Columbia Business School

CENTER ON JAPANESE ECONOMY AND BUSINESS

日本経済経営研究所

Working Paper Series

August 2009, No. 284

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Abstract

This paper examines the perceptions of a scientist at a global diversified company. I found that IP managers can modify the cognitive biases of scientists, and bring them to seek common assumptions with core business logics - that is, find common ground. As a result, management can frame existing capabilities in new ways using common assumptions with scientists' cognitions as led by the IP management viewpoint. Organizations can then add new strategic alternatives via innovation based on newly interpreted capabilities.

Acknowledgement: The author thanks Professor Hugh Patrick of the Center on Japanese Economy and Business, Columbia University, Professor Bruce Kogut, Columbia Business School, Professor Harold S.H. Edgar, Columbia Law School, Dr. Robert A. Myers, Adjunct Professor of Columbia Business School, and Larry Meissner for valuable comments.

When Intellectual Property Management Changes Management Perceptions:
A Research Note on the Invention of Proanthocyanidins

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This is a case study of when a researcher is allowed to pursue a project that is not directly related to the R&D division's work in support of the company's current core products, and successfully develops a new product that extends the company's core businesses.

Scientific knowledge is public, transferable, and separate from social values (Cantwell 2001). This means that perceptions in searching for scientific seeds of invention can be separated from firm-specific assumptions. For example, the chemical compound discussed in this paper can be used to prevent oxidization of food, treat cataracts, and remove blotches, among other uses. From a management perspective, these differ, because the management resources, organizational processes, and potential customers differ. From a scientific perspective, they are the same because all three are based on a single scientific hypothesis - that active oxygen (free radicals) damages tissues, cells, and DNA.

The underlying assumptions of management and scientific staff differ. The differences derive from the dual identification of science staff, who belong both to an organizational unit and professional science communities, such as academic societies. This difference can result in both misunderstanding and enhanced perception in both groups. The challenge for management was how to accept and develop something outside, and in some ways disruptive of, the company's strategy. Both the inventor and management had to alter their perceptions, and then their practices, in order to advance the development and commercialization of the initial invention and its spin-offs.

Top management appears to have determined the company's scope based on an orthodox process of formulation of strategy, so I focus on the scientist's perceptions and attitudes, which evolved during the project, and thus changed the organization's, and his own, mindset.

Intellectual property (IP) management severed the pre-invention relationship between the perceptions and attitudes of the inventor. That is, IP management modified the inventor's attitudes, and added new attitudes, so that he was willing to seek common ground with management. The findings show that, when attention was paid to IP accumulation in the company, the inventor and management reached common ground between existing corporate capabilities and new capabilities flowing from the inventor's work. Management then created synergistic solutions involving existing capabilities and new capabilities to increase the company's scope. Had common ground not been found, the inventor's contributions would have been isolated from the company's other operations.

1.1 The Research

My aim was to determine a set of hypotheses by observing processes, organizational output, and an inventor's perceptions and attitudes, mainly before and after an initiation of a research project, at a major Japan-based food company. The scientist-inventor is Toshiaki Ariga, the company is Kikkoman, a global food company best known as the world's largest soy sauce brewer.

The reasons for analyzing this case are: 1) it was possible to observe the inventor's perceptions throughout the process of innovation; 2) the company already had well-established business segments; 3) the invention was outside the organization's core capabilities; and 4) the invention yielded organization changes.

I collected data on subjective perceptions of the inventor based on Ariga and Okada 2007, which was written by Ariga following an interview with Okada. That paper focused on the invention itself; Ariga was unaware of possible difficulties, organizational incentives, and top management's way of thinking during the process of innovation.

The company's expansion of scope resulted from the invention's having passed the "better-off test" and "ownership test". That is, management's thought process appears in accord with an orthodox, resource-based view of strategy formulation. (On strategy formulation, see, Piskorski 2007 and Collis and Montgomery 1998.)

1.2 The Corporation: Kikkoman

In 1983 when the scientific research discussed in this paper began, Kikkoman was already a global diversified food company, and was well-established in the world seasoning market. It had manufacturing subsidiaries in the United States, Germany, and Singapore.

Table 1 presents an overview of Kikkoman business segments in 1983. The company has subsequently grown mainly in organic fashion in these areas, including expansion of its non-Japanese operations. As a result of the invention discussed in this paper, Kikkoman formed a biochemicals segment in 1993 because of the field's prospects for growth. This led to involvement in the health food business in the United States beginning around 2001.

In 2007 when the company announced its long-term strategy ("Global Vision 2020), "health-related business" were now one of the four "basic strategies" (core businesses). This consists of bio-technology (a broadening of biochemicals) and health foods. As explained in this chapter, it can thus be seen that what had started as a project peripheral to the company's core strategies was the basis for what has become a core business.

Table 1 here

1.3 The Inventor: Toshiaki Ariga

Toshiaki Ariga worked for Kikkoman from April 1975 until retiring in May 2009. He studied at University of Tokyo, receiving a BA. Initially, he was a researcher in the R&D Division. The success of his work on proanthocyanidins (PAs) resulted in his transfer to the Intellectual Property Department in 1999 after the complete of the PA project. He became general manager (senior manager) of the department in 2001.

In 2004 he became an adjunct professor at Japan Women's University in the Food and Nutrition Department. After his retirement from Kikkoman, he became special-appointment professor of Kagoshima University, Innovation Center.

The originality of his work means he has published widely in international journals. While working at Kikkoman he was awarded a PhD from University of Tokyo. His thesis was on his PA invention.

1.4 Outline

The next section introduces the role of perceptions and core business logic as related to them. An overview of the invention and its consequences to the company is then presented. Next, a more detailed look is taken at the R&D process leading to the invention and its integration into the company's operations. Particular attention is paid to the inventor's perceptions and attitudes, and how they changed during this process. Finally, I discuss how it is important for novel inventions to seek common assumptions with existing capabilities in order for management to create synergetic solutions based on them.

2 Perceptions and Core Business Logic

Core business logic is the set of thinking processes and mindsets within which a business make decisions. In and of itself, it is neither good nor bad. (See Prahalad and Bettis 1986. Core business logic is termed "dominant logic" in Prahalad and Bettis 1986.)

Perceptions are important because change begins with perception (Rumelt 1995). Rumelt argued that distorted perception is one source of difficulty in organizational change. However, even if perceptions are not distorted, core capabilities often function as "core rigidities", leading to inertia within the organization (Leonard-Barton 1992). In general, people perceive circumstances based on both implicit and explicit assumptions, which are characterized by the loop illustrated in Figure 1.

Figure 1: Loop comprising core business logic

Fig 1 here

Assumptions, which are formed from many sources, selectively determine perceptions – how circumstances are understood. Perceptions affect attitudes toward the circumstances. Behaviors in response to circumstances are generated based on attitudes. Experience is accumulated by individuals as a result of behaviors, which strengthen or loosen assumptions regarding the organization. Through repetitions of the loop, core business logics are formed.

At the same time, the characterization of situations is not necessarily the same among organizational units, particularly when external events are involved for which ends-means relationships are uncertain. Perceptions are different among organization units because the content on which unit members focus is different, as are their organization sub-goals. Differences between science staff and managers may be especially large because of the dual identification of science staff. (Regarding the dual identification and the attention shift within an organization unit, see March and Simon 1958.)

2.1 Scientific Perception versus Management Perception

Scientists and managers perceive the same situation differently. To consider such differences, we begin with some definitions.

Science can be defined as the organized body of knowledge concerning the physical world. (A more complete definition includes the attitudes and methods through which this body of knowledge is formed.) The behavior of scientists include collecting data, often by observation of phenomena, and formulating hypotheses, usually by inductive reasoning. By deductive logic, hypotheses can lead to a number of implications that may be tested by further observations and experiments. The implicit assumption of scientists is that scientists should examine the mechanisms of nature and modify them to enhance the well-being of people (See, Adler 2002). Management, on the other hand, is commonly defined as the orchestration of people to accomplish desired goals.

Both scientists and managers have bounded rationality (see March and Simon 1958). Both groups examine how reality works in order to accomplish certain goals. They factor complex problems into quasi-independent parts. They try to deal with alternate consequences of action by estimating probabilities of possible outcomes, although future events are not completely known (see March and Simon 1958). The main difference between the two groups is that the subject of management is people with bounded rationality, whereas the subject of science is the physical world. There are scientists in management, but their work as managers is different from that of science staff.

Managers generate alternatives by relatively stable and sequential search processes. They formulate strategies in part, if not wholly, based on organizational resources including capabilities, which are path-dependent and not isolated from the values of an organization's members (see Teece, Pisano, and Shuen 1997). In scientific research, scientists generally can consider a wider range of alternatives. That is, the perceptions of scientists can be more divorced from organizational capabilities and beliefs than the perceptions of management. This has both positive and negative consequences in the interactions between scientists and management.

2.2 Two Aspects of Core Business Logic

Core business logic can both facilitates and prevents organizational learning. Positively, there is the accumulation of firm-specific capabilities through the selective perceptions they yield over time in business practice. As firm-specific capabilities can neither be easily codified nor easily transferred to other organizations (see Prahalad and Hamel 1990; Kogut and Zander 1993; Doz et al 2001), they are sources of competitive advantage for companies.

Negatively, the persistence of core business logics screens out innovative opportunities to grow, or even to adapt and survive. Thus, established companies sometimes fail to create new capabilities because their core business logic depends on existing core capabilities. Leonard-Barton 1992 calls this "core rigidities". As an organized collection of people, once an organization sees something in a particular way, there is a tendency to continue to see it that way (Adler 2002).

To discontinue the persistence of an organizational mindset and develop the positive aspect of core business logic, a company needs to integrate different mindsets into its process of thinking. The mindset of a scientist is one possible alternative. (Other sources of alternative mindsets include lead customers and entrepreneurial activities in foreign subsidiaries). Scientists and entrepreneurs who are out of the collective frame also have persistent perceptions. However, they are not in a position of making business decisions. In this way, their persistent mindsets are different from managements' in their influence on organizations.

Firm-specific capabilities are apparently sources of competitive advantage, which are accumulated in organizations through selective perception. This is similar to what occurs with individuals. Like people, organizations screen stimuli from their external environment, and allow only selected information through their perceptual filters. Here, perceptual filters are called "assumptions" (Adler 2002), which are formed around an organization's routines. A firm with an established routine possesses a resource - knowledge - on which it can draw in the task of applying that routine on a large scale (Nelson and Winter 1982).

2.3 Problems Caused by Core Business Logics

There are many examples of companies missing opportunities as a direct or indirect result of the persistence of a core business logic. Often this is the result of considering past success the result of factors that were coincidental and bear no causal relationship to such success (Rumelt 1995). Or it may occur when the success of a company's products has reinforced its core business logic. This persistence leads not only to the missing of opportunities but to overlooking emerging threats from other companies, and to delays in developing and commercializing competitive new products. The literature on this is huge. (See, for example, Clark 1988 on the automobile and ceramics industries; Henderson and Clark 1990 on architectural innovation of photolithographic alignment equipment; Leonard-Barton 1992 on core capabilities and core rigidities of 20 product development projects in five companies; and Trispus and Gavetti 2000 on Polaroid; among others).

Geography can also be a factor. For example, at many multinational firms, particularly historically, the persistence of core business logic at headquarters has been the result of a belief in the primacy of the home country. This can lead to the assumption that local adaptation is relevant only locally, and can prevent local entrepreneurial activities from being pursued and local innovations being integrated into a firm's global activities (see, for example, Doz et al 2001; Verbeke and Yuan 2007).

As to means for breaking this persistence, Leonard-Barton (1990) observed that a series of product development projects can show the way for organizational change by highlighting core rigidities, though the mechanism of such change has not always been clearly discussed. Doz et al 2001 sought to overcome core business logic problems arising from geography by renewing organizational mechanisms into what are called "metanational" mechanisms. These involve use of individuals or teams inside and outside of an organization that have a specific role in searching for valuable knowledge globally (sensors), and mobilizing it in innovation (magnet). They are utilized in some global companies, such as the Research Technology Center of Pfizer.

However, we cannot fully solve the problems created by the persistence of core business logics with organizational mechanisms alone, as these problems relate to mindsets and perceptions, and the structure of organizational mechanisms is itself affected by mindsets and perceptions. That is, core business logic problems cannot be fully solved without consideration of organizational cognition - how organization members model reality and how such models interact with behaviors.

Kaplan and Tripsas 2008 developed a co-evolutionary model of technological frames and technology by applying a cognitive lens. Their focus was on collectives, such as users and producers, and the influence of their interactions on technological trajectories. In developing their model, Kaplan and Tripsas looked at why new technologies are often ignored. They indicated, drawing on Christensen and Bower 1996, among others, that this was because new technologies did not fit the predominant collective frame. Kaplan and Tripsas suggested that discontinuity of technological trajectories occurs 1) when entrepreneurial action outside of the collective frame breaks the existing frame, and 2) in a process of continuous problem-solving regarding anomalies. Their model is useful for analyzing organizational behavior as collective cognition. However, entrepreneurial action and perception are not fully discussed, as they are beyond the scope of their model.

3 The Invention of Proanthocyanidin

The scientific work considered in this paper deals with the production of antioxidants. These have attracted a great deal of public attention because of their presumed health benefits, as indicated in Box 1.

Box 1 here

3.1 Background

Deterioration of the quality of food often occurs during the manufacture, preservation, and cooking of it, because of lipid oxidation. Antioxidants are used to avoid this. Historically, there has been wide use of synthetic antioxidants. However, in 1982, an academic researcher reported that BHA (butylated hydroxyanisole, a synthetic antioxidant) might be carcinogenic. Further research showed that BHA is safe with normal use. Still,some people thought that the very chemical properties that make BHA an excellent preservative might also yield undesirable health effects.

In response to the announcement, Japan's Ministry of Health, Labor, and Welfare in 1982 asked companies to refrain from use of synthetic antioxidants. This unexpected event caused considerable confusion in the Japanese food industry.

Meanwhile, Denham Harman's free radical hypothesis was gradually drawing world-wide attention. His hypothesis was that active oxygen and free radicals that developed within the human body injured tissue, cells, and DNA, and that this injury increases the risk of various diseases, including those caused by aging. He hypothesized that it would be possible to prevent diseases and moderate the aging process by avoiding the production of active oxygen and free radicals with the use of antioxidant substances. (Harman published his first work on free radicals in 1956, an animal study on cancer rates in 1961, a dietary antioxidant study in 1968, and his modified theory in 1972.)

Although his hypothesis appeared promising, it had not been fully tested. In 1968 Harman published a study of the dietary antioxidant BHT, a synthetic relative of BHA. The study found that mice fed BHT over their lives lived 45% longer than the control group. Toshiaki Ariga, a researcher, was interested in testing Harman's hypothesis further. This interest was combined with the need to invent a natural, non-carcinogenic, and effective food antioxidant.

3.2 Ariga's Idea

Ariga examined the mechanisms of antioxidants and proposed a hypothesis regarding proanthocyanindins (PAs), which are active ingredients in polyphenols. (Polyphenols, a substances found in many plants, have antioxidant activity. They also give some flowers, fruits, and vegetables their color.)

The original idea was to invent an antioxidant for use in preserving food. Based on Ariga's research, Kikkoman filed basic patents in Japan (in 1985) and the United States (in 1987). Because the basic patent was a physical patent which included a mechanism for eliminating free radicals, the company could develop several uses, including health foods and agents for health supplements. Although Kikkoman was not the only company looking at PAs, the focus of other companies was principally pharmaceutical.

4 Outcomes

One of the most important outcomes of Ariga's invention is that it added a biochemicals segment to Kikkoman. This outcome is of importance to my research, because organizational structure reflects what is attended to in work processes. That is, organizational structure is a powerful vehicle for focusing attention on certain aspects of a business and ignoring others (Davenport and Beck 2001). One of the principal reasons people form organizations is to focus attention on a selected goal (Davis and Paul 1977).

When a company combines biochemistry-related activities into an organizational routine within a formally created unit of the firm, organization-specific knowledge regarding biochemistry accumulates around the routine. Based on this, the formal creation in 1993 of a new business unit implies that Kikkoman's management decided to create organizational capabilities around the routine of biochemical products.

The issue is why management chose biochemicals as "promising", since a product's being "promising" is not, in general, sufficient reason to include it within a company's scope. To understand management's mindset, it is necessary to know the perspective it took with regard to strategy itself (see Davenport and Deck 2001). A clue lies in the timing of initial involvement of top management in the PA project. According to Ariga's record, this occurred in 1991 when the project succeeded in manufacturing trial products using non-Japanese grape seeds as a material. Since Kikkoman already had a wine subsidiary and commissioned manufacturing to foreign companies, it can be inferred that management conducted the "better off" test and "ownership" test based on a resource-based view. This presumption is supported by the facts considered in the next two sections.

4.1 Changes of, and Anchoring in, Capabilities

The PA invention of Ariga brought a major shift in the focus of Kikkoman's research and development. This is reflected in the classification of US patents issued. Attitudes towards intellectual property also changed after the basic patent for PA. In the traditional food industry, companies usually secured their inventions as know-how, tacit knowledge, and trade secrets (such as the formula for Coca Cola or Kentucky Fried Chicken). After Ariga's invention, however, Kikkoman began to secure inventions as patents, a strategy more typical of biotechnology and chemistry.

As regards the basic patent, Kikkoman identified its main US patent classification as 420 (chemical compound), a strategy completely new to the company. The basic PA patent also involved other classifications new to Kikkoman. Among them, "drug, bio-affecting and body treating compositions" (514) was especially important. A series of experiments which followed the basic patent showed that PAs were as effective, or more effective, for medical treatments than prevailing drug ingredients. However, at the same time, the basic patent also covered classification 426 (food), consistent with the core logic of the company.

Ariga's work also led to development of complementary assets. In this case, complementary assets are special processes for extracting or purifying and the like, as well as a flavor-enhancer for soy protein, which add value to products. (On complementary assets generally, see Teece 1986.)

Thus, 10 years after the basic patent, Kikkoman filed a patent for the process of preparation of PAs. The main classification of this complementary asset was 435 (molecular biology), in which the company already had strength. Further, the claims covered "grape seeds" (grape seed extract (GSE)) and "fermentation", a technology platform in common with the wine subsidiary.

In short, the invention of PA was completely new to the company. This undoubtedly helped alter the otherwise persistent perceptions of the organization. Today Kikkoman reports its technology capabilities lie in brewing, which utilize fermentation technology, and, at the basic science level, biology, analytical chemistry, medicine and veterinary science, nutritional science, and organic chemistry.

In general, management does not expand a company's scope based only on a prominent invention. That is, a company does not add new scope unless it can obtain an economy of scope (Collis and Montgomery 1998; Piskorski 2007). An economy of scope can be obtained when a potential new field shares common ground with fields already existing within the company, such as a common technology platform or supply chain platform.

Examination of the content of the US patents of Kikkoman revealed that the "process of purification of PA as GSE" (class 435) had common ground with the company's core technology. Considering the timing of involvement of top management, it can be presumed that management paid attention to "resources" in strategy formulation, including technological capabilities and IP. Management must thus have decided company scope using the "better off" test.

Table 2 here
Table 3 here

4.2 Alliances vs Ownership

In general, the better-off test is not sufficient for a company to add new scope. A company can contract with other companies to manufacture and sell products instead of owning such businesses, if contract costs are small (Piskorski 2007).

In the case of PA, the biochemistry unit had dual aspects for Kikkoman: vertical integration and horizontal diversification. As concerns vertical integration, production of PAs involves in part a relation-specific investment. For example, the wine subsidiary could improve its products with use of PA as an antioxidant instead of using an artificial additive. In contrast, a large number of biochemical products are involved in the horizontal diversification. Therefore, Kikkoman used both alliances and ownership.

Since many of the uses of the invention were outside Kikkoman's areas of expertise, it sought alliances and partnerships with companies that had complementary capabilities, primarily in the United States.

In 2003 Kikkoman arranged a business collaboration with TIAX, a privately held company based in Cambridge, Massachusetts, that describes itself as "A technology processing company that transforms emerging innovations into technology platforms for interactive hand-off to industry." The agreement was to create a new line of beverages, nutrition bars, and breakfast cereals containing PAs. In 2005 Kikkoman launched a health-supplement joint venture, Country Life, with a New York-based nutritional supplement manufacturer, the Consac Industries Inc Group. The contract was to market products co-developed under the Country Life brand, as well as to produce and market both parent companies' supplements and health foods. (In 2005 Kikkoman held a 46.3% stake in Country Life; in 2006 it took a full control.)

The advantage of the use of contracts is that when a business is owned separately, rather than as one company having two or more businesses within itself, it can make resource-allocation decisions independently of company headquarters. Business unit managers might otherwise have to engage in internal political maneuvering to obtain resources, rather than devoting time to winning in the marketplace. For this reason, use of contracts is often less costly in gaining economies of scope or cross-selling benefits (Piskorski 2007).

In this context, patent claims facilitate negotiating alliance contracts with potential partners, especially in the case of licensing agreements. Without clear patent claims, problems tend to occur with respect to the scope of knowledge the company can provide and the scope it cannot. With alliance agreements, Kikkoman could develop its biotechnology capabilities into a new health food and supplement businesses in the United States.

Based on this pattern of diversification and ownership, it can be presumed that the process of thought of Kikkoman's management involved orthodox strategies.

How, then, did Kikkoman come to consider certain contractual arrangements more costly and others less costly in doing business? Generally, contractual arrangements cost more, particularly when companies share or trade intangible assets such as manufacturing know-how and management skills (Piskorski 2007). In Kikkoman's case, the company vertically integrated its PA business into the existing wine and other food segments, where the company had firm-specific capabilities and IP (know-how) that were difficult to codify. (Regarding the transferability of capabilities, see Kogut and Zander 1993; Doz et al 2001.)

Even when the company used foreign companies to manufacture PAs, the contracts secured exclusivity, which made the partner relationship nearly internal. On the other hand, Kikkoman contracted alliance arrangements when it did not have firm-specific capabilities, for example, in health foods and supplements.

It can thus be said that management at Kikkoman made decisions concerning business ownership with attention given to IP, whether or not they were conscious of this or not. It is thus reasonable to consider this case in detail, with attention paid to IP including patents as a reflection of the company's technological capabilities.

Box 2 here

5 The Invention of Proanthocyanidin

This section summarizes business circumstances before and after Ariga's initiation of the research project that led to the invention and its integration into Kikkoman's business operations.

In 1983, before the PA project began, Ariga was engaged in research involving seven R&D themes other than PAs. However, he considered it difficult for him to obtain ground-breaking results from any of these projects. He therefore devised a new R&D theme, "Research on Preanthcyandin: Development of Antioxidants". This project was outside the company's core capabilities from the viewpoint of its business scope. However, Ariga had previously worked on projects involving PAs contained in azuki (red beans). The results were published in international academic journals, before and after the patent filing for PAs as antioxidant (Ariga and Asao 1981; Ariga, Koshiyama, and Fukushima 1988; Ariga and Hamano 1990). This shows Ariga had a basis for perceiving an external opportunity in the project. The project was approved and initiated based on the criteria of "appropriate process of conceiving scientific hypothesis" and "promising potential use".

Kikkoman's basic research center was named the "Food Research Institute", and food was its focus. On the other hand, Ariga's invention was mainly chemical. Ariga's interest was outside the company's research focus. It also was not necessarily important for the company business. If the company thought BHA were harmful, it must not have taken long to develop a natural antioxidant. Rather, it seems Kikkoman had a policy to be tolerant with motivated researchers to initiate research. Such a policy is consistent with a "stage gate" policy, which allows diversified ideas in the initial stage, although the term was not used in Japan at the time. (On stage gate, see Cooper 2001; Cooper, Kleinschmidt, and Edgett 2001.)

Kikkoman's overall R&D strategy at the time, according to Ariga, was to develop unique products based on firm-specific capabilities. The strategies were loosely grouped in four categories: 1) leader (R&D-oriented), 2) leader (marketing-oriented), 3) follower (improvement-oriented), and 4) follower (replication-oriented). Among these, the inventor perceived the PA project came under category (1), and was in line with the company's R&D policy. However, no company in the world was accumulating technological capabilities on natural antioxidants at that time. In addition, Kikkoman did not internalize the synthetic antioxidant product business. At the same time, Ariga notes that "The invention of PAs was a disruptive one, not on the company's continuous technological trajectory."

Although he said that he could manage the new R&D project in line with the company's R&D policy, he also said that the invention was disruptive. This appears inconsistent but, if we assume he had two types of perceptions based on dual identifications, it is not. As a scientist, he perceived he could invent a natural antioxidant with his scientific knowledge and the company's accumulated knowledge. And, when he looked at actual managerial resources such as technological accumulation, facilities, and customer networks, he perceived that there was no managerial resource accumulation in the company. This indicates that it is important to distinguish scientific perception from the perception of the organizational man who belongs to an organizational unit.

The inventor's perception of the antioxidant market also differed from a management viewpoint. Ariga observed, "The Japanese domestic market for antioxidants in 1982 was about 20 billion yen (US$200 million at 2009 exchange rates), of which 90% was vitamin C (top maker: Takeda) and vitamin E (top maker: Eisai). Afterwards, the domestic market actually grew to 70 billion yen in 1998, and 150 billion yen in 2004." (In the 1980s, Vitamin C and E were mainly promoted in Japan as quasi-medicines after illness and for fatigue. They were also used for food preservation, though this was not an important use. Their use as preventatives was not promoted at that time.)

Notably, he conceived Takeda and Eisai, which are large pharmaceutical companies, as competitors. The inventor, as a scientist, did not do a "local search". That is, he did not search for opportunities within the specialized field of "food". Instead, he performed a "distant search", in which people search for opportunities or strategic alternatives beyond their specialized field or organizational segment. (On "distant search" versus "local search" see Cyert and March 1963; March 1991; Katila and Ahuja 2002; Fleming and Sorenson 2004.)

Thus, Ariga's perceptions of the market and competitors were derived from his assumptions as a scientist. He focused only on the domestic market in the initial stage. In this sense, he was dependent on the past trajectories of the organization (path dependency).

Table 4 summarizes the inventor's perceptions of the scientific and management aspects throughout the basic research phase. Comparisons of the two perspectives show that they converged on, if not the same thing, a similar conclusion. For example, the management integrated R&D theme is one specific application of the scientific theme. In addition, the immediate scientific sub-goal is a related specific task subsumed under the goals of management. Thus, the two perspectives often turn out to be similar on examination.

Table 4 here

5.1 Ariga's Research

Ariga's goal was "to develop a novel antioxidant substance that is safe for the human body [not cancer-causing] and is more effective than vitamins C or E in preventing oxidants and free radicals from being activated." This goal included two testable hypotheses, related to safety and efficacy. The safety goal evolved, through collective interpretations, to that of "preventing or treating diseases such as cataracts and arteriosclerosis", which led to the development of health supplements.

After setting the goal, the task was to identify a target substance. For this purpose, Ariga spent three months examining research reported in international academic journals and patent files. Such an approach to create hypothesis by the deductive method was unusual for a researcher in the food industry at that time. The usual approach was trial and error.

Study of the chemical structures of 152 antioxidants described in available sources showed that most antioxidants have a phenolic hydroxyl (OH) in their molecular structure. Next, Ariga focused on food ingredients that had a phenolic OH but whose antioxidant properties had not been reported. He came to focus on proanthocyanidins (PAs), whose molecules had phenolic OH in the greatest abundance, and prepared a PA sample via extraction from azuki (red beans).

In the basic patent filing, the company included several materials as examples of raw material, and did not make any claims with respect to a specific one. However, to secure the business development of PAs, it was necessary to specify and claim raw material and purification processes. Although azuki are common, they did not meet the criteria established for the selection of raw materials. These criteria were:

- safety,
- stable supply of a large quantity,
- high yield of PAs per unit of source material,
- non-perishable,
- effective use of an unused by-product, and

- low opportunity costs.

Ariga selected grape seed extract (GSE), which featured the highest yield of PAs per unit (Ariga and Okada 2007). Ariga then formulated various types of GSE to progressively increase the percentage of PAs in samples, which ultimately reached 90.2%. Management appreciated the selection of GSE for other reasons.

Several tests confirmed that GSE was safe and had stronger antioxidant effects than vitamins C and E.

5.2 The Basic Patent Changed the Inventor's Attitudes

The principal US patent was filed in 1985, modified in 1987, and registered in 1989. This was the first physical patent in the United States that claimed an antioxidant as a food and cosmetics. Specifically, the claim included antioxidant of fats and oils for food composition and cosmetics preparation. It was the second that claimed PAs for any use; the first involved a pharmaceutical use. While the attention of other companies focused on pharmaceutical uses, Kikkoman had time to develop other uses by deploying medical knowledge. In 1997 Kikkoman filed in the United States on an "agent for the prevention or treatment of cataracts", in 1998 and 2000 for a "protein food", and in 2000 for an "anti-arteriosclerotic food".

Ariga had a strong belief in the need to establish a patent fence to protect the basic patent. Such a belief can lead an inventor to incorporate management attitudes, even if the inventor has had a strong interest in a scientific hypothesis. In general, building a patent fence around a physical patent means creating use patents and other necessary patents around the basic patent to protect business development activities. If use patents are developed by other companies, the product development activities of the inventing company become more limited. Thus, an intellectual property manager must formulate a strategy and specify what needs to be developed in the near future before and after the company files a basic patent. In other words, if research staff in an R&D project are conscious of a specified patent fence, they will contribute to the development of business activities. In this sense, IP management specifies "what to develop" in a certain situation. In this way, IP strategy affects R&D strategy.

At Kikkoman, Ariga's direct superior and the director of the basic research institute together played a pacemaking role in basic research at that time. In the normal course of review, some R&D themes were omitted during 1983-87. In 1987 and 1988, Ariga additionally reduced the number of themes, narrowing his focus so that just two R&D themes remained in 1988:

- Research and development of novel PA antioxidants
- Development of dietary protein products

The "development of dietary protein products" had not been part of Ariga's original concept, nor had it emerged as an explicit theme during the early R&D process. Rather, it suddenly appeared as an integrated theme during the post-basic research phase. Kikkoman appeared to appreciate the product development of proteins. For example, Takuro Koga, the product manager of the biochemistry division that was later established, noted in an interview in an American journal that PA not only was a natural food preservative, it also "appears to work synergistically with soy to improve the flavor profile of soy-based products – an attribute unique enough to secure yet another Gravinol-specific patent" (Food Industry, Feb 2003). (Gravinol is a Kikkoman brand.)

This internal evaluation is reflected in the patent filing activity. Eight US patents in which Ariga was involved were issued related to PAs. Two were for dietary protein products. (They are "protein food comprising flavor improver that is a PA and an isolated soybean protein food" and "high-protein food of plate form".)

In addition, Ariga's junior researchers, including Jun Yamakoshi, filed a US patent for an anti-arteriosclerotic food based on a protein food-related invention, after Ariga's move from the R&D division to the IP division. Development of protein food was beyond the scope of Ariga's research. Thus, the belief in patenting of protein food-related inventions can be considered evidence of Ariga's management identification as regards production of a patent fence.

5.3 Perceptions in the R&D Phase

After the basic research phase, the PA themes were integrated into a company project. The R&D manager also coordinated joint research with Kikkoman's wine subsidiary, as well as universities. Ariga perceived that these actions were designed only to speed research and commercialization. However, the collaboration with the wine subsidiary was of crucial significance to top management in determining business scope. Table 5 shows the research themes and how the work was performed.

At the same time, the research coordination clearly enhanced the technological capabilities of the company. The Ariga team tested aspects of the PA hypothesis in order, or concurrently, with some results published in scientific journals. Many related to medical treatments, which were outside the company's core competencies and strategy. Around that time, Ariga also began reviewing papers for a journal of the American Chemical Association by appointment.

Table 5

Table 6

5.4 Use Development, Product Development and Launch

Ariga perceived that, as GSE (PAs) was a novel functional material, various uses of it in diverse fields appeared promising. Nine main product brands of GSE materials were developed and launched in Japan, the United States, Australia, and Korea by 1999. Kikkoman thus successfully integrated the invention into its operations by adding new business scope to the company. Table 6 shows the uses developed.

The research resulted in 24 use patents being applied for in Japan. In the United States, 6 were issued as uses. Among 21 developed uses, 14 were completely outside the company's core competencies and business; these included drugs and medical treatment (7 uses), cosmetics (3), pet foods (2), and health food or food supplements (2). These were also beyond Ariga's original conception of development of a food antioxidant. Ariga's scientific, or perhaps unusual management, perspective on the market could have given the people involved room to add various interpretations to the functions of PAs.

Kikkoman manufactures PAs through a joint venture with a non-Japanese wine maker. Kikkoman created two manufacturing bases, one in the northern hemisphere and the other in the southern. This was aimed at obtaining a stable supply of PAs throughout the year. At the same time, the company created the bases of firm-specific investment. The company dispatched the inventor to transfer the newly patented processes and know-how to the joint venture. Ariga perceived that his involvement was necessary for the special process of purification to work. Such an outlook is more typical of a management perspective than of a scientific perspective.

6 Overview of the Inventor’s Perceptions

Ariga’s perceptions were derived from his dual identifications in ways that must have been similar to other science staff. However, according to Ariga’s description, his perceptions raised a problem. At Kikkoman, R&D is divided and specified within the fields of soy sauce, micro-organisms, and fermentation. Each area has a firm-specific accumulation of technology, human capital, research facilities, test facilities, manufacturing facilities, and purchase and sales networks. The invention of PAs was outside these areas. Therefore, Ariga perceived that he “had to be involved in all the innovation processes, whether he liked it or not.” He also was involved in operations, including the design of manufacturing facilities, developing control and analysis methodologies, setting quality control standards, consulting with government regulators, and providing technology services in four foreign countries. He perceived that his behavior was unusual for a scientist in an established company. He also perceived that his attitudes and behavior were even against the norm for scientists.

As to involvement in commercialization by inventors at basic research institutes, two views emerged in interviews I have conducted. One is expressed by scientists at the National Institutes of Health (NIH) in Washington DC, a part of the US government. They answered that they were not interested in what management thought, even when they were discussing efficient screening methods of pharmaceutical substance (interviewed in 2007). The scientists at Hitachi Basic Research Institute who invented the mu-chip (the world smallest radio frequency identification integrated circuit left the project when the invention was integrated into a product (interviewed 2004). On the other hand, some scientists in Palo Alto Research Center (PARC) answered that they were willing to participate in all aspects of the innovation processes (2005).

Again, Ariga’s perceptions appear slightly inconsistent. We observed that other science staff added several interpretations of PAs on which Ariga did not focus his attention. Examples include dietary protein foods with soy flavor and improved anti-arteriosclerotic foods. In addition, as a result of the involvement of other people, the original concept of “not cancer-causing (safe)” evolved into food products promoted for “self-improvement, wellness and self-care” by Country Life, Kikkoman’s joint-venture in the United States.

However, Ariga’s perception can be explained by the fundamental theory of organizational cognition. In companies, tasks are allocated to organizational units, including the R&D division, in terms of sub-goals. In the R&D division of Kikkoman, R&D was further allocated to sub-units for soy sauce, microorganisms, and fermentation. This specification is needed to deepen professional capabilities and increase R&D efficiency. On the other hand, other goals of the overall organization tend to be ignored. This is, in the case of individuals, due to selective perception. At the same time, at the organizational unit and sub-unit levels, there is reinforcement through the content of in-group communication. Such communication affects the focus of information, and thereby increases sub-goal persistence (March and Simon 1958).

In the context of this framework, Ariga's attention to PA could have been beyond the range of in-group communication among other science staff members. It is also possible that Ariga's understanding of PAs differed from the focus of other organizational units such as the product development division. As such, even if other organization members were capable and willing to participate in the process of innovation, the work flow would have stopped without Ariga's involvement.

In addition, a group norm exists within individual perceptions, not in objective reality. When a person confronts a majority, and when social (or group) influence is mediated by the motive approved by a group, a perception is said to be normative (Kitayama and Burnstein 1990). Based on this proposition, Ariga's perception and attitudes toward the "group norm" can be interpreted as follows: Ariga behaved not for the purpose of being accepted by the group. In sum, he was outside of the collective frame. This is consistent with the Kaplan and Tripsus model 2008.

Ariga perceived operational work as a heavy burden. "Until the biochemistry business segment was created in 1993, the PA-related work processes were not specifically divided." However, he now believes that "such unspecialized work processes will be necessary also for other diversified companies when they are challenged by disruptive innovations." However, in reality, it is impossible for one person to be involved in all work processes. This suggests that Ariga broke the informational-attentional focus created around each organization routine in each organizational unit.

The inventor's attitudes during the R&D and operational integration phases are summarized in Table 7. A management perspective as organizational identification showed up frequently after the use-development phase. What is important is that the inventor attempted to find common technological ground with the wine-manufacturing subsidiary (fermentation). Further, an IP management viewpoint found a common technology platform with soy sauce manufacturing (molecular biology).

The chemical compounds developed by Ariga were outside the company's previous capabilities. However, if we see his invention as based on IP accumulation of biochemical knowledge, his invention is in line with organizational capabilities. In sum, the invention was able to find common assumptions with existing organizational capabilities from the perspective of IP management.

Table 7 here

7 Seeking Common Assumptions and Synergetic Solutions

Management must have paid attention to the company's IP accumulation in determining diversification type and ownership type, whether they were conscious of doing so or not. At the same time, Ariga's invention also converged on the core IP accumulation in the company. Further, Ariga's original work to invent effective and safe antioxidants evolved into health foods.

To reach this understanding, I investigated the content and classification of Kikkoman's US patents, as this shows how the company framed its inventions. The classification "Chemistry: molecular biology and microbiology" (class 435) was a common technological platform for PA-related biochemistry, soy sauce- and wine-related biochemistry, and soy sauce development. The basic PA patent did not fall under classification 435. However, subsequent patents often did. Wine fermentation and soy sauce development often also are in 435.

The success in seeking a common ground changed top management perceptions of the company's technological capabilities. Although the inventor did not understand the pattern of formulation of strategy by top management, he found a way to common assumptions, led by IP management. Based on these assumptions, management could obtain a synergetic solution to create the biochemistry unit of Kikkoman's business. In the case of PA, the patent class "Chemistry: molecular biology and microbiology" was a common technological ground, which enabled common assumptions between the PA invention and the company's core business logic.

8 Conclusion

The following propositions are suggested based on the findings here.

1 An inventor's perceptions and attitudes can affect the perceptions of management, even if they differ from management viewpoint. Top management can deploy such perceptions to change business organization.

2 Management perceptions, including IP strategies, affect an inventor's attitudes and behavior, expanding the inventor's perceptions beyond the scientific, to seek common assumptions with core business logic.

3 Management can frame existing capabilities within different perspectives based on common assumptions, leading to synergetic solutions and the addition of strategic alternatives.

The first two are different aspects of the same issue. In the case studied here, the inventor had two types of perceptions based on his dual identifications: one as a scientist belonging to academic societies, the other as an individual working for an organizational unit.

Before the basic patent was filed, the inventor gave priority to his perception as a scientist. This was reflected in his research activity and interests. When the basic physical patent was filed, he became conscious of the need to create a patent fence. He also perceived the creation of IP to be worthwhile.

Building a patent fence implies extensive use-development and creation of complementary assets to obtain value from inventions. The criteria for patentability include utility, as well as novelty and non-obviousness. The usual scientific attitude considers only the last two. The need for utility may require the inventor to develop new attitudes. In the present case, this was reflected in the behavior of

Ariga. He was involved in all the coordinated research tasks, developing uses, developing processes of extraction and purification, and other operational work. His involvement must have broken the attentional focus of organizational units.

A key to this process was IP management. In the choice of company scope and ownership type, management must have paid attention to the company's IP accumulation, whether they were conscious of doing so or not. The inventor Ariga was also led by the IP viewpoint to seek common ground with the company's capabilities. Based on the common assumptions reflected in IP accumulation, management framed the company's capability in a new way. Based on the common assumption that the company has strong capability in molecular biology, management created a synergetic solution, adding an explicit biochemicals unit to the company's scope.

We have shown how scientific perceptions can unintentionally affect management perceptions, and vice versa. We have not considered whether the inventor understood management's pattern of strategic formulation, nor whether top management understood the scientific details. Instead, we found that two perspectives can expand and converge in the process of searching for alternatives, framing organizational capabilities, and determining company scope. For this to happen, it is necessary to seek common assumptions enabling synergetic solutions. This lead to the third proposition: management can enhance the organizational mindset by creating synergetic solutions based on common assumptions. Thus, novel inventions outside the organization's core capabilities can enhance core business logics.

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Box 1
What are antioxidants?

Antioxidants are substances that may protect cells from injury caused by unstable molecules known as free radicals. Free-radical injury may lead to cancer. Antioxidants interact with, and stabilize, free radicals and may prevent some of the injury free radicals might otherwise cause. Examples of antioxidants include beta-carotene, lycopene, vitamins C, E, and A, and other substances. (www.cancer.gov/cancertopics/factsheet/antioxidantsprevention

Box 2 Chronology of PA Development

1983 Start of the research project
1984 Application for basic patent of antioxidant in Japan
1985 Application for basic patent of antioxidant in United States
1987 Filing for basic patent of antioxidant in United States (continuation of 1985, abandoned the file of 1985)
1989 End of the basic (test-tube) research phase
1990 Manufacturing trials using domestic grape seeds (TF 20%)
1991 Manufacturing trials using foreign grape seeds (joint development with the wine subsidiary) (TF 30%)
1992 Test manufacturing and sales in the domestic market
1993 First test manufacturing outside Japan (TF 33%)
1993 Creation of the biotechnology unit
1994 Second test manufacturing outside Japan (TF 40%)
1995 Establishment of a factory outside Japan
1995 Start of manufacturing (TF 40%) and sales (antioxidant)
1996 Start of animal trials testing effectiveness of PA
1997 Start of human trials testing effectiveness of PA
1998 Launch of high-purity Grape Seed Extract (GSE) (TF 95%)
1998 Presentations at academic societies, Press Release
2001 Alliance with TIAX (functional food)
2003 Alliance with Consac (health supplements)

TF = Total Flavanols, the conventional index for proanthocyanidins.

Source: Ariga and Okada 2007; adapted by Okada.

Table 1

Kikkoman Business Segments, 1983

Food manufacturing	Soy sauce, soy sauce derivatives, sake, and wine. (Soy-sauce-related products about 55% of revenue, alcoholic beverages 15%).
	Del Monte products in the Asia-Pacific region (1961).
Food wholesaler	Japan Food Corp (1969), Pacific Trading Ltd (1970). These deal in Asian foods.
Coca-Cola	Bottler and distributer of Coca-Cola products in Japan (1962).
Restaurants	In Germany (1974).

Dates in parentheses are when Kikkoman began the activity or acquired an interest in the company. Both JFC and Pacific Trading descend from the Dupont Company, founded in the United States in 1906 as an importer of Japanese foods.

Data are primarily from the Japan Company Handbook (Shikiho) for 1984 First Half.

Table 2

Shifts in US Patents Received Before and After the Basic PA Patent

1973-87	1988-2001	Main classification listed in filing
54(100%)	106(100%)	Total US patents
27(50.4%)	19(17.9%)	Food (426)
16(29.6%)	76(71.6%)	Biotechnology-related total
11	56	Chemistry (435,436)
5	7	Biochemical: compounds (420, 532,536, 544,549)
0	13	Biochemical: drugs(424,514)
11(20.0%)	11(10.3%)	Others

The basic patent was received in 1987.

US patent classifications filings.

420: Alloys or metallic compositions

424: Drug, bio-affecting and body treating compositions

426: Food or edible material: processes, compositions, and products

435: Chemistry: molecular biology and microbiology

436: Chemistry: analytical and immunological testing

504: Plant protecting and regulating composition

514: Drug, bio-affecting and body treating compositions

532-570: Organic compounds

536: Carbohydrates or derivatives (pectin, glycosides, etc)

549: Sulfur containing hetero ring (thiiranes, etc)

Table 3

Capabilities Shift From the 1987 Basic Patent Until 1993 Biochemistry Unit Created, Reflected in Classification of US Patents Issued

426	435	504	514	536	549	Period
27	15	3	0	6	0	1973 - Sep 1987
7	19	0	3	12	2	Sep 1987 – 1992

See Table 2 for what the Classifications include.

Table 4

The Inventor's Perceptions in the Basic Research Phase

	Scientific perspective (scientist identification)	Management perspective (organization identification)
Overall R&D theme	Development of antioxidant	Developing commercially useful food ingredients
Integrated R&D themes at end of basic research	Developing novel antioxidants comprising PAs	Developing dietary protein food (free radical scavenger)
Immediate sub-goals before setting project theme	More effective antioxidant compared to vitamins C and E	Extract active ingredients (from polyphenol: make a sample using food ingredients)
Constraints	Prevent oxidant and free radicals from being activated	Safe for human body (not cancer-causing)
Attitudes toward patents	Recognize patents are an important achievement of research	Create a strong patent fence around the basic patent, which makes business development advantageous
Basic patent	Classes 420, 514, 549	Class 426

Table 5

R&D Themes and Research Partners

General issues
- Formulation of grape seed extract (GSE)
- Safety test

General effects
- Antioxidant nature
- Radical capture efficiency and molecular orbital elimination effect
- Inhibit effect against oxygen ferment
- Radical capture efficiency of GSE[1]

Medical effects
- Anti-mutagenity
- Colon cancer restrain function
- Arteriosclerosis restrain function
- Gastric ulcer restrain effect
- Cataract restrain effect
- Antioxidant effect in a living body during exercise
- Restraining effect on diabetes and its complications[2]
- Preventing muscular fatigue of human body[3]

All research and development was done in-house except as noted.

1 Joint research with Hoshi Pharmaceutical University

2 Joint development with Nihon Women's University

3 Joint Development with Tokyo University

Source: Ariga and Okada 2007; adapted by Okada.

Table 6

Developed Uses of PAs

Antioxidant
- antioxidant

Agent for the prevention of oxidation and discoloration of:
- myoglobin (meat pigment)
- astaxanthin (pigment of salmon and trout)
- anthcyanin (pigment of red wine)

Stabilizer for
- melanoidin (pigment of soy sauce)
- quality of coffee
- vitamin C

Protein food
- flavor improver of soybean protein food
- high-protein food of plate form

Drugs and medical treatments
- cataracts
- gastric ulcers
- diabetes
- fatigue relief
- dermatological agent
- prevention of mutagenicity
- deodorant agents for oral use for discharging
- prevention of arteriosclerosis

Cosmetics
- cosmetics
- bleaching
- agent for the prevention of hyaluronan

Pet care
- pet food
- fish food

Others
- paint

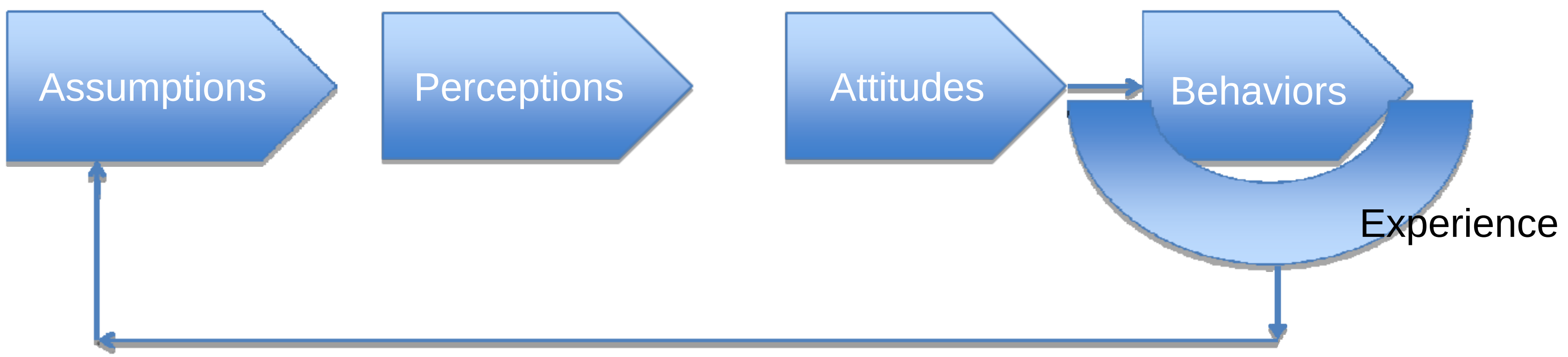
Among these, Ariga did not participate as an inventor of “Deoderant agent for oral use for discharges and method” (US patent filed for in 1999), and “Anti-arteriosclerotic food” (filed for in 2000).
Source: Ariga and Okada 2007; adapted by Okada.

Table 7

The Inventor's Attitudes Reflected in His Behavior

Area	Scientific Behavior	Management Behavior
R&D	Followed scientific methodology; Resolved antioxidant mechanism; Mainly medical-treatment theme	Participated in all coordinated work
Use development	Lots of external uses such as drug and medical treatment	Participated in use development
Selecting raw material	Selected raw material which contains high yield of PA per unit	Utilized organization resources, which converged into the core capability
Process development	Added new capabilities	Participated in developing complimentary assets; Utilized common technological platform of the company
Product development		Participated in product development; Set standard requirements for control of PA quality
Manufacturing		Spent 7 months at foreign joint ventures to transfer technologies and know-how
Operations		Participated in operational work to launch products
Marketing		Participated in merchandising work to launch products

Figure 1: Loop comprising Core Business Logic



Source: Adler 2002; adapted by Okada.