한국지역지리학회지 제8권 제4호(2002) 529~541

The Shifting Process of R&D Spaces in Firm's Adaptation: Competences, Learning and Proximity

Jong-Ho Lee*

기업의 적응에 있어 R&D 공간의 변화: 조직적 역량, 학습 그리고 근접성

이 종 호*

Abstract : This paper aims to provide a context-specific interpretation on the shifting process of in-house R&D spaces in a large Korean firm in the context of rapidly changing markets and technology. Drawing on the case study of LG Electronics Company, one of the Korea's flagship companies, I examine the causes and mechanisms leading to a shift in domestic R&D spaces and the nature of learning processes between R&D teams and between R&D and other organizational units, particularly manufacturing. It appears that the current reshaping processes of domestic R&D spaces in LGE focus more on the clustering of core R&D laboratories than the geographical integration of conception and execution. However, it should not simply be viewed that such a move would be reduced to the linear model of innovation and organizational learning. Instead, it involves the firm-specific mode of regulating organizational competences. As contextual variables to induce such a firm-specific mode of organizational change, I consider the spatial form of organization, the spatial sources of knowledge and learning, and the powers of relational learning that can be made between distanciated actors and teams.
Key Words: : competence, learning, adaptation, organizational form, proximity, LG Electronics Co.

요약 : 본 논문은 시장과 기술의 급속한 변화에 직면한 한국 대기업의 R&D 공간의 변화 과정과 메커니즘을 학습과 적응의 맥락에서 고찰한 것이다. 사례연구는 한국의 대표적인 전자업체인 LG전자를 대상으로 한 심층적 인터뷰 결과와 문헌조사를 토대로 하였다. 본 연구에서는 대기업 조직의 R&D 공간의 변화는 조직의 공간 형태, 지식과 학습의 공간적 및 조직적 원천, 관계적 근접성에 기초한 학습의 역할 등과도 밀접한 관계를 가지고 있음을 밝힌다. 사례기업의 최근 국내 R&D 공간의 변화는 구상과 실행의 공간적 통합보다는 핵심 연구개발 기능들의 서울중심 집적 강화 경향이 점진적으로 나타나고 있다. 그러나, 본 논문에서는 이러한 R&D 공간의 변화가 학습과 혁신의 선형적 모델로의 회귀를 의미한다고 보기 보다는, 조직적 근접성과 상호작용적 학습 양식을 통해 공간적으로 분산된 조직 역량 및 학습 능력을 유지·강화하고자 하는 기업의 전략적 노력과 조직적 프로세스를 반영하고 있다는 점을 강조한다.
주요어 : 역량, 학습, 적응, 조직형태, 근접성, LG전자

1. Introduction

For a competence-based perspective, research and development (R&D) activities are considered to play a key role in both gaining and maintaining corporate-specific technological capabilities for innovation. In addition, R&D capabilities can be a foundation for building absorptive capacity (Cohen and Levinthal, 1990), which is a prerequisite for obtaining important knowledge from outside the firm. These technological capabilities can be made more robust through both continuous strengthening of in-house R&D capabilities and vigorous technological networking with the outside. As far as the technological aspects are concerned, adaptation is to a large degree dependent upon how firms effectively mobilize their technological competences.

In this paper, the main aim is to explore the changing nature of in-house R&D spaces taking place in a large Korean firm. In contemporary economic geography and innovation studies, it is generally assumed that innovations in the firm can occur not only in formal R&D laboratories

* Lecturer, Department of Geography, Kyungpook National University(경북대학교 사회과학대학 지리학과 강사) (dgg3jhl@empal.com)

but also in workplaces and thus the functional and geographical integration between conception and execution can be critical for both sustaining innovations and improving organizational competences. However, the recent move of a Korean firm studied in this paper appears to be going against this academic assumption.

This paper draws on the case study of LGE, one of Korea's largest industrial firms, using both in-depth interviews with managers, engineers and industry specialists, which I carried out between June and October 2000, and the secondary sources such as press releases and corporate releases. I will argue that the present spatial reorganizing processes of domestic R&D units in a large firm are closely associated with the corporate strategy, which focuses more on the clustering of core R&D laboratories than the geographical integration of conception and execution, the spatial form of organization, the nature of products the firm make, differences in the sources of knowledge and learning between regions and the powers of relational learning that can be made between distanciated actors and teams.

2. Organizational form, learning and R&D space

Innovation studies and economic geography literature suggests that the organizational form has been shifting from a traditional Fordist model to an emerging new organizational model which encourages innovation and learning. From this point of view, it is argued that traditional forms of organization have become obsolescent as revealing their limitation in coping with a rapidly changing environment. Firms have thus faced the challenge to move towards more decentralized and networked organizational forms away from hierarchical and concentrated ones (Cooke and Morgan, 1998; Hedlund, 1994; Levinthal, 1996).

Evolutionary and competence-based theories of the firm are helpful in explaining the changing features of organizational form in a large firm. A theoretical framework of these views emphasizes the capabilities of firms to mobilize the knowledge distributed inside and outside the firm, as well as to sustain collective learning as the most crucial strategic asset (Amin and Cohendet, 2000; Foss, 1993; Hodgson, 1998). In view of this, it is critical to reset the boundaries of the demarcated divisions of labor between organizational units, in order to foster interactive learning between distributed units or subgroups. To do this, Cooke and Morgan (1998) stress the need to consider the role of peripheral organizations such as branches and subsidiaries, the responsibility of work teams, local autonomy, the link between R&D and production, and the importance of suppliers.

Under the Fordist mass production regime, typical organization forms consist of highly segmented divisions of labor, characterized by task specialization, functional fragmentation, and hierarchical management control. This model also emphasizes the vertical flow of information that is well reflected in the linear process of innovation (Cooke and Morgan, 1998; Lam, 1996). Thus it has no space for accepting cognitive diversity and multiple voices. Daily work practices are carried out on the basis of officially defined relationships. All of those aspects result in the limitation to the possibilities for members of the firm to interact and communicate. In addition, this model is based on simple adaptive responses to environmental change. As a result, firms have great difficulties in sustaining adaptation and learning in the context of a rapidly changing environment and market competition.

In contrast, an innovation-mediated organizational model is designed to increase the degree of innovation and collective learning to sustain and secure high quality and productivity. This model differs significantly from the Fordist model of organization in the organizing and managing of the divisions of labor among teams, departments, functions or individual workers. It stresses that learning and knowledge creation are the responsibility of everyone in the organization, not just a selected few such as R&D engineers and managerial groups (Nonaka and Takeuchi, 1995). The shared divisions of labor are characterized by functional fluidity and boundary blurring, with the intention to increase the capabilities to solve problems, learn, innovate and adapt. This overlap and the crossing of functional boundaries foster collective learning based on learning-by-interacting (Morgan, 1996). Work practices are designed to encourage workers to learn and innovate through learning-by-interacting, learning-by-doing and learning-in-doing, drawing upon interactive participation and communication.

In addition, this model emphasizes boundary blurring between conception and execution, inspired by the recognition that organizational forms designed to adapt to hyper-competitive environment must be suited to integrate the knowledge and intelligence of all workers. Excessive functional specialization leads to a separation between technical and organizational knowledge and thus brings about a variety of problems in the coordination between functions and the knowledge management. In this sense, some organizational theorists such as Kenney and Florida (1993) and Lam (1996) argue that the functional link between R&D and down-stream functions would be important to effectively combine the abstract scientific and technical knowledge of R&D workers, which is embodied in innovations and saleable commodities, and shop-floor workers' knowledge, which provides a crucial source of shop-floor product and process improvements.

Economic geographical literature suggests that the co-location between R&D and manufacturing can be useful in two ways (Cooke and Morgan, 1998; Hayter, 1996; Morgan, 2001). First, the co-location between conception and execution would help avoid functional specialization and realize functional integration. Secondly and more importantly, the geographical clustering of R&D and manufacturing would contribute to improving the potential for learning and innovation because it allows employees in different job boundaries to interact on a face-to-face basis. However, the recent literature in economic geography has begun to argue that geographical proximity would not necessarily be equivalent to learning and innovation, as these are the product of collective processes of interactions and communications between individuals, teams and firms (see for more details Lee, 2001).

3. Learning and proximity

The concept of proximity involves multi-dimensional aspects that mediate and influence learning between agents. Agents and groups may be close not only territorially, but also relationally, organizationally, institutionally and so on. Proximity thus should be much less the spatial interactions per se than the mix of situated culture and institutions that characterizes the context and facilities communication, cumulative informative exchange and learning (de la Mothe and Paquet, 1998). In this context, proximity is seen as defining the web of complex human relationships and social interactions. Regarding the characteristics of learning reflecting the dynamic process of social interaction, the focus should lie on examining such processes. This is to highlight the role of relational dimensions in learning.

In the level of the firm, learning involves complex social interactions across individuals, functional boundaries or a firm boundary (Amin and Cohendet, 1999; Cohendet et al., 1999). Relational proximity refers to the nature of the relationship between individuals, members of a group, or groups. This can be sustained through common language and culture, mutual trust, mutually respected norms of behavior. Thus, the extent to which agents are proximate relationally seems to relate to the creation of social capital. The concept of relational proximity involves not only informal relationship between individuals such as informal networks but also formal relationship between agents who belong to a purposive organization. Meanwhile, the concept of organizational proximity is referred to as a coordination mechanism that binds individuals engaged in a purposive activity together (Blanc and Sierra, 1999). Thus, firms try to establish common codes of coordination and communication that facilitate social interactions, while avoiding the possibility of mismatch or conflicts in communications between members. Conventionally, organizational proximity applies to intra-firm relationships. But, organizational proximity is required to coordinate the relationships between intra-firm operations as well as between firms, such as user-producer (Blanc and Sierra, 1999).

Learning would be initiated and realized through complex and multi-faceted organizational processes across space and place or even beyond a restricted place. Learning by firms is a product of complex human relationships and social interactions surrounding firms. The effectiveness of learning is likely to rely significantly upon the quality of social interactions, the nature of learning and the nature of ties among agents, regardless of whatever it is collective or individual. Therefore, it is right to see that geographical proximity is part of factors that influences socio-cultural and institutional proce-

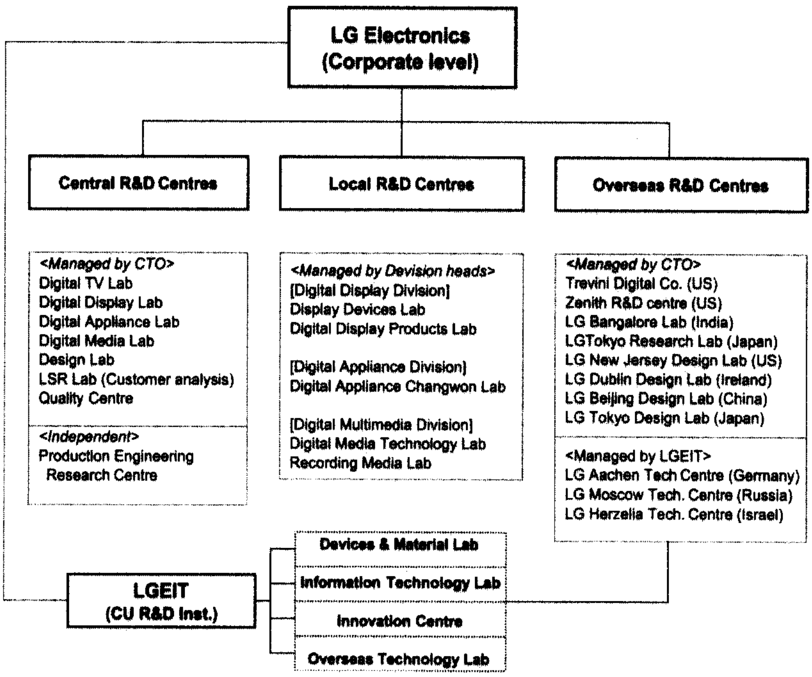

Figure 1. Structure of LGE R&D units

sses which are complicatedly interwoven surrounding organizational learning. Understanding the process and mechanism of learning needs to depart from unpacking corporate contexts in which learning takes place.

4. Spatial reorganization of domestic R&D activities in LGE

To begin with, the characteristics of LGE's R&D organizations need to be understood. While the company started with its own R&D activities from the beginning, it is difficult to say the company pursued formally organized R&D activities from that period. The focus of technological learning was exclusively based on 'learning by imitating' external knowledge, notably from Japanese technologies, and 'learning by doing' through repetitive trial and error (Ernst, 2000; Kim, 1997). Formal research activities were begun in 1976, when the central R&D center was established in Seoul. As of 2000, the company operates a global R&D network covering most domains of the electronics industry related to what it does (see Figure 1).

Basically, the company uses a three-tier R&D system, including the Group-wide R&D centre, Business divisional central labs and Product-specific labs. Being an hub R&D organization for all LG group's Electronics CU companies[2], LGEIT (LG Electronics Institute of Technology) is committed to basic and applied research related to future technology on a long-term basis and thus its work areas are usually beyond the boundary of individual firms. Business divisional central labs are concerned with business division-specific R&D activities. Their main aims are not only to develop emerging new technologies and technologically converged products but also to search prospective business or products. Meanwhile, product-specific labs are closely associated with the development of new products and technologies.

LGE has a geographically decentralized form of R&D organization (see Figure 2).[1] One of the prime reasons is that the major domestic production sites are geographically decentralized and distant from Seoul. While LGEIT and business divisional R&D laboratories (called central labs) are clustered in a corporate-wide research complex in Seoul, product-specific R&D laboratories (called local labs) are largely based in each domestic core production base.

The reason why the company has built this kind of spatial form of organization may to some degree be understood by taking into account the spatiality of competences and knowledge. The operation of central R&D laboratories in Seoul is seen to give the company some distinctive

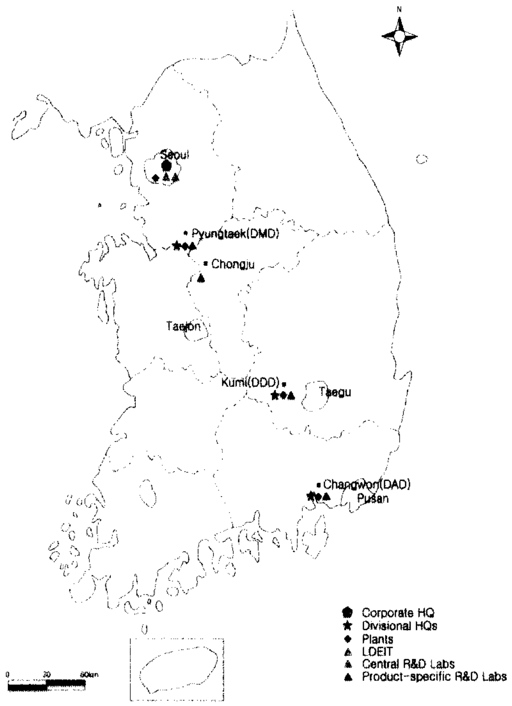

Figure 2. Spatial distribution of LGE sub-organizational units

geographical sources of advantage. Firstly, Seoul and its surrounding areas are known to have favorable access to sources of scientific and technological information and knowledge within the national boundary. The capital region retains the majority of public & private research institutions and leading universities. There is no doubt that the capital region is the most competitive place in Korea in terms of institutional presence. Secondly, Seoul offers greater possibilities to recruit qualified scientists, engineers and graduates than elsewhere in Korea in the sense that human capital plays an important role in gaining and improving organizational technological competences and knowledge. Thirdly, the operation of central R&D laboratories in Seoul allows LGE to keep close connections with the LG Electronics Institute of Technology (LGEIT), as they are all clustered together in a certain site in south Seoul, called the LG group central research park, established to foster synergy effects in research & development. LGEIT performs not only basic and applied research projects distinguished from central and local R&D laboratories, but also short-term joint projects with firm-level

Table 1. LGE domestic R&D laboratories

Name	Location	Research areas	Estab.
LGEIT [a]	Seoul	Basic research in electricity and electronics (element materials, information technology, ASIC, and so on)	1975
Digital Media Lab [a]	Seoul	Optical storage technology, digital A/V technology and product development	1998
Digital TV Lab [a]	Seoul	Digital TV and ASIC technologies, and product Development	1998
Digital Display Lab [a]	Seoul	Display devices and application technologies (PDP, FED)	1998
Digital Appliance Lab	Seoul	Development of core components and technology for home electronics products	1987
Digital Design Lab	Seoul	R&D of product design	1983
Quality Centre	Seoul	Research and analysis on product quality and reliability	1982
LSR Lab	Seoul	Research on product concepts through customer analysis	1989
Production Engineering Lab	Pyungtaek	R&D of production technologies (factory automation, system engineering and etc.)	1987
Digital Media Technology Lab [b]	Pyungtaek	Development of new multimedia products	2000
Digital Display Products Lab [b]	Kumi	Development of new display products (HDTV, Flat TV and etc.)	1984
Digital Display Devices Lab [b]	Kumi	Development of next generation display devices (PDP, Flat display, etc.)	1988
Digital Appliance Changwon Lab [b]	Changwon	Development of new home appliance products	1984
Digital Recording Media Lab [b]	Chungju	Development of AV tape and optical disks	1975

Source: LG Electronics Company (as of January 2000).
[a] Clustered together with LG Electronics Institute of Technology in the LG group central research park in the south of Seoul.
[b] On-site laboratories established within focal factories.

laboratories. LGEIT thus has a complementary relationship with firm-level R&D laboratories. As the group-wide R&D hub, LGEIT plays a central role in coordinating research projects between similar R&D laboratories as well as in mobilizing in-house technological competences.

Meanwhile, the company operates product-specific laboratories by business division. The purpose is to utilize the potential advantage that may be derived from the combination of R&D and manufacturing. According to interviews with managers of product-specific laboratories in Kumi, the co-location of R&D and manufacturing tends to be important at the stage of commercializing new products.[3] A new product development cannot be finalized until completing a series of tests on feasibility and manufacturability of the product. Such a process needs to use equipment and facilities in the manufacturing plant as well as to interact with engineers in the plant. In addition, the process of setting up a new production line requires frequent and intensive interaction and communication between different parties, including the R&D team, the engineering team and the manufacturing technology team.

This situational context is important in understanding the latest changes in the composition of R&D units. Since 1998, LGE has formally established four R&D laboratories related to the development of the emerging digital technology (see Table 1). At first, these new laboratories were established as part of the existing R&D units. But, later on these became an independent R&D unit as LGE decided to focus organizational competences on the development of products based on the emerging digital technology, which is said to be core strategic business, such as display devices, digital TVs and multimedia products. The company wants each of the new laboratories to focus all of its competences only on its own technological area. Three of them were established in the LG group central research park in Seoul as part of central R&D laboratories. Only one of them is founded as a local product-specific laboratory within the Digital Media Business Division (DMD) plant in Pyungtaek.[4]

However, we need to take into account the features of change in the spatial form of R&D organization. Two of the newly established central R&D laboratories have a direct link to local laboratories of the DDD (Digital Display Division) in Kumi in terms of the nature of research which they carry out. In the process of founding new laboratories, many of the engineers at local product-specific laboratories - about a third of all engineers - moved to new laboratories in Seoul.[5] LGE, instead, reduced the function and organization of the local laboratories. To surmount a lack of staff at the local laboratories, some engineers in the engineering team were shifted to the product laboratory, and in turn the engineering team decided to outsource routine work in order to cover a shortage of staff. Managers interviewed predict that this kind of R&D system will continue to remain, whilst the role of local R&D units will be decreased incrementally with the scale of minimum efficiency.[6] This prospect, however, can only be available when the company continues to keep in-house manufacturing activities without outsourcing manufacturing functions.[7] The following section tackles these issues in more detail, on the basis of in-depth interviews and several workplace observations.

5. Regulating organizational competences: the division of labor, learning and the problem of proximity

This section illustrates the processes of organizational and technological learning occurring around R&D units and centers upon the relationship between the division of labor in R&D and proximity.[8)] A particular concern relates to the influence of proximity and place on interaction and learning between R&D units and between R&D and manufacturing, in order to understand the changing processes of R&D spaces. The following description is based on the fieldwork survey centered upon the Kumi TV plant and R&D laboratories of the DDD.

The DDD has three domestic plants, all of which have been based in Kumi in the Southeast of Korea since the late 1970s. This business division is closely associated with two product-specific local laboratories in Kumi plants(Digital Display Products Lab and Digital Display Devices Lab) and two business divisional central laboratories in Seoul(Digital TV Lab and Digital Display Lab). The TV plant has a product-specific laboratory with more than 130 engineers and the engineering team (140 engineers), the manufacturing technology team (70 engineers) and the manufacturing team. The engineering team is closely related to the R&D laboratory in the nature of its work. It usually performs engineering tasks, needed not only for linking new products to mass production but also for handling technological problems with and improving the existing products. The product-specific laboratory and the engineering team intersect at the boundary of their work in many ways, and sometimes they interchange members of the staff. Thus, I shall here treat it as part of the R&D unit.

The central Digital TV Laboratory (hereafter, the central laboratory) actually performs research projects in a broad range of basic and core technologies associated with digital TV. Mean-while, the TV laboratory in the manufacturing site (hereafter, the local laboratory) takes the responsibility for the development of display device parts, the development of products at the commercialization stage, and the improvement and modification of the existing products based on analog display technology.

The case study exemplifies the development of digital TVs. To commercialize a brand-new product, more than a quarter of the staff members at the central laboratory in Seoul join the local laboratory in the Kumi TV plant. In general, they stay at the local laboratory for 3 to over 6 months until completing the test of a new product and set-up of the production line. During this time, a lot of interactions and communications between the two are needed. Additionally, some of the local laboratory engineers are sent to the central laboratory in the course of developing a new product. Such a mutual exchange of people between the central laboratory and the local laboratory tends to be further encouraged at the final stage of commercialization. In terms of technological learning, these interactions are intensified in a way that technological interdependence can be increased. That is to say, staff of the local laboratory may acquire knowledge on basic technologies that the central laboratory has developed and accumulated and, at the same time, staff in central laboratory may understand overall processes, ranging from the development of products through engineering works to manufacturing, and learn product-based technologies that the local laboratory specializing in applied technology possesses. The local laboratory in Kumi has long accumulated a variety of competences in the form of both tacit knowledge, such as know-how and skills, and codified knowledge, such as research files. R&D engineers interviewed argue that technologies associated with digital display products are not completely separate from analogue based technologies. Rather, it may be more effective when both technologies are incorporated complementarily.

This technological non-discontinuity between both technologies is of critical importance when we consider the ways in which firms adapt and learn in technological discontinuities. That is because the strategic move to digital technology and products may also, to a greater or lesser extent, be dependent upon an existing technological base. This feature challenges a received wisdom on corporate adaptability and technological discontinuity. There is an idea that large firms show strong performance by seeking scale economies during the phase where technologies evolve at an incremental pace, while they are likely to lose their advantageous positions in technologically changing conditions due to their path-dependency in both technology and organization (McKelvey and Texier, 2000). However, such an idea might ignore the complex and continuous nature of changing technological attributes. It cannot be viewed that knowledge and competence accumulated at the product-specific laboratory are obsolete. Rather, the local laboratory can play a critical role in accessing new technological knowledge more swiftly by mediating between an emerging digital technology and an existing analogue technology. Organizational assets of knowledge and competences embedded through incremental learning over a long period of time can be a valuable source necessary for sustaining innovation in products and processes.[9)]

Let us move back to an explanation of the interactive tie in LGE between the central laboratory and the product-specific local laboratory. This relationship implies frequent, interactive communications and learning from one another. In doing this, communication methods such as email and telephone are utilized conventionally. The use of ICTs is likely to be increased with the help of the rapid progress of ICT technology. According to head of the local laboratory, LGE is also considering interactive video-teleconferencing, in order to make communications between remote R&D units more effective (interview, 26 July 2000). He recognizes, nevertheless, that these methods for distant communications may not be sufficient not only to resolve technological problems and issues but also to share knowledge one another. The sharing of know-how and the coordination of cognitive distance between distant R&D teams are considered as critical to the process of the R&D project, and these may only be effective through improving relational/organizational proximity on a face-to-face basis (see, for more details, Lee, 2001).[10)]

Thus, engineers of both laboratories in charge of a certain project often gather in a suitable place to solve problems at a given point in time, or until completing joint-projects. However, the problem becomes more complex when a task must be carried out at a local laboratory but needs co-working between local lab members and central lab members. If it is a short-term project taking normally less than two weeks, the central lab staff would not go back home during the project. If the project is, however, a long-term project taking more than a month, they would go back home once every week or two weeks. Throughout this time, staff members of the central lab and the local lab establish common values, mutual understanding and common sense. These elements of relational/organizational proximity constructed as a result of the process of making connections between engineers can be a basic condition for not only working together effectively but also sustaining interactive learning. It implies that building organizational proximity seems to be, to greater or lesser extent, influenced by spatial proximity. Conversely, once different parties at a distance gain organizational proximity through continuous co-working activities, difficulties in interaction and communication between them can be mitigated.

It is problematic that the nature of organizational ties between workers within the company is not as strong as the frequency of contact and interaction between workers. However, it is hard to say that this characteristic is one that is found only in this company. It may reflect Korean organizational culture, steeped as it is in hierarchical order and obedience to one's seniors (Fukuyama, 1995). However, this kind of cultural characteristic may be used to regulate and control individuals, teams and sub-organizational units who may have different interests. A senior engineer of a local laboratory states:

> The spatial separation of R&D units should make it difficult for us to interact and communicate with the staff of the central laboratory as well as to coordinate tasks between local and central labs. Quite often, members of the staff at both labs must undertake business travel to meet their counterparts. Workers who have been working for a long time, like myself, may have thought that this is part of the work routine given to us from the start of joining the company. But, recently joined young engineers tend to increasingly complain about that problem. More seriously, young graduates are increasingly unwilling to work at local labs located in non-capital regions (6 August 2000).

The corollary of this is that formal R&D activities in LGE have increasingly been concentrating into Seoul where LGEIT and business divisional central labs are running. This may be viewed as going against the latest academic fashion on innovation. Geographical literature on learning and innovation tends to argue that a spatial integration between R&D and manufacturing becomes critical as the post-Fordist mode of innovation requires the interactive flow of knowledge and innovation (Cooke and Morgan, 1998; Hayter, 1996; Kenney and Florida, 1993). LGE's managers interviewed, in principle, agreed with this claim. Nevertheless, they argue that LGE's movement towards a spatial separation of manufacturing and R&D does not necessarily mean the one-way circulation of knowledge, or a disadvantage to the innovation capabilities. As argued by a senior engineer in a product-specific laboratory in Kumi:

> In the course of basic research and the development of a new product, the interaction between R&D and manufacturing would be less critical. Rather, for the development of an existing technology and the improvement of established technology, more frequent interactions and communications may be required at corporate-wide level (11 August 2000).

As a crucial rationale of this view, a head of the central D-TV laboratory demonstrates that a key element of Digital TV is a digital chip-set [based on ICT and semiconductor technology] and the competitiveness of D-TV is not dependent on its manufacturing capability, but exclusively on its design capability (Korea Electronics Times, 18 January 1999). A former engineer who had worked until recently in the Digital TV laboratory says:

> For digital electronics goods such as Digital TVs and digital media, the importance of manufacturing seems to be no longer significant. Only R&D capability will remain crucial for determining corporate competitiveness. That is because the size of commodities becomes smaller as well as those commodities being composed of fewer and smaller parts. These commodities seem to require a less complex process of manufacturing than analog ones (6 July 2000).

Jointly, they think that R&D activities can be sufficiently pursued without co-location with manufacturing and more crucial is to intensify interactions among R&D staff. In their view, in-depth interactions between R&D and manufacturing would be needed when attempting to commercialize new products as it is critical for the firm to realize rapid time-to-market and the optimization of a new product and production line. The flow of knowledge and learning may be constructed through more complex organizational processes than might be generally assumed. Thus, the functional units of organization such as R&D, manufacturing, design and marketing may not have a precise boundary between them.

6. Conclusion

In this paper, I have examined the shifting processes of R&D spaces in LGE, a large Korean firm, and their implications for learning and adaptation. LGE has recently attempted to improve organizational competences and learning capabilities by seeking reshaping spaces of R&D units in the domestic level. It has revealed that LGE, once sought the geographical co-location between R&D and production, is now attempting to seek to cluster core R&D functions around LGEIT and central laboratories in Seoul.

One would argue that such changing patterns in the form of R&D organization can be a return to the Fordist linear R&D model, which is characterized as a top-down, one way flow of innovation and learning and the precise division of labor between R&D groups. However, this does not necessarily mean that their tasks and roles are clearly departmentalized or their knowledge flows are unidirectional. As illustrated earlier, in many ways interactive relationships between people in different parts of an organization are sustained through boundary-spanning, co-working activities. The processes of interactive learning based on frequent, in-depth interactions and communications between the central lab's staff members and people in local plants, not least the local lab, play a crucial role in avoiding a one-way direction for innovation.

What is clear is that while central laboratories play a key role as a mediator linking business divisional R&D laboratories to LGEIT, local laboratories including engineering departments act as a bridge for combining the rest of the teams/departments involved in production activities. On the other hand, an obvious trend in the R&D domain, which has recently occurred in LGE, is that the priority of corporate R&D performance have been placed increasingly upon central R&D units, away from the geographical integration between R&D and manufacturing. These characteristics appear conceptually paradoxical, but it should be understood that such a spatial form of R&D reflects a corporate-specific mode of regulating organizational competences.

Notes

1) LGE's spatial form of R&D units obviously contrasts with that of Samsung Electronics Company (see Lee, 2002).
2) CU (Culture Unit) is a term referring to a group of firms interrelated among affiliate firms within the LG group. The Electronics CU includes companies such as LGE, LG Innotech, LG-Hitachi, LG-Philips LCD and LG Electronics Parts.
3) Interviews with director of Digital Network Division, DDD (25 August 2000), a senior engineer of New display device product lab, DDD (1 August 2000) and a manager of the Development support team, DDD (19 August 2000).
4) Pyungtaek plant is the closest among all domestic plants, taking about an hour by train from Seoul. In fact, the local product-specific lab in Pyungtaek had already existed from 1984 with the name the Video research lab. The company dissolved the organization to establish a new R&D lab to perform local-specific R&D on multimedia products

in 2000.

5) Interview with a manager of the Development support team, DDD (19 August 2000).

6) Interviews with a general manager of New display product lab, DDD (6 August 2000), a chief engineer of the DND engineering department, DDD (26 July 2000) and director of Digital Network Division, DDD (25 August 2000).

7) For example, most recently the Sony Electronics company decided to outsource production activities and instead concentrate on only conception functions, such as basic and applied research and marketing, which are regarded as core competences.

8) This section is based on interviews with managers of R&D and manufacturing teams: manager, the production engineering team, DDD (30 August 2000), general manager, New display product lab, DDD (6 August 2000), manager, the development support team, DDD (3 September 2000), chief engineer, DND engineering department, DDD (26 July 2000), director, Digital Network Division, DDD (25 August 2000), senior engineer, New display product lab, DDD (1 August 2000), senior engineer, Digital TV lab (11 August 2000), senior engineer, DND engineering department, DDD (11 August 2000) and engineer, Digital TV lab (10 September 2000).

9) Helfat and Raubitschek (2000), on the basis of the case of some Japanese electronics companies, also illustrate that the success of radical learning can be dependent upon ideas and assets accumulated through incremental learning.

10) See Rallet and Torre (1999) for an example of the empirical research supporting this view.

References

Amin, A. and Cohendet, P., 1999, Learning and adaptation in decentralised business networks, *Environment and Planning D: Society and Space*, 17, 87-104.

Amin, A. and Cohendet, P., 2000, Organisational learning and governance through embedded practices, *Journal of Management and Governance*, 4, 93-116.

Blanc, H. and Sierra, C., 1999, The internationalisation of R&D by multinationals: a trade-off between external and internal proximity, *Cambridge Journal of Economics*, 23(2), 187-206.

Cohen, W. and Levinthal, D., 1990, Absorptive capacity: a new perspective on learning and innovation, *Administrative Science Quarterly*, 35 (1), 128-152.

Cohendet, P., Kern, F., Mehmanpazir, B. and Munier, F., 1999, Knowledge coordination, competence creation and integrated networks in globalised firms, *Cambridge Journal of Economics*, 23(2), 225-41.

Cooke, P. and Morgan, K., 1998, *The Associational Economy: Firms, Regions, and Innovation*, New York: Oxford University Press.

de la Mothe, J. and Paquet, G., 1998, Local and regional systems of innovation as learning socio-economies, in de la Mothe, J. and Paquet, G. (eds.), *Local and regional Systems of Innovation*, Massachusetts: Kluwer Academic Publishers, 1-18.

Ernst, D., 2000, Catching-up and post-crisis industrial upgrading: searching for new sources of growth in Korea's electronics industry, Working Paper, No. 2, East-West Center, University of Hawaii, USA.

Foss, N. J., 1993, The theory of the firm: contractual and competence perspectives, *Journal of Evolutionary Economics*, 3, 127-44.

Fukuyama, F., 1995, *Trust: the Social Virtures and the Creation of Prosperity*, London: Hamish Hamilton.

Hayter, R., 1996, Research and development, in Daniels, P. and Lever, W. (eds.), *The Global Economy in Transitions*, London: Longman, 164-190.

Hedlund, G., 1994, A model of knowledge management and the N-form corporation, *Strategic Management Journal*, 15, 73-90.

Helfat, C. E. and Raubitschek, R. S., 2000, Product sequencing: co-evolution of knowledge, capabilities and products, *Strategic Manage-*

ment Journal, 21, 961-979.

Hodgson, G. M., 1998, Evolutionary and competence-based theories of the firm, *Journal of Economic Studies*, 25(1), 25-56.

Kenney, M. and Florida, R., 1993, *Beyond Mass Production: the Japanese System and Its Transfer to the U.S.*, Oxford: Oxford University Press.

Kim, L., 1997, *Imitation to Innovation: The Dynamics of Korea's Technological Learning*, Boston: Harvard Business School Press.

Lam, A., 1996, Engineers, management and work organization: a comparative analysis of engineers work roles in British and Japanese electronics firms, *Journal of Management Studies*, 33(2), 183-212.

Lee, J. H., 2001, Geographies of learning and proximity: a relational/organizational perspective, *Journal of the Korean Geographical Society*, 36(5), 539-560.

Lee, J. H., 2002, Organisational change, learning and the usage of space: the case of Samsung Electronics Company, *Journal of the Korean Association of Regional Geographers*, 8(3), 396-411.

Levinthal, D., 1996, Learning and Schumpeterian dynamics, in Dosi, G. and Malerba, F. (eds.), *Organisation and Strategy in the Evolution of the Enterprise*, London: Macmillan, 27-41.

McKelvey, M. and Texier, F., 2000, Surviving technological discontinuities through evolutionary systems of innovation: Ericsson and mobile telecommunication, in Saviotti, P. P. and Nooteboom, B. (eds.), *Technology and Knowledge: From the Firm to Innovation Systems*, Cheltenham: Edward Elgar, 227-248.

Morgan, K., 1996, Learning-by-interacting: inter-firm networks and enterprise support, in OECD, *Networks of Enterprises and Local Development: Competing and Co-operating in Local Productive Systems*, Paris: OECD, 53-66.

Morgan, K., 2001, The exaggerated death of geography: localised learning, innovation and uneven development, mimeo, Department of City and Regional Planning, Cardiff University.

Nonaka, I. and Takeuchi, H., 1995, *The Knowledge-Creating Company: How Japanese Companies Create the Dynamics of Innovation*, New York: Oxford University Press.

Rallet, A. and Torre, A., 1999, Is geographical proximity necessary in the innovation networks in the era of global economy, *GeoJournal*, 49, 373-380.

(2002년 9월 27일 접수)