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Path Research to Achieve Breakthroughs In "Card Neck" Technology with Iterative Thinking

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Abstract

Ultra-thin display glass technology has been monopolized by foreign countries for a long time. How to break through the foreign blockade of "card neck" technology is a major national strategic demand for the development of ultra-thin display glass industry.The biggest advantage of core technology iterative innovation is that it can promote the overall transformation of downstream manufacturing industry and enhance its international status.BBY is the only technology manufacturing enterprise in the world capable of producing a full range of ultra-thin float electronic glass from 0.12 mm to 1.1 mm. As a nesting case study object, it historically traces the company's "10 years of grinding" from 2011 to 2020, realizing the stage leapfrog process from focusing on "thinning" to pursuing "flexible and foldable".

Keywords

Iterative innovation; "Card neck" technology; Resource Action; Technological innovation.

1. INTRODUCTION

"card neck" technology refers to the key core technology that has a long-term technological gap, is difficult to catch up with the gap in a short time, has a high degree of technological monopoly, and is difficult to realize technology transfer [1].The incidents of ZTE and Huawei in recent years are all caused by the existence of "card neck" technologies in key industries [2].As a key strategic material for the new display industry, ultra-thin electronic glass is widely used in information and communication, smart city, defense technology and other fields.However, due to the complexity of ultra-thin display glass technology, production difficulty is great, the key core technologies and products and minority several companies have long been the United States and Japan, the lack of the key link of China's electronic information industry, industry limited scale, product prices, according to information industry development in China as well as the national strategic security caused serious influence and restriction.Therefore, break through technology blockade, break the product monopoly, obtain "card neck" technology breakthrough, the development ultra-thin information display glass, becomes our country electronic information display industry development significant strategic need, is also a problem that the business community needs to solve urgently.

Combing the existing research results of "card neck" technology found that the academic community focused on three topics to discuss.One is the cause of "card neck" technology. The causes can be divided into external causes and internal causes. From the perspective of external causes, the "card neck" problem is the direct result caused by the supply interruption of foreign key and core technologies [3].From the perspective of internal causes, it mainly includes four aspects: insufficient basic scientific innovation in key fields [4], failure to identify the

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localization path to break technological bottlenecks [5], lack of talents in key fields [6-7], and unsound commercial ecology of core technologies [8].The second is the identification framework of "card neck" technology.Previous studies have pointed out that a technology can be called "card neck" only if it meets the following characteristics: it is a key core technology, it has technology monopoly, it is difficult to overcome the technology, and it is in the core position of the value chain [1-9].Correctly identifying the "card neck" technology is the primary task to overcome the "card neck" problem [10].The third is the breakthrough path of "card neck" technology. It mainly includes three aspects: optimizing the system and mechanism of science and technology, improving the development ecology of science and technology industry, and building an innovation community with enterprises as the main body [1-9].How to break through the "card neck" of key and core technologies is the top priority of the current research, but the existing research is mostly based on experience summary, and there is a lack of process research combined with the actual enterprise case analysis.Furthermore, the development history of Chinese technology is a history of iteration [3].However, there is still no clear answer on how to break through the "card neck" dilemma by iterative thinking, which provides exploration space for this paper.

2. LITERATURE REVIEW

2.1. Resourse-focused Action

Resources are considered as the source of competitive advantages of enterprises [11]. To break through the "bottleneck" problem of key core technologies, enterprises need to make changes in the way of resource actions [1]. However, the traditional resource-based view fails to elaborate on how enterprises obtain competitive advantages through resource actions [12].

Existing studies have pointed out that Resourse-focused action mainly includes two aspects: resource patchwork and resource collaboration [13].Baker and Nelson (2005) [14] put forward the concept of patchwork for the first time. They believe that patchwork refers to the use of existing resources by entrepreneurs to seize entrepreneurial opportunities or cope with challenges under resource-poor conditions, so it can also be called entrepreneurial patchwork.After the proposal of entrepreneurial patchwork, the academic community has put forward concepts such as network patchwork [15] and enterprise internal patchwork [16], which focus on the entrepreneurial process to define resource patchwork behavior.Senyard et al. (2014) [17] put forward that resource patchwork is an enterprise's resource acquisition action in the early stage of development under the condition of resource limitation, and it is an enterprise's simple combination of limited resources.This view initially realizes the analysis of resource patchwork behavior from the perspective of evolution [18], that is, the occurrence of resource patchwork behavior is related to the development cycle of enterprises, and may change with the change of enterprise development cycle.Sirmon et al. (2011) [19] put forward the theory of resource orchestration, believing that resource orchestration is the behavior of managers to help enterprises obtain competitive advantages by adjusting resource elements.Then, a theoretical framework is proposed to describe the resource collaboration by structuring, bundling and utilizing three aspects. Focusing on the general organizational context, resource collaboration explains the relationship between resource possession and organizational capability, that is, having resource advantage does not mean having competitive advantage, but the key lies in the coordinated utilization of resources.In essence, resource patchwork and resource coordination are both resource mobilization behaviors taken by enterprises to gain competitive advantages [20], but the coordination emphasizes the resource actions of managers under the condition of sufficient resource stock [13].

Through the review of existing literature, it can be seen that existing studies have recognized that resource patchwork and resource collaboration are related to the dynamics of resources in

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different stages of enterprises [20], which provides a good perspective for further exploring the evolution process of core driving factors in the leapfrog growth of enterprises.

2.2. Technological Innovation and Breakthrough of The "Card Neck" Dilemma

Due to the lack of independent innovation ability and foreign technology blockade, the situation that key core technologies are subject to others is called the "card neck" dilemma.The starting point of the independent innovation of key core technologies is the competition for the right to survive, and its goal is to get rid of the passive situation of "exchanging technology with market" and to shape the economic development environment of scientific and technological independence and industrial safety.However, "key and core technologies are not available, bought or demanded", so solving the "card neck" problem of key and core technologies is related to China's status as a major country and industrial development.

As for how technological innovation plays a role in the breakthrough of "stuck neck" dilemma, existing researches mainly discuss from the following three aspects: First, Is the technological imitation.Bessen and Maskin (2009) [21] proposed that when innovation is continuous and complementary, technological imitation helps to enhance the motivation of enterprises to innovate, thus increasing the number of innovations.Hyum et al. (2019) [22] used the patent data of American enterprises from 1977 to 2005 to investigate the relationship between technological innovation and enterprise innovation activities.Their research further reveals that there is an inverted U-shaped relationship between technology imitation and the market value of innovation at the firm level, that is, moderate technology imitation is conducive to improving the innovation level and innovation motivation of the firm, while excessive technology imitation leads to the "free rider" problem, which will reduce the innovation level and innovation motivation of the firm.The precondition for technological imitation to play a role is a relatively weak intellectual property protection system, but when economic development reaches a certain stage, it will be accompanied by strong intellectual property protection. As a result, the utility of technical imitation is limited.Second, Is the introduction of technology.Blumenthal (2006) [23] proposed that the key for Japan to narrow the technology gap with developed countries since World War II was technology introduction.Rijesh (2020) [24] investigated the export data of India's manufacturing products from 1995 to 2016 and found that technology introduction significantly improved the technological level of India's manufacturing industry and at the same time increased the export of domestic consumer goods and capital goods. But the negative effects of technology introduction are also obvious.Laursen et al. (2006) [25] put forward that being addicted to technology introduction has a significant negative impact on the internal innovation ability of local enterprises.Third, Is the independent technological innovation. With the increasing speed of technological upgrading, the increasingly strict restriction of intellectual property protection and the emergence of technological blockade, it is impossible to achieve the breakthrough of technological "card neck" by simply relying on technological imitation and technological introduction. Technology independent innovation is the core task that we have to do and have to do under the new situation. Howell (2020) [26], by analyzing the process of local innovation in China and the role of industrial association, proposed that under the background of economic transformation, technological independent innovation can significantly improve the productivity of enterprises and help enterprises cope with the dilemma of technological blockade called "card neck".

At present, the stage division of technological innovation in academia is complex and diverse.Among them, the research on technology innovation in the developing world stage division, Xiaobo Wu (1995) proposed by the [27] backwardness enterprise pursued "second innovation" dynamic process model have the effect of the beginning, on the basis of the technology import, after the introduction of enterprise technology innovation can be divided into imitation innovation, creative imitation and improve innovation three stages.Yibo Lv et al.

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(2017) [28] put forward a three-stage technological innovation model of "imitation innovation - improved innovation - independent innovation" for latecomers based on the case study of CRRC locomotive.Based on the existing research results and the actual situation of the case enterprises, this paper divides the technological innovation of enterprises into two stages: creation and imitation and independent innovation. Among them, creation and imitation refers to the integration of existing technologies and imported technologies to develop products, and independent innovation refers to getting rid of technological dependence and completely using its own technology to develop products [27-29].

2.3. Iterative Innovation Strategy and Its Application Value

Iterative innovation is a nonlinear adaptive development process composed of iterative cycles, through which product quality can be continuously improved in the whole product life cycle [30]. Its characteristics include openness, persistence, rapidity, timeliness and transcendence [31-32]. The volatile and uncertain market environment makes the traditional linear innovation mode unable to solve the continuous problems in the innovation process, and the real innovation process in practice is a highly and continuously iterative dynamic process [33].As an emerging research topic in the field of innovation research, iterative innovation has drawn research views such as rapid innovation and user innovation [34]. Relevant studies point out that when the environment is highly uncertain, enterprises will face more complex strategic management and decision-making [35]. Iterative innovation strategy can help enterprises cope with the uncertainty and lack of resources in the creation process, and then enhance strategic diversity to gain competitive advantages [36-37].

As for iterative innovation, the academic circle mainly focuses on two aspects: one is the linear iterative innovation model under static situation. The research mainly covers concept discrimination, feature induction and applicable context.For example, Li Sun et al. (2014) [38] believe that iterative innovation is a shortcut for enterprises in the network era, and put forward an iterative innovation evolution model of "problem-first - rapid trial and error - micro-innovation - user participation". Wijekoon et al. (2021) [39] proposed that iterative innovation of software products has a direct linear relationship with customer heterogeneity.The second is the nonlinear iterative innovation mode under dynamic situation. The research mainly covers evolution mechanism, critical path and theoretical model construction. For example, Xiaohong Zhu et al. (2019) [37] focused on the growth process of platform enterprises and explored the nonlinear evolution of iterative innovation mode in the growth process of platform enterprises based on the perspective of dynamic capabilities. Jiang et al. (2021) [30] focused on the influence of customer heterogeneity on iterative innovation of software products and proposed that iterative innovation of software products follows an inverted U-shaped nonlinear effect.The disadvantage is that the former does not realize that in the dynamic and uncertain market environment, the linear iterative innovation model cannot solve the continuous problems in the process of product innovation, and it is easy for enterprises to fall into a small incremental innovation "trap" that is difficult to break through the existing technology trajectory [28]. Although the latter focus on the high and continuous dynamic nonlinear iterative innovation model [40], but focus on the discuss iterative innovation in the commercial design, industrial design and design organization influence [41], for the current development situation of enterprises, especially manufacturing enterprises, how to make use of iterative thinking realize iteration key core technology and core products, the lack of enough attention and research.

2.4. Research Reviews and Theoretical Gaps

Based on the above literature review, it can be seen that technological innovation and resource actions are of great significance to improve the innovation ability of enterprises and break through the "card neck" dilemma. Although the existing research is helpful to understand

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the breakthrough path of the key core technology "card neck" dilemma, there are still shortcomings.First of all, the existing research lacks contextualized explanation on how catch-up enterprises achieve technological innovation through technological cycle iteration, and then achieve breakthrough of the "card neck" dilemma of key and core technologies. Secondly, existing studies fail to elaborate on the process mechanism of enterprises' use of resources to promote the breakthrough of the "card neck" dilemma, that is, how enterprises achieve the autonomy and control of key core technologies through the rolling development of resource elements in each development stage.Based on this, this paper hopes to answer the following questions: How can enterprises break the "card neck" of key core technologies and achieve sustainable growth? How to systematically plan iterative innovation strategy in the process of stage-type leapfrog?

3. RESEARCH DESIGN AND METHODS

3.1. Method Selection

In view of the research questions, this paper chooses a nested longitudinal case study design. Firstly, the research question in this paper is a typical "How" research question, which is suitable for case study [42]. Secondly, this paper discusses the complex and dynamic evolution process of resource action and technological innovation in different stages of BBY enterprise development from 2011 to 2020. Longitudinal case analysis can confirm the order of occurrence of critical time, which is conducive to identifying causal relationship, so as to deeply grasp its internal action mechanism and influence mechanism on enterprise transformation and upgrading [34]. Finally, the nested case study divides the cases into multiple sub-level analysis units according to certain standards [43], which can grasp the dual advantages of the dynamic and systematic process mechanism in the time longitudinal perspective [44]. Centering on the research problem, this paper focuses on the two stages of "gradual change" and "breakthrough" represented by the two characteristics of "thinning" and "flexible folding" in the stage-type leapfrog process of the enterprise, and develops the two development stages of the case enterprise into two independent but interrelated research units.

3.2. Case Selection

Based on the comprehensive consideration of case typicality, accessibility of longitudinal data and research convenience, this paper chooses (Cnbm) Bengbu Design & Research Institute For Glass Industry Co., Ltd.(BBY) as the case study object.

3.3. Data Collection

In this study, semi-structured interviews, secondary data and other sources were used to collect data to ensure that different forms of data sources complement and cross-validate each other. Multiple forms of data sources avoid the bias caused by a single source, and multiple verification methods are conducive to verifying the same fact, which improves the reliability and validity of the case study itself.

3.4. Stage Division

The stage division of longitudinal case study is mainly based on the key events and turning points that lead to the change of the construct [48]. At the same time, an investigation period with a long enough time span should be selected to facilitate a detailed review of the case evolution process. In this paper, the investigation period of the case enterprise is determined as 2011-2020, in order to trace the iterative innovation process of the enterprise "a decade of grinding". The period from 2011 to 2015 is a gradual phase characterized by "thinning", and the period from 2016 to 2020 is a breakthrough phase characterized by "flexible folding".

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4. CASE ANALYSIS

4.1. Gradual Transition Phase Characterized By "Thinning" (2011-2015)

It is generally believed that the "new and weak" and "small and weak" problems caused by the lack of legitimacy and high growth uncertainty are the key to the resource constraint in the early stage of enterprise development. In the early stage of enterprise development, due to the short establishment time and immature development, it is difficult to obtain external resources through trading. Moreover, the resource blockade of competitors and the lack of market resource elements also make it difficult to obtain and utilize resources.Resource patchwork provides a new way for enterprises to obtain growth resources, and encourages enterprises to make use of the resources at hand and explore the maximum value of resources based on the principle of "appropriate" rather than "optimal".In 2013, the two-year 150t/d electronic information shows that the ultra-thin substrate project was finally completed and ignited online, but the enterprise is also facing the shortage of talent, capital and other resources. To this end, BBY first made use of the original personnel reserve of the group company and sent some experts and technical backbones from the group to the plant, process production and other related personnel for online debugging. At the same time, with the help of the group dispatched experts to the guidance of internal technical personnel, help enterprises to train a number of technical and technical personnel.In order to obtain development funds, On the one hand, BBY made use of its own funds to conduct commissioning exploration in the trial production stage; on the other hand, BBY actively connected with the government for specific projects and sought for government financial support. In order to make up for the shortcomings of backward technology, BBY relied on the experts dispatched to the factory and the original production technology reserves to apply to the ultra-thin substrate production line project of the company, and made adjustments according to the design and operation of the production line.

4.2. Breakthrough Phase Characterized By "Flexible Foldable" (2016-2020)

The theory of resource collaboration puts forward that enterprises can realize the transformation of "acquiring resources - utilizing resources to form capabilities - utilizing capabilities to form competitive advantages" through three processes: structuring, bundling and utilizing. Among them, the binding and utilization process refers to the absorption and integration of the acquired resources.Since 2016, in order to further improve the innovation ability and level of the enterprise, BBY has continuously trained and tapped potential young technicians and skilled hands on the basis of the original talent resources, and carried out in-depth mentor-mentoring work. The company breaks the institutional barriers of state-owned enterprises in the selection and employment, implements the term system and contract system management of management members, and establishes the professional manager system. At the same time, we carry out the talent development model of "leading talents + innovation team", cultivate international and domestic leading talents and outstanding young top-notch talents, and establish and improve the long-term incentive mechanism, so as to maximize the talent potential.Meanwhile, BBY provided financial guarantee for enterprise development through diversified capital operation. The first is to obtain government policy support through policy subsidies and joint ventures with the government; Second, through capital market financing, play the platform and core role of listed companies to raise project development funds; Third, we should carry out financing innovation around major investment projects of enterprises, innovate credit methods through banks, and comprehensively use debt financing tools such as short-term financing bonds, medium-term notes and perpetual bonds.

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5. RESEARCH SUMMARY

5.1. Practical Implications

The practical implications of this paper mainly include the following aspects: First, in the face of the "card neck" problem of key core technologies and the intensified competition among high-tech enterprises, enterprises need to use iterative thinking to divide the long-term goals with a long cycle into stages and realize the short-cycle stage innovation of technologies and products.Secondly, how to identify key elements is particularly important in the phased iterative innovation development. In the rapid development of enterprises, especially in the "no man's land" exploration and development, we must seize the key elements to quickly cut in.Finally, capability building is becoming more and more important for enterprise development.This paper makes an in-depth analysis of the components and changes in the center of gravity of enterprise capabilities in the development of BBY, and finds that with the leapfrog development of enterprises, resource action capabilities and technological innovation capabilities play an increasingly important role. How to make dynamic adjustment of enterprise capabilities is also a problem faced by many enterprises. The study on BBY can be used as a reference.

5.2. Research Limitations and Prospects

From the perspective of research methods, there are two limitations: the nested case study has advantages in constructing theories and exploring new problems, but compared with the large sample study, the single case study has external validity limitations; The data collection method based on interviews may have limited content validity due to the memory and expression of interviewees.Future research can find a number of representative scientific and technological manufacturing enterprises and explore the leapfrog growth mechanism of enterprises by combining "qualitative" and "quantitative" research methods around their growth process.From the perspective of research content, there are three limitations: they only focus on the possibility of iterative success, and lack of attention to the risks of iterative innovation; Under the background of international technology suppression, there is a lack of targeted research on the impact of international technology blockade on industrial suppression. It is not mature to construct independent innovation system from the perspective of industrial chain. Future research can make in-depth exploration based on the shortcomings of the above research content.

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