

# Enterprise Radical Innovation Management from the Perspective of Complex Scientific Management

Haokun Wang, Lisha Huo, Yudie Hu

School of Business Southwestern Minzu University, Chengdu, 610000, China

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**Abstract:** Radical innovation is of great strategic significance for the future survival and development of enterprises. However, there are few studies on the development problems encountered in the process of implementing radical innovation and the corresponding solutions. Complex scientific management theory is integrated into the essence of computer science, mathematics, complexity science and other disciplines. It is a new management theory proposed for the characteristics of The Times in the 21st century. By introducing the theory of complex scientific management into enterprises, new ideas are put forward to solve the problems faced by enterprises in the process of radical innovation, such as complex technology emergence and complex technology market.

## 1. Introduction

Nowadays, with the rapid development of science and technology, the integration of technical resources, interdisciplinary and cross-border integration of industries has become the trend leading the development of The Times. Radical innovation refers to the breakthrough technological progress, which will significantly change the market competition pattern. Radical innovation is the key for enterprises to seize market opportunities and gain international competitive advantages, and it is also one of the important ways to implement innovation-driven strategy in China.<sup>[1]</sup>Therefore, how to systematically grasp the characteristics and realization mechanism of radical innovation in enterprises is an urgent problem to be studied.

Complex scientific management theory (CSM) is the scientific management and humanistic management, strategic management, learning organization after stage, on the basis of globalization in the 21st century, knowledge-based, complexity, the criticality and characteristics of a new era of harmony development of the new management ideas, can effectively reveal the implementation mechanism of radical innovation and multi-agent multi-factor symbiotic evolution, CSM is a new perspective to study radical innovation.<sup>[2]</sup>Complex science management is a process of continuous exploration, continuous cognition, seeking the law of complex things, and finding out the solution. The theoretical framework of complex scientific management -- “18151” system has laid a rich theoretical foundation for the research of radical innovation.”18511” system refers to 1 theoretical hypothesis, 8 basic principles, 1 way of thinking, 5 basic theories and 1 methodology.



Fig.1 Development Stage of Management Theory

## 2. Complexity Analysis of Radical Innovation in Enterprises

Complex scientific management studies complex systems at the social level, reveals the interactive operation mechanism of the system, and explains the process of the system from order to disorder, then to new order and finally to new equilibrium state. It discusses the intelligent operation

of organizations, that is, how to achieve their specific goals through the integration of new innovative resources. Radical innovation is a novel and unique product in a product category or represents a breakthrough technological progress, which significantly changes the market competition situation and subverts the industry competition pattern. It is the key for enterprises to foothold in the increasingly competitive market environment. In the process of radical innovation, the dependence of relevant resource elements is becoming higher and higher, and the interaction between relevant innovation subjects is becoming more and more frequent, which has high risk and uncertainty.<sup>[3]</sup> Therefore, enterprise radical innovation belongs to the complex system at the social level and is the object of complex scientific management research.

The complexity of emerging breakthrough technologies. The emergence of breakthrough technologies is characterized by random leaps. Different from the incremental technological innovation based on the improvement of the existing technological track, breakthrough technologies adopt new scientific and technological principles and find a new path to achieve the technological track leap. The emergence of a radical innovation technology may be accompanied by several years of research. There are high requirements on the investment of talents, technology, capital and other aspects of enterprises. However, the factors affecting the emergence of breakthrough technologies are nonlinear, uncertain and discontinuous. The emergence of a breakthrough technology is the product of multi-disciplinary intersection, multi-resource combination and multi-technology cross-border integration, which is full of contingency and complexity, so it is difficult to predict.<sup>[4]</sup>

The complexity of breakthrough technology market. At first, the performance of breakthrough innovation products is not high and the price is expensive, and the price ratio is far inferior to the existing products, which can not well meet the market demand of mainstream users. There are even challenges of upstream supplier components or downstream huge complementary parts, and the market value cannot be realized in a short time, and the risk of opportunism and commercialization is great.<sup>[5]</sup> For example, the development of new energy vehicles is affected by the imperfect infrastructure such as charging piles. The application of artificial intelligence technology has temporarily failed to lead the mainstream market demand due to various factors, reflecting the complexity of the breakthrough technology market.

The complexity of breakthrough innovation resources. The complexity of radical innovation resources is reflected in the resource system composed of highly dependent resource elements (natural resources, tangible resources, social resources, organizational resources, individual resources, etc.), which is open, multi-layered and self-organizing dynamic evolution.<sup>[6]</sup> High-quality complementary resources are introduced through a variety of ways to continuously interact and evolve with the environment, optimize the resource system, provide support for radical innovation and create new value.

The participants of radical innovation are complex and diverse. The participants of radical innovation include not only enterprises themselves, but also universities and research institutions that provide knowledge and technical resources, partners and even competitors that provide complementary technical resources, suppliers that provide components, users that provide creative sources, and governments that provide institutional and infrastructure support. The emergence of radical innovation technology cannot be accomplished by any individual or organization. It requires multiple innovation entities to condense into an interactive, synergistic and complex interwoven innovation network to help core enterprises achieve radical innovation. Even for Alibaba, Huawei, Apple and other international technology giants, the realization of breakthrough technologies also requires full cooperation among enterprises to obtain complementary resources.

The complexity of the environment for radical innovation. Radical innovation is the result of the interaction between enterprises and the environment, which cannot be developed in isolation from the social environment. The innovation environment includes social environment, technological environment, institutional environment, cultural environment and international environment, which are complex and changeable among each other.<sup>[7]</sup> Once a certain environmental factor changes, it may have a strong inhibitory effect on the development of radical innovation. Taking the social environment as an example, cloning technology is a major breakthrough in the field of biological

sciences, which means that human beings have made significant progress in the control of nuclear differentiation technology, cell culture and control technology. However, due to disputes from all sides, its technology cannot be widely applied. Radical innovation is characterized by great uncertainty. Therefore, the complexity of radical innovation environment and the dynamic interaction of related factors increase the difficulty of radical innovation to a certain extent.

### **3. The Csm System Thinking Model is Used to Understand the Enterprise Radical Innovation**

Radical innovation in an enterprise is not achieved by one person, nor by a single enterprise. Instead, multiple innovation subjects adhere to the unified value concept and come together to form an innovation system, which integrates multiple resource elements and frequently makes trial and error adjustments with the environment. The system of radical innovation should include multiple subsystems such as technology research and development, knowledge materialization and commercialization. Therefore, the complexity of radical innovation and the characteristics of multi-agent and multi-factor co-evolution determine that radical innovation is a systematic process, which is nonlinear, self-organized and dynamically evolving.<sup>[8]</sup>As the core of complex scientific management theory, CSM system thinking mode integrates science and art, and provides a new perspective for enterprises and scholars to study radical innovation: The resource integration and system architecture element collocation process of radical innovation are studied through the system thinking method, and the information and resources inside and outside the system are integrated cooperatively with the phased goals of the system as the starting point, so as to stimulate the collective creative wisdom and improve the competitiveness of the radical innovation system. The nonlinear dynamic evolution of radical innovation is observed from the perspective of circular view of cause and effect, focusing not only on the results but also on the interaction, such as: Enterprises should not only regard customers as service objects, but also as the source of innovation. They should integrate the advanced consumption concepts of leading users into the design of breakthrough technology products, improve the conversion rate of results, and focus on the interaction and embeddedness of innovation subjects and factors in the innovation system at different stages. Structural and modular thinking is used to analyze the radical innovation system, and different strategic goal orientations at each stage are emphasized. The management problems of radical innovation are decided by visual thinking method, and the creativity and enthusiasm of members are mobilized.

### **4. Use the Basic Theory of Csm to Guide the Management of Radical Innovation**

In the 21st century, mankind has entered the era of globalization. China's economy is changing with each passing day. The economic environment is highly dynamic, open and hierarchical, and enterprises are facing increasing uncertainties and complexities. Therefore, if an enterprise owns a breakthrough technology or product and successfully commercializes it, it will gain a competitive advantage in the market and become a leader in the industry. It is urgent to analyze the mechanism of radical innovation and guide the management of radical innovation by applying the new theory of complex scientific management and focusing on the combination of qualitative and quantitative methods.

From the holistic view of CSM, we should pay attention to the three basic elements of the organization to realize the breakthrough innovation, namely, people, resources and the commercialization goal of breakthrough technology. In the process of radical innovation, enterprises should pay attention to the cultivation of talents. Talents are the top priority for the survival and development of enterprises. In order to achieve radical innovation, enterprises should capture talents from a global perspective. At the same time, to develop in harmony with the environment, in today's world development pattern green, ecological, sustainable development is the overall trend, breakthrough innovation technology must not violate the principle of sustainable development; Secondly, we should not only pay attention to the current benefits, but also consider it from the perspective of the future. It is far from enough to immerse ourselves in the research and

development of breakthrough technology. We should find the application field of breakthrough technology, improve the product performance to meet the market demand, pay attention to the needs of users, and let users' expectations of products participate in the research and development thinking. Pay attention to the balance between the system as a whole and the interests of individuals and even individuals. For example, in order to achieve radical innovation and obtain sustainable competitive advantages, BMW conducts technology research and development in alliance with emerging high-tech companies across industry boundaries to reduce its dependence on strategic suppliers.

The new resource concept of CSM is taken as the source to stimulate radical innovation. In the view of CSM resource theory, resources are the source of social progress and economic development. In the new resource view of CSM, the concept of resources does not simply refer to the natural material resources, but also includes knowledge resources, technical resources, human resources and other resources. New resources are scarce, inimitable and substitutable, which is the key for enterprises to survive in the increasingly competitive market environment. Therefore, enterprises should take a variety of ways to acquire, utilize and integrate new resources to lay the resource foundation for their radical innovation.

Based on the interaction theory of CSM, the process management of radical innovation is guided. The process of radical innovation is dynamic. Due to the limited technology and information resources, enterprises need to constantly search for heterogeneous groups to join the system to provide key complementary resources and constantly adjust the system structure. The relevant innovation subjects frequently interact and influence each other with the resource elements to jointly commit to the R&D and materialization of breakthrough technologies. The symbiotic evolution relationship of each component of the radical innovation system was analyzed by the circular thinking mode of circular view of cause and effect. The economic resource alliance of radical innovation is maintained by information flow. The core enterprises share resources with suppliers, partners, customers and other innovation subjects through building information trading platforms, and achieve mutual benefit and win-win results, so as to ensure the information flow of each subsystem can be fast, stable and smooth. Dynamically coordinate the information system among all subsystems to enhance their common value. This new management idea is convenient for enterprises to quickly find the shortcut to achieve radical innovation and improve the efficiency of radical innovation management.<sup>[9]</sup>

The order-disorder theory of CSM is used to manage the operation law of radical innovation system. Radical innovation experiences a process transformation from disorder to order. At the beginning, the creation of ideas makes the organization face disorder, and through the concentration of collective wisdom, the organization enters the technology research and development stage, and then the organization turns into order...Such a spiral of “disorders-orders-disorders-high-level order” and self-organizational evolution contributes to the successful commercialization of breakthrough technologies. Therefore, the process of radical innovation is the result of the nonlinear interaction between the system and the environment. The system constantly exchanges information, material and energy with the outside world. When the system reaches a certain threshold, the equilibrium relationship will be broken again, and the system will spontaneously adjust to form a new orderly state. Enterprises need flexible management of this “unknowable” state, which is the edge of chaos at the critical point between order and disorder, so as to keep the system in the creative space and stimulate the potential of radical innovation.

CSM integration theory is the core of the five basic theories of CSM. “Integration” is a verb, which emphasizes the evolution process of different parts as a main body.<sup>[10]</sup> CSM integration theory emphasizes that in the process of integration, resources should be reasonably allocated from a global perspective instead of focusing on a single point. Through integration, several parts should be integrated into a system with certain rules, and through optimization of system resources, the whole can emerge characteristics that some parts do not have, namely, “innovation effect”. The radical innovation system is an organic whole composed of various parts. The dynamic complexity of the radical innovation process requires enterprises to continuously integrate internal and external

resources, create a new resource environment conducive to radical innovation, and improve the resource output capacity. Therefore, the CSM integration theory is the key to guide the enterprise's radical innovation.

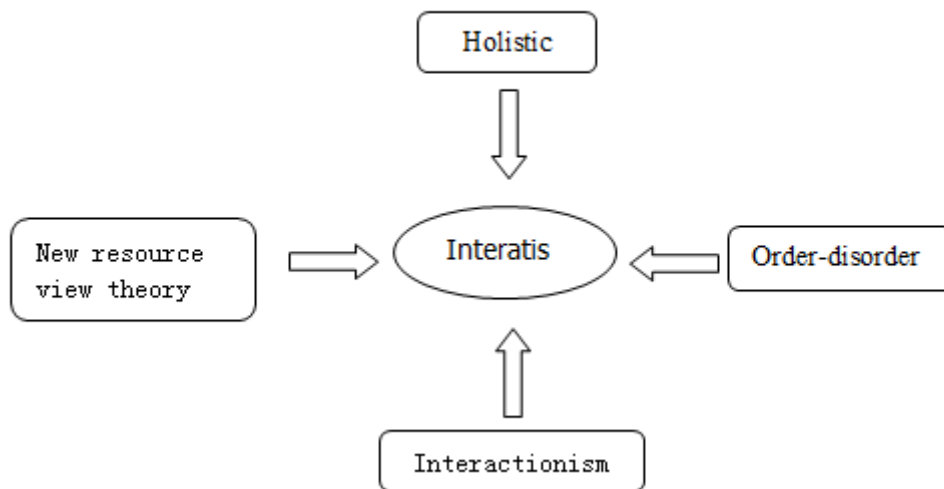


Fig.2 Relationship between the Five Basic Theories of Csm

## 5. Conclusion

This paper explores the adaptability of complex scientific management theory to enterprise radical innovation from the thinking mode of complex scientific management theory and five basic theories, starting from the implementation of complex scientific management theory to meet the essential elements of enterprise radical innovation. The breakthrough innovation of enterprises is characterized by the complexity of technology emergence, technology market, innovation resources, participants and so on. The traditional management theory can not well meet the emergence of breakthrough innovation technology incubation. The complex scientific management theory changes the original segmented and linear thinking mode with the viewpoints of new management, new perspective and new hypothesis, and realizes the collision of innovative thinking.

The research shortcomings of this paper are mainly reflected in two aspects: One is only from the theoretical analysis of the complex scientific management theory and the effectiveness of the associated enterprises breakthrough innovation, the second is in the theoretical framework of complex scientific management - "18511" research system, the only one thinking mode from the theoretical framework with five basic theory, theory of other the correlation between enterprise breakthrough innovation and research. Future research will focus on specific cases and analyze the whole content of the theoretical framework of complex scientific management in detail, so as to further study and supplement the relationship between complex scientific management of existing enterprises and the promotion of radical innovation in enterprises.

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