International Journal of Strategic Management, Vol.9, No.1, 2009, 1-17.

KNOWLEDGE CREATION AND THE MANAGEMENT OF DIVERSITIES — COMPARATIVE ANALYSIS OF KAO CORP. AND P&G.—

Takabumi Hayashi, Rikkyo University, Japan
Atsuo Nakayama, Rikkyo University, Japan

ABSTACT

Many theories on knowledge creation, including strategic management theories, seem to be argued, based on the assumption that contexts are homogeneous under the environment against the background of the industrial digitalization and the market globalization. In addition, traditional knowledge creation theories have hardly highlighted the impact of cultural and technological diversities on knowledge creation processes and the dynamic interconnectedness between them. This study has examined the impact of cultural and technological diversity on corporate R&D activities that can be regarded as knowledge creation processes. As a result of the analysis, the authors have noted that there is increasingly dynamic interconnectedness between knowledge creation and cultural and technological diversities.

Key Words: Knowledge Creation, Management of Diversity, Cultural Diversity, Technological Diversity, Boundary Management

1 INTRODUCTION

The geographical decentralization of scientific and technological knowledge production (Tidd, Bessant and Pavitt: 1997, Hayashi: 2004, 2007), the increasing risks associated with R&D, the growing significance of responding to foreign markets and the global market as a whole, as well as the rapidly shortening trend of product development lead time have staggeringly increased the strategic importance of the strategic leverage of external knowledge (Badaracco,1991, Rosenbloom and Spencer,1996, Robert,2001, Chesbrough,2003, 2006). In this regard, while the development of internationally renowned new technology needs constant contact between multiple technological fields, this trend has at the same time led to the necessity for collaborative research with other internationally distinguished organizations in related fields. As a result, the internationalization (i.e., globalization) of R&D(=research and development) activities and networking has become an inevitable trend (e.g., Pearce and Papanastassiou,1996, Nakahara:,2000; Takahashi,2000, Serapio and Hayashi,2004, Medcof:,2001, 2004, Hayashi and Serapio,2006, Iwata:,2007).

In this changing competitive environment, business organizations have been under considerable pressure to respond even more dominantly to rival firms with the “development of an even more differentiated new product” on an even larger global scale. Most notably, generating new technological knowledge and new concepts that are in high demand in order to develop new products has become a necessity more than ever before. In order to raise the probability of success in new product development, the general policy which had been used until recently was to invest further in R&D and human resources, and in so doing to raise the R&D capability within the organization. However, due to changes in the global competitive environment and the shortening trend of the product lifecycle, strengthening R&D activities in many organizations merely led to the further lowering of R&D investment efficiency. The more global the company, the more it was pressured to employ R&D human resources in a strategic manner regardless of nationality. As a result, these global companies were able to retain their multicultural knowledge resources as part of their institutional capability. The more the production of scientific technological knowledge has decentralized globally against the backdrop of even the most global companies having difficulty in forming a competitive global edge, based on the closed national innovation system, it is evident that the focus has shifted to centering on the principle of “metanational innovation” (Doz, Santos and Williamson,2001, Doz,2006, Asakawa,2006).

The focus of the paper rests on the relationship between knowledge creation within the product development process and the diversity of context, cognitive approach and culture, as well as with boundary management. The main reason for the view lies in the following point. The directional shift toward the decentralization of scientific technological knowledge on a global scale and meta-national strategy leads to tendencies that effective knowledge creation activities are subject to cross pollination across borders and cultures, and that the context and cognitive approach come to be performed within a meta-national framework. Therefore, an inherently different knowledge creation mechanism is being sought even in regard to the product development process. This paper examines the relationship between knowledge creation and diversities mentioned above, through analyzing the outcome of R&D activities of Kao Corp. and P&G.

2 KNOWLEDGE CREATION AND CULTURAL DIVERSITY

2-1 Cultural Diversity and the Diversity of Context

Globalized companies need to develop new products that can differentiate itself on a global scale, the source of its global competitive edge. For this purpose, they require radical innovation based on key insights which embrace, at its core, new concepts that transcend cultural differences with an acknowledgement toward cultural differences and the fusion of diverse technological knowledge. In return, to create these new concepts that transcend cultural differences with an acknowledgement toward cultural differences, it is necessary to recognize the differences in the context which provides the base for cultural differences. The paper will further explore the meaning of cultural difference in this context. An individual's values, thoughts and cognitive approaches are basically formed by national culture, regional culture, cultural differences in gender and generation, business culture, organizational culture, subsystem culture, family structure, lifestyle, and academic background as well as in an individual's genes. Henceforth, the paper uses the definition of culture, taken from G. Hofstede, as mental programs or software of the mind (Hofstede, 1991) that predetermined the "patterns of thinking, feeling and potential acting," if you will, a "collective programming of the mind that distinguishes the members of one group or category of people from others" (Hofstede, 1991a).

Every individual's mind is determined by the mental program against the backdrop of a multi-layered culture. Therefore, cultural diversity, with a basis of cultural multi-layering, provides the context in which communication among its constituents can be conducted. From this viewpoint, it is necessary to understand that all communication is multicultural and inter-cultural communication.

As long as exchanges of ideas among project members are multi-cultural and inter-cultural communication, there are inherent cognitive differences in their context.

Even if the relevant people were communicating with the same terminology in the same language, there are still inherent differences in their contexts of their thoughts and ideas because each person has his own unique cultural backdrop and personality. In other words, even if these same project members use the same terminology while conversing, it is highly unlikely that are all coming from the same context. There are inevitable disparities in each individual's acknowledged contexts, and the degree of their commonality is inherently limited to differing degrees. This fact does not cease in the acknowledgement of shared contexts, but also implies the existence of ambiguity. The disparities in this ambiguity, as defined in this paper, lead to the acknowledgement of differences through continuing dialogue, and consequently new insights and discoveries are produced. From this perspective, ambiguity is the critical resource out of which new ideas emerge (Lester and Piore, 2004: 52-54). Therefore, the more new product development projects are oriented from their domestic market to foreign markets, the more these projects must obtain comprehensive cognitive capabilities by integrating various market characteristics from diverse approaches. Consequently, project members and the leader are required to design a "Ba" and boundary management capabilities which value the diverse cognitive contexts based on the cultural diversities, and harmonize the differences that arise from these various contexts. As long as the mission of new product development projects remains to aspire for global competitive advantage, there will always remain a demand for higher requisite diversity. Thus, the project is more required to possess higher levels of meta-cognitive capability and multi-cultural management capability.

2-2 New Product Development and Technological Diversities

As long as the target of new product development projects becomes much more oriented to global market places, the product is required to secure the global competitive advantage. In consequence, the projects must spring forward from radical innovations that depart from conventional technological bases. In order to create products that embody radical insights and concepts based on unconventional technological bases, it is necessary to integrate the technological knowledge from a wide variety of fields.

L. Fleming (2004) examines the relationship between alignment of team members' disciplines and value of innovations by analyzing around 17,000 U.S. patents. His analysis shows that the greater the differences among the disciplines of the research members, the more innovative breakthroughs that were achieved, and the higher risk of failure. This shows that the project leader and members must possess the ability to recognize strategic potential in a new blended knowledge which integrates the various knowledge that comes from diverse technological fields. As long as the technological field of R&D projects overlaps with other fields, there will be a growing demand for competent skills of deepening knowledge in individual technological fields as well as for skills in integrating this knowledge with that of other fields. There will be a high demand for analytical and interpretive approaches, as well as a holistic approach. When putting together, these can be expressed as a T-shaped approach.[i] Indeed, there are higher risks of commercial failure in R&D projects that integrate more diverse fields as they strive to achieve breakthroughs in technological knowledge and product features. As these potential risks increase, the necessity towards collaborative R&D projects with other research institutions increases. This also means that the project leader for such collaborations among various organizations and research institutions will need to be able to facilitate cross-pollination and multicultural communication. As such, the requisite diversity in R&D projects would increase.

2 -3 Boundary Management and Knowledge Creation

Radically new insights and developments often arise at the boundaries between communities (Wenger, 2002: 153). This paper is basically based on the concept that the creation of radical insights and knowledge often arise at the boundaries between diverse cultures, and between diverse technological domains. Nonaka and Takeuchi argue that organizational knowledge creation process in the “Ba” consists of five phases; sharing tacit knowledge, creating concepts, justifying concepts, building an archetype, and cross leveling of knowledge (Nonaka and Takeuchi, 1995: 85-89). Through these processes, members are able to recognize their respective differences and share their knowledge. This paper does not use the term “ Ba” , but “boundary” where diverse contexts and domain specific knowledge overlap.

On the other hand, D. Leonard (1998) discusses the creation of new knowledge from the perspective of “creative abrasion.” He reasons that it is through this creative abrasion process that individuals integrate their various problem-solving approaches, and that this gives rise to new insights and knowledge. “Innovation rises from the boundaries of diverse mindsets ,not within the provincial territory of one knowledge and skill base” (D. Leonard, ibid.,64). However, “diversities is not essential to the presence of creative abrasion between contrasting cognitive styles. Creative abrasion involves much more specific attention to people’s cognitive approaches to problem-solving and innovation” (Leonard, ibid., 64). Put another way, general cultural diversity does not necessarily give rise to new knowledge and concepts merely because it yields different viewpoints or different approaches to problems. What is important is developing and utilizing an organizational capability that embodies diverse cognitive approaches that stems from valuing the various cognitive styles of its diverse members.

Essentially, the emphasis should be on the elucidation of the mechanisms that generate these innovative insights and knowledge from those boundaries that are the composites of domain specific knowledge of members from specific domains. The matters of discussion here, therefore, are not limited to the scientific and technological knowledge domain of those who participate in the mechanism of knowledge creation at the early product development phase. The paper also discusses the culture-specific context of the affiliated organizations (i.e., suppliers and other research institutions) and related departments of the participating members. Regarding the idea of “boundaries,” this paper not only examines the participating members’ scientific and technological domain-specific knowledge, but also the members’ cultural differences that influence their differences in their cognitive approaches and contexts. Accordingly, the fundamental role of the project leader at the initial stage of the new product development is to fulfill the role of a boundary spanner between the specific domains of knowledge. Hence, keeping all of the above in mind, knowledge creation at the boundaries is further examined here.

New insights and knowledge are often created in overlapping domains of the participating members. The primary reasons for this are that the members shared a common goal, proceeded with serious dialogues, deepened their respective specialty knowledge domains, came to comprehend the differences in their respective perceiving contexts, exchanged knowledge correctly, clarified their ambiguities, acknowledged the meeting points with other knowledge domains, and were able to successfully integrate their knowledge. The key factor here is whether the project leader is able to share with all of his project members the overall mission of the project, as well as the goal of each development stage as the project progresses. It is also about how effectively the project leader can practice boundary management by being the boundary spanner among the varying knowledge domains, and promote communication among them. In other words, the boundary management capability of the project leader is the determining factor in the strategic creation of knowledge. Put another way, " Despite substantial resources, motivated and talented people, and even the ability to work together effectively, some teams fail because they are unable to develop a new product that meets the expectations of others in the organization" (Ancona and Caldwell, 1997). Only the project leader's dynamic process of structural creation of knowledge can lead to the project members attaining new insights and knowledge (Lester and Piore, 2004). In consequence, the more new R&D capabilities with globally competitive advantages are required, the more technological and cultural requisite diversities of R&D projects expand, the more important relevant designing of "Ba", and the more important management of boundary where domains overlap.

3. Cultural Diversity of Kao Corporation and Procter & Gamble's (P&G's) R&D Activities

Based on the critical thinking noted above, this study seeks to analyze the results of Kao and P&G's R&D activities to examine the cultural and technological diversity of their project members. The paper also assesses the importance of boundary management, the realm where those diverse cultural and technological elements meet. In conducting these examinations, the report focuses on the following two hypotheses:

Hypothesis 1: To develop products from new concepts, it is necessary to integrate multiple ideas by organizing a wide variety of members who have diverse cultural backgrounds.

Hypothesis 2: To develop products from new concepts, it is necessary to integrate a wide range of technological ideas in an effort to create new technologies, which eventually leads to projects taking on a tone of technological diversity.

Many outcome of R&D projects activities are often published in journals in the form of technological papers or applied for patent. The authors have searched technological papers and patents in which the names of researchers and engineers working for Kao and P&G, which are competitive in R&D, and belong to the culture bound industry, are specified to check their divisions and technological diversity. The database that the authors have accessed for reference is JSTPlus (database of the Japan Science and Technology Agency) on technological papers and USPATFUL (database of STN International) on U.S. patent information.

3-1. Diversity of organizational affiliations to which authors of scientific papers belong

This section examines what category those papers are grouped into: the papers by individual researchers, the papers written jointly within a department or division of a particular institute, the papers written in collaboration with other divisions within a particular institute, and the papers written in collaboration with other research organizations (universities and private companies). In addition, the section identifies the number of papers whose projects were participated in by female researchers (and engineers) and foreign nationalities. Through these processes, the authors intend to examine the diversity of organizational culture characterizing the participants at the initial stage, the cultural diversity of sub-systems inherent to their specific organizations, genders and nationalities. By searching the papers, the paper also categorizes their technological fields and evaluates the degree of their diversity.

This study examines the search results on Kao and P&G's papers and then conducts a comparative analysis of both companies.

3-1-1. Diversity of Kao's organizational affiliations to which authors of scientific papers belong in the case of Kao Corp.

In examining the validity of the above-mentioned two hypotheses at the early stage of development, that is, in the basic research phases, this paper focuses on two Japanese and American toiletry companies as typical examples of consumer goods manufacturers. Kao can often be regarded as a major successful toiletry maker in Japan. In implementing product development measures, the company is committed to the "Kao Way" and its five principles of development[ii] and has been carrying out its strategy of promoting essential technological research on interface science, oil and fat chemistry, high polymer chemistry, biological chemistry and applied physics and the integration of these technologies.

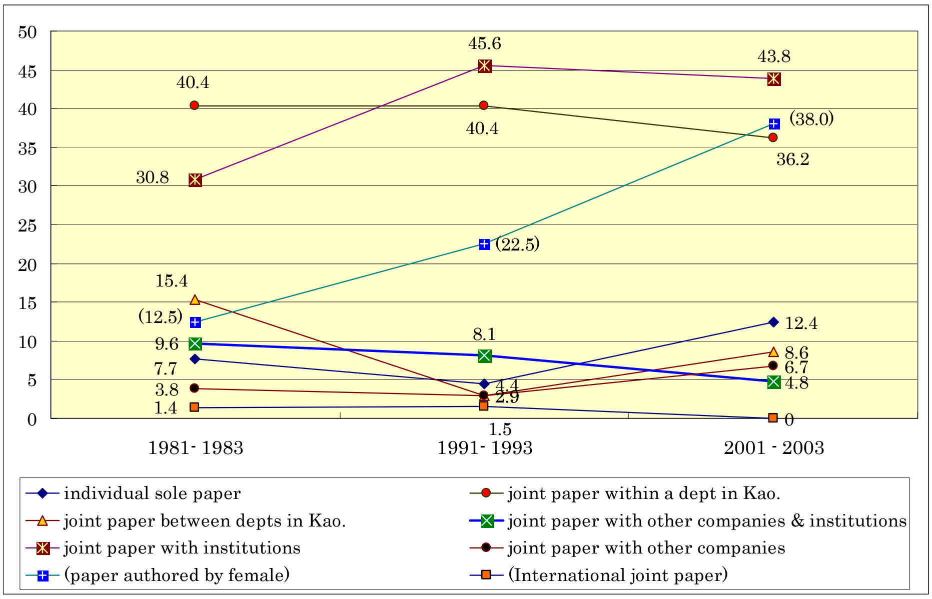
This study seeks to examine the diversity of the company's R&D activities by searching technological papers published in Japan in which the names of the researchers and engineers are specified.

Figure 1 illustrates the details of technological papers published in Japan, individually or jointly, by

those researchers and engineers during three separate time periods, 1981–1983, 1991–1993 and 2001–2003, with a focus on ten-year intervals. This figure shows the following four points:
(1) Of the papers published during the period from 1981–1983, the ones written individually made up 7.7% and collaborative works constituted the remaining 92.3%. With regard to these joint papers, the ones written within a particular department (or division) of Kao accounted for 40.4%, followed by the collaborative ones with universities (0.8%), the collaborative ones with Kao's other research divisions (15.4%), the joint works of both other companies and universities (9.6%) and the joint works with other companies (8%). This suggests that the joint papers with other organizations (other companies, universities and other research institutes) made up 44.2% of all the collaborative works.
(2) During the periods from 1991–1993 and 2001–2003, the joint papers with universities and other research institutes topped the rankings with 43.8%, followed by the group works by a particular division within Kao (36.2%). The total of the joint works with other organizations (other companies, universities and other research institutes) made up 55.3%; the joints works with other divisions within Kao scored 8.6% and the individual works constituted 12.4%.
(3) The authors note that the percentage of projects with female participants sharply increased from 12.5% in 1981–1983 to 22.5% in 1991–1993, and to 38.0% in 2001–2003.
(4) International collaborative joint papers marked only 1.4%, 1.5% and 0% in each period, which suggests that the efforts in this category have hardly born fruit.

These four points show the following noticeable results. First, the collaborative works with other companies, universities and other research institutes have showed an overwhelming increase of 44.2% to 55.3%. More specifically, the joint works with universities demonstrated the highest increase from 30.8% to 43.8%. Second, as for the joint papers within Kao, the ones in a particular division decreased moderately, but its percentage of about 36% in 2001–2003 remains relatively high. In contrast, the interdivisional works within Kao did not increase and were below the individual works.

FIGURE 1: THE BREAKDOWN OF PAPERS BY THE AFFLIATION OF AUTHORS THAT KAO'S RESEARCHERS AND ENGINEERS ARE INVOLVED (PUBLISHED IN JAPAN: %)



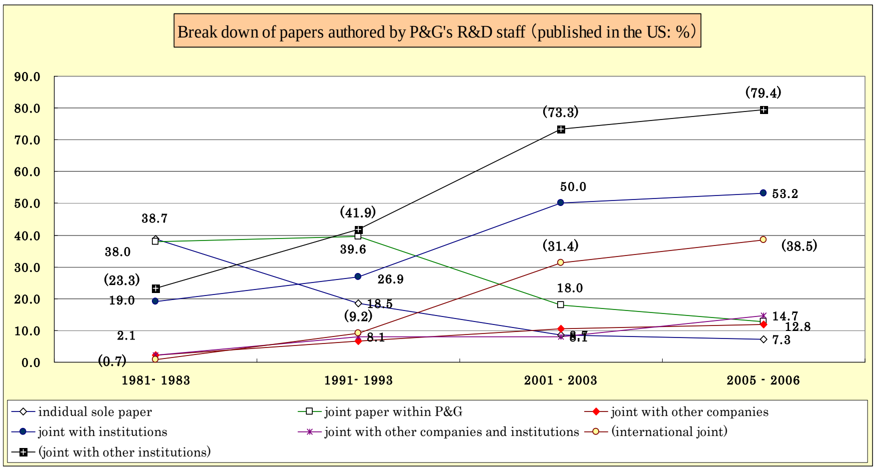
Source: JSTPlus

Third, it is particularly noticeable that the joint works involving female participants consistently rose from 12.5% to 36.2%. Fourth, few international collaborative works were conducted.

3-1-2. Diversity of P&G's Researchers and Engineers

Next, this section examines the diversity of P&G's R&D activities by searching technological papers published <u>in the US</u> in which the names of their researchers and engineers are specified. Figure 2 suggests the following three points:

FIGURE 2: THE BREAKDOWN OF PAPERS BY THE AFFILIATION OF AUTHORS THAT P&G'S RESEARCHERS AND ENGINEERS (PUBLISHES IN THE UNITED STATES: %)



Source: JSTPlus

(1) Of all the papers written by the P&G's researchers and engineers in 1981–1983, the individual works comprised the highest percentage and the joint works constituted the remaining 61.3%. Of all these collaborative works, the ones within a particular division of the company made up 38.0%, followed by the works with universities and other research institutes (19.0%), the collaborative works both with other companies and universities (2.1%) and the works with other companies (2.1%). This means that a total of the joint works with other organizations (other companies, universities and other research institutes) constituted 23.3%; during that period of time, 76.7% of the projects were conducted within the company and the individual works formed the core of the study.

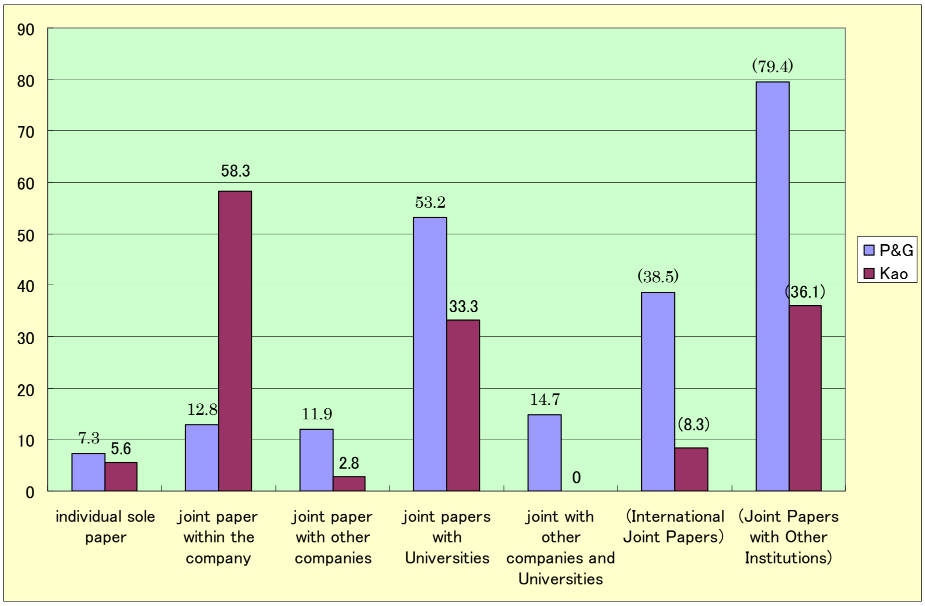
(2) There was a major change in the organizational research style from 1991–1993 through 2005–2006. First of all, the joint works with universities and other research institutes had the highest value of 53.2% and the collaborative works with both other companies and universities came in second with 14.7%. In the meantime, the papers by individuals, which were the highest with 38.7% in 1981–1983, sharply dropped to 7.3% in 2005–2006. The joint ones by a particular division within the company went down by a large margin from 38.0% in 1981–1983 to 12.8% in 2005–2006. As a result, the total of the collaborative works with other organizations ballooned to 79.4%.

(3) The strikingly remarkable change in the organizational research style during the targeted period accounts for the dramatic increase in the percentages of international joint works. The percentage was just 0.7% in 1981–1983, but drastically leaped to 38.5% in 2005–2006.

3-1-3. Comparison of the R&D Styles and the Diversity Between Kao and P&G

As noted above, the papers on the R&D outcomes of both companies suggest that the percentage of collaborative works with outside organizations increased noticeably and made up the majority. That is, the active utilization of the knowledge of other organizations is becoming increasingly important especially for the exploratory R&D activities during the product development processes.

FIGURE 3: BREAKDOWN OF PAPERS BY THE AFFILIATION OF AUTHORS THAT P&G'S AND KAO'S RESEARCHERS AND ENGINEERS ARE INVOLVED (PUBLISHED IN THE UNITED STATES IN 2005–2006: %)



Source: JSTPlus

In examining the technological papers authored or coauthored by the researchers and engineers of the two corporations, this section compares their characteristics with a particular focus on papers publishes in the United States during the period of 2005–2006. As Figure 3 illustrates, the international collaborative works and the joint works with outside organizations exhibit major differences between the two toiletry companies.

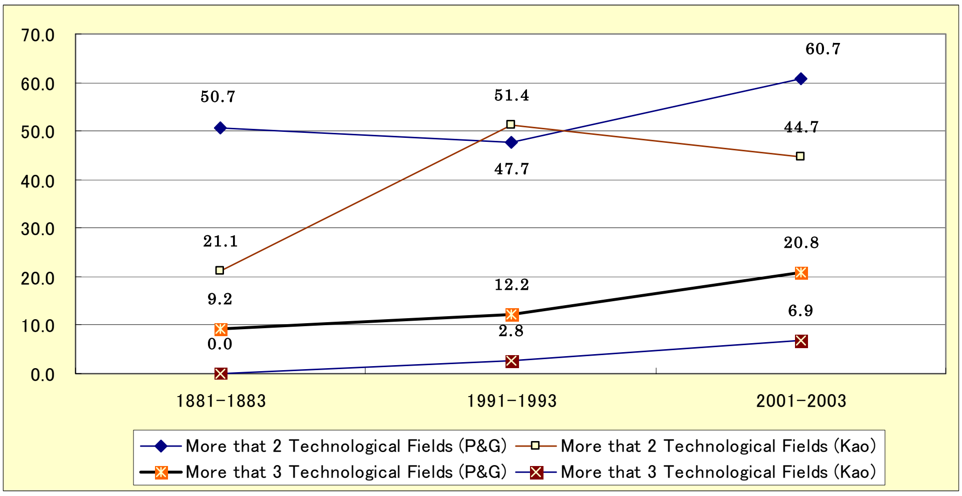
Of all the papers that P&G's researchers and engineers joined, the international works made up 38.5%, whereas the equivalent figure was just 8.3% with Kao. In addition, with regard to the joint works with other organizations, P&G marked an exceedingly high percentage of 79.5%, but Kao scored just 36.1%. However, the joint works inside the company displayed a strikingly different landscape. In the case of the American company, the joint papers within the company made up just 12.8% (six papers); the joint works by a particular division within the company accounted for 12.2% and the interdivisional joint works constituted only 2.4%. In sharp contrast, the group works within the Japanese counterpart tallied 58.3%; the joint works by researchers(or engineers) in a particular division of the company made up 36.1% and the interdivisional joint works accounted for 22.2%. This shows that Kao has intentionally employed the R&D strategy of utilizing a wide variety of know-how within the organization.

3-2. Technological Diversity of P&G and Kao in Terms of Their Technological Papers

The authors have examined how U.S.-published papers involving multiple technological areas have changed along with the current of the times. The authors have found out that the number of papers involving multiple areas increased as time went by (See Figure 4).

These increases in the number of papers involving multiple technological areas are suggestive of the greater diversification of technological fields because of the closer associations of multiple technological areas. To explore this tendency, the authors focused on whether the papers focusing on particular technological areas had been adopted or the papers involving multiple technological areas had been adopted. From this perspective, the authors examined P&G and Kao's papers involving multiple technological areas published in the United States using the Lorenz curve.

FIGURE 4: THE PERCENTAGE RATIO OF PAPERS INVOLVING MULTIPLE TECHNOLOGICAL FIELDS (P&G AND KAO): (PUBLISHED IN THE UNITED STATES)



Source: JSTPlus

The Lorenz curve is a graphical tool to display statistical gaps and bow-shaped curves bending downward farther from the diagonal line suggest greater gaps. That is, the larger area between the perfect equality line and the observed Lorenz curve shows greater gaps. The Gini coefficient is the numerical representation of these gaps. This coefficient is defined as follows:

$$G = \frac{\sum_{i=1}^{n}\sum_{j=}^{n}\left|Y_i - Y_j\right|}{2\bar{Y}n^2}$$

In this formula, *n* refers to the number of technological areas, Y_i refers to the number of papers involving multiple technological areas, which is placed in the order of *i* (*i*=1・・*n*), and $\bar{Y}$ refers to the average number of papers involving multiple areas. The Gini coefficient is 1 when the gap is the largest and the value is 0 when perfect equality is obtained. The coefficient represents the rate of the area shaped between the curve and the perfect equality line to the area of a triangle shaped by the perfect equality line and both axes.

Figure 5 and Figure 6 illustrate that the curves are getting closer to perfect equality line from 1981–1983 to 1991–1993 to 2001–2003 with only moderate changes. The comparison of both companies' curves hints that P&G's is closer to the perfect equality line than that of Kao and that the U.S. company has smaller gaps in the development of technological areas.

FIGURE 5: THE LORENZ CURVE OF P&G'S U.S.-PUBLISHED PAPERS INVOLVING MULTIPLE TECHNOLOGICAL AREAS

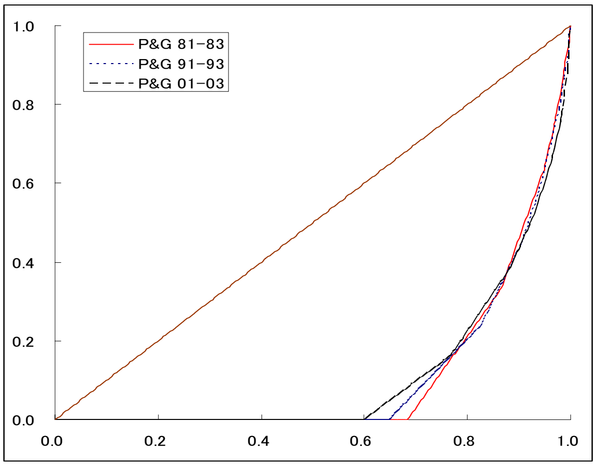
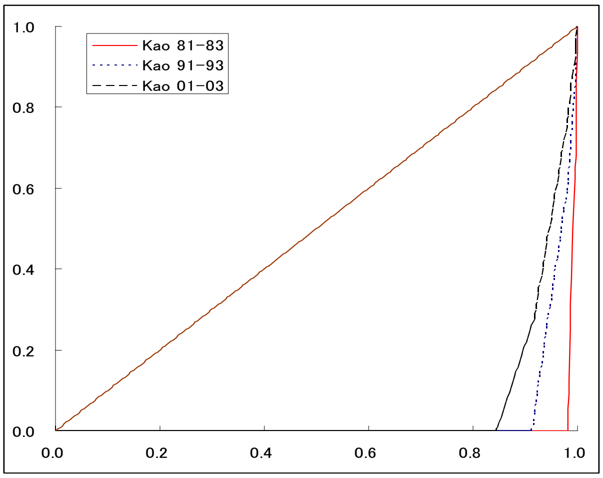


FIGURE 6: THE LORENZ CURVE OF KAO'S U.S.-PUBLISHED PAPERS INVOLVING MULTIPLE TECHNOLOGICAL AREAS



Although the authors could gain only a limited number of data for this survey, updating data and conducting follow-up surveys and further analyses will result in obtaining new insights into the technological development diversity between the two companies.

The Gini coefficients on the gaps among technological areas constantly decreased during the same period of time(see Figure 7). The value went down slightly in 2001–2003, compared with fewer changes from 1981–1983 to 1991–1993. This implies that gradual decreases emerged in the gap of the number of papers involving multiple technological areas along with the trends of the times. This analysis shows the growing trend of the papers involving multiple areas being adopted rather than the papers concerning particular areas.

FIGURE 7: THE GINI COEFFICIENT ON THE NUMBER OF PAPERS INVOLVING MULTIPLE AREAS

	P&G	Kao
1981-1983	0.777	0.982
1991-1993	0.777	0.931
2001-2003	0.771	0.882

In addition, the comparison of both companies' coefficients during each period of time suggests that P&G's value is smaller than Kao's, which hints that the U.S. toiletry corporation has smaller area gaps in its technological development. However, Kao's rate of decrease is larger than P&G's, which suggests that area gaps in Kao's technological development will further decrease.

As noted above, both graphical data and numerical figures show that the area gaps of papers involving multiple technological areas are moderately shrinking and that more papers involving multiple areas are being gradually adopted rather than the papers concerning particular areas. Behind this lies the trend of diversification in which more emphasis is placed on R&D activities with broader technological areas than on the intensive development of particular areas. That is, the active and diverse combination of multiple technologies has been taking place in recent years. The authors could gain only a limited number of data for this survey, but updating data and conducting follow-up surveys and further analyses will result in obtaining new insights into the technological development diversity between the two companies.

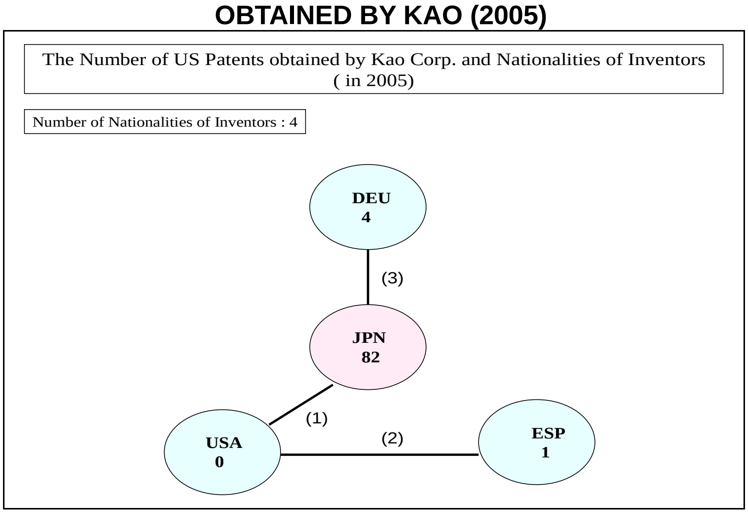
4. Diversity of Nationalities of Inventors and Their Technological Areas in Terms of U.S. Patent

Generally speaking, the more important their successful technological outcomes are in their international business strategy, the more companies try to secure the exclusive rights of those technologies by applying for patents to major overseas countries, especially to the United States, where the market is vast and a large number of competitors are running their activities. Considering this fact, the authors focused on the patents that Kao and P&G had filed with the U.S. Patent Office, and examined the diversity of the nationalities of those inventors.

4-1-1. Diversity of Kao's U.S. Patents and Their Inventors' Nationalities

With regard to the number of Kao's patents accepted in the United States and the nationality of their inventors, there were 68 granted cases, with the nationality of all of their inventors being Japanese, in 1980; in 1990, 99 patents were granted and of them, 97 were invented by people of Japanese descent and two were American; and in 2000, of all the 58 successful applications, 56 were Japanese inventions, one was of an American invention and the other was of a Spanish invention. Next, with a focus on 2005, Figure 8 illustrates 93 U.S. patents granted to Kao by the inventor's nationality. As this figure shows, there were 82 inventions created by Japanese researchers, four by German researchers, one by a Spanish researcher, three through the collaboration of Japanese and German researchers, one jointly by Japanese and American researchers and two jointly by American and Spanish researchers.
In that year, the inventions created by only those whose nationality was Japanese constituted 88.2% of all the company's US patents granted in the United States and there were a total of four nationalities. Kao's patents granted in the United States suggest that the Japanese company has shown moderate progress in its international R&D activities since 1980. However, it is still far from making use of diverse, transnational knowledge from a highly strategic and global viewpoint.

FIGURE 8: NATIONALITY OF INVENTORS AND THE NUMBER OF US PATENTS OBTAINED BY KAO (2005)



Note 1: The numbers in the circles show the inventions by single nationalities. For example, DEU 4 means four inventions by researchers of German nationality. As for the parenthesized numbers beside the lines, for example, (3) beside the line connecting DEU with JPN means three joint inventions by German and Japanese researchers or engineers.
Note 2: Refer to Figure 7 for nationality codes.

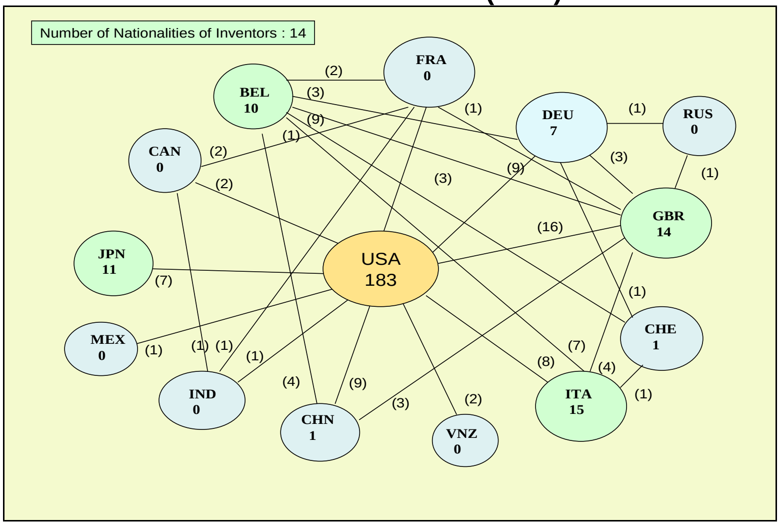
Source: USPATFUL.

4-1-2. Diversity of P&G's U.S. Patents and Their Inventors' Nationalities

P&G's inventions patented in the United States show a striking contrast to Kao in terms of both their successful numbers and their inventors' nationalities. In 1980, of all the 118 patents, there were 106 patents created by those with U.S. nationality, accounting for 89.8%, and the nationalities of the inventors of the remaining patents were Swiss, Japanese, German, French, British and Belgian; in 1990, of all the 133, there were 116 patents created by those with U.S. nationality, making up 87.2%, and the other ones were invented by people with Swiss, German, French, British, Belgian and Indonesian nationalities. Next, as Figure 8 illustrates, of the company's patents granted in the United

States in 2005, there were 183 cases only by inventors of American nationality and there were 130 U.S. inventions created by overseas researchers.

FIGURE 9: NATIONALITY OF INVENTORS AND THE NUMBER OF US PATENTS OBTAINED BY P&G (2005)



Note 1: The nationality codes are as follows: BEL (Belgium), CAN (Canada), CHE (Switzerland), CHN (China), DEU (Germany), ESP(Spain), FRA (France), GBR (Great Britain), IND(India), ITA (Italy) JPN (Japan), MEX (Mexico), RUS (Russia), VNZ (Venezuela) and USA .

Source: USPATFUL

This means that the U.S. patents by people of American nationality constituted 58.5% of P&G's total number of patents granted in the United States and that the U.S. patents by other nationalities made up 41.5%. More specifically, there were 15 patents invented by researchers of Italian nationality, 14 of British nationality, 11 of Japanese nationality, 10 of Belgian nationality, seven of German nationality, one of Swiss nationality and one of Chinese nationality. In addition, with a focus on more than five joint inventions by people of different nationalities, there were 16 collaborative inventions by researchers of British and American nationalities, nine by German and American inventors, nine by Chinese and American inventors, eight by Italian and American inventors and seven by Japanese and American inventors. Moreover, with a particular focus on British nationality with regard to the projects led by inventors of alien nationalities, there were nine joint works by British and Belgian inventors, four by British and Italian inventors, three by British and Chinese inventors three by British and German inventors and one by British and Russian inventors.

As noted above, P&G's 2005 U.S. patents by inventor nationality show not only that diverse nationals involved in the successful patent inventions comprising as many as 14 nationalities but also that the company has been developing increasingly multinational networks for its R&D activities. That is, although the company's patent activities are largely based on the research by people of American nationality, the contribution by inventors of diverse nationalities is growing and the collaborative efforts by multinational R&D task forces are also playing an increasingly important role in enhancing its R&D capabilities.

4-1-3. Comparison of the Diversity of P&G and Kao's Inventors' Nationalities in Terms of U.S. Patent

As Figures 7 and 8 illustrate clearly, P&G's R&D activities involve researchers of various nationalities who have a high standard of capability for obtaining U.S. patents, whereas Kao utilizes those people of various nationalities in only a few cases. For its patents granted in 2005, the U.S. company had inventors of 13 nationalities, excluding American; in contrast, in the case of the Japanese company, its inventors were of only three nationalities, excluding Japanese. In addition, P&G's R&D activities are based on its global networks, while Kao's activities are conducted according to the stand-alone model with its base in Japan. That is, P&G has established the global system to fully utilize a wide variety of high-level researchers, but Kao's personnel management system is largely domestically-oriented.

4-2. P&G's and Kao's Technological Diversity in Terms of U.S. Patent Granted

Next, the authors focused on both companies' percentage and number of patents involving multiple technological areas. Then, the authors have found out that the number of patents involving multiple areas increased from 1980 to 2005 (See Figure 10). Considering these data, with regard to patents involving multiple technological areas, the authors compared their numbers by area to examine whether those patents are centered intensively on particular areas or they spread across a wide range of areas. If there are patents combining multiple technologies in various fields, it means that development projects involving technological diversities are underway.

FIGURE 10: P&G'S AND KAO'S PERCENTAGE AND NUMBER OF PATENTS INVOLVING MULTIPLE AREAS

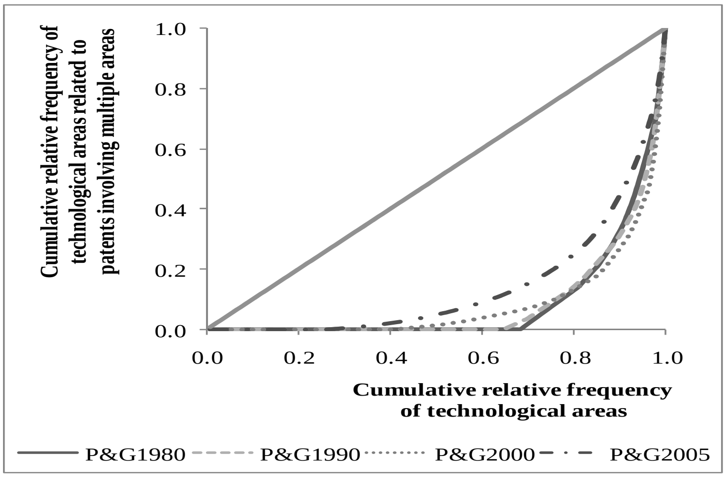
Number of patents with multiple technological areas				
	1980	1990	2000	2005
P&G	44(37.3%)	57(42.9%)	245(33.5%)	197(57.3%)
KAO	22(66.7%)	37(62.7%)	63(49.2%)	75(67.0%)

Source: USPATFUL.

That is, it can be speculated that there is growing interconnectedness among various technological areas, which creates technological diversities. In line with this assumption, the authors conducted the above-mentioned comparative analysis to examine the gaps among technological areas. The authors calculated the cumulative percentages of patents involving multiple areas with a focus on the period from 1980 to 1990 and compared the values graphically by the Lorenz curve.

Figures 11 and 12 illustrate the Lorenz curves depicting the number of P&G's and Kao's technological areas, respectively. Figures 11 illustrates that P&G's curves of 1980 and 1990 got closer to the perfect equality line.

FIGURE 11: P&G'S LORENZ CURVE



Source: USPATFUL.

However, the company's curve of 2000 was farther away from the perfect equality line than those of 1980 and 1990. This tendency can also be observed in the Gini coefficients in Figure 13. This chart suggests that the coefficients decreased from 1980 to 1990 but that increased from 1990 to 2000. The company's Lorenz curve of 2000 offers the reasons for this.

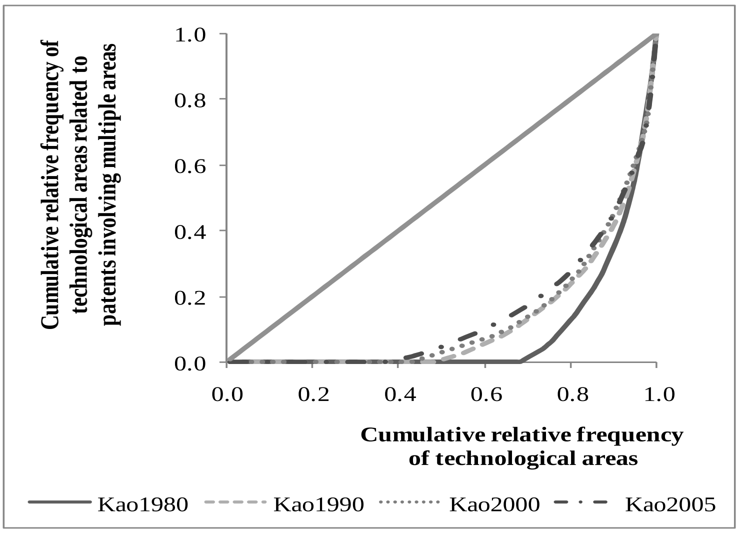
The curve suggests that in comparison with the cumulative percentages of technological areas, the higher percentages of patents involving multiple areas marked remarkable increases. These noticeable increases result from patents increasing in the fields of A61K[iii] and C11D[iv] more dramatically than in other technological areas. (A61K scored a 8.5-fold increase from 1980 and a 5.6-fold increase from 1990; C11D marked a 7.9-fold increase from 1980 and a 510.7-fold increase from 1990.)

In this way, many patents involving multiple technological areas, including these two specific fields, were obtained in 2000. In addition, in 1980 and 1990, C11D ranked on top in the number of patents involving multiple areas and A61K came in second. These facts suggest that the two technological areas play a central part in patent acquisitions and that many patents have been intensively obtained in these areas in recent years. P&G has been producing numerous patents combining multiple technological areas with a particular emphasis on A61K and C11D, which boosts technological diversities.

Moreover, with a focus on the initial stages of P&G's Lorenz curve of 2000, the curve clearly shows a gradual increase relatively with other periods. This suggests that in this year, P&G obtained more patents involving multiple areas than in other years. That is, in recent years, patent acquisitions have focused not on particular areas but on combined wider areas, which contributes not only to the expansion of technological diversities but also to the closer linkage of individual areas.

In contrast, in Kao's case, the Lorenz curves consistently got closer to the perfect equality line from 1980 to 2000 (See Figure 12). The Gini coefficients on the gaps among technological areas constantly decreased during the same period of time (See Figure 13).

FIGURE 12: KAO'S LORENZ CURVE



Source: USPATFUL.

FIGURE 13: THE GINI COEFFICIENT ON THE NUMBER OF PATENTS INVOLVING MULTIPLE AREAS

Gini Coefficients	1980	1990	2000	2005
P&G	0.829	0.830	0.831	0.718
KAO	0.823	0.753	0.735	0.712

Source: USPATFUL.

These data show that the company's gaps by area in the number of patents involving multiple areas narrowed. With respect to the Japanese company's patent acquisitions involving multiple technological areas, there was a noticeable shift from an intensive focus on particular areas to a broader focus on various areas. This is probably because the company has launched joint research and development projects well beyond the walls of technological fields. In addition, Kao also came to place a stronger focus of attention on A61K and C11D, which form the core of P&G's patent acquisitions. In this case, it can be said that in recent years, patent acquisitions have focused on combined wider areas with a remarkable emphasis on A61K and C11D, which contributes not only to the expansion of technological diversities but also to the closer associations of individual areas.

To summarize the insights into both companies' patent acquisitions in the United States in recent years, patent innovations involving multiple technological areas, including A61K and C11D, have been aggressively conducted, which boosts technological diversification and interconnectedness among various areas. This growing interconnectedness has provided more necessity for research and development activities.

5. Conclusion

Companies running international activities have been making steady efforts to utilize external knowledge and conduct transnational R&D activities amid the rapid globalization of markets and competitions. However, many theories on knowledge creation, including strategic management theories and innovation theories, seem to be argued, based on the assumption that contexts are homogeneous under the same cultural environment against the background of the industrial digitalization and the market globalization. In addition, traditional knowledge creation theories have hardly highlighted the impact of cultural and technological diversities on knowledge creation processes and the dynamic interconnectedness between them. This study has examined the impact of cultural and technological diversity on corporate R&D activities that can be regarded as knowledge creation processes. In analyzing this aspect, the report set the following two hypotheses. Hypothesis 1: To develop products from new concepts, it is necessary to integrate multiple concepts by organizing a wide variety of members who have diverse cultural backgrounds; and Hypothesis 2: To develop products from new concepts, it is necessary to integrate a wide range of technological ideas in an effort to create new technologies, which eventually leads to projects taking on a tone of technological diversity.

As the analytical methods to examine these hypotheses, this study focused on technological papers and patents reflecting outcomes of corporate R&D activities and categorized their inventors' institutes, divisions, genders and nationalities, and their technological areas with the intent of extracting "cultural and technological diversities" using those factors. As a result of these explorations, the authors have noted that there is increasingly dynamic interconnectedness between knowledge creation and cultural and technological diversity. This means that the boundary management of strategic knowledge creation combining multi cultural and technological areas is becoming increasingly important. To conclude the paper, the organizational knowledge creation with a focus on the close interconnectedness between knowledge creations and cultural and technological diversities forms the foundation for organizational dynamic capabilities enabling entities to evolve on their own in response to highly competitive global environments. That is, in an era when global competitive conditions are changing rapidly, corporate competitive advantage can be attributed primarily to the management of diversity" to fully utilize cultural and technological diversities, especially the boundary management capability to handle strategic knowledge creation in the "boundary" where multi technological areas meet. In the fast changing competitive environments, a major paradigm shift in innovation systems is required from those by increasing R&D investment and the number of R&D personnel toward those by strategically leveraging cultural and technological diversity.

The paper, however, still remains following several issues to be solved. In addition to the two limited number of companies which belong to the toiletry industry, it does not demonstrate the knowledge creation mechanism in the boundary between project members which consist of diverse cultural and technological backgrounds. It is also necessary for the boundary management to clarify the relationship between knowledge transfer and the difference of contexts among these diverse project members with diverse cognitive approaches in creating new knowledge in the boundary.

Authors' Profile

References

Adler,N.(1991), *International Dimensions of Organizational Behavior*, Cincinnati: South Western,

Amabile, T.A(1998), HOW TO KILL CREATIVITY, *HBR*, Sep.-Oct. 77-87

Amabile, T.A(1996), *Creativity in Context*, Boulder: Westview.

Ancona D.G., and Caldwell D.F.(1997), Managing Teamwork Work, in Tushman,M.L. and Anderson P.,(eds), *Managing Strategic Innovation and Chang*e, NY: Oxford University Press, 432-440.

Argyris, C. and D.A. Schon (1978), *Organizational Learning: A Theory of Action Perspective*, Reading, MA: Adison-Wesley.

Asakawa,K.(2002), 'Gurohbaru R&D Senryaku To Narejji Manejimento', *Soshikikagaku*, 36-1, 51-67.

Asakawa,K.(2006), 'Metanashoraru Keieironn Ni Okeru Rontenn To Kongo No Kennkyuu No Houkousei', *Sosikikagaku*, 40(1), 13-25.

Badaracco,Jr.J.L.(1991), *The Knowledge Link*, Boston: Harvard Business School Press.

Boer,F.P,(1999), *The Valuation of Technology*, NY: John Wiley & Sons.

Brown,S.L. and Eisenhardt,K.M.(1998), *Competing on the Edge*, Boston: Harvard Business School Press.

Burgleman ,R.A, Maidique,M.A. and Wheelwright,S.C.(2001), *Strategic Management of Technology and Innovation*, NY: McGraw-Hill.

Cantwell,J, Gambardella,A. and O.Grandstrand(2004), *The economics and management of technological diversification*, London: Routledge.

Carlile, P.R.(2004), "Transferring, Translating, and Transforming: An Integrative Framework for Managing Knowledge Across Boundaries", *Organization Science*, 15(5), 555-568

Chesbrough,H.W(2003), *Open Innovation*, Boston: Harvard Business Scholl Press.

Chesbrough,H.W(2006), *Open Business Models*, Boston: Harvard Business Scholl Press.

Cooper, R.G(2001), *Winning at New Products*, NY: Basic Books.

David, E.(2006), Creating value from cross-cultural teams, *Cross Cultural Management*, 13(4), 316-329.

DavidJ.P, Ling-Ling,W and Sally D.(2007), "Exploring the relationship between National and Organizational Culture, and Knowledge Management", in D.J.Pauleen(ed), in *Cros Cultural Perspectives on Knowledge Management*, London: Libralies unlimited, 3-19.

Dosi,G, Nelson,R.R. and Winter,S.,ed.(2000), *The Nature and Dynamics of Organizational Capabilities*, London: Oxford University Press.

Doz,Y.(2006), 'Meta Nashonaru Inobeishon Purosesu Wo Saitekika Suru', *Soshikikagaku*, 40(1),4-12.

Doz,Y., Santos,J., and Williamson,P(2001), *From Global to Metanational*, Boston: Harvard Business School Press.

Finke,R, Ward,T. and Smith,S.(1992), *Creative Cognition*, Cambridge: MIT Press.

Fleming,L.(2004), Perfecting Cross- Pollination, *Harvard Business Review*, Sep, 22-24

Hall, E.D.(1976), *Beyond Culture*, NY: Anchor Books.

Hamel,G., and Prahalad,C.K.,（1994）,*Competing for the future*, Boston: Harvard Business School.

Haas,P.(1992), Introduction: Epistemic Communities and International Policy Coordination, *International Organization*, 46-1, 1-35.

Hayashi,T.(2007), 'Dejitaru Shinshugijidai No Senryakutekikadai To kyosoyuhi', in *Yubikitasu Jidai No Sangyou To Kigyo*, Tokyo :Zeimukeirikyokai, 81-105.

Hayashi,T. and Serapio,M.(2006), Cross-Border Linakages in Reasearch and Development: Evidence from 22 US, Asian and European MNCs, *Asian Business and Management,* 15(2), 271-298.

Hayashi,T.(2004), 'Gijutsukaihatsuryoku no Kokusaiteki Bunsanka To Shuhchuhka', *Rikkyo Keizaigaku Kenkyu*, 57(3), 63-88.

Hofstede,G.(1991), *Cultures and Organizations*, London: Harper Collins Business.

Hofstede,G.(2001), *Culture's Consequences*, London: Sage Publications.

Husto,L. and Skkab,N.(2006), Connect and Develop, *HBR*, March.

Iwata,T.(2007), *Gurohbaru Inobeishon No Nettowahkuka*, Tokyo:Chuoukeizaisha.

Leonard-Barton,D.(1998), *Wellsprings of Knowledge*, Boston: Harvard Business School Press.

Lester, R.K. and Piore,M.J.,(2004), *Innovation: The Missing Dimension*, Boston: Harvard University Press.

Magoshi,E.(2000), *Ibunka Keieiron No Tenkai*, Tokyo:Gakubunsha.

Medcof, J.(2001),"Resource-based strategy and managerial power in networks of internationally dispersed technology units", *Strategic Management Journal*, 22(11), 999-1012.

Little,S. , Quintas.P., and Ray.T(eds)(2002). *Managing Knowledge*, London: Sage Publicatons.

Mason,R.(2006), "Culture : An Overlooked Key to Unlocking Organizational Knowledge", in

D.J.Pauleen(ed), *Cross Cultural Perspectives on Knowledge Management*, NY: Libralies unlimited, 21-34..
Nonaka,I. and Takeuchi,H.(1995) The Knowledge Creating Company, NY: Oxford University Press.
Nonaka,I., R.Toyama and N.Konno(2002), "SECI, Ba and Leadership: a Unified Model of Dynamic Knowledge Creation", in Little,S, P.Quintas and T.Ray)eds), *Managing Knowledge*, London: Sage Publications, 41-67.
Pauleen,D.J.(2007), Cross –Cultural Perspectives on Knowledge Management, London: Libraries Unlimited.
Pearce,R.D. and Papanastassiou,M(1996), R&D networks and innovation :Decentralized product development in multinational enterprises, *R&D Management*, 26(4), 315-333.
Pink,D.H.,(2005), *A Whole New Mind*, NY: Riverhead Books.
Roberts,E(2001), Benchmarking Global Strategic Management of Technology, *Research Technology Management*, 44(2), 25-36.
Rosenbloom,R. and Spencer,W.(1996), *Engines of Innovation*, Boston: Harvard Business School Press.
Serapio,M and Hayahshi,T(eds.)(2004), *Internationalization of R&D and the Emergence of Global R&D Networks*, London: ELESEVIER
Shein,E.H.(2004), *Organizational Culture and Leadership*, the third edition, San Fransisco: Jossey-Bass
Shouyama,Y(2001), 'Gurohbaruka SuruSehinkaihatsu No Bunsekishikaku', *Soshikikagaku*, 35(2), 81-94.
Szulanski,G.(1996), "Exploring Internal Stickiness: Impediments to the Transfer of Best Practice within a Firm", *Strategic Management Journal*, 17, 27-44.
Takahashi,H.(2000), *Kenkyukaihatsu No Gurohbaru Nettowahku*, Tokyo:Bunshindo.
Teece,D.J., Pisano,G., and Schuen,A., （1997） ,"Dynamic Capabilities and Strategic Management," *Strategic Management Journal*, 18(7), 509-533.
Teramoto,Y.(2005), *Kontekisutotenkann No Manejimento*, Tokyo:Hakutohshobo.
Tidd Joe, Bessant John and Pavitt Keith(1997), *Managing Innovation*, NY: John Wiley& Sons
Trompenaas.F. and C.Hampden-Turner, *Riding the Waves of Culture*, NY: McGraw-Hill.
Von Hippel, Eric(1994), Sticky Information and the Locus of Problem Solving: Implications for Innovation, *Management Science*, 40(4), April, 429-439.
Wenger,E., Mcdermotto,R. and Snyder, W.M.(2002), *Cultivating Communities of Practice*, Boston: Harvard Business School Press
Zaltman,G.(2003), *How Customers Think: Essential Insights into the Mind of the Market*, Boston:Harvard Business School Press.

---

[i] The T-shaped capability embodies the competent skills of further deepening knowledge of one's one specialty field, and the integrative and generative ability to forge new technological meeting points with other fields of specialty (D. Leonard, pp.75-77). The notable American industrial design firm, IDEO, mentions this T-shaped capability on its website (http://www.ideo.com/ideo.asp) "People here are T-shaped: broad and deep. Broad in their skills and interests and able to work with a wide range of people. Deep in their knowledge and experience in one or more disciplines."

[ii] The "Kao Way" consists of "Mission," "Vision," "Values" and "Principles." "Mission" means what they exist for—the satisfaction and enrichment of the lives of people; "Vision" means where they want to go—to be closest to the consumer and customer; "Values" means what they believe in—*Yoki-Monozukuri* (good goods creation), innovation and integrity; and "Principles" means how they behave—consumer-driven attitude, Gemba-ism, respect, teamwork and global perspective. In addition, Kao's Five Principles of Product Development consist of "usefulness and value to society," "creativity and originality," "effective cost performance," "thorough market and customer research" and "comprehensive features of retailers" (Refer to Kao's official websites.).

[iii] A61K includes the following areas: dental pharmaceuticals, cosmetics and other related pharmaceuticals, medical pharmaceuticals characterized by special physical forms, medical pharmaceuticals with organic and inorganic active materials and so forth.

[iv] C11D is the code of the following areas: cleansing composites, the use of single materials as washing agents, soap and soap manufacturing and so on. For details on these patent fields, refer to http://www.ipdl.inpit.go.jp/Tokujitu/tokujitu.htm compiled by the National Center for Industrial Property Information and Training.