Incremental and radical innovation from a complex system theory perspective

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Abstract - **One challenge in Total Innovation Management (TIM) is to include all personnel of the organization in all kinds of innovative processes. Most former models have suggested separating incremental and radical innovation in different departments, since they need different kinds of thinking, acting and relating; exploiting respectively exploring. In this paper we are going to develop an understanding of innovation based on complex systems theory in order to transcend the paradox between exploiting and exploring. Activities like communication and experiments are important. We will describe processes and structures for practical use of the TIM-model and point at the need for integrated autonomy to facilitate emergence and structures like culture, praxis and relatonics for organizing of the innovation system.**

Keywords – **Complex system theory, Emergence, Exploring-Exploiting, Paradox, Integrated autonomy, Total Innovation Management**

I. THE TIM MODEL

Innovation is today increasingly recognized as a key for productivity, competitive advantage and growth. During the last decades, there has been a broadening of the field of innovation management. Models of innovation have moved from simple linear models towards increasing complex interactive models [1] implying a need for broad interaction of a multiple of actors. Enterprise innovation systems is recognized as complex self-adaptive systems with a need to involve not only all members of the organization but also external partners and customers. Based on these developments a novel paradigm – Total Innovation Management (TIM) – has emerged in the Chinese context [2]. It is conceived as a tri-dimensional innovation strategy model emphasizing innovation everywhere, every time and by everyone.

The TIM model looks at innovation from a perspective of the company. Innovation processes occurs in interaction between people and departments within the company and with external people and organizations. Innovation is central for long term sustainability of organizations, and it is not good enough neither to engage only a few people in innovation nor to have a shattered understanding of the different development processes of the company. The TIM model makes it possible to manage all development processes of a company within the same strategy, leadership and organization. It understand innovation as the development of all sorts of products; physical products, services, production systems, business models, work procedures, markets etc. Both radical innovations and incremental improvements are included, where radical innovation is connected to novelty, uniqueness and have influence on future innovations, and incremental to a gradual progress along an established path, e.g. continuous improvement and quality work. The TIM model aims at making the resources of all people in the company assessable for innovation. This is common when it comes to continues improvement using e.g. six sigma or idea/suggestion boxes, but nor when it comes to radical innovation, where some researchers means that this is an activity for special people detached from normal production. The TIM model adopts the idea that using recourses of all employees also in radical innovation is needed for long term sustainability of the company.

This paper addresses two challenges of the TIM model. Firstly, a company can achieve synergy effects using the TIM model since different development processes are allowed to interact and strengthen each other. But previous research has suggested a need to separate incremental and radical innovation processes, seen as dualistic and conflicting in traditional models. This need for separation is challenged in the paper. A suggestion is given based on complex systems theory, on how to transcend the paradox between exploitation and exploration. Secondly, a simplification and reduction may be needed to make the TIM model actionable and usable for describing, understanding and managing innovation. One possible is to focus on a limited number of processes and structures at collective level. This way to simplify complex systems is used in complex system theory and described in this paper.

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II. EXPLORATIVE VS. EXPLOITATIVE PARADOX

The concepts explorative and exploitative are often used to describe two different types of thinking, acting and relating connected to radical and incremental innovation. The originator of this framework, James G March [3], defines exploration of new possibilities as including things captured by terms such as search, variation, risk taking, experimentation, play, flexibility, discovery and innovation. And exploitation of old certainties with terms as refinement, choice, production, efficiency, selection, implementation and execution. A common understanding is that the exploitative mainly results in incremental innovation and explorative mainly in radical innovation, e.g. "How companies can simultaneously achieve both exploration of new knowledge for radical innovations and exploitation of existing knowledge for incremental innovations is still one of the key dilemmas in the organizational learning research" ([4], p.2).

In the light of, on one hand, complementary benefits of exploration and exploitation and, on the other hand, inherent tensions, contradictions and trade-offs between them, scholars have suggested that maintaining a balance between them is key for survival and prosperity. Lavie, Stettner, & Tushman [5] have reviewed the exploration and exploitation literature and found four ways to reach balance between exploration and exploitation: Contextual ambidexterity, where they are performed simultaneously. Organizational separation, where units for radical innovation are separated from units for incremental innovation. Temporal separation, where they are performed by the same units, but at different points in time. Domain separation, where firms choose to focus on one of the two.

The TIM model is supporting employee participation in both incremental and radical innovation, and interested in the combination of exploitative and explorative ways to think, act and relate. Thus, neither organizational separation nor domain separation are relevant options for us. In a complex system perspective of emergence the contextual ambidexterity and temporal separation merge into one strategy. We agree with Lavie et al. (ibid) that they can be seen as reinforcing each other in a natural cycle, e.g. exploration generates opportunities to exploit, and exploitation generates resources for exploration. We prefer the punctuated equilibrium model [6], which is predominant in temporal separation [5], where radical changes are divided by periods of stability. Internal possibilities for radical transformations are developed during these periods of stability [7]. This idea, increasing the competence for radical innovation also during stable periods, is important. We mean that explorative work has to be present all the time, as in contextual ambidexterity, for the organization to have the innovation competence needed to be able to be radical when possible and/or necessary, as in temporal separation.

Different activities to increase the competence for radical innovation during stable periods are suggested by different authors from a complex systems perspective. Some examples: Fitness scouts that are appointed to look for possibilities for radical innovations, and alliances and networks with organizations that have a high potential for new ideas [8]. Learning from experiments during stable periods to try out and get information about possible radical innovations and to learn how to collectively act in the innovation reordering needed in a radical innovation [9].

We disagree with the common understanding that the exploitative mainly results in incremental innovation and explorative mainly in radical innovation. Our hypothesis is that both the explorative way and the exploitative way to think, act and relate is needed for World Class in radical as well as in incremental innovations. Exploration of new possibilities will increase effectiveness in continuous improvements, and exploitation of old certainties has to be used in radical innovations.

We also disagree with the recommendation to find a balance somewhere between the extreme points of the exploration - exploitation scale [5]. We have to question the use of the concept balance in exploration and exploitation research. We understand exploration and exploitation as independent competences that can be used individually when needed. At the same time they are dependent parts of the innovation system; to be really good in one of them you have to be good also in the other.

It can be seen as a paradox and impossibility to have both a culture for exploitation, and at the same time a culture for exploration. This is the reason behind that "Organizational separation offers a primary solution to the balance dilemma in the literature on ambidexterity" ([5], p.131). Our hypothesis is instead that managers should transcend this paradox [10, 11]. Our research project "Kaikaku in production" has shown indications that it is possible to do that and that Japanese companies actually use radical innovation projects to strengthen their continuous improvement capacity and vice versa that those companies who are already competent in incremental innovation will more easily develop also competence for radical innovation [12].

We believe that this is a question of how you understand the reality. The paradox is caused by our Western way to understand things; using analyzing and a polarized "either-or" thinking. This may be a reason why most of the examples of successful combining of exploration and exploitation activities to strengthen each other seem to come from Japan (e.g. [13, 12]). In the Eastern way of thinking it is

more common to avoid simplistic distinctions and see "a natural wholeness composed of contradictions" ([10], p 762), symbolized by e.g. Ying and Yang. In the theories of complex systems paradoxes are seen as important for the dynamical possibilities to incrementally adapt with the context and to radically transform the system and the context. Paradoxes give energy, only dead things are without paradoxes. Approaches to transcend paradoxes is suggested by Sánchez-Runde & Pettigrew [11] are: open communication, accepting experiments, having common goals that include both parts of the duality, have a focus on the task, value diversity and reducing power differences. Suggestions we recognize from our understanding of innovation systems from a complexity perspective.

III. PROCESSES AND STRUCTURES FOR TIM

Emergence and order parameters are central concepts in complex systems theory. Emergence deals with the behavior of a system with many actors [14]. It is the mechanism behind self-organization: through the interaction between actors a structure emerges that organize the actors.

Order parameter is an originally mathematical concept to describe an emerging organizing structure; it is a way to reduce the amount of information needed to describe a complex system [15]. The traditional Western way to handle complicated systems is to analyze, i.e. divide the system in understandable parts and describe each part, and synthesize, i.e. make a sum of these descriptions. An alternative strategy is to find an order parameter at macro level, which describes the most important features of each agent at micro level. The mathematical proofs of the concept are valid only close to instability points, but it has empirically showed to useful even far from such points. An order parameter emerges when fluctuations in the actions of individuals strengthen and stabilize each other and thus forms a pattern at macro level which wins the competition with all other possible patterns. This pattern will then control actions of all individuals. An order parameter is changing slowly relative the behavior it is connected to, except in moments of phase transition.

An order parameter is formed by self organized emergence occurring when autonomous individuals interact. And, at the same time, the order parameter is enslaving the individuals and by that integrating them to a system (ibid). It is a circular causality, where the order parameter is both formed by behavior of individuals and forming behavior of individuals. The order parameter is in the center of a life-giving dynamic between autonomy and integration. The order parameter is a regime at aggregated level which is not random, but characterized by regularities and integration. It is emerging from multiple autonomous choices of individual agents which are correlated through transactional interaction with each other.

Culture is one example of an emerging organizing structure [16]. The emergence of culture may be illustrated metaphorically by the development of paths in the wilderness. The wilderness represents all possible meanings and the paths the sub-set of meanings used by culture. Actors have already passed through the wilderness, each with varying intentions. Paths have emerged that fit the intentions of these former wanderers and the reality of the landscape. These paths are recognized by and are a part of the nature for wanderers of today. It is easier to walk on a path than to not do so, and thus you might follow it even if it does not fit your intentions precisely. However, when your intention differs a great deal from those of former wanderers, you might go in a new direction. Furthermore, if this direction is used recurrently, a new path will develop, and reality will change. What is more, paths not suiting modern intentions will not be used. Thus, they will become overgrown and disappear after a while, which also changes reality.

Employee autonomy and integration are two key conditions for emergence [17]. Autonomy means that the employee can, knows how, and wants to be autonomous. The employee can be autonomous in the sense that it is possible, permissible, and expected that each employee acts independently in the local situation. Knowledge of autonomy involves having the competence to act independently. In addition, a subset of members in each social group need to have the ability to lift the perspective and understand each situation in a larger context. Wanting to be autonomous means acknowledging the reasons for autonomy. It takes more energy and is more risky to design one's own way, instead of just doing what one normally does or is told to do.

Integration involves the co-worker consciously or unconsciously lending themselves to the structures that emerge. We can divide these structures into three to facilitate understanding them: Culture, praxis and relatonics [18]. Culture is about a common language and thought pattern: A shared and consistent way of evaluating phenomena and events [19], and a common direction to work towards created and accept by co-workers [20]. Praxis is collective habits and common patterns of division of labour where people expect colleagues to do the same as they usually do [21]. Relatonics is the patterns of relationships around a work task [22].

IV. CONCLUSION

There is a need for activities to increase the competence for radical innovation also during stable periods of incremental improvements: e.g. inviting new actors, roles and competences to the innovation system and develop good communication and trust, and training to be radical by using experiments to learn and get information from.

We also note that emergence is a central process in innovation systems. To obtain emergence requires employees with integrated autonomy: who can, knows how, and wants to be autonomous and who are integrated in the culture, praxis and relatonics of the organization.

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