

Strategic Research of the Crossing of the “Death Valley” in Newly-Emerging Industry

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Abstract

Based on the four-dimensional perspective of "science-technology-engineering-industry", the paper follows the general law of the growth of newly-emerging industry to discuss its connotation, growth phases, technology innovation in different stages, and traits of market needs. The research focuses on the two “Death Valleys” in the development process of newly-emerging industry, analyzes crucial elements and factors to cross the death valleys, and then proposes to achieve the final survival by making use of technology roadmap and the strategy roadmap of industrialization of newly-emerging industry based on leading-market theory.

Keywords: newly-emerging industry, Death Valley, cross, roadmap

1. Preface

In recent years, scholars have begun national-level discussions about issues in the development of newly-emerging industry, but it is still insufficient in relation to the awareness of the fundamental laws in emerging industry evolution, such as connotation of emerging industries, its essential characteristics and constraints. There is a lack, particularly of how to cross insufficient study of problems and bottlenecks in the development of emerg-

ing industries. At this point, this paper discusses the connotation, characteristic of emerging industries and key success factors for formation of a new industry, and raises the strategic solution to cross the "Valley of Death", based on technology roadmap and leading market theory.

2. Mechanism of the Formation of New Industries

2.1. Connotation and characteristics of the emerging industry

- Currently, there is no uniform definition about the concept of emerging industry at home and abroad. Mostly scholars describe and define it from perspectives of newness and being strategic^{[1]-[7]}. This article is supposed to study the formation of industry on the basis of philosophy. The reason behind our analysis is that when we ask questions like “Is industry something existing from the very beginning? Is purpose of industry to meet people’s material culture needs? Is industry development all pleasant? Does there exist a pervasive industry development mode?” When we face such series of problems, we thus enter the philosophical domain of industry, which means to enter the domain of origin of industry. If these questions go unanswered, then any research are in vain.

- Some scholars, such as Chen Chang-shu^[8], Zhu Xun, propose to study industry in a philosophical perspective, and establish the four dimensional view of science-technology-engineering-industry, and thus analyze industry and the ongoing adjustment and optimization of the industrial structure of our country. The links among science, technology, engineering, and industry make it possible to realize industrialization of science and technology, and industry is the human use of science, technology and engineering, directly or indirectly, in the face of nature, producing a variety of products or the provision of services to meet the needs of production and human social living practice activities^[9].

This paper investigates the new emerging industry that is likely to become dominant, pillar, and strategic in future national development. Innovation is the essential attributes of new emerging industry, especially in scientific and technological innovation, which is best illustrated by the key breakthroughs in core technologies, from "technology to engineering", as well as the industry's expansion of the leading market, that is, from "engineering to industrial" development of business model innovation.

2.2. The formation causes, stages of the formation of new industry and key influential factors

The formation causes of newly-emerging industry are based on its internal basis. There are three main causes of the formation: expansion and deepening of industrial division, industrial innovation and enterprise innovation dynamics, changes in the structure of demand and the demand level motivation.

As for the stages of the formation of new industry, so-called "industry" is, from the perspective of industry life cycle, the process from generation to the decline and fall of an industry development. Generally speaking, in accordance with the theory of industry life cycle, industry's evolution goes through four stages: the period of germination, growth, maturity and decline. Since new-emerging industry is in the early stage of evolution, focus is given to the periods of germination and growth, and each stage has unique characteristics.

Although it is inherent that emerging industry is to grow, yet during the course of evolution, it is still subject to such conditions as market capacity and its prospects for development, innovation and the environment, availability of inputs and related government policies and many other external factors.

2.3. Technology innovation, characteristics of market demand and critical success factors in the formation of newly-emerging industry

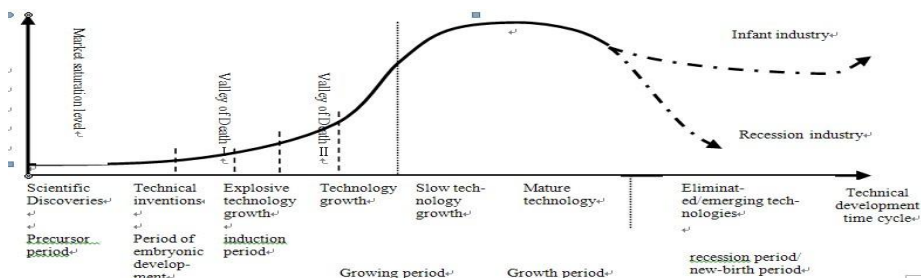


Fig. 1 Main stages of development in emerging industries, technical characteristics and the "Valley of Death"

According to penetration level of emerging technology and leading position of newly-emerging industry in economic system, referred to Phaal et al. (2009) used industry life cycle theory of technology-intensive industry evolution process of six-stage-division method, there are six stages: pilot period, embryos period, birth period, growth period, and maturity period, and recession period or new birth period^[10]. This article mainly concerns four early growth stages (see Fig. 1).

From perspective of the four-element theory of science-technology-

engineering-industry, emerging industry has different characteristics at different stages, and the focus of competition also differs. Therefore, in terms of technical innovation and market demand, it presents different inherent characteristics, and critical success factors. New industry during the pilot period, embryos period, birth period and growth period shows different inherent characteristics, technological innovation, market requirements and critical success factors a (Comparison as shown in Table 1 below.)

		Precursor, Period of embryonic development	Induction period	Fast growth period
Activities		Fundamental research: scientific discoveries, technical inventions	New product research and development	Industrialization
Obstacles in development route		Valley of Death I		Valley of Death II
Leading force		Government	Government, enterprises	Enterprises
Inherent characteristics	Product feature	diversity customized Rapid product changes	Gradual improvement of products Relative stability in at least one product design, able to make batch production	Standardized products Great improvement in quality and function
	Innovative feature	Breakthrough in the major product core technology	Innovative processing, major product development and processing issues solved	Technology match of the upper and lower stream of product chains, gradual products and processing innovation
Technical innovation		Original innovation Core technology innovation Multi-technical routes	Coexistence of multi-technical routes Leading design competition Core technology improvement Key manufacture complete sets of equipment technical innovation Product innovation	Industry innovation Manufacture complete sets of equipment, auxiliary technique equipment, material technique, major design completion
Market needs		Occasional market need, sprouting market, little relation between production and consumption	Some demand, not hot Market is developing into some scale, many serious market difficulties, most consumers are waiting to see	The demand is urgent, in need of prompt of perfection, bottlenecks to be solved, large market scale
Key factors to success		Government support High-level talents	Self innovation ability Researchers and developers How to form dominant design	Market cultivation Model innovation

Table 1 Inherent features of the emerging industry development, technical innovation, market needs, key success factors

3. New technology industrialization strategy map based on leading market

New technology industrialization strategy map^[11] based on leading market is originated from technology route map, breaking through its single-perspective, following basic features of emerging technology and the general law of emerging technology industrialization, especially following the natural law in emerging technology industrialization of leading market, analyzing the strategic option of technology, achievement timetable of key technology, market occupation, especially international market occupation, and path of industrial development visions and strategies, and the relationship between technology innovation, market leadership and innovation, identify emerging industries in the development of technological opportunities, key success factors and critical bottlenecks, exploring cultivation approaches of combining technological innovation and market development.

New technology industrialization strategy map is comprised of three parts: the industrialization of strategic vision, envisaged global aerial view map of industrialization and key technologies and emerging technology nodes and bottlenecks in the market. Strategic vision and process envisaged mainly involves targeting, describing future society and the characteristics of the market potential of new technologies and industries, as well as listing timetable and key node to achieve the above objectives. Envisaged global aerial view map of industrialization is the bird's eye view of the world in the field of advanced technology research and industry trends to determine relevant subjects in technological innovation and industrialization strategy in location, strategic direction and strategic policy. Emerging technology nodes and bottle-

necks in the market is to clarify the main progress of individual tasks, determine the position in the progress as a whole and their relationship to form new industrial development of economic system reform path.

4. "Valley of Death" across policy in the formation of new industries

Due to the dynamic and complex nature of newly-emerging industry, there exist gaps between basic research and product development, which is also called "Valley of Death". Hereby the paper proposes strategy and policies to successfully cross the two valleys of death in the formation of emerging industry based on market-leading new technology industrialization strategies.

4.1. The "Valley of Death" problem in the development of emerging industries

The "Valley of Death" has become the popular description of the failure of a large number of scientific and technological achievements to achieve commercialization and industrialization. Then-United States House of representatives Science Committee Vice Chairman Vernon. Ehlers (Vernon Ehlers,1998) pointed out that the formation process is dynamic and complex, with several stages, each stage having different characteristics, and therefore exists between the basic research and product development, "Valley of Death" (the Valley of Death).

This article claims that there are two valleys of death during the formation of newly-emerging industry from a "Science-Technology-Engineering-industrial" perspective: one in "technology-engineering" process, the other in "engineering-industry" process.

4.2. Crossing the first "Valley of Death" by using the technology roadmap

The "Valley of Death" is located in the formation stage when it is the duration for technical innovation to develop into product production. That is to say, the transform of the technical inventions or patented technologies in concept to its realization carries big risks, or it may be said that "technology-project" transformation of risk reflects whether the scientific and technological achievements are of practical value. This is the critical stage to form the dominant design, which determines the formation of emerging industries' international competitiveness and sustainability levels.

There may be obstacles to the early growth in the industry. "Valley of Death" is a global common problem, highlighting the low conversion rate of scientific and technological achievements. And the key factor primarily accounting for the failure is the uncertainty of technological innovation, resulting in the insufficient originality in innovation, in imitation innovation, and poor technology innovation system.

The strategy to cross the first "Valley of Death" is to make use of technology roadmaps and universal technology measurement to promote the evolution route of technology innovation from uncertainty to relative certainty, or is to figure out from the multiple complicated technology routes a relative clear one, and then pooling resources for mission-critical core technology breakthrough, creating technical conditions for formation of dominant design of emerging industry.

4.3. Strategy of crossing the second "Valley of Death" based on market-leading emerging technology roadmap

The second "Valley of Death" is in nature the great risks existing in the process of the transformation from technology products or product technology to batch manufacturing to meet market demands. The article argues that the second "Valley of Death" is the result of the failure to smoothly immerge the technology innovation value and customer value (which is the reflection of market needs).

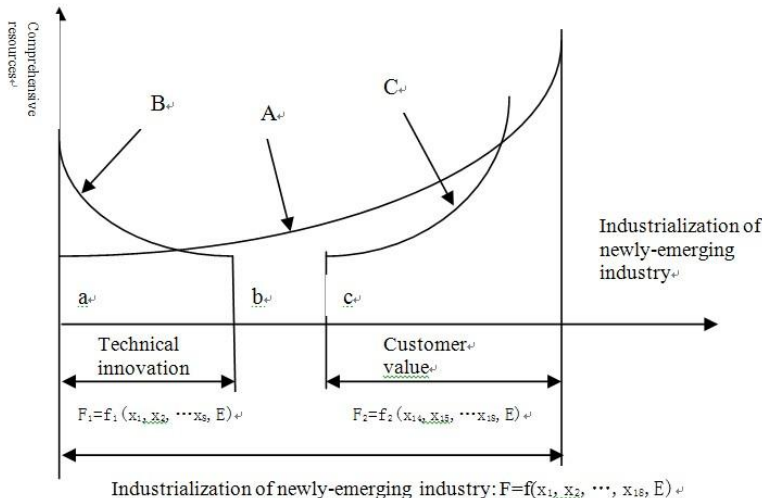


Fig. 2 Industrialization of technical innovation chain of emerging technologies, customer value chain integration mechanisms

"Engineering-industry" is the key economic process of technology birth and growth, outcome of the interaction between various integrated technology innovations, resources and environment. It can be embodied by continuous function $F=f(x_1, x_2, \dots, x_{18}, E)$, or that curve A, in which X_1 represents application innovation capacity, X_2 represents technology route analysis capacity, X_3 represents technology development direction study capacity, X_4 products schema design capacity, X_5 represents research human resources, X_6 represents research means resources, X_7 represents research financial resources, x_8 represents global technology resources of integrated capacity, X_9 represents core technology, and key technology of breakthrough capacity, X_{10} represents for consumers reduced cost of capacity (not only including acquisition cost and using cost, economic cost, also low energy, and low emissions, social cost), X_{11} represents efficient products of design capacity (not only including production the products of efficient, and including consumers using products of efficient), x_{12} represents supporting technology support capacity, X_{13} for small scale and pilot, x_{14} on behalf of marketing ability; x_{15} market sensitivity and responsiveness; x_{16} for business model innovation; x_{17} for integrated management and operation ability; x_{18} for mass production capacity and E represent the external environment of industrialization of the emerging technology.

Technological innovation in supply chain is the comprehensive resource for research and Innovation Agency, can consist of a continuous function $F_1=f_1(x_1, x_2, \dots, x_8, E)$, or Curve B. Customer value chain on a customer or consumer value and comprehensive resource supply situation, can consist of a continuous function $F_2=f_2(x_{14}, x_{15}, \dots, x_{18}, E)$, or the Curve C.

From Figure 2 above, there exists a gap between the chain of technological inno-

vation and customer value chains breaking BC. The geometric space means that the two chains do not correspond to each other. Therefore, whether emerging technologies can achieve the industrialization of supply chain depends not only on technological innovation and integrated resource supply, function F_1 , and function F_2 , customer value chains, but also on the transfer function between F_{12} and external environmental factors of the industrialization, namely $F=f(F_1, F_{12}, F_2, E)$, $F_{12}=f_{12}(x_9, x_{10}, x_{11}, x_{12}, x_{13}, E)$. Technology innovation, customer value chain, and the chain transfer function and the structural imbalances that exist between the external environmental factors, which are causing the industry to fail as the root cause.

Existence of the function F_{12} is likely to mislead social funds to easily project blind investment on projects that has achievements scientific and technical acceptance or identification of industrialization, but having no industrialization prospects. This leads to the failure technology industrialization. The day to pass the identification is the time to terminate its innovation. Lack early industrialization capacity, a lot of papers, and report and test prototype of idle and backlog accumulate^[12]. The existence of transfer function F_{12} decides that in the development of emerging industry it is bound to meet the second "Valley of Death"^[11]. It is obvious that strategy of crossing the second "Valley of Death" lies in solving the transfer function.

It is inevitable that the formation of new industry will go through the "Valley of Death I" in order to experience the "Valley of Death II". Only with the survival of the two "Valley of Deaths" a newly-emerging industry and evolve into real industry.

5. Conclusion

From the four dimensional philosophical view of science-technology-engineering-industry, it works well on general law connotation, characteristics and development of newly-emerging industry. Due to the dynamics of the formation process and complexity of decision formation stages in emerging industry, each stage has different characteristics and therefore there exist the "Valley of Death I" and the "Valley of Death II" in the industry formation. Thus with the help of the technology roadmap and the strategy roadmap of industrialization of newly-emerging industry based on leading-market theory, it will assist to achieve industrialization of emerging technology industry, and be more promising in crossing the two "Valley of Deaths".

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