＜論　　説＞

Corporate Strategy in Japanese High-Tech Industries

Kazunobu Oyama

Abstract

In the modern high-tech industries, the mutual relationship between technological development and Business performance is extremely important. Some Japanese high-tech companies intend to make an impact on the technological circumstances, and introduce a new currency of technology and a market.

A high-tech company typically makes use of two different types of logic. The first logic is that of science or technology. The second logic is the logic of business. The logic of science or technology refers to the cause and effect chain of natural science or engineering. The business logic is concerned with ways of obtaining and increasing profits or market share.

These two different types of logic bring about some difficult problems. For example, a radical new high technology cannot always create a new market. Therefore companies must adopt well-balanced resource allocation between technological and marketing development.

Japanese high-tech companies attempt to resolve this serious contradiction by organizational means. In order to analyze their behaviour, the concept of strategy is very important. Further the classification of the technological innovations under specific type is extremely useful in understanding the strategy of technological innovation.

1.　What is Technological Innovation Strategy ?

Innovation is not the same as invention. Technological innovation is a process of research and development, which include invention, production and marketing. The technological innovation process contains several stages, namely the Research Stage, the Development Stage, the Production Stage and the Marketing Stage. In addition, the Research Stage is divided into the two sub-stages of fundamental research and applied research. The Development Stage is also divided into two sub-stages namely elementary model building stage and improving practicability stage. Technological innovation consists of various stages, from the fundamental research to diffusion. Moreover, these stages always have interactions with each other.

Technological innovation has a complex influence on business. For example, some new core-concept of technology or new application will lead to a new performance of the technology, which will also create and develop a new market. In some cases, new products expand the existing market or promote the re-newal of purchase.

The Technological Innovation Strategy consists of the R&D Strategy and the Business Strategy. The former is based on the logic of science or technology. The logic of science implies scientific decision making about what research themes have to be adopted, while the later implies technological decision making about which development processes have to be adopted. The scientist or engineer in a company usually makes these decisions. The Business Strategy is based on the logic of business. It is concerned with ways to obtain profits or to increase the market share. These decisions are usually made by the top management of a company. The R&D and Business Strategies are mixed in a corporate organization, thus leading to the formulation of the Technological Innovation Strategy.

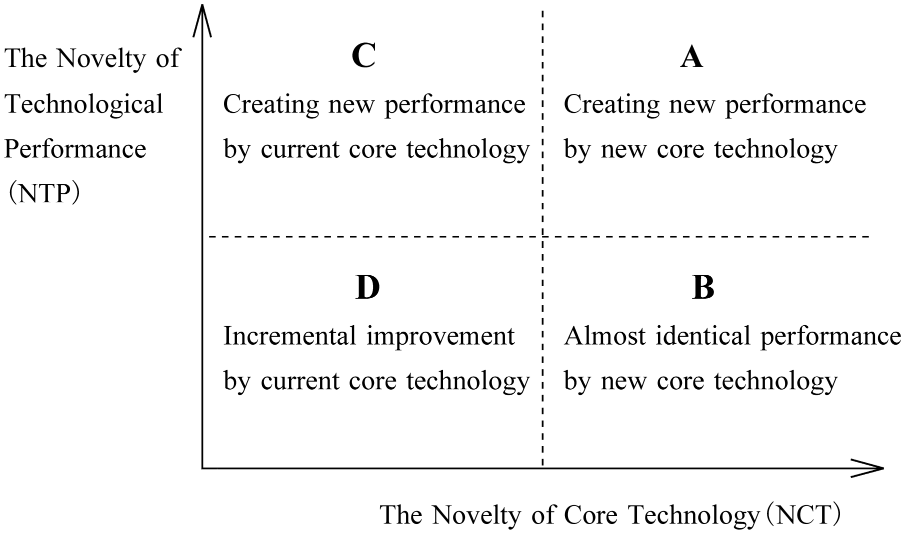
To formulate and successfully execute the Technological Innovation Strategy, co-operation among the members of R&D, Production and Marketing Department is crucial. Mutual co-operation of different activities in different departments helps realize technological innovation. Some Japanese high-tech companies attempt to build constructive interactions among scientists, engineers, and business managers.

With the progress of science and technology, specialization also proceeded. The field of scientific specialization is becoming extremely niche. However the related fields of modern high-tech innovation are increasingly becoming wider. Therefore modern high-tech innovation needs the integrated activity of scientists, engineers, and other members who belong to different specialized fields. In this modern background of technological innovation, the organization is the key concept of technological innovation.

Strategy certainly has a long-range prospects. As modern industries progress, the initial investment for R&D is becoming so enormous and the new specialized equipments are less flexible using. Thus the major modern companies that attempt to challenge high-tech innovation must have long-range prospect. Strategy has a long-range prospect which is concerned with technological change, market trend, competitors' activities and some obstacles.

2. Types of Technological Innovation

We can categorize technological innovation into four types based on two criteria. (See Figure-1). The first criterion is that of The Novelty of Core Technology (the horizontal axis of Figure-1). The



【Figure-1】 Types of Technological Innovation

second criterion is that of The Novelty of Technological Performance (the vertical axis of Figure-1).

The Novelty of Core Technology (NCT) means the fundamental change in the core technological part of the products. For example, the core technological part of an automobile is the engine system. The gasoline engine system is completely different from the steam engine system. Therefore the development of the gasoline engine realized high novelty of core technology. Additionally, the electric engine system is entirely different from the steam engine or gasoline engine system. Therefore the development of the electric engine system also realized the high novelty of core technology. However these three engine system realized almost the same performance as a personal passenger car.

The Novelty of Technological Performance (NTP) refers to the manner in which the new performance is realized. If the new product achieves new performance which any former products have not yet realized,- for example such as heat-resistance, water-resistance, other extreme high quality functions, or extreme cost downing - the NTP of that products is high. We consider only some cases of each type of technological innovation.

Type-A Innovation

This type of innovation can be exemplified through the following developments: the development of the steam engine locomotive train, which contained the new core technology in those days and the new performance of mass transportation; the development of a gasoline engine aircraft, which employed new core technology and introduced new standards in aviation. The development of the vacuum tube, which introduced a novel core technological system and realized the new performance of amplifying electricity, is also categorized under Type-A Innovation. In summary, Type-A innovation is a category of the pioneer innovations.

Type-B Innovation

The development of the early electric engine train, the jet gas-turbine engine in aircrafts, or a transistor made from a semiconductor is categorized under Type-B Innovation. These new products contain novel core technology which involves a mechanism entirely different from that of the former models. However, their performance is almost identical to the technological performance or function of their earlier counterpart products. The electric engine is fundamentally different from the steam engine. However, the early electric engine train realized the almost the same performance as that of a locomotive one as a means of mass transportation. This is also the case with the jet gas-turbine aircraft and the transistor. Needless to say, the later models which are highly improved realize some new performance, such as high-speed and miniaturization.

Type-C Innovation

The development of the revolving gun realized the new performance of fire in rapid succession. However, this development was concerned with the subsidiary technological improvement instead of changing the core technology. It was concerned with the revolving system instead of fundamental fire-mechanism. The early Integrated Circuit was highly compact; however its core technology was the same as that of the transistor. These cases are categorized under Type-C Innovation.

Further, the luxurious automobile model known as the Road Cruiser by General Motors Company is also categorized under Type-C Innovation. This model realized some new performance such as comfortable riding due to a high quality spring or social prestige due to its high cost and lavish appearance. Despite this, the core technology of the gasoline engine system was the same as that of the former model.

Type-D Innovation

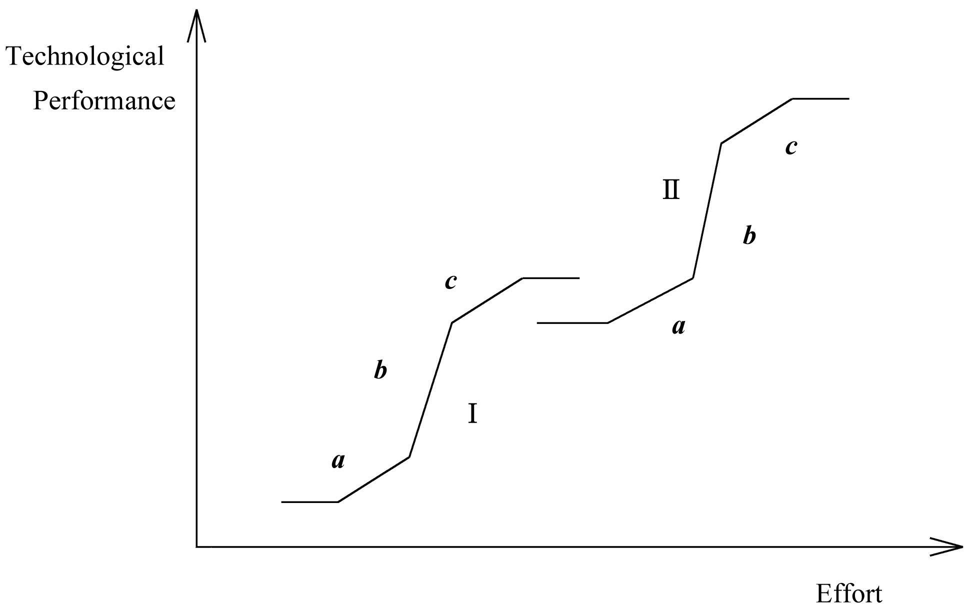
The incremental improvements in safety, credibility, durability, weight (making the product lightweight for instance), strength, miniaturization, or other qualities and cost-cutting by the development which are concerned with the subsidiary technological problems instead of the core technology are categorized under Type-D Innovation. Type-D Innovation is very important to achieve the high practical use of any new products. Particularly in the early stage of Type-A Innovation, Type-

D Innovation plays a very important role.

3. The Necessity of Co-ordination between The Logic of Science or Technology and The Logic of Business

The Novelty of Technological Performance (NTP), which is the vertical axis of Figure-1 is concerned with the users' utilities, for example the new functions such as heat-resistance or water-resistance, and improvements such as safety, high-speed, lightweight, miniaturization, cost downing and so on. Thus, NTP is directly concerned with the pioneering power for the new market. High-tech companies enter the big new or renewal market by developing NTP. This is very important from the point of view of business logic.

However, NTP is restricted by The Novelty of Core Technology (NCT). For example, the very primitive locomotive steam engine cannot achieve a speed of 30 km/h. After many of years spent in attempting to improve the performance, the locomotive engine performed at 100 km/h. However, it can never perform over 150 km/h. It is limited by the core technology of the steam engine system. In general, we can hypothesize using the technological S-Curve which was proposed by R.N. Foster[1]. The higher performance of over 150 km/h, can be realized by new core-technology such as the electric engine system (See the Figure-2). The is also the case with aircrafts or other products.



【Figure-2】 Technological S-Curve
(Source : Foster, R. N. *INNOVATION - The Attacker's Advantage* Chap. 4)

In the early stages of implementing a new technology, there is considerable room for improvement. Stage a in Figure-2 indicates the early stage of a new technology. Although there is considerable room for improvement in this stage, the efforts cannot obtain the performance easily. In stage b, the efforts can obtain a major performance by the learning effect. In stage c, the core technology is matured. There is little room for improvement in this stage, and even a great effort can obtain only little performance.

In order to obtain higher performance, we must change the core technology. The shift from I to II in Figure-2 indicates a breakthrough. It implies Type-B Innovation. Alternatively in some case, it implies Type-A Innovation. Thus high-tech companies usually invest tremendous effort in fundamental research which is concerned with the core technology of the products. To expand the market share or for pioneering the new market, not only incremental improvement in the adaptation to market needs, but also fundamental research for breakthrough is necessary.

4. Constructing the Technological Innovation Strategy : Cases of Japanese High-Tech Companies

The main problem of constructing the Technological Innovation Strategy is how to mix or how to cope with the logic of science or technology and that of business. Japanese high-tech companies co-ordinate or integrate these two different types of logic by organizational systems. Initially, from the viewpoint of decision-tree of application process, the logic of science or technology would constitute beginning from the fundamental knowledge of science or technology to the final products[2)]. This application process constitutes a hierarchy of problems and solutions. The top business managers who occupy the first position in the power hierarchy usually cannot understand the fundamental knowledge of science or technology. This fundamental knowledge as the critical starting point of scientific or technological hierarchy is concentrated in young scientists who are at the bottom of the power hierarchy. The scientific knowledge hierarchy and the power hierarchy are expanding in opposite directions. This *Reverse Hierarchy* is a serious problem in technological innovation.

In general, the information at the end of the organization is not so important for the organization on the whole. Each piece of information does not have a significant meaning until it is integrated. However, in the high-tech innovation process, the limited specialized information held by young scientists who are at the bottom level of the organization is highly critical in the overall development plan or design hierarchy.

Some Japanese high-tech companies such as Hitachi, Toshiba, NEC, or Matsushita cope with this *Reverse Hierarchy* problem by following two methods. The first method constitutes expanding the discretionary power of young scientists. They can usually use 10% of experiment budget for any theme according to their own discretion.

The second method is that of the intermediation of middle managers such as team leader scientists or project leader business managers. They can understand the languages of science and business. They are also aware of the interests of science and business. In Japanese high-tech companies, middle managers play a very important role in co-ordinating the logic of science or technology and that of business.

In recent years, scientists or engineers are getting a considerably grater share of top managerial positions in Japanese high-tech companies. This recent trend is likely to resolve the *Reverse Hierarchy* problem. However, the engineer top manager or the scientist top manager is capable of introducing another problem of the *Paradox of Success and Conservatism.*

The *Paradox of Success and Conservatism* means that the distinguished success of technological innovation is likely to lead to a conservative tendency because of the adherence of the innovator as a scientist or an engineer. In a classical well-known case, Henry Ford stuck to his own Model-T which achieved exemplary results. Almost member of Ford Motor Company could not resist for the conservative trend, especially they could not against H. Ford of president of the company. Therefore, they were inclined to Type-D Innovation. After about some decades, they were defeated by General Motors' Type-C Innovation.

Sony also succumbed to the *Paradox*, it stuck to its brilliant transistor system. As it was inclined towards Type-D Innovation, the integrated circuit (Type-C Innovation) by NEC or Hitachi swept over the entire transistor market.

In the Technological Innovation Strategy, the scientific or technological perspective is certainly very important, however, business perspective is also important. Japanese high-tech companies develop decision making systems in which two types of logic or perspectives can be co-ordinated and integrated.

Japanese high-tech companies developed some systems or organizations which can investigate both scientific or technological prospects and marketable promise. For example, NEC corporation organizes a *Technological Strategy Interaction Meeting* consisting of scientists, engineers and business managers. In this meeting, the R&D Strategy which is built using the logic of science or technology is made to interact with the Business Strategy which is built using the logic of business. NEC also separates the fundamental research laboratory from applied research laboratories or development research laboratories. Further, some laboratories are built for each specialized field (for example, Micro-Electronics Labo., Optical-Electronics Labo., Computer & Communication System Labo. or Material Development Labo. etc.). The *R&D Technology Center* integrates these separated laboratories.

Hitachi Corporation developed similar systems which can co-ordinate the logic of both science or technology and business. It also separates the fundamental research laboratory from the applied or development research laboratories. The *Central Laboratory* plays an important role in Hitachi. It is one of the biggest laboratories in Hitachi with over 1,000 members and is concerned with Micro-Electronics from the fundamental stage to the applied developing stage. Hitachi organizes several laboratories in each specialized fields, for example, Energy Labo., System Development Labo. and Design Labo. Furthermore, the *R&D Promotion Center* integrates these separated laboratories.

Toshiba Corporation dramatically changed its main business domain from the heavy electric industry to the micro-electronics and information systems industry in the 1980 s. This dramatic change has been introduced by the Technological Innovation Strategy which investigated the logic of science or technology and that of business. The firm investigated its technological potentiality and business prospects through interactions among the scientists, engineers and business managers.

Matsushita Corporation established a multi-level meeting system which can check the technological and marketing problems. After the meeting of engineers or business manager, the top managers who are concerned with technology or marketing integrate the promising themes.

Further, the Job-Rotation System which is very popular in Japanese companies, is a characteristic system in comparison with European companies. The scientists employed as fundamental researchers occasionally work in an applied or development research laboratory, despite this additional scientists are dispatched to the factory in one or two years. Moreover, engineers or R&D managers occasionally visit the laboratories, factories or integration centres. Japanese companies are improving co-operation not only among scientists, engineers and business members but also between labour and management through this Job-Rotation System to some extent.

Bibliography

1） Foster, R. N. *Innovation - The Attacker' s Advantage* - Mckinsey and Co. INC. 1986

2） Abernathy, W. J. *The Productivity Dilemma*, The Johns Hopkins University Press 1978