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DSSR

Discussion Paper No. 6

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May 2013

Data Science and Service Research
Discussion Paper

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Research into Ambidextrous R&D in Product Development
New Product Development at a Precision Device Maker

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Abstract

Through research into new product development processes at a precision device maker, this paper discusses the skilful management of knowledge boundaries that lie between various organizations, and between specialized human skills and functions that make up a project organization, and presents the ways in which new organizational capabilities are brought about for the development of new products, as exploratory activities that dynamically merge and integrated the various knowledge within a company. This paper describes some of the implications derived from analysis and observations of the new organizational forms of the company's ambidextrous R&D management which the company uses to engage in both 'uncertainty management (exploration)' and 'existing product management (exploitation),' through the partnering of its existing formal organizations and dynamic structuring of diverse multifunctional teams formed as projects spanning different specializations and capabilities.

1. Introduction

In knowledge firms, the diverse knowledge that human beings have is a resource that can give rise to valuable, new and competitive products, services and business models (e.g., Kodama, 2011). The research question of this paper is "What kind of management is executed in companies that not only maintain competitiveness with their core products, but are able to continually develop new and superior products?"

This question arrives back at classic research questions (March, 1991) as to how 'exploration' and 'exploitation' should be combined. R&D companies in particular must achieve innovative new products through the acquisition of new knowledge and capabilities to ensure growth over the long-term, while at the same time, these companies must also ensure profitability in the short term by raising the level of efficiency and reliability of existing products and so on.

The dilemma posed by these different corporate activities of exploration and exploitation remains as an important research theme in present-day innovation and technology management. The message from existing research is in its implications for improving corporate performance by maintaining an appropriate balance between exploratory and exploitative activities (e.g., McCarthy and Gordon, 2011: Ahn, et al., 2006: Kodama, 2009: Gibson and Birkinshaw, 2004) and in the promoting of synergies between exploratory and exploitative activities (He and Wong, 2004). From the viewpoint of organizational theory however, 'ambidextrous organizations' (organizations that operate along 2 fronts) (Tushman and O'Reilly, 1996) have been reported to be the best organizational systems for combining exploration and exploitation and succeed in exploratory activities to develop new businesses.

Of course, exploratory activities aimed at new product development present challenges for a company in maintaining its competitiveness. Many high-tech corporations in high-risk industries are directly faced with the challenges of executing imaginative and efficient management to develop new products and services where markets, technologies and the competitive landscape are rapidly changing (uncertainty of success, development costs etc).

One solution that many high-tech companies have used to promote their exploratory activities is to flatten company hierarchies and form cross-functional teams (CFTs) and project-based organizations with a high degree of organizational integration, into which these companies invest resources for new product development. Although market conditions and the state of technology is contingent to successful new product development with project-based organizations or CFTs, it has been reported that a high level of organizational integration is an effective method of product development when attempting to develop new products in such risky or uncertain circumstances (e.g. Gemser and Leenders, 2011).

Multinational corporations (MNCs) (e.g., Forsgren, 1997; Bartlett and Ghoshal, 1989;

Nohria and ghoshal, 1997) create project-based organizations as horizontally integrated organizational structures that are more flexible and flatter than the hierarchies in conventional organizational systems (e.g., Child and McGrath, 2001; Child and Rodrigues, 2003). In highly volatile markets and fluctuating technological circumstances, these flexible and autonomous project-based organizations are a suitable organizational system for integrating knowledge both inside and outside the company to bring about new products, services and business models (e.g.,Lundin and Midler, 1998; Hobday, 2000; DeFillipi, 2002; Lindqvist, 2004). In these systems, project team members work towards common objectives by collaborating under a fixed timetable (e.g. Henrie and Sousa-Poza, 2005).

As an organizational form, the project team has been applied in a wide range of industries to date. Classic examples include the construction business (e.g., Gann and Salter, 1998), IT and communications industries (e.g., Kodama, 1999), the automotive industry (e.g., Clark and Fujimoto, 1991), media industries (e.g., Windeler and Sydow, 2001; DeFillippi and Arthur, 1998) and consultancy and service businesses (e.g., Alvesson, 1995).

Essentially, as temporary organizations, project-based organizations are formed from specialist staff within a company, who work together over a fixed time period, and are on a mission to bring about new products in response to specific customer demands. However, in organizations like consultancy firms in which there is hardly any routine business, the entire company can be thought of as a collection of project-based organizations.

There is a wealth of accumulated research into project-based organizations (e.g., Turner, 1999; DeFillippi, 2001; Sydow, Lindkvist and DeFillippi, 2004) and diversity among theorists regarding related terminology.

Firstly, project-based organizations consist of individual functions and resources both inside and outside of the company (for development, manufacturing and sales etc), and there are different systems for executing business between project-based organizations and existing organizations (Hobday, 1998, 2000; Prencip and Tell, 2001). Secondly, in order to meet the greatest challenges facing large corporations (projects to improve business efficiency, new product development projects etc), members of established organizations are temporarily brought together as a project team in which team members take charge of executing business (e.g., Midler, 1995; Keegan and Turner, 2002). Thirdly, there are matrix systems in which team members participate in additional projects while performing their main business duties in their existing organizations (e.g., Galbraith, 1969). And fourthly, there are systems in which project-based organizations are formed unofficially by members of existing organizations both inside and outside of the company (e.g., Kodama, 2005).

Although there are some meanings and terms described for these various project-based organizations, for the purposes of this paper, these are redefined as just project-based

organizations.

Through research conducted into new product development processes at Japanese company Mabuchi Motor, this paper describes the dexterous management of the project-based organizations that the company forms across the knowledge boundaries between different organizations and human skills and capabilities, and presents the ways that new organizational capabilities are brought forth by dynamically merging and fusing the diverse knowledge inside of the company as "exploratory activities" to develop new products. This paper also observes and analyses the tiered organizational structures of Mabuchi's ambidextrous R&D that enable the company to dually engage in "uncertainty management (exploration)" and "existing product management (exploitation)," by dynamically linking diverse skills and capabilities as various project-based organizations formed from its existing official organizations.

The structure of this paper is as follows: Firstly the paper reviews the existing research into project-based organizations. Secondly the paper describes the research methodology used. Thirdly, the paper presents a theoretical framework. Fourthly, the paper describes and analyses the case study of the processes of new product development at Mabuchi Motor. Section 5 describes observations from the case study. Finally, the paper describes new insights and implications that can be derived from the research.

2. Literature Review

2.1 The Characteristics of Project-based organizations

Terminology describing project-based organizations has been expressed with the following words: "A project is a temporary organization to which resources are assigned to undertake a unique, novel and transient endeavor managing the inherent uncertainty and need for integration in order to deliver beneficial objectives of change" (Turner and Miller, 2003, p.7) and "Project-based organizations refer to a variety of organizational forms that involve the creation of temporary systems for the performance of project tasks. " (Sydow, Lindkvist and Defillippi, 2004, p.1475)

Project-based organizations are effective exploratory mechanisms for facing challenging new and high-risk products, or dealing with new issues as they surface, but because project-based organizations are formed to execute specific business tasks, they are usually temporary and specially formulated organizations.

This is not always the case however, especially in Japanese corporations. For example, there are companies that adopt project-based organizations as organizations charged with exploratory activities aimed at driving strategy into the future. Also in Japanese corporations, project-based organizations are not only formed as official organizations, but are also formed informally as ad-hoc project-based organizations through unofficial networks across functional organizations

(Kodama, 2007).

Not only can project-based organizations be interpreted as simply existing as closed organizations within a company or between the company and certain customers, but also as organizations formed across wide-ranging networks between companies that include customers, group companies and partners (these can appropriately be called project networks). Accordingly, as well is the idea of projects existing as temporary, autonomous and closed systems, this paper also describes project-based organizations as "organizational structures optimized to formulate and execute future strategies, and achieve particular business objectives through the merging and coordination of resources and capabilities that exist both inside and outside of the company, including its customers."

The following section describes some of the important differences between projects in western companies and projects in Japanese companies.

In existing academic research that has focused on western companies, projects are seen as a favorable method that should be adopted to bring about innovation (e.g. Hobday, 2000; Lundin and Midler, 1998). In contrast however, since the majority of project-based organizations are temporary organizations, it has been pointed out that there is often insufficient accumulation of knowledge within project themselves, and that there are difficulties with organizational learning through transferring and sharing of knowledge with other project-based organizations or existing organizations (e.g. DeFillippi, 2001; Keegan and Turner, 2001; Grabher, 2002; Newell et al, 2003; Prencipe and Tell, 2001; Middleton, 1967). This means that the difficulties in transferring and sharing knowledge smoothly with other organizations is due to some degree of constraints arising with "exploitative activities" for improving and upgrading new products where related technical skills and know-how must be shared with other organizations (organizations other than those whose members are engaged in the product development project).

How do project-based organizations in Japanese companies deal with this problem?

In comparisons made with western companies to date, research has verified that Japanese companies encourage mutual learning, knowledge transfer and sharing among project-based organizations and between project-based organizations and existing organizations (e.g., Kodama, 2011). Therefore, regarding the aforementioned proposition that the nature of projects in these kinds of Japanese companies is characterized by sustained new product development (exploration), combined with the strengthening of existing products (exploitation), this paper aims to present a new framework that can have beneficial effects.

Following is a general review of the organizational systems of project-based organizations identified to date.

2.2 Communities of Practice and Collectives of Practice

Firstly, here are a few observations about the organizational forms that are intrinsically related to the framework of a project-based organization. In recent research, Lindkvist (2005) compared and analyzed knowledge activity typologies of communities of practice (Wenger, 1998) and identified characteristics of new organizational behaviors of temporary projects. Just as Wenger (1998) stated, a project is clearly different from a community of practice. A community of practice is a group formed from actors with similar specializations and capabilities within the company. These groups are basically characterized as learning communities (Lave and Wenger, 1991; Brown and Duguid, 1991; Orr, 1996) consisting of groups of specialists in the same field (i.e. actors who specialize in sales, development, production etc).

A community of practice has no dependency on any specific personal knowledge. The members of these groups create and share a consistent knowledge base among themselves through gently-paced and sustained cooperative endeavors, and knowledge accumulated through sustained learning in communities of practice has advantages for organizational growth. In these communities, the knowledge boundaries between actors (Brown and Duguid, 2001), who are in the same areas of specialization and perform similar functions, are comparatively small, and community members also operate in similar thought worlds (Dougherty, 1992).

Furthermore, these communities are mainly concerned with routine and daily business, and so do not have to deal with high levels of novelty or uncertainty. Thus, there is not much conflict or friction between the actors in these communities. As members bring forth and deeply share new meaning from their day-to-day business routines, they encourage gradual improvements and upgrade activities through learning. In other words, they engage in exploitative activities.

However in contrast to communities of practice, members of project-based organizations gather together from a diverse range of specializations. Lindkvist (2005, p.1190) has observed that organizational behaviors in projects are as follows: "Typically, such temporary organizations or groups within firms consist of people, most of whom have not met before, who have to engage in swift socialization and carry out a pre-specific task within set limits as to time and costs. Moreover, they comprise a mix of individuals with highly specialized competences, making it difficult to establish shared understandings or a common knowledge base. Such a transient group, I suggest, operates more like a 'collectivity of practice.'"

As far as objectives are concerned, projects are highly autonomous. Notably projects have strict time limits in which to reach their goals, and thus in contrast to communities of practice, they do not have sufficient time to learn by accumulating and sharing knowledge by spending time on new behaviors. Therefore, projects are strongly dependent on the individual knowledge and capabilities of their team members.

Projects do not depend on common values and knowledge like communities of practice, rather, project members have to perform their jobs based on the highly dispersed personal knowledge of the team members, while project leaders are under particular pressure to provide coordination that merges and unifies the unique knowledge and capabilities of the individual team members. As a result, when the project is over and the team disbands, individual members walk away with more accumulated and personal knowledge. However, this knowledge doesn't seem to be easily transferred or shared with other projects or other existing organizations.

There are actual cases of projects that are as follows: Once a project for a particular client has finished, and the project disbands, it has been suggested that organizational learning becomes difficult within the project, between projects and between projects and existing organizations (e.g. DeFillippi, 2001; Keegan and Turner, 2001; Grabher, 2002; Newell et al, 2003; Prencipe and Tell, 2001; Middleton, 1967). However, once the results of the project have been deployed by the client, it is no good if the client company and the project company both say "great! That's that! Finished!" because in IT systems or large-scale systems for instance, there will be a substantial amount of follow-up with maintenance and upgrading, and as such, some project members who were involved right from the beginning will have to continue to work on the product (because these are the people who have the technical skills and know-how, and remember the circumstances and details of the project).

This type of progression is an example of moving from exploratory activities at the outset to exploitative activities later on. Depending on the type of project, if there are cases that continue as they are in the form of a project, then there should be cases where control of projects is transferred to existing organizations, but this all depends on organizational operations in the individual company or on the human resources available in the company at the time.

Business people involved in 'collectives of practice' must face the large knowledge boundaries and varied thought worlds across their differing capabilities and areas of specialization, and because of greater factors of novelty and uncertainty, project-based organizations are places where big conflicts and friction can occur easily.

Figure 1 illustrates communities of practice and collectives of practice like these with axes describing the size of knowledge boundaries between actors, the level of conflict and friction between actors, and the differences of thought worlds that the actors have.

In communities of practice, actors who have knowledge of similar capabilities and specializations (actors with small knowledge boundaries between themselves) also share a similar thought world, and engage in business practices through deep dialogue and collaboration (low levels of friction and conflict between actors) based on common contexts and meanings, and then embed new knowledge in their group or organization as it arises.

In contrast, collectives of practice are characterized by knowledge of dissimilar

specializations (large knowledge boundaries exist among actors, and as a result there is greater conflict and friction) and actors coming from different thought worlds. Collaboration and coordination in these communities is based on a bare minimum of shared and common knowledge. Thus, through the fusion of individual specializations in collectives of practice, results are delivered as new explicit knowledge - new objectives reached.

Characteristically, communities of practice and collectives of practice also involve completely opposite ways of thinking.

As a simple classification of these types of organizations, groups such as divisions, departments or sections with similar functions or specializations within a company can be said to be communities of practice, while temporary projects can be said to be collectives of practice. However, is it really possible to describe all projects in a company as collectives of practice?
In recalling experiences as a project manager and leaders, we found that there was even more complexity to real-life organizational systems, including project-based organizations charged with executing various strategies.

Based on existing research into the above project-based organizations, the theoretical framework described by this paper is explained as a new organizational concept called "teams of boundaries (ToB)." The research question as to the extent to which exploration and exploitation can be combined in this theoretical framework also ties in with the discussion about the way an organizational system should be in order to combine 'uncertainty management (exploration)' and 'existing product management (exploitation).'

3. Research Methodology and Data Collection

Due to the exploratory nature of this research and interest in identifying the main people, events, activities, and influences that affect the progress of innovation, in the methodological approach chosen for this study, we adopted a qualitative, in-depth case study. This study enabled us to collect rich data and generate theoretical categories that we could not derive satisfactorily from existing theory. By developing a theory using case studies, the researcher is able to initiate the study as close as possible to the ideal of no theory under consideration and no hypotheses to test.

Various scholars (Eisenhardt, 1989; Pettgrew, 1990; Yin, 1994) have discussed the validity of case studies. Case studies make it possible to explain the relevance and cause-and-effect relationships of a variety of observations through deep and detailed insights with consideration given to qualitative information and subjectivity resulting from the peculiarities of individual cases and the difficulties of general analyses. Case studies not only compensate for the weaknesses of generalities but are also indispensable to new and creative theorization.

The case study in this paper enables a detailed analysis of specific focal points within the company in question, such as their internal strategies, organizational structure, culture and capabilities, as a means to understanding how specific innovation objectives were achieved.

The Mabuchi case study is based on in-depth interviews with senior managers, and on internal and external materials. Based on the data obtained from field studies, we first produced an in-depth case concerning the Mabuchi business. Next, based on this study, we performed analyses and observations of new product development management. Finally, we drew a number of managerial implications from these analyses.

4. Theoretical Framework

4.1 Project-Based Organizations as 'Teams of Boundaries'

As people with experience as a project team managers and leaders, and through dialog with business people in a number of companies, we have clearly recognized aspects of collectives of practice as project team behavior. However, we believe that the nature of projects depends considerably on countries and individual corporate cultures. Furthermore, project team actions vary depending on the goals of each individual project (e.g. the complexity and level of difficulty of business models, difficulty of product development, demands of particular clients etc.)

Firstly, different factors in countries or corporations bear a relationship with the training of project managers and leaders. Compared to Japanese companies, western companies show much clearer career paths due to greater segmentation of competencies and fields of expertise.

For example in western companies, there are often clear distinctions between project managers who specialize in management, and technical staff who are concerned with fundamental research and engineering (in product development etc). In much of the existing research, these western training systems have been called the 'dual ladder system' (e.g., Bailyn, 1991; Maccoby, 1999; McKinnon, 1987; Allen and Kats, 1986; Kochanski, 2003), and it has been often reported that these western-centered systems function well (e.g., Gunz, 1980; Omta and van Engelen, 1998). 3M is a well-known American example that uses this dual ladder system to bring about its innovative products.

In western companies, project management is executed by specialist business coordinators who are charged with managing the progress of projects, confirming that milestones have been reached, managing the individual tasks of project members, and solving problems as they arise. Accordingly, these personnel understand the detailed technical aspects of a project and are committed to their careers.

However, project management mechanisms in Japanese companies differ on this point. Project leaders and project managers are not just managers, although in nearly all cases these personnel are

also committed to understanding technical details. In particular in the electronics, machine tool and ICT fields, there are a wide-range of specialist demands placed on project managers and leaders.

In the case of corporations, after earning a bachelor or graduate degree and joining a company, diverse career paths await new employees in which they will gain experience in a variety of competencies and specialist divisions. In electronics manufacturers, bachelor and graduate degree holders from technological universities will embark on training paths that advance their skills as engineers from micro technologies through to macro technologies. For instance, they begin by learning about individual components and parts, and then move on to the technologies and designs of entire systems, and there are often cases in these training paths in which people are moved into factories, product planning and marketing departments, and even into sales. Thus, project leaders and managers will usually have experience in more than one specialized field and hold a number of competencies. With each advancement and new responsibility, these people have been able to polish their skills in managing subordinates and coordinating with departments, including those that deal with external partners[1].

In this way, we believe that these experiences in varied fields of expertise and competencies foster a comparatively greater degree of flexibility in project leaders and managers in Japanese companies. For instance, project leaders and managers who start out on the technical side of things learn to propose new technologies from the point of view of marketability, while those leaders who started out in sales and marketing are highly motivated to learn more about technology, something that is relatively foreign to them. Thus, Japanese project managers tend to place great importance on efforts to root out the relationships between markets and technologies.

Based on these crossover career paths of project leaders and managers, this paper defines the thought worlds of individuals with skills in different areas of specialization as "shared thought worlds," in which the redundancy or overlapping of those individual thought worlds is retained.

Project leaders and managers in Japanese corporations do not only have to manage people, things and money, they also must also have wide-ranging specialized technical knowledge, and as they implement project management, these leaders must coordinate and cooperate with existing organizations, and even carry out business linked to other projects, even though these are dependent on individual corporate cultures.

At the outset, projects in Japanese companies are formed officially or unofficially beginning with participation from a variety of existing 'community of practice' functional organizations, in which the mutual sharing and transfer of knowledge and know-how between existing organizations is of particular importance. These project teams often consist of colleagues who have worked together in the past, bosses, subordinates, and members of staff who are old acquaintances. Therefore, there are not very many people in Japanese project-based

organizations who have never met (Lindkvist, 2005, P.1190), and so there are many cases in which people enter into projects with shared understandings and mutual knowledge (Cramton, 2001), and common knowledge (Carlile, 2002) that preexists the formation of the project.

Thus, we conceptualize the fundamental knowledge on which projects are based in Japanese companies as not only knowledge as skills and know-how refined by individuals, or knowledge in a particular field of expertise, but also as a complete merging of these with the "knowledge abilities" (Orlikowski, 2002) and "competences in practice" that have come to be embedded in the organization from its business practices across its history (Lave, 1988; Wenger, 1998). This can also be viewed as the group knowledge of a community of practice combined with the knowledge held by individuals in collectives of practice. This paper describes this as the 'harmonized knowledge' of a project.

The following discusses behaviors among project team members.

The more a business proposition is like a project, the greater the level of novelty and uncertainty stemming from the context and details of it, and the greater the number of problems and issues that will arise in the process of executing it. Naturally, project members will experience conflicts and friction among themselves, and due to time constraints, often team members will look for trade-offs and compromises.

However, project teams should not just look for these kinds of solutions. As has been observed in our case study research, project members often aim to find genuine combinations and integration through thorough accumulation of dialogue and discussion among themselves, however contradictory, rather than just seek compromise (Kodama, 2005). These ideas of "practical yet creative confrontations or abrasion" (Leonard-Barton, 1995) and "productive friction" (Hagel III and Brown, 2005) can act as wellsprings of new and creative knowledge.

A higher-up in one company (Canon marketing) described projects as "battles."… Japanese corporate projects also feature many cases where other organizations or projects offer support by helping out or lending a hand to a project (cases at Sharp), as well as regular and familial meetings within projects (cases at Honda).

This paper describes the simultaneous pursuit of organizational actions by members in projects that confront the knowledge in collectives of practice, and fuse the familiar knowledge from communities of practice, as the "creative collaboration" of a project.

The following describes the characteristics of the knowledge boundaries that are required for project management to achieve innovation.

It goes without saying that knowledge is a source of corporate competitiveness (Kogut and Zander, 1992; Nonaka and Takeuchi, 1995; Leonard-Barton, 1995). We believe that the starting point for setting down and executing strategies is knowledge held by human beings. Tacit knowledge as skills, know-how and competences are embedded in individual people (Brown

and Duguid, 1991), and in the process of integrating the knowledge necessary for project management (Kodama, 2011a), knowledge held by various people both in and out of the company must be gathered and integrated across organizational boundaries.

There is a strong tendency for new knowledge to be created, in other words innovation, along the boundaries between different principles and areas of expertise (Leonard-Barton, 1995), and corporations have within them diverse functional organizations assigned to different fields of expertise, among which many boundaries, both visible and invisible exist.

However as previously stated, conflicts and frictions often arise among actors with different knowledge and present obstacles to knowledge merging (Leonard-Barton, 1995). These are not just organizational boundaries that exist as sectionalism among actors in a corporation, but also the different values that individual actors hold, and knowledge boundaries that exist as a result of their differing backgrounds and areas of specialization (Brown and Duguid, 2001).

This is because the actors become dominated by their fixed mental models that have evolved from their different backgrounds and experiences (e.g. Markides, 1999; Spender, 1990; Grinyer and McKiernan, 1994), or have become dominated by path dependency (Rosenberg, 1982; Hargadon and Sutton, 1997), and thus feel uncomfortable when faced with unfamiliar or new knowledge along organizational boundaries and become resistant to it (Carlile, 2002).

Existing research has shown that corporations and organizations in which fixed mental models dominate are often unable to avoid competency traps (Levitt and March, 1988; Martines and Kambil, 1999) and core rigidities (Leonard-Barton, 1992, 1995), and as a result of their path-dependent knowledge, they miss opportunities for innovation (Christensen, 1997).

Therefore, in a world of fluctuating markets and ferocious competition, actors in many companies must execute strategies that fuse wide-ranging knowledge across diverse boundaries both in and out of the company, including its customers.

As examples of dealing with fluctuating markets and rapid technological advances in the mobile telephone and digital appliance businesses, Sharp, Canon and Panasonic do not only seek out deep collaboration across the boundaries between their many different technical divisions to fuse technologies, but also execute market domination strategies by continually producing new products by simultaneously involving all of their marketing, sales, technology and production divisions (e.g., Kodama, 2011).

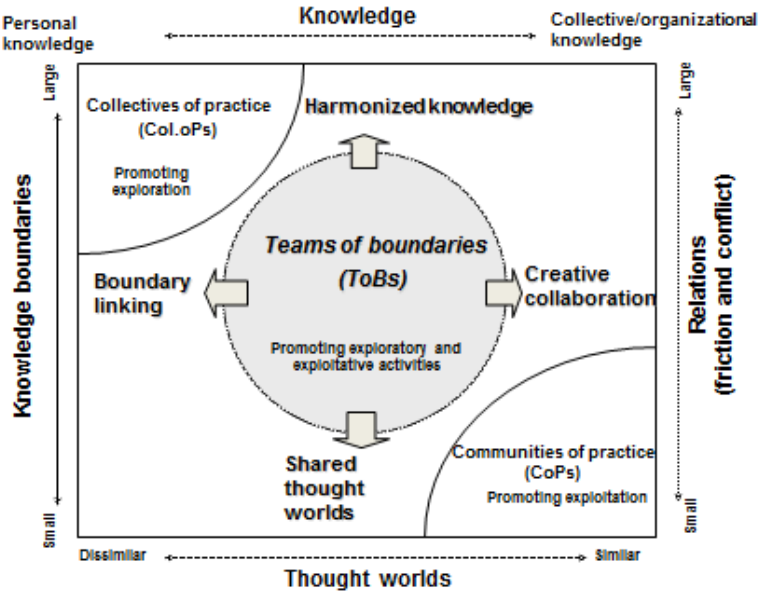
This means that project members must hone their thinking in different fields of specialization, and perpetually share product and technological development roadmaps across departments.

As well as advancing technologies, projects to innovate new business models also have to form diverse partnerships through project networks that transcend organizations and individual companies, businesses and industries, and include customers. Project networks formed by NTT DOCOMO for its mobile communication business and Nintendo for its game business are

examples of these (Kodama, 2011). This paper describes this type of project organizational behavior in which new knowledge is created across different knowledge boundaries as 'boundaries penetration.'

In this paper, Figure 1 illustrates the 4 elements of 'shared thought worlds,' 'harmonized knowledge,' 'creative collaboration,' and 'boundaries penetration' in project organizations as 'teams of boundaries' (ToB), and compares these with communities of practice (CoPs) and collectives of practice (Col.oPs). As shown, teams of boundaries lie between communities of practice and collectives of practice, because we interpret these as projects that have characteristics of both.

Figure 1 Characteristics of 3 Organizational Systems



4.2 Product Development Performance and the 3 Organizational Systems

This section describes the degree of integration between organizations with product development in these 3 organizational systems (Col.oPs, ToBs, CoPs).

Much has been reported about the relationship between product development performance and organizational integration (e.g., Allen, 1970; Gupta et al., 1986; Song et al., 1997). Allen (1970) showed that the structure of company communication networks and the level of communication through them influence the performance of R&D organizations. Notably, the communications interfaces between marketing and R&D are a factor in determining the success of a product development (Griffin and Hauser, 1996). Furthermore, in cases of high-risk product development or highly uncertain circumstances, strong integration between organizations raises the chances of success with new product development, although it has been reported that the degree of inter-organizational linking should be selected according to the difficulty of the

product development (Gomez et al., 2003; Gemser and Leenders, 2011). This is because knowledge boundaries exist between different departments, and the way in which business people behave in response to the disparities (Lawrence and Lorsch, 1967; Dougherty, 1992; Friffin and Hauser, 1996) that accompany these knowledge boundaries influences the process of developing a product and influences performance.

In relation to the degree of organizational integration, Kahn (1996) describes the behavior of business people in organizational relationships in product development as ‘interaction’ and ‘collaboration.’ ‘Interaction’ indicates a relaxed level of integration between functions of structured organizations, in which organizational and personal inter-relationships include routine business such as communicating company rules or business manuals, and communications by telephone, e-mail and business meetings. In the context of product development, these interactions are equivalent to the traditional sequential model (Cooper, 1988, 1990) of a product development process - product development processes as routine innovation to improve and upgrade existing products. Interpreted differently, these are routines that are born from the interactions of the ‘communities of practice’ in each functional organization.

On the other hand, ‘collaboration’ involves relationships between formal and functional organizations and informal and unstructured organizations, which is equivalent to project organizations that operate as cross-functional teams with a high degree of organizational integration. Collaboration is also an important factor to bring about creative friction and productive discord while controlling the negative behaviors and ideas of businesspeople between different organizations and specializations. Accordingly, the functions of ‘collaboration’ are important to teams of boundaries and collectives of practice.

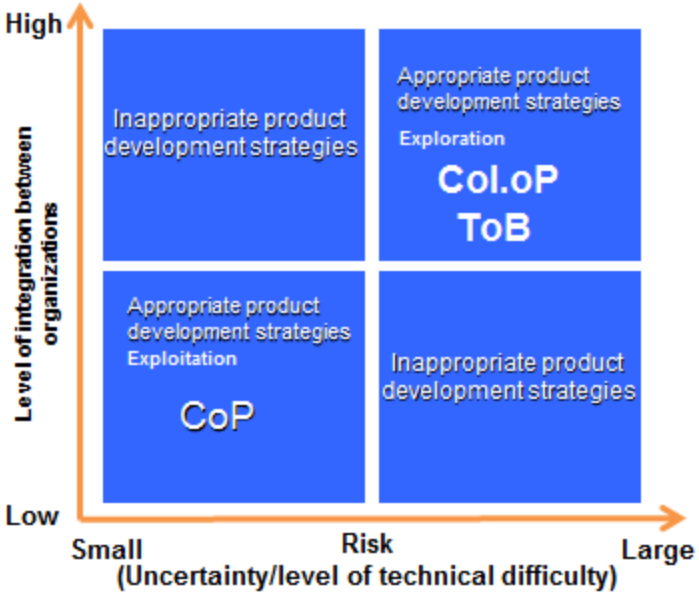
Gomes et al(2003) argues that ‘collaboration’ with a high degree of integration is a necessary factor for the success of new products that carry a high risk (uncertainties and technical difficulties), while ‘interaction’ is important for the success of routine developments such as improving and upgrading existing products. In contrast, teams of boundaries and collectives of practice are not suitable for low-risk and routine upgrading of existing products, while existing routine organizations are not suited to dealing with high risk and technical difficulty (Gemser and Leenders, 2011).

From the above discussion, and with reference to the studies carried out by Gemser and Leenders (2011), Figure 2 describes the suitability of organizational forms in terms of the level of organizational integration of CoPs, ToBs, and Col.oPs, and risk (uncertainty and technical difficulty).

In other words, an appropriate organizational form must be selected for exploration for new product development when there is a high level of uncertainty, and exploitation for routine development to upgrade and improve products. This means that by appropriately allocating

resources necessary for the organizational form (CoP, ToB, Col.oP), 'parallel development' as ambidextrous R&D strategy with exploration and exploitation will become possible, depending on the nature of the target product development.

Figure 2 Product Development Strategies with the 3 Organizational Systems



Source: Based on Gemser and Leenders (2011)

4.3 Combining Exploratory and Exploitative Activities with Teams of Boundaries (ToBs)

The following takes a look at the influences of 4 characteristics of ToBs on exploration and exploitation (see Figure 3). Firstly is the relationship between ToBs and exploratory activities. Madhaven and Grover (1998) suggest that leaders and staff involved in exploratory activities for new product development require cognitive skills that they describe as 'A-shaped skills' and 'T-shaped skills[2].'

A-shaped skills are the skills that leaders need to build new innovative visions through the synergistic integration of specialized fields in diverse markets and technologies, based on new perspectives and insights. Based on the new perspectives gained through sharing a variety of values and knowledge, A-shaped skills involve 'shared thought worlds' and 'harmonized knowledge' factors that raise the potential for ideas to be triggered and imagination to be stimulated.

On the other hand, T-shaped skills are the skills needed to bring about new knowledge integration (technological integration) by simultaneously pursuing vertical depth into particular areas of specialization, while horizontally branching out into other fields. T-shaped skills are the factors of 'creative collaboration' among team members that function across different fields of

specialization and knowledge boundaries to link boundaries and seamlessly integrate knowledge as the project members work to create new knowledge.

ToBs also have qualities of communities of practice. The accumulated daily routines of communities of practice in all functional organizations also promote improvements and upgrading aiming for more efficient existing business processes as 'exploitative activities' (in other words 'process innovation'). These activities are deployed across all functional organizations (sales, product development, production technology, services and so on) right up to task levels that include product assembly processing at the micro level. Thus, value chains are not only optimized by innovating processes for existing products - value chain optimization also becomes possible by innovating business processes for new products as well.

Furthermore, according to traditional technology life cycle theory (TLC) (e.g., Abernathy and Utterback, 1978), product innovation occurs at the initial stages of the TLC, whereas process innovation occurs at the post dominant design stage in the latter half of the TLC. Many electronics and automotive products have been based on this TLC theory.

However, in product innovation and process innovation, upstream (R&D, marketing) and downstream (production technology, manufacture, sales, support) processes occur independently in their value chains. Also, the business details of these innovations are based on dissimilar knowledge and routines. Accordingly, business people are also required to have the skills to execute these two different types of innovation. In short, although staff who can deal with individual areas of business must be assigned, and suitable organizations must be configured for a company to simultaneously execute different innovation processes, it is possible (Tai and Huang, 2008).

Real-world examples of this developmental system[3] include Taiwanese EMS businesses that have followed the OEM→ODM→OBM path (and continue to do so), such as Acer, Lenovo and ASUS. There are a number of Taiwanese companies like this that not only follow the conventional process innovation path but also simultaneously focus on product innovation for their development and manufacturing.

Also in the past, semiconductor manufacturers undertook product innovation for new products simultaneously executed with process innovation to transform their semiconductor manufacturing processes. In other words, new exploratory product innovations simultaneously brought forth new process innovations as exploitive activities. These organizational solutions correspond to the 'ambidextrous organizations' mentioned as the theme of this paper, although they are not organizational systems that are specifically configured to simultaneously execute product and process innovation. In contrast, the ToB organizational form is characterized by its ability to bring forth both product and process innovation.

In thinking about the exploratory and exploitative characteristics of ToBs in this regard, as

far as different capabilities and specializations are concerned, the ‘harmonized knowledge’ that arises from shared understandings, mutual knowledge and common knowledge among project team members, and the flexibility of their ‘shared thought worlds’ enables them to demonstrate the A-type skills needed to draw new perspectives and values to focus on product development from the customer's point of view, consider disruptive innovations, and reinforce their exploratory activities and develop products with efficient production technologies to overcome ‘productivity dilemmas.’

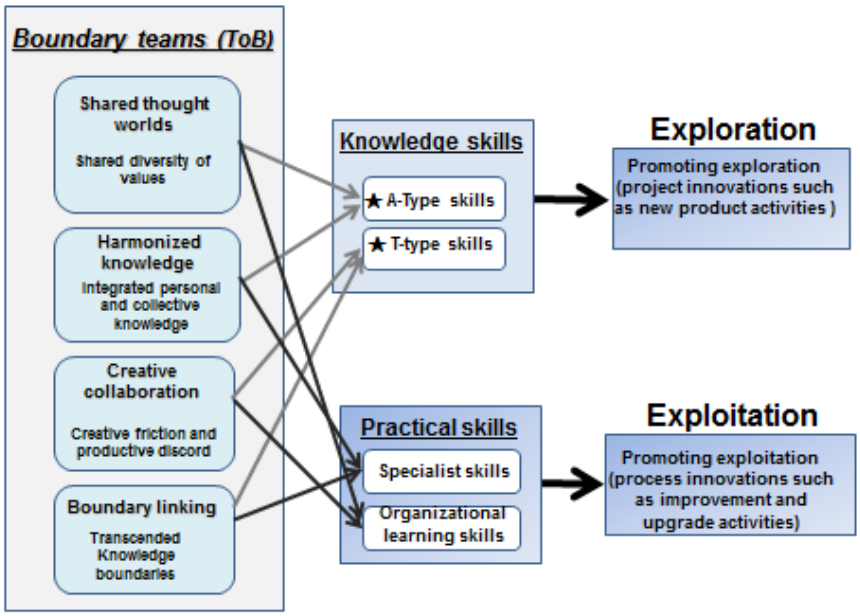
As well as that, as qualities of communities of practice, the specialist skills and organizational learning skills in ToBs encourage exploitative activities to improve efficiency with process innovation not only for optimizing value chains from product planning and development through to manufacturing technologies and sales for existing products, but also encourage process innovation for new product developments (even at the modular level of the product).

Furthermore, creative collaboration among members spanning the knowledge boundaries of different specializations through seamless integration and boundary linking triggers the T-shaped skills needed for the exploratory activities that fuse the dissimilar knowledge both inside and outside of the company required to create new knowledge for product innovation, while the community of practice-type specialist and organizational learning skills trigger cross-organizational, imaginative and productive cooperation, and go on to encourage exploitative activities to optimize value chains through process innovation for new product developments, as well as existing products.

Thus, teams of boundaries can be said to have the ambidextrous R&D management capabilities needed to simultaneously encourage and balance the different corporate activities of exploration for new product development with exploitation to improve and upgrade existing products.

Therefore, in answering the research question of this paper, communities of practice encourage organizational learning as formal organizations in functional organizations, while companies that dynamically and constantly adjust their formal organizations as well as their teams of boundaries across various communities of practice are companies that can be said to have achieved ambidextrous R&D management and are able to maintain a suitable balance between exploration and exploitation.

Figure 3: Concurrent Exploration and Exploitation in Boundary Teams (ToB)



5. New Product Development at Mabuchi Motor – a Case Study and Analysis

5.1 Overview of Mabuchi Motor

Mabuchi Motor is a miniature motor specialist that is the largest manufacturer of compact DC motors for consumer products in the world with more than half of the global market share, and is renowned for its high-precision, high-performance products, which are used in a wide range of Japanese and internationally manufactured consumer goods.

Since the mid-1980s, the company's compact motor products have been manufactured overseas, mostly in Asia. Only the company's headquarters (including sales and development departments) and its research facilities remain in Japan.

Currently, company sales consist of 49% for automotive electrics such as mirrors and door locks, 21% for electric appliances, tools and toys such as electric shavers and toothbrushes, roughly 14% for motors for audiovisual devices such as CD/DVD players, and 17% for information processing devices such as inkjet printers and digital cameras.

The Mabuchi story would not be complete without mentioning models. The company gained its worldwide reputation during the slot racing car boom when its products were used by Tamiya and others. Mabuchi also has an inseparable relationship with motorized model combat vehicles and so forth, and the company's motors are also used in hit products such as radio-controlled and mini four-wheel-drive electric model cars.

Based on its corporate concept 'dream,' Mabuchi strives to meet the dreams of people,

children, adults, engineers and customers alike, and continues to grow, and as the company moves into the revolutionary era that is the 21st-century, Mabuchi aims to create new ‘dreams’ in various scenes all over the world as it continues its efforts to support lifestyles, industries and society with its motors - compact and functional components.

Mabuchi is aiming for capabilities to realize these dreams one by one, by bringing its compact DC motors to the peoples of the world even faster, even cheaper, and with even more reliability while never compromising the high performance that the company has strived to deliver since its establishment.

Mabuchi’s management principles involve raising the level of its social contribution and continuing as a company indispensable to society at large. All staff in the Mabuchi Group are inculcated with ideas of participating in social contribution through work as individual members of a corporation, not only thinking of human beings as important but encompassing nature, the environment and all other things into their worldview while learning to grow as a human beings with a richness of mind that is not solely concerned with material wealth.

These Mabuchi business ideals are essential for the running of the company and are the company’s ‘genetic material’ that is passed on into the future.

As a cornerstone of Mabuchi’s management philosophy, however the idea of ‘contribution’ expressed in the company’s business ideals might be interpreted or expressed, it stands as a clear mission to be realized through the company’s business activities.

In specific terms, it is defined as follows:

(1) To contribute toward the realization of a rich society comfortable to everyone by supplying better quality and cheaper products.
(2) To transfer technologies to, and offer employment in foreign countries, and contribute to economic development in those countries and the general equalizing of international economic disparities.
(3) To put people as the most important of all economic resources, and to train people to play a useful role in society through their work.
(4) To carry out business that does not sacrifice the global environment or the health of people.

As well as being highly-acclaimed by its customers and society as a company that delivers value through its business activities, Mabuchi’s efforts to contribute also result in convincing profit for the company.

Also, the company sets guidelines for its activities that act as the starting point for Mabuchi to create value and achieve healthy growth which enables it to offer even more of a social contribution. Specifically, these guidelines are as follows:

(1) To develop products with a general-purpose focus, and maintain conditions for optimal production.
(2) To ensure standardization of components and materials, and to develop and improve products with a devotion to value analysis.
(3) To pursue advanced processing technologies and waste minimization to keep costs down.
(4) To pioneer new markets and ensure proper occupancy in them.
(5) To place personnel in the most appropriate positions and conduct personnel training through business activities.
(6) To engage in corporate activities that always pursue safety and minimal environmental impact.
(7) To promote business policies with long-term stability perspectives.

As well as these, the company has other management guidelines defined for its overseas bases.

Items 1 to 4 above are intrinsically related to Mabuchi's product development management, which are described later. Moreover, Mabuchi drives its business activities based on the concept of "consolidating organizational capabilities based on selection and convergence, to continually produce difficult-to-copy 'Mabuchiness'", which the company declares as follows:

(1) Enhancing contribution through new business.
Mabuchi challenges itself to create synergies of the technologies it has fostered with the new fields on which it is focusing. In facing these challenges, Mabuchi establishes new technological frameworks while utilizing resources both inside and outside of the company, raises skill levels needed for industrialization and commercialization, and establishes company systems that correspond with these efforts.

While looking at current technological trends and growth prospects, Mabuchi focuses its resources into business areas that invigorate potential, and aims to move forward into the future by continuing to offer new high-performance technologies, quality and services that exemplify the company's 'Mabuchiness.'

(2) Enhancing contribution through existing business
In its existing business fields, Mabuchi continues to improve products and processes and maintain its important component technologies, and by thoroughly investigating causes, Mabuchi is also able to respond quickly to troubles.

The company is also active on networks using its all-Mabuchi technologies and wisdom to

improve a whole host of production aspects, and thoroughly reflect the effects of these improvements to technological, service and cost reduction capabilities into its products to genuinely improve customer satisfaction levels.

(3) Demonstrating resilience

By fostering individuality and a sense of responsibility in all staff members, and engaging staff in challenging and worthwhile work, Mabuchi brings forth realistic and effective organizational capabilities. Staff members who have these strengths are able to demonstrate leadership, share a common sense of direction, and work in teams aiming for success.

Mabuchi strives to demonstrate its ‘Mabuchiness’ by bringing out the best in individuals, and combining their capabilities to maximize the company's social contribution through cooperation among personnel with unique strengths.

Regarding the above, how does Mabuchi combine ‘exploration’ described in (1) ‘enhancing contribution through new business, and ‘exploitation’ described in (2) ‘enhancing contribution through existing businesses’? The answer to this question is closely related to how Mabuchi combines exploration as uncertainty management, and exploitation as existing product management for its new product development strategies.

Furthermore, with item (3) ‘Demonstrating resilience,’ Mabuchi fosters teamwork and leadership, and in its code of conduct it encourages staff to share common values. staff are able to operate based on a unique Mabuchi corporate and organizational culture in which they simultaneously pursue the closely related ideas of enhancing contribution through new business (1) and enhancing contribution through existing business (2).

In specific terms, company’s code of conduct is described below

As an indispensable global company in the wildly fluctuating competitive environment of the 21st century, Mabuchi strives to add more value to its existence. For this reason, all Mabuchi staff members understand the essence of the company's business ideology, and form groups that are actively invigorated from within themselves. The code of conduct below illustrates the values that staff at Mabuchi share to overcome difficulties and discordance that occur in the course of their work, and achieve further growth.

(1) Achieve both social contribution and self-realization through work.

(2) Always be fair and honest with others, and always be willing to cooperate with and support other staff members.

(3) Consider how to best contribute in light of other peoples’ roles

(4) Formulate unique strengths as sources of social contribution, and strive to continually cultivate and enhance those strengths.
(5) Take the initiative to uncover issues, challenge yourself with difficult issues, and don't give up until a solution is found.

In this way, Mabuchi's code of conduct is the source that brings forth the 4 qualities of teams of boundaries, as well as A-type skills/T-type skills and practical skills in the aforementioned theoretical framework.

5.2 From developing custom products (exploration) to a line up of standardized components (exploitation)

When Mabuchi was established, it started out making customized parts (step one in Figure 4), and achieved good performance. Mabuchi's business activities during this period can be interpreted as exploratory, focusing on product innovation to respond to its customers' needs. After that, (around 1965) the company began to think about standardization as the model racing car boom at the time saw its sales skyrocket.

In 1964 the company sold 47 million units, which by 1968 had ballooned to 100 million. On this sort of scale, with custom part orders from different companies having slightly different dimensions, control on the production floor became overloaded with a diversity of models and components. In other words, production had to be smoothed out.

The key for company founders Kenichi and Takaichi Mabuchi to solve this problem was to continue standardizing motors with process innovation, while the only other thing they could do was set up their business to enable make-to-stock production instead of made-to-order production.

As a result of the company's technical studies, they found that systemizing the motors sufficiently enabled them to continue with standardization, and eventually Mabuchi won support and acceptance of these standardized products, and by 1971 more than 80% of Mabuchi's products had been standardized.

These changes represent a shift in product development focus from product innovation to process innovation that drove component modularization that enabled complete motors to be produced by assembling modules in order to meet customer needs. Mabuchi's engineers were encouraged to think differently during this shift to standardization (Figure 4 step 2) as they move from product innovation to process innovation, and then again in response to further changes, from process innovation back to product innovation again.

Standardization brought with it novelty in product architecture development, to which the company was able to apply its own unique imaginative powers and years of experience and

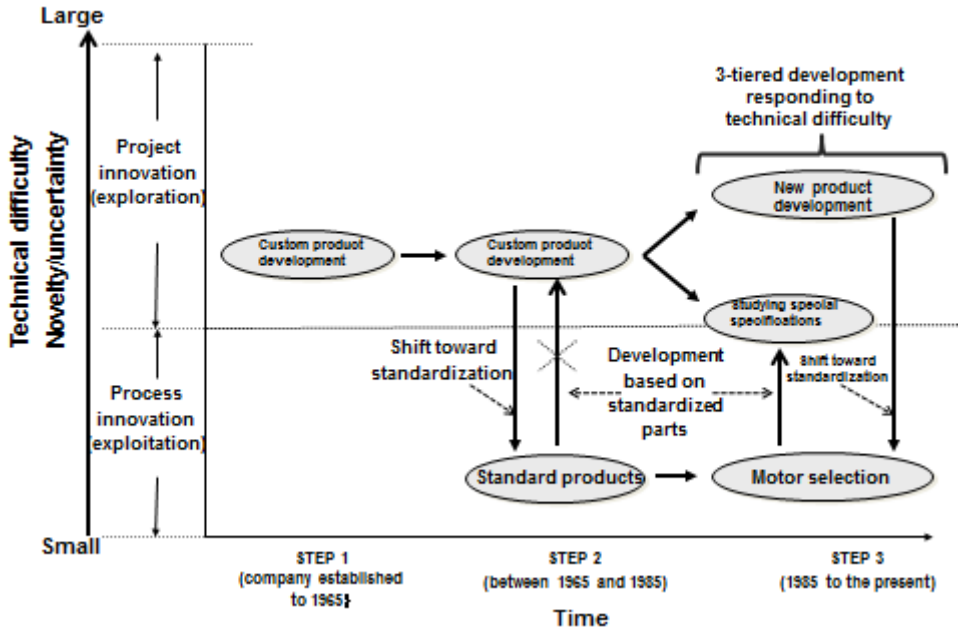
know-how. Engineers were required to engage in the novel approaches of architecture innovation and modular innovation (Henderson and Clark, 1990). In this way it can be seen that the business of developing standardized products weighs heavily on new product development, and can also be seen as an example of exploratory activity. Similarly, developing customized products from components that have already been standardized can be seen as an example of exploitative activity.

However, component manufacturers, once they have standardized parts, must make conscious efforts to maintain their ideas of standardization. As final product manufacturers, customers for these components have a strong tendency to demand parts with custom specs. Component makers also are justified in listening to their customers' demands and responding as faithfully as they can – obviously it is difficult for them to advocate anything different.

For this reason, once standardization has been achieved, if some organizational mechanism is not put in place to maintain those standards, they will become rarefied as custom products increase, and such a state of affairs can result in willy-nilly development to make custom parts just as the customer requests, which in turn leads to an increase in different models, and thus an increase in defects and troubles.

Illustrating this point in Figure 4 step 2 is the X mark in development based on standard products, in which there was not enough shift in thinking from process innovation to product innovation.

Figure 4 Product Development Strategy Transitions at Mabuchi



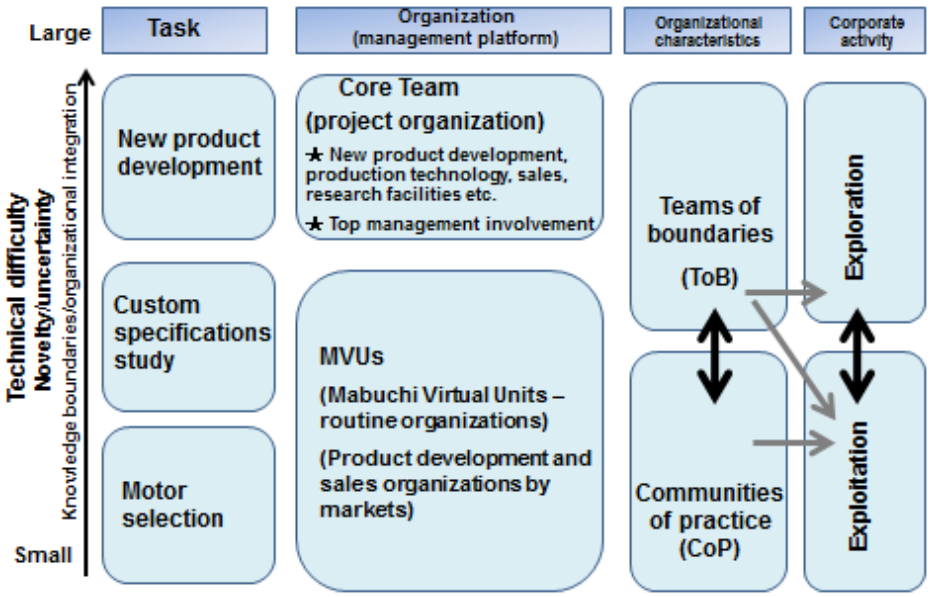
5.3 Establishing New Strategic Product Development Systems

Although standardization from custom products was continuing at Step 2 in Figure 4, in reality, the number of customized products on the factory floor increased, and as the factory was caught up dealing with custom orders for certain customers, the number of things that needed to be developed increased, and the company's main developmental aims became impossible to achieve. Furthermore, because only conventional technology could be applied to these developments, basic technological capabilities also rapidly declined. Mabuchi's reputation as a tech company had become embroiled in a dangerous situation.

To demolish the overdevelopment situation at the time, the company established organizational mechanisms to maintain standardization, which are illustrated as strategic development systems at Step 3 in Figure 4 and in Figure 5.

These mechanisms are characterized by a 3-tiered development system. For basic motors, existing motors are selected to be used as they are, or they can be modified for customized specifications with the inclusion of optional functions, or if a new basic motor is to be developed as a new product, each new project is dealt with by a different organizational system in Mabuchi's 3-tiered development system, because project teams who study custom specifications for basic motors have different qualities than project teams involved in actually creating new basic motors, keeping these projects clearly separated is clearly a most rational approach.

Figure 5 Characteristics and Form of Mabuchi's Multitiered Development Organizations for Ambidextrous R&D



First of all, the sales team fills out a specification requirements sheet with the customer demands and sends it to the product development Department. The product development department starts off by selecting a motor. They do this by considering performance, voltage, vibration and temperature characteristics, service life and so forth of existing Mabuchi basic motors to select a motor that best matches the customer's request. At this stage Mabuchi also uses its unique know-how to consider whether a motor that meets the customer's demands can be achieved by assembling parts that are already on hand.

In its motor routine selection work, Mabuchi has accumulated many years of experience and knowledge – also an example of exploitative activities focusing on process innovation through regular upgrading and improving activities.

Because Mabuchi's ideal of thorough standardization cannot create motors with totally customized specifications, staff must first of all think about how motors that they already have can be used, because it isn't easy to make customized devices. If they have a motor which meets the specifications demanded by the customer, then they suggest it to the customer.

If they do not have a basic motor which meets these demands, then Mabuchi staff consider modifying a basic motor to respond to customer demands. This task is called 'studying custom specifications.' In these cases, although final product is not the basic motor in its original form, the adding of optional functions to respond to the customer's requests does not change it very much.

The work of studying custom specifications until the customer's needs are met is repeated over and over again between the customer and a Mabuchi Virtual unit (MVU). MVUs are integrated units established in 2005 comprising the company's sales and product development groups, and are currently set up as specialist units dedicated to the automotive electrics, audiovisual, optical and precision, appliance and toy markets.

One of the objectives for the MVUs for each market is to quickly enact motor selection and custom specifications studies. Although the MVUs perform other 'boundary spanner-like' functions (Allen, 1977) and are actually involved in the business of new product development, they also perform search functions across diverse range of fields and connect these with specific new businesses.

Although these custom specifications studies are based on basic motors, development of products optimized to fit customer needs is carried out through repeated trial and error in the MVUs (recursive frameworks) (Adams, 2003; Constant, 2000; Schroeder et al, 1989; West, 1990). These recursive processes are 'innovation routines' for normal improvement and upgrading of existing products, and are different from the simple sequential model of product development processes (Cooper, 1988, 1990).

In our interpretation, these custom specification studies are close examples of product innovation as architecture innovation and modular innovation, in that they involve demands for technological novelty (exploration) (see Figure 4 step 3).

On the other hand, if a basic motor is to be created anew, or drastically rebuilt, Mabuchi sets up a new product development project (a core team) to do the job. Product development leaders propose these multifunctional core teams (since 2000) as cross-functional teams across the company's research facilities, production technology, product development and sales departments etc, with participation from group managers and team leaders (assistant managers and so forth) from all groups. On average, Mabuchi has about 20 core teams up and running at any one time, with participation by about 10 staff members in each team.

Members in core teams are not dedicated only to the team, but participate in them as additional duties while remaining active as members of their regular functional organizations. There are no special team rooms or team member seating in Mabuchi's offices, rather, team members remain at their regular posts and meet or work together as necessary. There are many similarities between Mabuchi's core team development systems and Canon's digital camera development projects (Kodama, 2007c).

Members of Mabuchi's core teams characteristically debate with each other and reach agreements autonomously. Right from the beginning, new product development projects explore the potential commonalities of a number of uses to carry out development with an awareness of the company's standardization objectives (Figure 4 step 3), and Mabuchi's 3-tiered product development system prevents custom products from being wantonly developed in attempts to meet every single customer's special requests, and thus alleviates the risk of difficult-to-manage increases in models.

These new product development core teams and MVUs studying custom specifications can be interpreted being teams of boundaries (ToB) which simultaneously have features of collectives of practice (Col.oP) as project organizations, and community of practice (CoP) features as functional organizations.

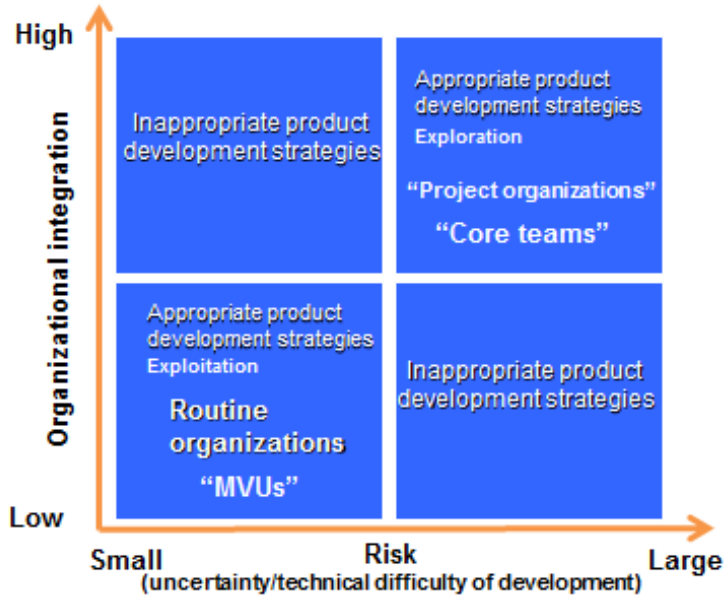
The organizations that carry out the motor selection are the existing functional organization such as the product development and sales departments. Thus, through linking with the MVUs, knowledge sharing and transfer is encouraged among members through the accumulation of collective knowledge in each of the routine 'community of practice (CoP)'functional organizations.

Mabuchi manages uncertainty and difficulty with its new product development by forming MVUs and core teams dynamically through the company's 3-tiered system, as teams of boundaries (ToB) across the company's formal functional organizations. In this way, Mabuchi's ambidextrous R&D management is able to combine product innovation (exploration) for new

product development and process innovation for standardization (exploitation) (see Figure 5).

In assessing Mabuchi's 3-tiered organizational structure and product strategies as shown in Figure 2, it can be said that Mabuchi is a company that achieves optimal product development performance by carefully managing its 3 organizational systems (managing levels of organizational integration) to suit the business circumstances it faces (risk - uncertainty and technical difficulty) (see Figure 6).

Figure 6 Product Development Strategies with Mabuchi's 3 Organizational Systems



Source: Based on Gemser and Leenders (2011)

6. Considerations

As observed in the Mabuchi case, it can be seen that the characteristics of ToBs as project organizations do not entirely match the conventional definitions of project management. Put differently, as top management invests resources necessary for a project towards some pre-decided goal, project objectives are not necessarily achieved only as 'planned strategies' (Mintzberg and Walters, 1985) within a certain time limit as exploitative activities.

With exploratory activities for new product development, teams of boundaries are formed across the divides between functional organizations within the company, and the project-based organizations that drive these exploratory activities focus on emergent and entrepreneurial strategy formation processes rather than strict deliberate strategies (Mintzberg et al, 1998). Furthermore, the term 'emergent strategies' does not imply that projects have a complete lack of planning - trial and error plays an important role in the process of working towards set objectives, and emergence occurs naturally in the project activity itself.

As teams of boundaries are formed across existing functional organizations (communities of practice - CoP) for product development projects, mutual sharing of values and learning with existing organizations can also be achieved. In this way, project team members are able to productively and imaginatively convert conflicts and frictions that exist in companies by engaging in creative collaboration, as team members, who hold dissimilar knowledge in new project-based organizations engage in sharing an integration of knowledge by 'boundary linking' of their dissimilar knowledge.

These development projects also promote 'harmonized knowledge.' Knowledge in projects is highly dependent on the knowledge and capabilities of individual team members, while at the same time, project organizations as teams of boundaries also have elements of communities of practice in which learning takes place in the project and in existing organizations, between project members and specialists in similar fields.

Mabuchi is a company that has grown from its origins as a venture business, and its culture of sharing of information and knowledge between different capabilities and areas of specialization is more infused than in ordinary large corporations. Thus, it can be interpreted that the 'shared thought worlds' that cross over specializations and capabilities are firmly embedded in the company's organizations, and, as teams of boundaries, projects simultaneously have the ambidextrous R&D management characteristics of both exploratory and exploitative aspects.

Projects pursue both refinement and efficiency with existing knowledge (exploitation) while engaging in risk taking and experimentation to create new knowledge (exploration) when there is a large degree of uncertainty or novelty involved.

In the Mabuchi case, the company engages in both product innovation for new product development (the development processes involving the studying of custom specifications) as exploratory activities, while simultaneously engaging in process innovation as exploitative activities to select motors that are based on standards. In other words as projects, teams of boundaries have the qualities of communities of practice, in that they work to gradually improve and upgrade products through organizational learning in which existing knowledge is accumulated and refined through routine and daily business, while at the same time, these types of project-based organizations also have a large potential to bring about innovations with new knowledge and creativity through exploratory activities as radical innovations or discontinuous transformation.

Expressing this differently, exploratory activities transform existing routines, pioneer new markets and bring forth new technologies, which in turn results in new company routines (Nelson and Winter, 1982).

As a rule However, especially in the science and technology fields, if there is no accumulation and refinement of knowledge in daily R&D activities, then project members will

not be able to surmount the high hurdles blocking the path towards their new goals, and will not achieve radical innovation.

There is also the important challenge of transferring knowledge (know-how skills, new routines and established technologies) gained through the achievement of an innovation to other projects and organizations, rather than just the sharing of the knowledge among certain project members themselves. More importantly, this really means that smooth execution of exploratory and exploitative activities will result in new knowledge and routines being deployed and embedded throughout the entire company.

In the Mabuchi case, the idea of product innovation through to process innovation is an important aspect of the company's standardization strategy. To keep current and future business within reach, Mabuchi's top management makes the best use of the company's functional organizations and the characteristics of projects simultaneously, in other words it uses the organizational qualities of both exploratory and exploitative activities as an ambidextrous R&D strategy that can respond to the circumstances of a product development or the details of a product strategy.

Mabuchi's top and middle management continually and dynamically form wide-ranging organizations that combine exploratory and exploitative activities in the company (by not only forming communities of practice, but also forming core teams and MVUs as teams of boundaries). The dynamic formation and linking (networking) of these various organizations is a management platform that enables fusing of diverse knowledge and is the source of Mabuchi's organizational capability (see Figure 5).

7. Implications and Conclusion

From the theoretical framework and the case study research, it can be concluded that the characteristics required for a project vary depending on the degree of complexity and difficulty of the target business model, the degree of technical difficulty with new product development, and the requirements of particular clients. However, new product developments are often dependent on technologies accumulated over time, even if there is a lot of weight placed on novel technological development. Thus in most cases, team members who participate in projects are well-versed in existing technologies.

In particular, the higher the degree of technical difficulty, for example the processes of analyzing specifications demanded by the customer through to entire system design (architecture) and the design details therein (subsystems, components, hardware and software) and so forth involve the deployment of more multitiered structures and multi-branched technological specializations. Such business projects are often accompanied by a radical and architecture innovation (Henderson and Clark, 1990). Furthermore, realistically speaking, it isn't

always a good idea for engineers who have never met each other to form a project for a difficult product development in typical large corporation.

Assembling modularized devices with clear technical interfaces enables the creation of new products, and enables development through routine business between existing functional organizations (e.g. Mabuchi's motor selection operations).

However, a product's competitiveness is hidden in individual modular devices, between modules, between subsystems, in unique software and in entire architectures and so forth as black boxing. Engineers who have accumulated know-how in black boxing are often members of existing organizations who have learnt path-dependent technologies.

With new product developments in which architecture or components are to be substantially reinvented, existing research argues that development should be carried out by new organizations consisting of members with new skills, rather than organizations with existing members (e.g., O'Reilly III and Tushman, 2004; Tushman and O'Reilly, 1997; Utterback, 1994; Tushman and Anderson, 1986). However, from a technological point of view, it really depends on the circumstances surrounding the development (e.g. the product lineup of individual businesses, the scale of the development, the scale of the organization doing the development, corporate culture, country, and so on).

For example, to achieve technological integration with many aspects of radical or architectural innovation, it is important at the beginning to consider forming a project from engineers with different specializations from within the company - creating a new organization with new members should not be a top priority.

Also, in cases of radical innovation where architectures and components are drastically reinvented, new ideas must be brought to the fore from an array of technological viewpoints.

In these sorts of cases, it is appropriate to bring in knowledge and abilities from outside the company as required, while making the best use of existing human resources. Making the best use of human resources means placing importance on engineers' experience and know-how, and accumulating scientific and technical knowledge through regular training. It is this kind of path-dependent accumulation of technologies that also enables a company to overcome the high hurdles that obstruct the path to creative radical innovation.

When it comes to focusing on existing resources and existing organizational capabilities, Japanese companies have a characteristic custom. Compared to western companies, the external labor markets surrounding Japanese companies have lower fluidity, and those recruited after obtaining a bachelor or graduate degree set out on career paths which involve gaining experience across a range of business divisions and specialist technologies.

Also, the peculiarity of lifetime employment offered by Japanese corporations, crossover career paths and mechanisms for learning in groups and organizations embed the unique tacit

knowledge, norms, values and culture of a company among its staff members. This has led to the formation of organizational systems in companies that are informal and autonomous communities or 'ba' (e.g., Ouchi, 1980: Nonaka and Takeuchi, 1995).

Accordingly, project organizations in Japanese companies have a strong tendency to be formed as extensions of existing organizations, regardless of whether they are official or otherwise, which when compared with Western businesses, means there is a greater likelihood that the 'community of practice' atmosphere of an existing organization will be introduced into the project.

Put differently, because Japanese corporations have unique employment customs and training systems strongly embedded in them, their first priority appears as a dependence on existing resources such as company personnel and organizations when it comes to forming projects for new product development or new businesses. These tendencies have the added benefit of enabling companies to get projects off the ground and execute business quickly.

More research is required into the processes of forming and executing projects, as there are a wide range of cases with varying aspects, including cases of project management systems in western companies.

This paper has considered product development strategies from the point of view of product development processes at Mabuchi Motor. Existing research has shown that when faced with changing circumstances (markets and technologies), an excessive tendency towards path-dependent knowledge (Rosenberg, 1982; Hargadon and Sutton, 1997), stemming from habits formed over long years of dealing with key products, is a cause of competency traps (Levitt and March, 1988; Martines and Kambil, 1999) and core rigidities (Leonard-Barton, 1992,1995).

Nobody can predict whether a company will be able to maintain its competitiveness over the long term - even a company that is currently profitable, but the lesson of the Mabuchi case is 'don't ever become content or complacent with your current main product lineup.'

Top and middle management in high-tech companies must consciously and continually acquire dynamic and new strategic positions to create the businesses of the future (the dynamic view of strategy)(e.g., Markides, 1997, 1999; Chakravarty, 1997; Eisenhardt and Sull, 2001), and project organizations as teams of boundaries are a management platform that enables the ambidextrous R&D management needed to execute businesses with a high degree of risk and uncertainty (new products and so forth) as 'exploration,' while refining existing businesses and expanding markets as 'exploitation.'

Acknowledgements

We would like to sincerely thank Mr. Kiyomi Sugamoto (business planning department , product planning group manager) for his time given in interviews. We would also like to express their sincere gratitude to the College of Commerce, Nihon University for research funding provided.

References

Adams, R. (2003). Perceptions of Innovations: Exploring and Developing Innovation Classification. Ph.D. diss., Cranfield University, Cranfield, UK.

Ahn, J.-H., Lee, D.-J., & Lee, S.-Y. (2006). Balancing business performance and knowledge performance of new product development. Lessons from ITS Industry. Long Range Planning, 39(6), 525-542.

Allen, T. and Cohen S.(1969). 'Information Flow in Research and Development Laboratories', Administrative Science Quarterly, 14, 12-20.

Allen, T.J. (1977), Managing the Flow of Technology, MIT Press, Cambridge, MA.

Allen, T.J. (1970). Communication networks in research and development laboratories. R&D Management, 1, 14-21.

Allen, T.J. and Katz, R. (1986). 'The Dual Ladder: Motivational Solution or Managerial Delusion?, R&D Management, 16(2), 185-197.

Alvesson, M. (1995). Management of Knowledge-Intensive Companies, De Gruyter, New York.

Bailyn, L.(1991), 'The Hybrid Career: An Exploratory Study of Career Routes in R&D', Journal of Engineering and Technology Management, 8(1), 1-14.

Barlett, C. and Ghoshal, S.(2000). Transnational Management. Boston, MA, McGraw-Hill.

Brown, J. S. and Duguid, P. (1991), 'Organizational Learning and communities-of-practice', Organization Science, 2(3): 40-57.

Brown, J.S. and Duguid, P., (2001), 'Knowledge and Organization: A Social-practice perspective', Organization Science 12(6): 198-213.

Carlile, P.(2002), 'A Pragmatic View of Knowledge and Boundaries: Boundary Objects in New Product Development', Organization Science, 13(4), 442-455.

Chakravarthy, B.(1997), 'A new strategy framework for coping with turbulence', Sloan Management Review, 38, 69-82.

Child, J. and Rodrigues, S. B. (2003). 'Corporate governance and new organizational forms: issues of double and multiple agency', Journal of Management and Governance, 7, 337-360.

Christensen, C.M.(1997), The Innovator's Dilemma: When New Technologies Cause Great

Firms to Fail, Harvard Business School Press, Boston, MA.

Clark, K.B. and Fujimoto, T.(1991), Product Development Performance, Harvard Business School Press, MA.

Constant, E. (2000). Recursive Practice and the Evolution of Technological Knowledge. In: Technological Innovation as an Evolutionary Process. J. Ziman (ed.). Cambridge, Cambridge University Press, 219–33, UK.

Cooper, R.G. (1988). The new product process: a decision guide for management. Journal of Marketing Management, 3(3), 238-258.

Cooper, R.G. (1990). Stage-gate systems: a new tool for managing new products. Business Horizons, 33(3), 44-54.

Cramton, C.(2001), 'The mutual knowledge problem', Organization Science, 12, 346-371.

DeFillippi, R. J. (2001). 'Introduction: project-based learning, reflective practices and learning outcomes'', Management Learning, 32, 5-10.

DeFillippi, R. J. (2002). 'Information technology and organizational models for project collaboration in the new economy', Human Resource Planning, 25(4), 7-18.

DeFillippi, R. J. and Arthur, M. (1998). 'Paradox in project-based enterprise: The case of filmmaking', California Management Review, 40(2),125-139.

Dougherty, D. (1992), 'Interpretive barriers to successful product innovation in large firms', Organization Science 3(2): 179-202.

Eisenhardt, K. M. (1989) 'Building Theories from Case Study Research', Academy of Management Review 14, 532-50.

Eisenhardt, K. M. and Sull, D. N. (2001,) 'Strategy as Simple Rules', Harvard Business Review 79, 106-16.

Forsgren, M. (1997). The advantage paradox of the multinational corporation: Nordic contribution to international business research. In I. Bjorkman and M. Forsgres (Eds.), The nature of the international firm, 69-83., Copenhagen, Handelshojskolens forlag.

Griffin, A. and Hauser, J.R. (1996). Integrating R&D and Marketing: A review and analysis of the literature. Journal of Product Innovation Management, 13, 191-215.

Galbraith, J. (1973), Designing Complex Organizations, Addison-Wesley, Reading, MA.

Gemser and Leenders, (2011). Managing Cross-Functional Cooperation for New Product Development Success, Long Range Planning, 44(1), 26-41.

Gibson, C.B. and Birkinshaw, J. (2004) The antecedents, consequences, and mediating role of organizational ambidexterity. Academy of Management Journal, 47, 2, 209–226.

Gomes, J., Weerd-Nederhof, P, Pearson, A. and Cunha, M. (2003) Is more always better? An

exploration of the differential effects of functional integration on performance in new product development, Technovation, 23(2), 185-191.

Grabher, G. (2002). 'Cool projects, boring institutions: Temporary collaboration in social context' ,Regional Studies, 36(3), 205-214.

Griffin, A. and Hauser, J.R. (1996). Integrating R&D and Marketing: A review and analysis of the literature. Journal of Product Innovation Management, 13, 191-215.

Grinyer, P. and McKiernan, P. (1994), 'Triggering Major and Sustained Changes in Stagnating Companies', in Strategic Groups, Strategic Moves and Performance, 173-195, ed. Herman Daems and Howard Thomas, New York: Pergamon.

Gunz, H. P. (1980). 'Dual ladders in research: A paradoxical organizational fix', R & D Management, 9(1), 29-32.

Gupta, A.K., Raj, S.P. and Wilemon, D. (1986). A model for studying R&DMarketing interface in the product innovation process. Journal of Marketing, 50(2), 7-17.

Hagel III and Brown, J.S. (2005), 'Productive Friction', Harvard Business Review 83(2): 139-145.

Hargadon, A. and Sutton, R. (1997), 'Technology brokering and innovation in a product development firm', Administration Science Quarterly 42, 716-749.

He, Z. and Wong, P.(2004). 'Exploration vs. exploitation: an Empirical test of the ambidexterity hypothesis', Organization Science, 15, 481-494.

Henderson, R.M. and Clark, K.B.(1990), 'Architectural innovation: The reconfiguration of existing product technologies and the failure of established firms', Administrative Science Quarterly, 35(1), 9-30.

Henrie, M. and Sousa-Poza, A. (2005). 'Project management: a cultural literature review', Project Management Journal, 36(2), 5-14.

Hobday, M.（1995）, 'East Asian latecomer firms: Learning the technology of electronics', World Development, 23(7), 1171-1193 .

Hobday, M. (1998). 'Product complexity, innovation and industrial organization', Research Policy, 26, 689-710.

Hobday, M. (2000). 'The project-based organisation: An ideal form for managing complex products and systems?' Research Policy, 29, 871-893.

Kahn, K.B. (1996). Interdepartmental integration: a definition with implications for product development performance. Journal of Product Innovation Management, 13(2), 137-151.

Keegan, A. and Turner, J. R. (2002). 'The management of innovation in project-based firms', Long Range Planning 35(4), 367-388.

Kochanski, J. M. (2003). 'Paul and Ledford, Gerry, "People Solutions for R&D"', Research-Technology Management, 46(1), 59-61.

Kodama, M (1999) 'Strategic innovation at large companies through strategic community management-an NTT multimedia revolution case study', European Journal of Innovation Management, 2(3), 95-108.

Kodama, M. (2005), 'Knowledge Creation through Networked Strategic Communities: Case Studies in New Product Development', Long Range Planning, 38(1), 27–49.

Kodama, M.(2009), 'Boundaries Innovation and Knowledge Integration In The Japanese Firm', Long Range Planning, 42(4), 463-494.

Kodama, M. (2011), Knowledge Integration Dynamics –Developing Strategic Innovation Capability, World Scientific Publishing, SI.

Kogut, B. and Zander, U. (1992), 'Knowledge of the firm, combinative capabilities and the replication of technology', Organization Science, 5(2), 383-397.

Lave, J. (1988), Cognition in Practice, Cambride University Press, Cambridge, U.K.

Lave, J. and Wenger, E. (1991). Situated Learning, Legitimate Peripheral Participation, New York, Cambridge University Press.

Lawrence, P. and Lorsch, J. (1967), Organization and Environments; Managing Differentiation and Integration, Harvard Business School Press, Cambridge, MA.

Leonard-Barton, D.(1992), 'Core capabilities and core rigidities: a paradox in managing new product development', Strategic Management Journal, 13, 111-125.

Leonard-Barton, D.(1995), Wellsprings of Knowledge: Building and Sustaining the Sources of Innovation, Boston, Harvard Business School Press.

Levitt, B. and March, J.B. (1988) 'Organization learning', W.R. Scott, J. Blake, eds., Annual Review of Sociology, Annual Reviews, Palo Alto, CA, 319-340.

Lindkvist, L. (2004). 'Governing project-based firms: Promoting market-like processes within hierarchies', Journal of Management and Governance, 8, 3-25

Lindkvist, L. (2005). 'Knowledge Communities and Knowledge Collectivities: A Typology of Knowledge Work in Groups', Journal of Management Studies, 42(6), 1189-1210.

Lundin, R. A. and Midler, C. (1998). Projects as arenas for renewal and learning processes, London, Kluwer Academic.

Maccoby, M. (1999). 'Find Young Leaders or Lose Them", Research-Technology Management', 42(1), 58-59.

Madhaven and Grover (1998) From Embedded Knowledge to Embodied Knowledge: New Product Development as Knowledge Management, Journal of Marketing, 62(4), 1-12.

March, J.(1991), 'Exploration and exploitation in organizational learning', Organization Science, 2(1):71-87.

Markides, C. (1998), 'Strategic Innovation in Established Companies', Sloan Management Review, 39(3): 31-42.

Markides,C.(1999), All the right moves:a guide to crafting breakthrough strategy, Boston, Harvard Business School Press.

Martines, L. and Kambil, A. (1999) 'Looking back and thinking ahead: Effects of priorsuccess on managers' interpretations of new information technologies', Academy of Management Journal 42: 652-661.

McCarthy, I.P., and Gordon, B.R. 2011. Achieving Contextual Ambidexterity in R&D Organizations: A Management Control System Approach. R&D Management, 41(3), 240-258.

Middleton, C. J. (1967). 'How to set up a project organization, Harvard Business Review, March-April, 73-82 .

Midler, C. (1995). '"Projectification" of the firm: The Renault case', Scandinavian Journal of Management, 11(4),363-375.

Mintzberg, H. & Walters, J. (1985) 'Of strategies deliberate and emergent, Strategic Management Journal, 6: 357-272.

Mintzberg, H., Ahlstrand, B. and Lampel, J.(1998), Strategy Safari: A Guided Tour Through the Wilds of Strategic Management. New York, The Tree Press.

Nelson, R. R. and Winter, S. G. (1982). An evolutionary theory of economic change, Cambridge, MA, Belknap Press.

Newell, S., Edelman, L., Scarbrough, H., Swan, J. and Bresnen, M. (2003). '"Best practice" development and transfer in the NHS: The importance of process as well as product knowledge' . Health Services Management Research, 16, 1-12.

Nohria, N. & Ghoshal, S. (1997) The Differentiated Network: Organizing Multinational Corporations for Value Creation, San Francisco, CA, Jossey-Bass.

Nonaka, I. & Takeuchi, H. (1995), The Knowledge-Creating Company. New York: Oxford University Press.

Omta, S.W.F. and van Engelen, J. M.L.(1998), 'Preparing for the 21st Century', Research-Technology Management, 41(1), 31-35

Orlikowski, (2002), 'Knowing in Practice: Enacting a Collective Capability in Distributed

Organizing', Organization Science, 13(3): 249-273.

Orr, J. (1996), Talking about machines: An ethnography of a modern job, ILP Press, Ithca, NY.

Ouchi, W.G. (1981). 'Theory Z: How American Business Can Meet the Japanese Challenge, Addison-Wesley, Reading, MA.

O'Reilley III, C. and Tushman, M. (2004), 'The Ambidextrous Organization', Harvard Business Review, 82, April, 74-82.

Prencipe, A. and Tell, F. (2001). 'Inter-project learning: Processes and outcomes of knowledge codification in project-based firms', Research Policy, 30, 1371-1394.

Rosenberg, N. (1982), Inside the black Box: Technology and Economics, Cambridge University Press.

Schroeder, R.G., Van De Ven, A.H., Scudder, G.D. and Polley, D. (1989). The Development of Innovation Ideas. In: Research on the Management of Innovation: The Minnesota Studies. A.H. Van de Ven, H.L. Angle and M. Poole (eds.). New York: Harper & Row, 107–33.

Song, X.M.; Montoya-Weiss, M.M. and Schmidt, J.B. (1997). Antecedents and consequences of cross-functional cooperation: a comparison of R&D, manufacturing, and marketing perspectives. Journal of Product Innovation Management, 14(1), 35-47.

Spender, C. (1990), Industry Recipes: An Enquiry into the Nature and Sources of Managerial Judgement, Oxford, Basil Blackwell.

Sydow, J., Lindkvist, L. and DeFillippi, R. (2004). 'Project-Based Organizations, Embeddedness and Repositories of Knowledge: Editorial', Organization Studies, 25(9), 1475-1489.

Turner, J. R. (1999). The Handbook of Project Based Management, 2nd ed. London, McGraw-Hill.

Turner, J. R. and Miller, R. (2003). 'On the nature of the project as a temporary organization', International Journal of Project Management, 21, 1-8.

Tushman, M. L. and Anderson, P. (1986). 'Technological Discontinuities and Organizational Environments', Administrative Science Quarterly, 31, 439-465.

Tushman, M. L., and O'Reilly, C. A. (1997) Winning Trough Innovation, Cambridge, NA, Harvard Business School Press.

Tsai, M-T and Huang, V-C.(2008). 'Exploratory Learning And New Product Performance: The Moderating Role Of Cognitive Skills And Environmental Uncertainty' Journal of High Technology Management Research, 19(2), 83-93.

Utterback, J.M.(1994). Mastering the Dynamics of Innovation, Boston, M.A, Harvard Business School Press, MA.

Wenger, E.(1998), Community of Practice: Learning, Meaning and Identity, Cambridge: Cambridge University Press.

West, M.A. (1990). The Social Psychology of Innovation in Groups. In: Innovation and Creativity at Work: Psychological and Organizational Strategies. M.A. West and J.L. Farr (eds.). Chichester, UK: John Wiley & Sons, 309–33.

Windeler, A. and Sydow, J. (2001). 'Project networks and changing industry practices: Collaborative content production in the German television industry', Organization Studies, 22(6),1035-1060.

Yin, R.K.,1994. Case study Research: Design and Methods, 2nd ed., London, Sage.

Notes

[1] This evidence is based on conversations with many business people and fellow graduate students who entered electronics companies. Also, one of the co-authors of this article has extensive experience in a number of duties and specialist fields working in a communications company, on a career path similar to those of electronics companies.

In the major Japanese communications company in which the co-author served, engineers are allocated to business or research divisions. Engineers allocated to the business division are rotated through a number of different functional departments every 2 to 3 years after joining the company.

For instance as one pattern, engineers experience career paths in which they will be allocated to technological departments (responsible for communications equipment and communications services development), office work (as assistant managers or section chiefs in facilities departments), again in technological departments (as development managers), in offices again (general manager of sales and facilities), technological department (general manager), offices (Director), marketing and sales department (Director) etc.

There are many other career paths, including cases where personnel from sales moved into to work as R&D managers, and there are also research personnel who mainly begin working on particular R&D projects and then get promoted to an R&D managerial position. There are also dedicated scientific and technological research career paths.

The exchange between the research and sales departments in Japanese companies is particularly vigorous, and there are many cases where researchers move into technical sections within business divisions, or into marketing and sales departments, and then after gaining experience in business divisions, sometimes these researchers go back to their original research posts.

This is a consistent personnel training approach that is oriented towards directly tying research and development with business to avoid the so-called ‘death Valley’ (Kodama, 2011).

[2] Tai and Huang (2008) verified that these two knowledge skills have positive effects on the performance of new product development.

[3] Refer to Hobday（1995）. OEM： Original Equipment Manufacturing (manufacturers who are contracted by the product branding company), ODM： Original Design Manufacturing (designers and manufacturers who are contracted by the product branding company), OBM: Own-Brand Manufacturing (a company that manufactures its own brands entirely).