Research on the Formation Modes of Emerging Technologies Based on the Species Origin Theory

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Abstract Based on the research on emerging technologies and “the technology species”, this thesis tries to find out the homologous relations between emerging technology and new species. The theory of the new biology species in synthetic evolution and the modern genetics is referred in the research. The modes of forming emerging technologies are discussed through some examples of IT evolvement according to modes of the biology speciation. Finally, it is pointed out that the biology species origin theory can analogize continuously the research about the evolvement mode of every emerging technology, and the implications have been bought to enterprises based on the formation conditions of each mode.

Key words emerging technology; species; IT evolvement; formation mode

The emerging technology is changing the market, business and society in 21 centuries unquestionably, and is impacting on the people's behavior and thinking modes. It is forming an importance researching direction and a fore area of the management science, which has been concerned deeply and increasingly by numerous research organization, scholars and government institutions all over the world.

The research on the emerging technology began on the 90's in the last century. Day and Schomaker put forward the concept “technology species” firstly and definitely in their research on the emerging technology, and pointed out that the emerging technology has similar characteristic with the biology species, and the emerging technology’s formation process is certain likeness with that of the new biology species. The emerging technology formation is also come from certain being broken or gradual changing. Be similar to the new biology species formation that is caused by genetic and variation, the emerging technology may be evolving continuously or “interruptedly with balance” in its formation.

The research on biology species formation started from the beginning of 19 centuries. In 1859, Darwin first announced the complete theory on the biology species formation from the point of view of evolution, in his book, The Origin of Species. The theory, which is developed and debated continuously, has already become a more perfect and systemic comprehensive evolution theory and modern genetics theory now.

From the concepts and characteristics of emerging technology, this thesis tries to find out the homologous relations between the main factors on the formation between emerging technology and new species. The paper concludes that the biology species origin theory can analogize continuously the research on the evolvement mode of every emerging technology, and the implications will been bought to enterprises based on the formation conditions of each mode.

1 Summarization on the Theory
1.1 Concepts and Characteristics of Emerging Technologies
Emerging technologies are science-based innovations that have the potential to create a new industry or transform an existing one. The definition of emerging technology was given as: it is the high-tech that brings important influences to economic structure, it appears recently or it is developing now. At present, studies on emerging technology focus mainly on the information techniques and the biology techniques. By contrasting with the traditional technology, the emerging technology has its own characteristics, as follows.

1) An emerging technology is a process of technique innovation that it is carrying on continuously, depending on extensive achievements of modern sciences and technologies, expanding and accumulating knowledge with high-cost investments in research and development.

2) An emerging technology is often a high-tech that is emerging and understanding by people gradually.
Maybe, it is just appeared or it has already existed. Only for the reasons of environments and markets etc., an emerging technology may not be perfected and promoted in applications. So it needs to be recognized and accepted by public.

3) It is great uncertain for the emerging technology on the whole value chain that what are the technique foundations, where are the application fields, how does the customer distribute and what are the trading conditions, especially, on its technical foundations and the market supporting\(^{[1,2-6]}\). The two main uncertainties may be enough to make one emerging technique that isn't extensively prosperous in some nations or districts to obtain great achievements in other nations or districts, if there are enough and suitable environments and conditions. The city wireless phone (PHS) has great success in Chinese market is a typical case\(^{[7]}\).

4) It is very important for the emerging technology to create destruction on a traditional field, and the drive characteristic is another trait of that it is usually a new motivation to make economy development in a region and even a nation. It filters through all traditional industrial field extensively, and push technique progress of all fields.

5) Because the emerging technology may be a breakthrough of some technique difficulty or a amalgamation of some new techniques into an existing application field, and even it is a new technique what is fused by combining some irrelevant techniques in. So, it is much complex for the emerging technology about its evolution and management patterns.

1.2 Summarization on Theory of Species Origin

In the sexual living creature, the species mean the natural community of which the individual can mutually mate actually to produce posterity that can procreate continuously\(^{[8]}\). The species formation theories have developed with some experience of phases such as the immutability of species, the multiple creation of disjunct species, the natural choice evolution theory in the ages of Darwin, and up to now the synthetic theory of evolution and the modern genetics theory. They think that the species evolution in time dimensionality is continuous, and that on its living “space” dimensionality is discontinuous \(^{[9]}\). Usually the evolution of species is most likely the common results of influences by time and spaces. Guided by these thoughts, a lot of different theories of species formation have formed. All which can be reduced to following main aspects generally as: The theory on geography and non-geography, the theory on inherit material and exterior characteristic, the theory on trunk and branch, etc\(^{[2]}\). Regardless which theory of species formation, the factors which affect on the species formation can be reduced to two types: internal factors (genetic materials) and external factors (geography environments) \(^{(\text{Mayr,1942})}\). According to such deduction, the comprehensive evolution theory and modern genetics theory sum up the formation modes of new species as: genetic material variety; geography environments influence; the function mechanism of species\(^{[2]}\).

The variety of the genetic material evolves mainly along the time dimension. Considering the influence of a species’ inner factor a new species forms by the performance of gene broken, chromosome variation and genes regroup, and to produce some descendible variation inside the species; The influence of the geography environment evolves along the space dimension. Considering the influence of outer factor of a species, a new species forms by that species’ genetic structure appears adaptability change through the natural choice with isolated conditions of geography; The function mechanism of species can performance along the time and space dimensions. Considering the joint influences of internal and external reasons, several species living in certain ecosystem environment would add their character divergence, to stimulate some subspecies emerging. Once the procreation isolation with the subspecies happens, it would become a new species.

2 Contrasting Research on Main Factors

The development or creation of any thing is always the result of interaction of its internal factors and external factors. Although the emerging technology is state on the high uncertainty, factors what influence its forming and evolution is numerous and complex. But, it can always be sum up into internal factors and external factors. First, science foundations form its internal factors, because the emerging technology is always an innovation based on the science development and take progress while scientific knowledge foundation is expanding. On the other hand, the environmental conditions in its application fields form its external factors, because the emerging technology is influenced intensely by the environmental conditions in its application domain. Meanwhile its application domain is changing, or a new domain is forming especially.
Along the internal factors and external factors, we can build up homologous relations between emerging technology formation and species formation as Fig.1.

3 Formation Modes of Emerging Technologies

The emerging technology is a kind of special high-tech. We have obtained three kinds of formation modes of emerging technology according to the analogy of above homologous relations between emerging technology formation and species formation, utilizing the formation modes of new biology species (the variety of the genetic materials, the influence of the geography environments and the function mechanism of species) for reference.

3.1 Mode 1: Corresponding to “Genetic Material Variety of Species”

This is a kind of formation mode for emerging technology with considering its internal factors variety mainly. The genetic materials variety of species such as regroup and mutation of gene can be corresponding to the change of knowledge foundations or knowledge structures for a high tech. So a high tech what has taken important science breakthrough along the existing development process and has expanded its application swiftly, and its application obtain expansion quickly to become the emerging technology, can be analogy with “the new species forming by the genetic material change”. For example, the transistor replaces the vacuum tube, the soft disk comes forth and the integrated circuits are invented which are the milestones in the history of computer hardware technique development. All of them are born because of that the knowledge foundations have taken place variety radically. Just as these knowledge foundations that are similar to “the genetic material of species” have changed, the application of computer technique can be expanded continuously. Therefore, the transistor technique, the soft disk technique and the integrated circuit technique all can be seen as the emerging technology corresponding to “the genetic material variety of species”.

3.2 Mode 2: Corresponding to “Geography Environments Influence”

This is a kind of formation mode with considering the external factors variety dominantly. The change of geography environments create a new species with that the genetic structure of the new species has made a choice suitable for environment adaptability, so they have very different characteristics with their ancestry. For example, the oats and rye are miscellaneous grass living with wheat and barley in farmland originally, but when they was planted in north area with very cold weather, they become main farm crops because they are more resistant to cold climates and their growth advantages can develop well in the cold region [10].

When a high tech turns from existing application domain (include the regions, crowds, industry, etc.) to a new domain, the technique application is acquiring expanding swiftly companied with the technique being perfected and changed. This kind of mode can be related with “the formation mode based on the influence of geography environments”. For example, the PHS technique originated in Japan at the beginning of 90's in 20 centuries, but isn’t successful in Japan. Whereas, when it was introduced into Chinese market by the China Telecom and the Netcom, not only the markets keep a growth greatly, but also the original technique is promoted further and innovated [7]. In this case, The change of application field is the main and significant reason to make the technique development. Entering into a new field make a change of choice standard (for lower costs), and large changes of available resources (for special customer groups, manage company, equipments supply company, policy) to support the technique development continuously. The special choice standard, the new invention with new resources supporting and the appearance of complement technique all that could make the new technique grow quickly in the new environment.

3.3 Mode 3: Corresponding to “Function Mechanism Based on the Species”

This is the mode that a new technique emerges from developing to fuse many techniques into the existing application domain or to combine two or more kinds of high techs into a new application domain. That is similar to the new species forming by conjunct function mechanism of internal factors and external
factors when many species groups live in the same ecosystem environment. It appears as two aspects:

1) This is the mode that a new technique emerges from fusion many techniques into the existing application. It may be that a high tech is developing in its existing application domain by introducing the other techniques, or that a more advanced and appropriate technique emerges by combining two or more kinds of high techs into the existing application domain of them\(^1\)\(^1\). For example: the modern medical image CAT scanner is the outcome that the calculator technique is applied into the existing medical image-scanning combining with the X ray technique effectively. Another example: the third generation mobile communication technology (3G) is the emerging technology that the data communication technique (the internet technique especially) is applied to and combined with the existing mobile communication, effectively. This is similar to that a species is introduced into the environment where another species living in, when the inherit material has changed at the same time. The transplantation and graft of the plant is a typical mode.

2) This is the mode that a new technique emerges from developing to combine two or more kinds of high techs into a new application domain. A new technique will be produced out when two or more high techs are fusion, once it is found out a fitting applied domain for the new technique. Such as: The biologic chip has developed since the 80's in 20 centuries, when it has inoculated the micro-electronics, tiny machine, physics, chemistry and computer science etc. It is the outcome of that the biology technique is crossed and infiltrated with other sciences & techniques, mutually. Once its application is restricted to a certain domain in any of the medical science, agriculture, industry and life sciences, the technique and its application would be perfecting gradually. Just it would have become a emerging technology that brings a "revolution" to the whole humankind of 21 centuries probably. This mode is similar to that when different species meet in a new surrounding, and their genetic material have changed because of hybrid, so the new species has formed once the geography isolation appears.

4 Conclusion and Implications

Although the emerging technologies are large illegibility and uncertainty, we have found the comparability of formation mode by analogizing them with biology species in their forming process. Depending on the comparability, we can further more study the evolvement process of emerging technology, with consulting the theories of gradual change and sudden change and the theories of geography and non-geography species formation etc.

But it is worthy of to point out that the formation and evolution of emerging technology don't completely equal with that of the creature. The creature evolution is limited by the natural reborn rules. On the opposition, the creation and development of emerging technology can be managed. An enterprise can choose the suitable mode to form the emerging technology fitting their own conditions such as their technique foundations and cognition for application domain of environmental condition, actively. The three kinds of modes of above, which can bring some implications to enterprise, are proposed out as follow.

4.1 Implication from Mode 1

The driving force mode 1 comes mainly from the development of technique itself, especially the knowledge foundation of a high-tech that has changed suddenly during the gradual evolution process along the time dimension. It is higher requests for an enterprise on such as the economic & technique power, the R & D ability, the resistance ability on risk and organization efficiency. This mode is often suitable for the multinational company with abundant funds and plentiful technical researching foundation. And to research its evolvement process further can analogize with the gradual change theory and the sudden change theory.

4.2 Implication from Mode 2

Mode 2 does not need an enterprise to focus on the technical invention or innovation on starting (the technique can be obtain from the external world), but to focus on the research on application domain (along the space dimension) such as the new choice standard in new surrounding, the environment resources (for market characteristics, infrastructure, policy, etc.). The enterprise can make right choice to expand the growth space of the existing technique by combining their own technique ability, development speed and directions with the existing environmental conditions effectively. And the technique will develop along the application needs with adaptability too. And to research its evolvement process further can analogize with the geography speciation theories. It is very important for the developing country and the enterprise with technology disadvantage to form the emerging
For mode 3 an enterprise need to do conjunct efforts on both technique growth (time dimension) and application development (space dimension) at the same time.

1) The formation mode of engrafting or transplanting requests that an enterprise focus on not only seeking the breakthrough along the original technique path, but also seeking those existing techniques in different fields and taking them into a creation combination, when there appears the obstacles in a technique development process or the suffocations in its application expansion. Then, it is helpful for the enterprise to expel the obstacles in a technique development process or the suffocations in its application expansion, and to make their products stepping over the original technique terrace and getting more quotas in an increasing market. But this kind of emerging technology is usually accompanied with demolition or exterminate to the existing technology, so the new coming enterprise prefers to choose it. But the old enterprise is in a dilemma as: try to prolong the existing technology’s life cycle or to abandon it and convert to the new? This is a new competition that brings the old-brand enterprise with a huge challenge and the new business enterprise with a wonderful opportunity[12].

2) The hybridization mode needs various techniques to combine effectively in a new domain. That is, not only should an enterprise hold very strong technique integration ability, but also it should have the ability to create a new domain while keeping the development of the technique. Only through the two above interaction, the combined technique would become an emerging technology with practical meaning. But only one enterprise can't complete it alone. It usually needs several enterprises to cooperate with, even governmental organization to participate in. For example, “The NBIC fusion technology”, it is proposed to be discussed and researched in America by the Department of Commerce (DOC) and the National Science Foundation (NSF) first[13]. The evolution and development of this kind of emerging technology can be researched right along by the gradual change theory and the abrupt change theory, and also the geography speciation theory and the non-geography speciation theory.