collaboration will predominate.

Organizational Creativity

"Organizational creativity" is a special form of collaborative creativity, but differs from "open creativity" in that it does not encompass the external creativity potential found among professionals or users and non-users. Instead, it only makes use of the organization's (such as a corporation, or NPO) internal creativity potentials (Figure 1). The internal creativity potential of an organization then results from the interaction arising between creative individuals and creative groups.

$$CP_{Org} = f(CP_{Ind/Int}, CP_{Coll/Int}) \qquad (3)$$

CP_{Org} .... Creative Performance of the organization

$CP_{Ind/Int}$ .... Creative Performance of the Individuals of the organization (as a source of internal creativity)

$CP_{Coll/Int}$.................... Creative Performance of groups within the organization (as a source of internal creativity)

The greater the number of inner-organizational levels that are involved within the collaborative creative process, the higher the inherent complexity of the creativity system. Hence, appropriate means of communication are a prerequisite for the functioning of complex creative problem solving processes. Without these, it will prove impossible to engage in effective communication.

Open creativity

Accelerating change, increasing problem complexity, higher demands for innovation, and the crucial question of how to create a sustainable future are the driving forces behind the need for greater individual and collaborative creativity, as was discussed earlier. In addition, two paradigm-shifts, one involving innovation characteristics, and one involving general thinking patterns, further demand more sophisticated methods for making use of potential sources of creativity based on the idea of open creativity.

According to the *Harvard Business Review's* breakthrough ideas for 2007, we are now facing a paradigm shift from producer-centered innovation to user-centered innovation (von Hippel, 2007). This calls for a reorientation in the way innovation is done.

According to von Hippel (2007), 70% to 80% of new product development fails "not for lack of advanced technology, but because of a failure to understand users' needs."

Another paradigm shift is taking place with respect to prevailing models of thinking. As Pink (2005) points out, society is changing now from the Information Age which is dominated by "left brain" capabilities (i.e., sequential, logical, and analytical thinking), to a Conceptual Age that further extends the capabilities of the Information Age to include right-brain qualities such as inventiveness, empathy and "big-picture capabilities" that show more non-linear, intuitive, and holistic thinking patterns.

Both the above paradigm shifts strongly support the usefulness of an open creativity system which makes use of internal creative capabilities and accessible external sources of creativity as a special form of collaborative creativity (see Figure 1 and equation (4)).

$$OC = f(CP_{Int}, CP_{Ext}) \qquad (4)$$

OC .... Open Creativity

CP_{Int} .... Internal Creative Performance of a system (such as an organization or a region)

CP_{Ext}......................... External Creative Performance of a system

The concept of "Open Creativity" is based on a systems thinking perspective. Open relates to an open system, implying that the sources of creativity cannot only be found within the borders of the system (i.e., an organization or a region), but that sources outside these borders are gaining increasing importance for the system's ability in creative problem solving. Therefore, the concept of open creativity calls for an extension of the problem solvers involvement by further potential stakeholders from outside the system's borders. An example of an open creativity system would be an industrial enterprise engaged in a joint problem solving process with independent industrial design companies in the role of "creative spark" or innovative "think-tank." The philosophy of open creativity allows the involvement of external professional and non-professional parties as well, including lead users and present non-users. Non-users might be the customers applying the innovation of tomorrow. Such stakeholder groups are not only important for the later economic success of the innovation, but also for social sustainability. Hence, the question is not only how innovations can best fulfill the needs of the customers, but also how single players or groups such as lead users can become active players within the creative problem solving process. This lead user concept was originally introduced by von Hippel (1986, 2005). This might also entail the inclusion of professionals and non-professionals within product development workshops and rapid-prototyping processes (Steiner, 2007b). Additionally, the involvement of scientific institutions within the creative problem solving process (described as the transdisciplinary approach), can also lead to an improvement of the accessible creativity potential (Steiner & Posch, 2006; Steiner & Laws, 2006; Scholz & Tietje, 2002).

While Chesbrough's concept of "open innovation" takes into account the whole innovation system, including considerations of how to find the most suitable business model (either this exist within or outside the company), the concept of "open creativity" focuses mainly on the joint working process of creative problem solving in collaboration with internal and external problem solvers (Chesbrough, 2006). The open innovation concept "[…] assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, […]" (Chesbrough, 2006, p. 24), without going deeper into the underlying creative working process. However, the open creativity concept is about how to collaborate in order to develop creative outcomes, instead of combining already available internal and external ideas to create value. In other words, open innovation involves more of what makes today's firms more innovative and successful. Open creativity however, revolves around how to make use of all available internal and external creative sources as the basis for innovation and economic success. Since the "open innovation paradigm" has a broader focus than previous "closed innovation paradigms," and already calls for an extended systems perspective, the open creativity concept can fruitfully contribute to an open innovation paradigm that makes use of the most appropriate internal or external business models.

The innovation project becomes the linking element for synergistically utilizing internal as well as external sources of creativity. Focusing on open creativity as an attempt to synergistically utilize internal and external sources of creativity requires that the creative performance of collaborative effort is not just viewed as a simple summing up of individual creative performances, but that it be extended to include communication processes, since these are a crucial element in collaborative creative problem solving (equation (2)). Communication as the link between external and internal creativity sources has outstanding importance for the collaborative process and calls for the provision of adequate means with regard to creative processes. Collaborative creativity has been said to be even more crucial for open creativity. In order to handle these complex processes, support can be provided by design-based means of communication such as rapid-prototyping, modeling, storytelling and persona-based scenarios. These are especially useful because they make use of more human senses than traditional methods usually do (Steiner, 2007b). They can also become crucial vehicles within creative collaboration in terms of complex issues, since many traditional means of communication are inappropriate for doing so. Besides, in order to constructively and synergistically include external creativity within the organization, the crucial roles of a common, appropriate, and "understandable" language, complementary value systems, behavioral styles and clearly defined competences become obvious.

Though creative effort within an organization occurs in relation to one specific organizational setting (e.g., within a specific culture, climate, or leadership environment), by bridging internal and external creativity, two potentially divergent organizational views are brought together which in turn, helps create positive synergies within the cross-border problem solving process. The appropriate organizational, environmental and communicational means have to be established in accordance with the given system peculiarities. In order to illustrate how collaborative creativity may be directed with a view towards generating open creativity, the Planetary Model is introduced below.

The Planetary Model: a Framework for Dealing with a System's Internal and External Potential for Collaborative Creative Problem Solving

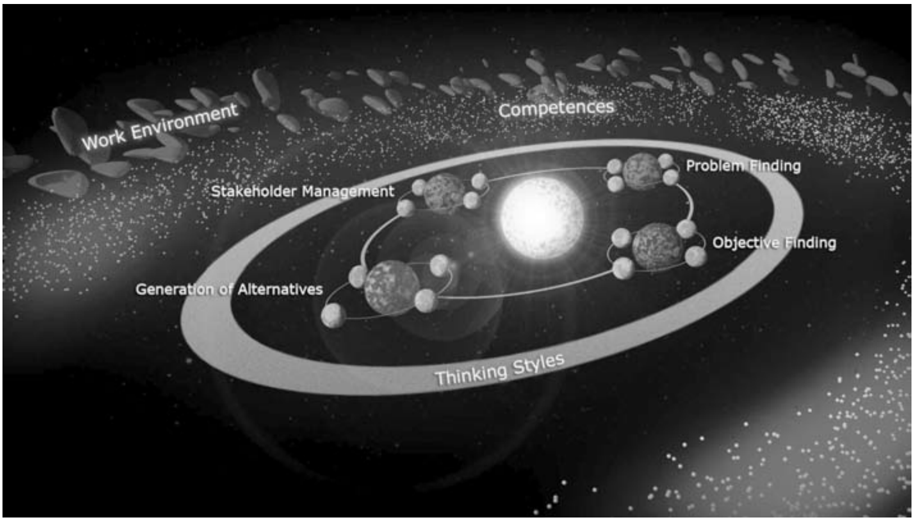
Making use of and actually further improving the inherent creative potential of a system – such as the organization and its environment, the innovation/creativity professionals, the users and non-users – requires an understanding of operation processes. Since creative problem solving processes are complex systems exhibiting nonlinear behavior (e.g., Joye & Van Locke, 2007), and on biomorphic constructions (Steiner, 2005) regarding creative systems, a flexible guiding framework is needed in order to avoid becoming lost within destructive chaotic disorder, and also to learn how to cope with uncertain and nondeterminable future system conditions.

In order to help organize the complex system of creatively generating ideas for innovations, the Planetary Model is introduced. This model is intended to provide internal guidance by making use of the metaphor of a planetary system that consists of the sun, four planets with four moons, and three kinds of cosmic clouds. In contrast to most other models used for explaining creative processes, this model takes into account the dynamic interaction between the subsystems of the creative problem solving processes. This means that the complex and real-life processes of creative problem solving can be better understood. Collaborative creative problem solving processes, in terms of both integration of internal and external creative potential, and the need to take account of individual creative effort, are always determined first by the peculiarities of the underlying system (which may or may not be reflected in the problem definition). They are then determined by the related system objectives, the potential for solution development (usually combinations of new and existing solutions enable a broad set of options to be made available for generating appropriate solutions) and by the choice, involvement, and/or participation of the appropriate problem solving actors in accordance with the specific needs of the specific stage of the problem solving process. Additionally, the problem solving group possesses the appropriate competences and make use of the right mix of divergent and convergent thinking capabilities within an appropriate supportive environment. This enables the inherent creative capabilities of those involved to flourish.

The Planetary Model can roughly be divided into three dimensions: the sun, the planets and the cosmic clouds. In the middle of the Planetary Model is the sun, standing for the solutions and ideas generated within the problem solving process. Although solutions, as well as ideas, are both outcomes of the creative problem solving process, solutions are directly connected to a certain problem, whereas ideas may have no obvious relation to the problem one is working on. The sun is surrounded by the planets: "Stakeholder Management," "Problem Finding," "Objective Finding," and "Generation of Alternatives." These act as the relevant subsystems of the creative problem solving process. Each planet also acts as a potential source for solutions and ideas, not only the planet "Generation of Alternatives." The sun and all the planets are embedded within cosmic clouds, which stand for the needed thinking styles and competences, as well as the work environment (Figure 2).

In an organizational context, creativity and creative problem solving are usually focused on the generation of solutions and ideas and consequently, on the creation of knowledge. Therefore, it needs to be stressed that the creative problem solving process is by no means restricted to problems presented to the problem solving agents. Instead, it is a characteristic of highly creative organizations and individuals that they continuously work on and search for new problems. Based on Popper's words "all life is problem solving" (Popper, 1999), this extension also proves highly fruitful in creative problem solving processes aiming at the generation of innovations.

Figure 2: *Planetary Model of Collaborative Creative Problem Solving*



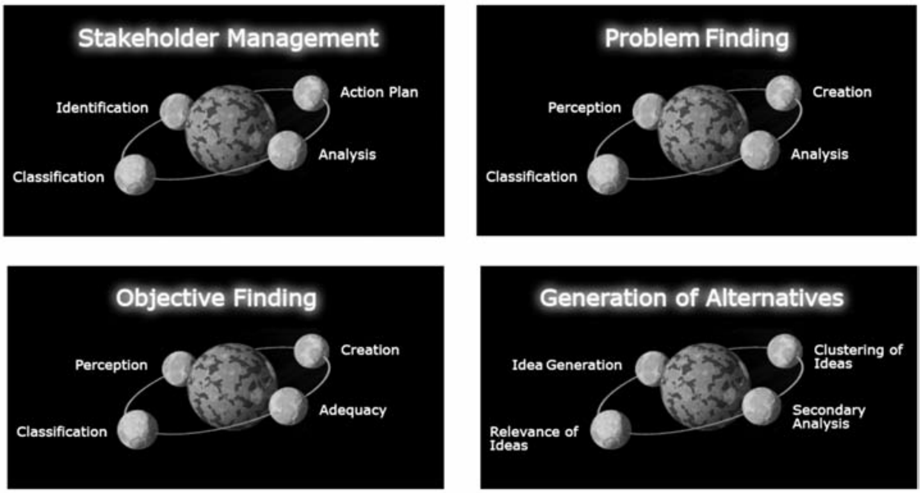
Since the whole system is strongly interconnected, the planets can be seen neither in isolation from each other, nor as being isolated from the influence of the rest of the cosmos. They are all continuously interacting. These interdependences also lead to permanently changing patterns. Circularity instead of linearity becomes the determining element.

In focusing on the single planets, it becomes obvious that each planet itself stands for another more detailed microcosmos, in which single moons (as subsystems of the single planets) revolve dynamically around the planets. Moreover, the moons are influenced by the other planets and the cosmic clouds as well (Figure 3).

The planet "Stakeholder Management" is surrounded by the moons "Stakeholder Identification," "Stakeholder Analysis," "Stakeholder Classification," and "Stakeholder Action Plan." Who are the relevant stakeholders with respect to the creative problem solving process and its outcome? Who should be involved actively within the process? An example would be the involvement of non-users within the problem finding stage. This could help in finding out what prevents someone from using a certain product and could also act as a starting point for developing new product characteristics.

The planet "Objective Finding" is surrounded by the moons "Perception of objectives," "Creation of objectives," "Adequacy of objectives," and "Objective classification." Relevant questions here are: How far is the objective of the creative problem solving process known, not only with regard to the innovation project at hand, but also with regard to its stakeholders? What stakeholders are to be involved? How can awareness about subobjectives among problem solvers and stakeholders be generated? Is the set of project-related objectives consistent with meta-objectives, such as organizational vision, strategy, or sustainability objectives? What about individual time preferences? How far can differences with regard to priorities among stakeholders be negotiated in order to get from individual to collective objectives?

Figure 3: *Planetary Model: the Planets with their Moons*



The planet "Problem Finding" is surrounded by the moons "Perception of problems," "Creation of problems," "Problem analysis," and "Problem classification." Further relevant questions here include: How far is the overall problem known or how can it be discovered? What are the stakeholder specific perceptions of the problem and how do their respective priorities differ? To what extent does the problem need to be reconstructed, discovered, or simulated (Runco, 1994)? Within the innovation generation phase, the creative problem solving process is usually related to various interconnected single problems. To what extent are nested subproblems a part of the overall problem? Distinctions can also be made between both problem content and characteristics. For example, a problem can be related to technical or user-related issues. Although the overall problem is complex, it can also contain simple and complicated sub problems that may be solved by existing means, based on rational and logical thinking processes.

The planet "Generation of Alternatives" is surrounded by the moons "Secondary analysis," "Idea generation," "Clustering of ideas," and "Relevance of ideas." Crucial questions to be answered are: How can creative solutions and ideas be generated? How can available solutions and new creations be compounded or combined? What kind of creativity and other problem solving techniques can be applied while still taking into account the peculiarities of the single problem solvers and the specific stage of the problem solving process (i.e., "System-Analysis and Design," "Conceptualization," “Specification,” and “Selection and Implementation”) (Steiner, 2007a). How relevant are the generated potential solutions and ideas with regard to the underlying objectives? As already mentioned, novel solutions and ideas are not only generated within the planet “Generation of Alternatives,” but often occur within the other planets as well. As an example, the discussion of a problem or potential set of stakeholder objectives can be a powerful source of creative sparks.

Although the sun includes specific procedures of instrumental evaluation and selection, in real world scenarios this is only one facet of evaluation and selection. However, in the context of the sun, concentration is on potential solutions such as dependence on a generated set of alternatives, a formal and an informal evaluation. Selection procedures also occur for all other planets and moons. These concern the interpretation of a problem, the construction of goals and the choice of certain creativity techniques that have to be applied.

It also seems necessary to broaden the paradigms of many traditional approaches of innovation management since they often consider problems as something that are given. Within sustainability-oriented change processes, a shared vision between the various stakeholders acts as a set of meta-objectives that is usually not something given but instead, has to be constructed. Additionally, as expressed in the planet “Objective Finding,” cognitive processes play an important role. Hereby, the planet "Stakeholder Management” strongly influences the process of the creation of a shared vision among the problem solving agents and other stakeholders. Consequently, the linearity of cause and effect can no longer be assumed. Therefore, the Planetary Model can support problem solving agents who are working together with other stakeholders on the complex task of developing sustainable innovation. This may include students and teachers working on case studies (e.g., in a regional context) (Steiner & Laws, 2006).

The Planetary Model as a Guide within the Innovation-oriented Working Process

The Planetary Model can also aid appropriate design of the creative problem solving processes and support the provision of a suitable creative climate at various stages of the working process. As shown, the Planetary Model realistically determines how creative solutions and other ideas are generated within the process of problem solving. Nevertheless, the problem solving agents need further process orientation when working on complex problems. By combining this model with the various single stages of a sequential innovation-oriented working process, which can easily be translated into specific working steps, the project related performance can be further improved by providing for positive organizational effects in the long run, and by raising the probability of achieving sustainable innovation.

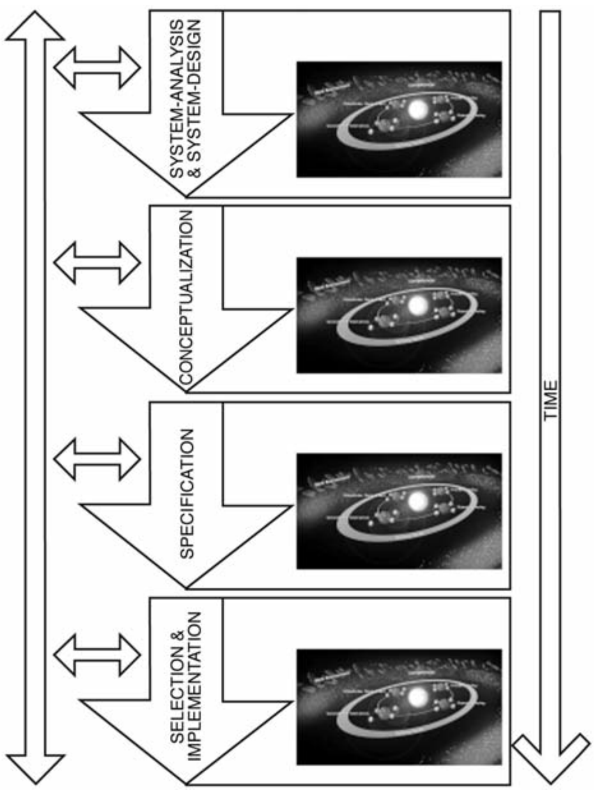
The Planetary Model aids understanding of creative processes by providing orientation for sequential processes without running the risk of oversimplification (Figure 4). This also implies enabling flexibility as well as providing necessary structures. In fact, the Planetary Model could be combined with every other sequential process guide. Here, working steps are introduced that are especially adequate when working on complex real world problems.

The underlying working process is roughly divided into four main interconnected phases:

1. System Analysis and Design
2. Conceptualization
3. Specification
4. Selection and Implementation

It is important to be aware that these four phases are intended to assure an effective and efficient work flow, allowing for constant revision of earlier process stages, while avoiding erratic jumps back and forth. This four-stage process is based on personal experience gained in managing product development and industrial design projects. As an example, IDEO's innovation process characterizes the process focus of one of today's most innovative companies, and it consists of the following: "understand," "observe," "synthesize," "visualize-realize-refine-evaluate-visualize" (as ongoing circle), "communicate," and "implement". An example of another broadly applied model is one provided by Thom (1980), based on a three-stage innovation process. Overviews of various innovation processes are provided by Vahs & Burmester (2002).

Figure 4: *Creativity management within the innovation process*



System Analysis and Design is the basis for understanding the underlying system, its main elements and interdependencies, its structure and patterns of behavior, its environment, and its initial state. It also includes some rough ideas or a rough vision of the target state of the system. Based on the understanding of this system identified within the conceptualization phase, different variants for future developments of the systems or potential solutions for an improvement of the underlying system are created by applying all kinds of rational and creative means. During the specification stage, the goal is to choose among potential alternatives, reduce them to the most promising ones, and move forward to more detailed developments. In the last stage, final selection between the remaining potential alternatives provides the basis for further measures of implementation concerning the final outcome of the whole innovation process.

Real world innovation processes, such as product development processes, require an easily understandable project structure in order to provide the project team with orientation. The danger of reducing a complex system, such as the underlying creative problem solving process needed for the creation of an innovation, into an easily understandable, interconnected four-stage working process that is also easy to communicate, lies in the potential of dangerously oversimplifying a complex problem and consequently being confronted with the negative outcome of having neglected important system peculiarities.

In order to overcome that potential danger, I suggest a two-dimensional procedure for the working process. Firstly, the four stages of system-analysis and design, conceptualization, specification and selection and implementation form the basis for structuring and guiding the working process in the sense of a project management philosophy. Secondly, every stage has to be seen in the context of its implications for the whole problem solving process and be expressed within the Planetary Model. The reason for this is that the ongoing problem solving process produces further knowledge and understanding of the whole problem solving system as perceptions of problems and objectives change in interaction with new stakeholder solutions and ideas. Therefore, each stage always has to be considered with regard to the problem, the system of objectives, the implications for the various stakeholders, and the resulting impact on the generation of alternatives in interplay with the needed thinking styles and competences. Interplay with the work environment also needs to be considered.

By going from one stage of the innovation process to the other, and consequently moving along the timeline, the system itself achieves increasing precision and concreteness with respect to the target state of the system. Potential solutions are attained, as in an improved level of knowledge, not only concerning the potential solutions themselves, but also in terms of process capabilities and experience gained.

The model described here has been applied and further adapted in various projects within industrial design, mainly as part of a joint endeavor of the School of Industrial Design at the University of Applied Sciences in Graz and various companies such as Audi and BMW. The model has also been used in other realworld innovation projects carried out in cooperation with industry and industrial design companies.

Conclusions and Directions for Future Research

This paper is directed towards creativity scholars as well as business people involved in real-life innovation processes. It was found that concentrating purely on the creative capabilities of individuals is seldom sufficient for creating successful innovations. Additionally, the increasing complexity of most innovation systems requires a collaborative creative effort that often exceeds the borders of the individual organization, and calls for the involvement of further external stakeholders based on an open creativity system. To handle creative processes within such open creativity systems, restricted research perspectives, such as approaches which focus purely on personality traits, or the application of methods aiding the generation of creative ideas like creativity techniques, are far too limited and only help generate partial understanding of isolated subsystems within the overall system of collaborative creativity. Consequently, the Planetary System, as a model for understanding and dealing with collaborative creativity involving internal and external creative potential, needs to be employed as well. The utilization and potential improvement of the overall creative capabilities of the underlying system, serve as vehicles for dealing with ill-defined complex problems in a real-life context. For this, the general model of collaborative creativity needs to be implemented within a practicable working process for the generation of innovations in order to provide orientation and process advice for those going through the "adventure" of innovation generation.

Empirical findings gained from Austrian and German industrial design companies provide tentative support for the model (Steiner, 2004), but more comprehensive empirical research is needed, especially with regard to collaborative creative problem solving within innovation systems based on cross multiple levels of analysis. Consideration of creativity systems must be undertaken. This includes people, problem solving processes, supportive environments and methodological support. Hence, potential cultural differences in leadership philosophies, inter and transdisciplinary collaboration, applied forms of communication designed to enhance creativity and work environment all need further investigation as well. Hereby, systems thinking might play a key role.

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