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An Autopoietic Systems Theory for Creativity

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Abstract

In this paper, a new, non-psychological and non-sociological approach to understanding creativity is proposed. The approach is based on autopoietic system theory, where an autopoietic system is defined as a unity whose organization is defined by a particular network of production processes of elements. While the theory was originally proposed in biology and then applied to sociology, I have applied it to understand the nature of creation, and called it "Creative Systems Theory". A creative system is an autopoietic system whose element is "discovery", which emerges only when a synthesis of three selections has occurred: "idea", "association", and "consequence". With using these concepts, we open the way to understand creation itself separated from psychic and social aspects of creativity. On this basis, the coupling between creative, psychic, and social systems is discussed. I suggest, in this paper, the future of creativity studies, re-defining a discipline "Creatology" for inquiring creative systems and propose an interdisciplinary field as "Creative Sciences" for interdisciplinary connections among creatology, psychology, and so on.

Keywords: creativity; systems theory; autopoiesis; pattern language

1. Introduction

In this paper, a new, non-psychological and non-sociological approach to understanding creativity is proposed. The approach is based on autopoietic system theory, where an autopoietic system is defined as a unity whose organization is defined by a particular network of production processes of elements. While the theory was originally proposed in biology and then applied to sociology, I have applied it to understand the nature of creation, and called it "Creative Systems Theory". A creative system is an autopoietic system whose element is "discovery", which emerges only when a synthesis of three selections has occurred: "idea", "association", and "consequence". With using these concepts, we open the way to understand creation itself separated from psychic and social aspects of creativity. On this basis, the coupling between creative, psychic, and social systems is discussed. I suggest, in this paper, the future of creativity studies, re-defining a discipline "Creatology" for inquiring creative systems and propose an interdisciplinary field as "Creative Sciences" for interdisciplinary connections among creatology, psychology, and so on.

There are several reasons why study of creativity is pursued from so many angles today. First, against the backdrop of the shift from labor-intensive work to knowledge-intensive work, many people involved in business need to make full use of intelligence and creativity for obtaining

added-valued outcomes (Florida 2002). While introducing information technologies has been changing the style of work, the newly emerging trend requires being more creative (Nonaka & Takeuchi, 1995, Malone 2004). As Daniel Pink (2006) has pointed out, we are no longer simply in an “Information Age”, but in an emerging age called the “Conceptual Age”. Thus thinking with both “left-brain” and “right-brain”, which is often called “design thinking”, is required today (Kelley & Littman 2001, Brown 2009).

Second, we have been realizing that enhancing creativity is necessary to shape the future in our complex, diverse, and "liquid" society. The problems today are quite complex and dynamic to solve, so we must gather the creative abilities beyond individual professions and disciplines. As Michael Gibbons et. al. (1994) has pointed out, the emerging mode of scientific knowledge production, which is called “mode 2” against the mode of conventional sciences, is characterized by transdisciplinarity, heterogeneity, heterarchicality, and transience. The challenge to create new trends for the future is often carried out with a growing network including creators, communicators, and collaborators, which Peter Gloor (2006) has called “Collaborative Innovation Networks” (COINs).

Third, people have been thinking that engaging in creative activities can meet the human desire on a deep level. For the past decade, information technologies, especially the Internet, has provided the infrastructure for everyone to enjoy participating in collaborations based on their interest (Torvalds & Diamond 2002, Friedman 2005, Tapscott & Williams 2008). According to psychological studies by Mihaly Csikszentmihalyi (1990; 1996), the “flow” experience when involved in creative activities is known to provide the feeling of happiness. Self-fulfillment in contemporary age is not based on material pleasures, but a higher stage of motivation such as creativity (Maslow 1954).

Thus the emergence of a “creative society” demands the enhancement of our creative abilities and the environment (Resnick 2002). There is, however, the crucial problem that the essential nature of creative process is still unknown. In fact, we know little about what goes on in creative process and how we can support it, although psychologists have endeavored to understand creativity. The psychological approach can reveal only one aspect of creativity, that is to say the psychological aspect, and other aspects remain to be studied. Against that background, this paper examines a new explanation of creative process using the latest system theory, namely autopoietic systems theory, which was originally proposed for explaining life and then applied for describing society. Using this theory, this paper aims to open a new way to unveil the nature of the creative process.

In the first half of this paper, theoretical consideration is provided. First of all, the concept of autopoietic systems theory, which is the fundamental framework for our theory is proposed. Then, we propose a new theory, which is called "Creative Systems Theory", within that framework. After that, the social system theory proposed by Niklas Luhmann in sociology is briefly explained in order to prepare to understand the relations among the creative, psychic, and social systems. In the latter half of the paper, the coupling between creative, psychic, and social systems is discussed, and then an example based on the theory is shown. Subsequently, "Creatology" that is a new discipline for studying creativity as well as psychology and sociology is defined, and a new interdisciplinary field, "Creative Sciences," which combines the perspectives of psychology, sociology, and others is proposed.

2. Spotlight on Creative Process, Not Creative Ability

What is creativity? — This question has been made from time immemorial, but scientific approaches to understanding creativity started just in the middle of the twentieth century (Boden 1994, Sternberg 1999, Sawyer 2006). Psychologists first studied creativity by focusing on personality and cognition, and then broadened their view to social and cultural aspects. Moreover,

social psychologists and sociologists have also studied creative collaborations done by two or more people, which are happening everywhere in the world today.

Although considerable effort has been dedicated to understanding the nature of creativity, we regret to say that these psychological and sociological approaches have their limits. There, in my view, remain following three, interrelated puzzles to be solved: (1) the intrinsic nature of creativity, (2) the contingent nature of creative processes, and (3) the differences between individual and group creativity.

2.1. The Intrinsic Nature of Creativity

Creativity is often defined by referring to others' evaluations about the novelty of the product. Mihaly Csikszentmihalyi, a leading psychologist of creativity studies, pointed out the importance of social and cultural dimension as follows: "[...] creativity cannot be recognized except as it operates within a system of cultural rules, and it cannot bring forth any thing new unless it can enlist the support of peers" (Csikszentmihalyi 1999). I agree that the reference to the difference from the existing ideas, products, or outcomes, is necessary to evaluate the social value of creative output, however, in this standpoint one cannot understand the intrinsic nature of the creative process. Let me explain why with some examples.

Imagine a scientist lived on an isolated island. He invented a new theory about a certain phenomenon, deliberating with series of his experiments. Then he wrote the paper about the theory and traveled to give a presentation in an academic conference. After the presentation, he learned that a very similar theory had already been presented years before. He was never credited with the theory because it was merely a re-invention. As such he is not considered "creative" in terms of the invention of the theory. This outcome is natural, and I agree that it is proper from a social viewpoint. Nevertheless, isn't there really any creativity at all? Can we say with assurance that the invention itself by the unlucky scientist is not "creative", if the process to invent the theory is improbable or unconventional?

Let me offer one more example. A child is playing with blocks in the room, and she is getting to feel bored. She realizes that this is because there is no sound. Then she thinks out a new way of playing blocks with the empty boxes. Drums! Using two bar blocks, she is able to make loud sounds by beating the boxes as drums. Needless to say, she is not the first person to do this, therefore we cannot call her "creative". Is that really so?

The above questions can be summarized as follows: Is it really inaccurate to call a process "creative" without the evaluation of novelty by others? The standpoint of this paper is that one can consider a process as "creative" without reference to others' evaluation of the product. In other words, there is an intrinsically creative process. I will re-define the term "creative" to fit such a usage, shifting the focus from abilities to processes. Furthermore, I offer to distinguish "creative" events in a (creative) process from "creative" evaluation in social context. Consequently, we can consider certain processes as "creative" even if their products are mere re-inventions.

2.2. The Contingent Nature of Creativity

During the last several decades, scientists have tried to make a measurement for creativity, however it turns out to be difficulty due to the contingent nature of creativity. Sources of discoveries are quite diverse and depend on a variety of circumstances, for example, logical deduction, induction, abduction, analogy, metaphor, inspiration, and just by accident. Even if investigating into the details of creative processes from the viewpoint of individual sources, one cannot thereby extrapolate to the universal. In other words, creative processes do not necessarily follow deterministic laws, nor do they necessarily happen at random.

In addition, creative processes are often built on several discoveries, and they tend to contain not only good ideas, but also wrong or useless ideas. As Keith Sawyer has pointed out about successful innovators, "They succeed by way of many small sparks, and by drawing on

collaboration over time to build those sparks into something tremendous. Many of the ideas turn out to be wildly off the mark, but it turns out many not-so-good ideas are needed on the way to that rare great idea." (Sawyer 2007: p.105). Indeed, for example Charles Darwin produced many ideas that were not only weird but also wrong in hindsight. As Sawyer said, however, these ideas also played an important role that contributes to his "creative" outcome.

"Even Darwin's dead ends provided critical links in the chain; the monad theory was wrong, but it led to Darwin's branching model of evolution. His work on hybridization led nowhere, but as a side-effect he learned about artificial selection, which he later realized was a man-made version of natural selection. His theory of coral reef formation, developed years before he'd even thought about evolution, had the same formal structure as the theory of evolution. Darwin had many key ideas before he realized how they would all fit together." (Sawyer 2003: p.107)

Consequently, in order to build a theory that explains the nature of creative processes it is necessary to take the contingent nature into account.

2.3. The Difference of Creativity between Individual and Group

Collaboration brings added value that cannot be achieved by an individual. In organizations and teams that successfully operate the process of creation through collaboration, communication gains "momentum," and it sympathizes and amplifies in a nexus. Along with this effect, connecting the path of communication one by one, it is possible to bring up unexpected, remarkable ideas and innovations.

Creation through collaboration is a matter of emergence, that unable individual to understand with existing theories, and is often taken as suspicious and mysterious thing. While a number of scientists have studied this kind of collective phenomena at group level, they merely reach to understand the effectiveness of collaboration. Collaboration is something that drives creativity by encouraging the generation of a long sequence of sparks beyond individual minds.

After all, is there any difference between individual creativity and group creativity? If there is the difference, it means that there are two types of creativity. Otherwise, a feature called "creativity" can be realized in the different loci: the mind inside an individual and the group made of individuals.

Considering these problems, we need to look at the relation between creativity and the creative process from the reverse angle, that is, from the view that "people who have creative abilities can conduct creative processes" to the view that "people who conduct creative processes can be creative". In this paper, we suggest an alternative approach to creativity rather than psychological and social ones. Our approach is based on a systems theory, which is transdisciplinary, for thinking about creativity in a way that transcends individual disciplines. Furthermore, we focus on creative processes rather than creative abilities. The current theory that describes such a process appropriately is systems theory. What is proposed in this paper is new viewpoint to describe what goes on in the creative process as a system, an autopoietic system. Applying the latest systems theory to understand the nature of creativity will reveal what goes on in the creative process. The fundamental question to be answered is how the creative process is at all possible. Moreover, the whole relation is redrawn as couplings between psychic, social, and creative systems.

3. A Brief History of Systems Theory

What is being applied to describe creative process in this paper is systems theory. I shall begin by presenting an overview of the history of systems theory, using a categorization suggested by

Hideo Kawamoto (1995) in which the development of systems theory is divided into three generations (Table 1).

The first generation is summarized as the theories of dynamic equilibrium systems, and their key concept is "homeostatis". It focused on the mechanism of how a system maintains itself despite fluctuations within the environment. Leading scholars in this generation are Walter Bradford Cannon ("homeostasis"; Cannon 1932), Ludwig von Bertalanffy ("general systems theory"; Bertalanffy 1968), Norbert Wiener and W. Ross Ashby ("cybernetics"; Wiener 1948, Ashby 1956). The sociologist who applies this generation theory is Talcott Parsons ("social systems theory"; Parsons 1951).

The second generation consisted of theories for dynamic nonequilibrium systems, and their key concept is "self-organization". These theories focused on the mechanism how a structure of system is crystallized from disorders. Leading scholars in this generation are Ilya Prigogine ("dissipative structure"; Prigogine & Nicolis 1977), Manfred Eigen ("hypercycle"; Eigen & Schuster 1979), and Hermann Haken ("synergetics"; Haken 1977).

The third generation consisted of theories of self-production, and their key concept was "autopoiesis". They focused on the mechanism of how a system itself is realized over time. An autopoietic system consists of a unity whose organization is defined by a particular network of production processes of elements. Leading scholars in this generation are Humberto Maturana and Francisco Varela ("autopoiesis"; (Maturana & Varela 1980). The leading sociologist who applies this generation theory as "social systems theory" is Niklas Luhmann (Luhmann 1984).

It is important to note that a clear distinction between "self-organization" and "autopoiesis" was made following the revolution caused by the aforementioned third generation. In this context, self-organization is focused on structural formation, but autopoiesis is focused on system formation. Luhmann emphasizes this distinction as follows:

“Autopoietic systems, then, are not only self-organizing systems, they not only produce and eventually change their own *structures*; their self-reference applies to the production of other *components* as well. This is the decisive conceptual innovation. [...] Thus, everything that is used as a unit by the system is produced as a unit by the system itself. This applies to elements, processes, boundaries, and other structures and, last but not least, to the unity of the system itself.” (Luhmann 1990: p.3)

Table 1 Three generations in system theories.

Generation	Spotlighted System	Key Concept	Leading Scholars (Theory)
1st	dynamic nonequilibrium system	homeostasis	W. B. Cannon (homeostasis) L. Bertalanffy (general system theory) N. Wiener (cybernetics) W. R. Ashby (cybernetics) T. Parsons (social systems theory)
2nd	dynamic equilibrium system	self-organization	Ilya Prigogine (dissipative structure) Manfred Eigen (hypercycle) Hermann Haken (synergetics)
3rd	self-production system	autopoiesis	Humberto Maturana (autopoiesis) Francisco Varela (autopoiesis) Niklas Luhmann (social system theory)

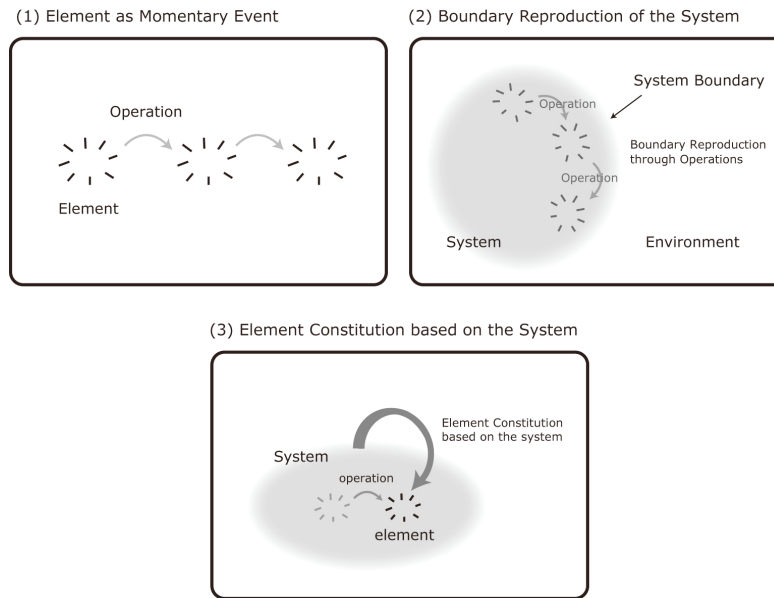


Figure 1 Three key features of system formation of autopoietic systems

"In order to clarify how much this concept of basal self-reference differs from an earlier discussion of "self-organization", Maturana and Varela have proposed the designation 'autopoiesis' for it." (Luhmann 1984: p.34)

As just quoted, the difference between "self-organization" and "autopoiesis" is of decisive importance for understanding the conceptual innovation of the systems theory. Recall that, in this paper, we apply third-generation systems theory of autopoiesis, not second-generation systems theory of self-organization. Our attempt is to describe creative processes as autopoietic systems.

4. Autopoietic Systems Theory

Next, I shall explain the details of autopoietic systems theory in the following order: system formation, element constitution, uncertainty and media, and structural coupling of systems. Note that the following explanation is based on my interpretation of the formulation by Niklas Luhmann, who generalized the concept from biological systems theory to general systems theory for building a new social systems theory.

4.1. System Formation

Autopoiesis means self-production, and autopoietic system means the system that produces itself. The concept of "autopoiesis" was originally proposed by biologists Humberto Maturana and Francisco Varela, and the term "autopoiesis" is invented from Greek words: "auto" (αὐτό) for self- and "poiesis" (ποίησις) for creation or production (Maturana & Varela 1972, Varela et. al. 1974, Maturana & Varela 1980; 1987).

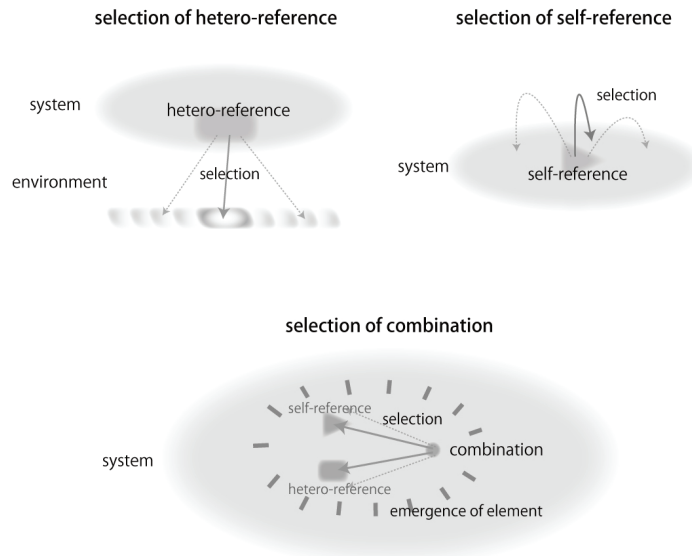


Figure 2 Three selections for element constitution

In short, an autopoietic system is a unity whose organization is defined by a particular network of production processes of elements, not by the components themselves or their static relations. Summarizing the concept of autopoiesis, it turns out that the system has three fundamental features: (1) element as momentary event, (2) boundary reproduction of the system, (3) element constitution based on the system (Figure 1).

The crucial point of autopoiesis in systems theory is the shift of viewpoint of element from substances to momentary events. Element of the system conventionally considered to keep existing, for example cell in living system or actor in social system. In the autopoietic system theory, however, the elements are momentary events that have no duration. This means that elements disappear as soon as they are realized. Consequently, the system must continue to produce the elements in order to keep itself in existence. Thus, the boundary of the system is determined circularly by the production of elements, and so it is called autopoietic system.

In this sense, autopoietic system does not emerge from the so-called "bottom-up", just because the concept of bottom-up is assumed to given elements before the whole emerges. Autopoietic intrinsically implies a circular relation between the system and its elements. Luhmann points out as follows: "Whether the unity of an element should be explained as emergence 'from below' or as constitution 'from above' seems to be a matter of theoretical dispute. We opt decisively for the latter. Elements are elements only for the system that employs them as units and they are such only through this system. This is formulated in the concept of autopoiesis." (Luhmann 1984; p.22)

4.2. *Element Constitution*

One might even go so far as to say that the paradigm shift by autopoiesis in systems theory was caused by a novel conceptualization of system elements. Elements of autopoietic systems are constituted by the system itself, not by importing from outside the system.

According to the theory, elements emerge only when a synthesis of three selections occurs: the selections of hetero-reference and self-reference, and the combination of both (Figure 2). System is closed in the sense of operation based on self-reference, but open in the sense of hetero-reference. The complementary combination of openness and closeness is characterized by the autopoietic system, which is very different from the ordinary system features in the input/output schema.

Here, each operation to constitute element has a double function of "production of system" and "preservation of structure". The former is related to autopoietic reproduction, and the latter is related to reproduction of structure on which the element constitution depends. Borrowing Luhmann's words, "An autopoietic system reproduces both its reproduction and the conditions for its reproduction."(Luhmann 1995, p.50) In this sense, autopoietic system is historical system.

4.3. Uncertainty and Media

Since there is uncertainty for realizing communication, it is intrinsically difficult that the nexus of communication is realized." They only show that the stability of systems based on time-sensitive events must be a dynamic; a stability that depends on the continual change of the system's resources."(Luhmann 1995; p.49) However, in reality, some kind of evolutionary achievement, called "media", support for communication to overcome the uncertainty. Media, so to speak, transforms improbable into probable.

5. Creative Systems

The creative process consists of a sequence of discoveries, which include problem finding, problem solving, observation, hypothesis formation, method selection, practice, and interpretation. The creative process does not follow deterministic laws, but it also does not happen at random. Rather, it includes contingency. The creative process is, so to speak, autonomous and therefore historical. In order to formulate this kind of processes, we would like to apply autopoietic systems theory. Creative systems theory describes how creation is possible. This attempt is done without psychological reduction, as most creative researches do, nor sociological reduction, as most studies of collaboration do.

5.1. System Formation

In order to describe the creative process as a sequence of discoveries, we would like to suggest that creativity is an autopoietic system whose element is discovery. In creative systems, discovery is produced by discovery based on on-going creation. The discovery is a momentary element that has no duration, so it must be constantly reproduced in order to realize the creative system. Element, discovery, is an emergent unity constituted in the system, therefore the system cannot receive discoveries from its environment or output discoveries to its environment. In this sense, the kinds of discoveries that are made depends on the ongoing system. Thus the creative system is operationally closed.

Note that discovery in this context does not imply that it is either true or useful. The problem here is only connectivity to further discoveries. As Sawyer has pointed out about successful innovators, "They succeed by way of many small sparks, and by drawing on collaboration over time to build those sparks into something tremendous. Many of the ideas turn out to be wildly off the mark, but it turns out many not-so-good ideas are needed on the way to that rare great idea."(Sawyer 2003; p.105) and indeed "Darwin's notebook show that he reached many dead ends and produced a lot of ideas that scientists now consider weird."(Sawyer 2003, p.106)

In addition, it does not matter where and how discoveries come from. It may be the result of deliberation, inspiration, or mere accident. It may be obtained by somebody alone or in collaboration by more than one person. Thus, in the viewpoint of creative systems theory, what is most important is the successive generation of discoveries, not where and how they came from. From such a standpoint, one can think of the creative process itself and also the relationship of the creative process to psychic or social processes.

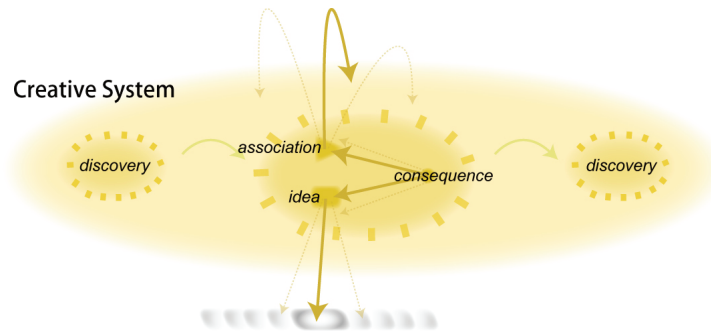


Figure 3 Overview of a creative system

5.2. Element Constitution

From the viewpoint of element constitution, discovery emerges from the synthesis of the three-part selection: "idea", "association", and "consequence" (Figure 3). It is required for the emergence of discovery that all of these selections are occurred. What we should emphasize here is that idea exists only inside the system. In other words, idea is meaningful only for ongoing creation. Outside the creation, one can no longer call it "idea". In this sense, idea cannot exist "out there" alone. In the same way, association can exist meaningfully only inside the system. It is just association to ongoing creation. Consequence occurs only as the combination of idea and selection, therefore it also can exist only inside the system.

Using words of the abstract framework of autopoietic systems, which we mentioned before, *idea* is *hetero-reference* to the environment; *association* is *self-reference* to the system itself; and *consequence* is *combination of the hetero-reference and the self-reference*. Thus, creative systems are recursively-closed systems with respect to *discoveries*.

Note that, exactly speaking, the selection just means the reduction of complexity in contingent situation, therefore without the reference to social status or psychic status. On one hand, *discovery* does not imply the novelty in society. Each *discovery* is independent on the status of the society. In this sense, even re-invention is considered as also creation in this theory. On the other hand, the feeling of surprising is not necessary to *discovery*, because it is not a problem in the creation, but a problem of the mind. In other word, the creation is creative even if the participants do not feel, so-called, "Eureka!"

5.3. Uncertainty and Media

There are intrinsically uncertainties for realization of *discovery*. In other words, *discoveries* hardly come about due to the uncertainties. One of the uncertainties is an uncertainty of *association* of *idea*. Thinking newly means that there is no guarantee that the *association* of *idea* is possible to apply. Another uncertainty is related to far-reaching *consequence* of *association* of *idea*. It is quite difficult to get *consequences* by thinking about complicated logic. Although there are such uncertainties, some kind of evolutionary achievements, called "*media*" in autopoietic systems theory, support for realization of *discovery* to overcome the uncertainties.

Against first type of uncertainty, that is uncertainty of *association* of *idea*, theories and rule of thumb work as *media*. Theories would reduce the complexity for selection of *idea* and *association*. They do not mean deterministic laws to strictly follow, rather spotlights to pay attention for selection. Typical theories in the discipline are sometimes helpful, and theories in other disciplines are also helpful to get *idea* or how to make *association* to it. Borrowing the words of

is a language plus reasoning; it is like a language plus logic. Mathematics is a tool for reasoning. It is in fact a big collection of the results of some person's careful thought and reasoning. By mathematics it is possible to connect one statement to another." (Feynman 1967; p.40)

Against second type of uncertainty, that is uncertainty of far-reaching *consequence*, several kind of tools work as *media*. For example, tools for computer simulation help to get *consequence* through complicated calculation. Likewise, tools for network analysis, text mining, and statistical analysis are helpful. Although obtaining far-reaching *consequence* does not necessarily require such tools, they contribute greatly to decrease the possibility to stop in midcourse by enhancing efficiency rather than human labor.

6. Social Systems and Psychic Systems

The sociologist who applied the autopoietic systems theory into sociology is Niklas Luhmann. He generalized the concept of autopoiesis from biology and suggested a new framework for understanding society. His fundamental problem is how societies are possible. He considered society and mind as autopoietic systems respectively, where society is an autopoietic system whose element is *communication* and mind is an autopoietic system whose element is *consciousness*.

The viewpoint that the element of the society is *communication* is quite radical in sociology, because actor or action is traditionally considered as an element of society. However, Luhmann thought one can explain freedom and autonomy of individuals from society, only if thinking from his viewpoint; otherwise the individuals must be just a part of the society without freedom and autonomy. Thus, Luhmann aimed to build a general theory of society with autopoietic systems theory, and also applied his theory into a wide variety of social phenomena including economy, law, politics, art, religion, education, science, mass media, and family.

6.1. System Formation

Here I shall explain system formation of psychic system and social system, which was proposed by Luhmann. Psychic system is a nexus of *consciousness*, and the system reproduces *consciousness* by *consciousness*. *Consciousness* can have no duration because of momentary operation, so it must be reproduced constantly. From the viewpoint of operation, psychic system is a closed system. It means that it cannot receive *consciousness* from outside of the system, and also cannot give *consciousness* away to outside. Psychic systems are mutually inaccessible, and therefore *communication* is necessary.

Social system is a nexus of *communication*, and the system can reproduce *communication* only by *communication*. *Communication* can have no duration because of momentary operation, so it must be reproduced constantly. From the viewpoint of operation, social system is a closed system. It means that it cannot receive *communication* from outside of the system, and also cannot give *communication* away to outside.

6.2. Element Constitution

From the viewpoint of element constitution, *communication* is emerged from the synthesis of three-part selection in social systems: selection of "*information*", "*utterance*", and "*understanding*". It is required for the emergence of *communication* that all of these selections are occurred. As borrowed from Luhmann, "The concepts of 'information,' 'utterance,' and 'understanding' should be taken without direct psychic reference" (Luhmann 1984; p.11). Selection just means the reduction of complexity in contingent situation, but the decision making of actors. Thus the crucial point of Luhmann's view is the standpoint from the side of communication.

Note that such a definition of *communication* is much different from conventional definition that is based on a metaphor of "transference". In the metaphor, a sender passes a message

(information) to a receiver, and then the information moves from the sender to the receiver. Luhmann pointed out the limitation in this perspective because the idea is prepossessed with existence of information, and there is a concern that the information transferred between sender and receiver is thought to be the same one. Luhmann claim that this perspective misses to understand the nature of communication as social phenomena. Instead, Luhmann claim that communication should be considered as the social phenomena related to meaning.

Furthermore, I would like to emphasize that Luhmann's conceptualization of *communication* is distinguished from so-called "communicative act". The concept of communicative act, as the name implies, is based on action theory rather than communication as mutual selection. Therefore, the concept of communicative act belongs to the formulization about which Luhmann criticized as just mentioned.

6.3. *Uncertainty and Media*

In social systems, there are always three uncertainties: uncertainty of understanding others, uncertainty of achievement, and the uncertainty of result of communication, due to the difficulty in general to understand what others are thinking since the psychic system is operationally closed to others. Since there is uncertainty for realizing communication, it is intrinsically difficult that the nexus of communication is realized. However, in reality, some kind of evolutional achievement, called "*media*", support for communication to overcome the uncertainty.

First, a media against the uncertainty of understanding others is "language". Languages as media provide the chance of coupling between consciousness and communication with symbolic generalizations for mutual comprehension. The language is a means of communication and also of thinking, as Luhmann noticed "linguistically formed thoughts play a part in the autopoiesis of consciousness, help to produce it" (Luhmann, 1984). Second, a media against the uncertainty of achievement is "dissemination media". Typical examples of dissemination media are newspaper, TV, and Internet. Communication and media studies generally have focused on these two types of media: language and dissemination media. Third, a media against the uncertainty of result of communication is called "symbolically generalized communication media" for communication, such as "love", "power", and "currency". These media activate the motivation of people for participating in communication, and bring the successful results of accepting the meaning of communication.

7. Coupling of Creative, Psychic, and Social Systems

To formulate interaction between autopoietic systems are much complex than the conventional system theory, because the autopoietic system is operationally closed. Autopoietic system cannot recognize the other systems because there is only distinction between own system and its environment. For describing the influence, the concept of "structural coupling" is introduced in contrast to operative coupling. Thus, the relationship between function systems can be described with the concept of "structural coupling" in the autopoietic system theory.

Now we shall think the affair of creation by combining the viewpoints that we just described (Figure 4). Although we have defined creative processes as autopoietic systems that are operationally closed and consequently human are considered as a factor in the environment, it does not mean that human are unrelated to the creation. Rather, human is a necessary factor, because any creation cannot happen without human. They are a necessary condition but not a sufficient condition. That is why we need to conceptualize creative process as a system that exists as a unity.

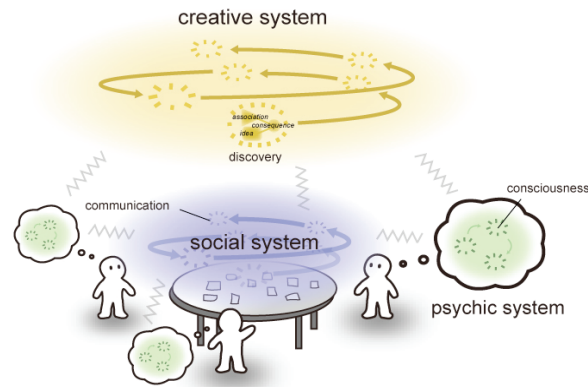


Figure 4 Coupling of creative, psychic, and social systems

8. Designing Media for Coupling of Systems

An example of media for coupling between creative, psychic, and social systems is “pattern languages”, which is known as the method to share “knowledge of practice”. The idea of pattern language was originally proposed in architectural design (Alexander et. al. 1977, Alexander 1979) and it has been applied and well known in the software design (Beck and Cunningham 1987, Gamma et. al. 1995). Recently, languages in specific theme like interface design (Tidwell 2005) and in broader domain like organization design (Coplien & Harrison 2004, Manns & Rising 2005) and human activity design of learning (Iba et. al. 2009), project management (Naruse *et.al.* 2008), and academic research (Kobayashi *et.al.* 2008).

There are two main purposes of using patterns. One is that the skill that is acquired from their own experience of experts is stipulated, thus it makes beginners easier to solve problems in the most efficient and cultivated way. Pattern language encourages creative thinking and creative action. Using patterns enables the psychic system of each person’s to structuralize the nexus of consciousness. The other is that it provides common vocabulary on designing principle of the problems, and therefore, it can be easily pointed out the relation between problems. With pattern language, communication on designing can be easily come into existence.

Pattern languages also work as *discovery media* (Figure 5). They help to transform improbable discoveries to probable and therefore support the creative system to form. Providing insights about hidden connections among “quality without a name”, “problem”, and “solution”, pattern languages increase the probability of *discoveries* of “problems” in individual situations, *discoveries* of “solutions” against the problems, and *discoveries* of “quality without a name” as consequences of the solutions. Moreover, the linkage among the individual patterns helps to generate further *discoveries*.

The difficulty for designing pattern languages is due to its double function for discovery media and communication media. It is not enough to design detail instruction or attractive buzzword, but the attractive language for supporting creation.

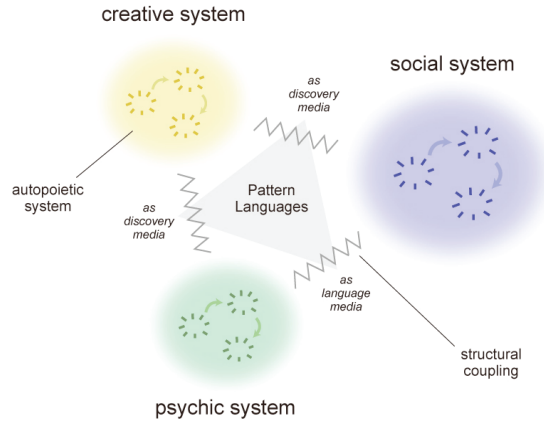


Figure 5 Pattern languages as discovery media for coupling of creative, psychic, and social systems.

9. The Future of Creativity Studies

Based on the discussion above, I shall give a perspective for the future of creativity studies (Figure 6). If one accepts the existence of creative systems, a new discipline for inquiring the systems will be born. I would like to call the discipline “Creatology”. While the term is coined with Istvan Magyari-Beck (1979, 1993) and he originally proposed it as an interdisciplinary field for creativity studies, I would like to redefine the term as a single discipline. It is because, according to the naming convention, “-ology” is used for names of disciplines such as psychology, sociology, and biology. Therefore, here I would like to use the name “Creatology” for representing a discipline for inquiring creativity focusing on creativity.

On the other hand, “- sciences”, like “natural sciences” and “social sciences”, is used in order to make bundles of disciplines. Recent examples are “network sciences”, “learning sciences”, and so on. Note that the term “science” here is used in broad sense, not in narrow sense like the science of logical positivism. Thus, one can see the interdisciplinary field named “Creative Sciences”, or “Creativity Sciences”. “Creative Sciences” must include that creatology, psychology, and sociology.

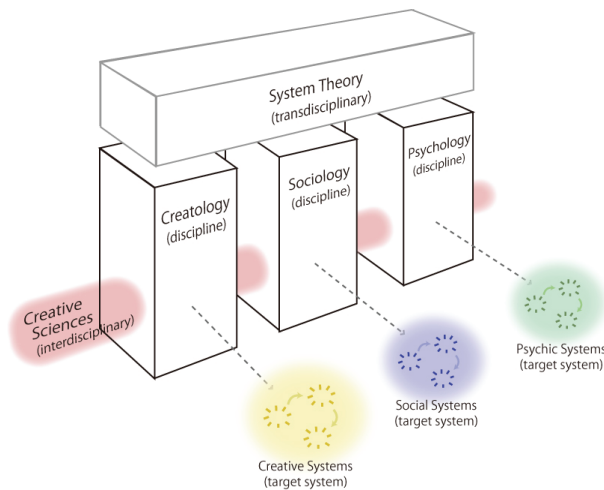


Figure 6 A perspective for the future structure of creativity studies

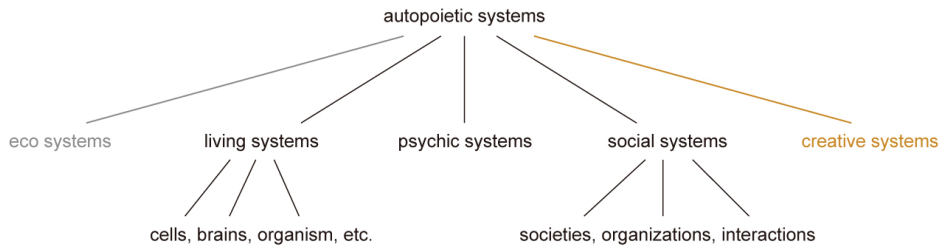


Figure 7 An overview list of autopoietic systems. This figure is extended from the figure of Luhmann (1990)

10. Conclusion

In this paper, we proposed “Creative Systems Theory” in order to understand creative processes in a new way, focusing the process itself without the reference to psychic or social aspects. The theory suggests that creative processes are autopoietic systems whose elements are *discoveries* emerged by a synthesis of three selections: *idea*, *association*, and *consequence*. Then, we drew a new perspective of scientific disciplines to study creativity, including “Creatology” and “Creative Sciences”.

In concluding this paper, I would like to update the list of autopoietic systems, adding a new system, namely “creative systems”, into the list (Figure 7). Note that “eco systems”, which has been also written in the list, was proposed in our previous papers (Naruse & Iba 2008, Iba & Naruse 2008). One may realize that all systems in this list — living systems, eco systems, psychic systems, social systems, and creative systems — are prime beings in our world, with which we human are always deeply both fascinated and awful.

Finally, I would like to quote some sentences from the book by Maturana & Varela (1980), because I strongly empathize with their thought and needs to new theories. In the introductory chapter of their book, Maturana reflected the prehistory of inventing the concept of autopoiesis. In his mind, the fundamental problem to study living systems was just as follows.

“We had to accept that we could recognize living systems when we encountered them, but that we could not yet say what they are.” (Maturana & Varela 1980: p.xiii)

After struggling to answer to the question what the organization of the living is, he reached to an important discovery.

“I realized that the difficulty was both epistemological and linguistic [...] one can only say with a given language what the language permits. I had to stop looking at living systems as open systems defined in an environment, and I needed a language that would permit me to describe an autonomous system in a manner that retained autonomy as a feature of the system or entity specified by the description.” (Maturana & Varela 1980: p.xiii)

Consequently, he invented the way to conceptualize the living system.

“[...] what was indeed needed was the characterization of a kind of system which, if allowed to operate, would operate in a manner indistinguishable from the operation

of living systems, and that one should do so using only neighborhood relations realized through the properties of the components of the system. It was with such aim that I spoke for the first time in 1969 of living systems as systems defined as unities through the basic circularity of their production of their components.” (Maturana & Varela 1980: p.xiv)

Likewise, our attempt in this paper is to create such a new language that can describe the creative process with its nature of circularity. This paper, however, marks only a step toward conceptual revolution in creativity studies. Now one can say that a creative system to create “Creative Systems Theory” is just started to operate. As we learned above, who contribute to this creation and what kind of discoveries will follow is open to the environment. It is hoped that the readers of this paper will join to this ongoing creation.

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