

R&D organizational reform to provide profitable products

by

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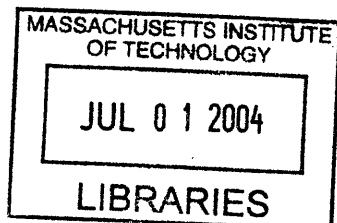
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ABSTRACT

Providing profitable products for corporate business success is an important mission for the R&D organization. Although good organization design may not guarantee corporate business success, it can be a critical factor to determining a company's ability to extract value from its R&D spending. There is no one best organizational design. Each company has to build an appropriate organization based on its business environment. The main subject of this thesis is Nippon Telegraph and Telephone Corporation's (NTT) R&D organization. NTT faces a severely competitive business environment from all angles of changing technology and service trends, competition, reorganization and financial difficulties. A case study of Bell Labs is also included, because of its similar situation and problems. Two critical internal organizational factors for providing profitable product are identified; marketing, and judgment of the development topics. A recommendation is given to build marketing capability in NTT holding company's R&D. Also, the collaboration method between marketing and R&D, and a new marketing approach for middle term R&D by using the lead user method are proposed. Furthermore, integration holding company's short term R&D into the subsidiary business corporations' R&D is also proposed.

Thesis Supervisor: Eric A. von Hippel
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Table of Contents

| | |
|---|----|
| 1. Introduction | 7 |
| 2. Bell Labs case study..... | 9 |
| 2.1. Overview..... | 9 |
| 2.2. Bell Labs organization change..... | 10 |
| 2.3. Bell Labs in Lucent..... | 14 |
| 2.4. Shift towards market oriented research..... | 15 |
| 2.5. Bell Labs New Concept for business oriented..... | 18 |
| 2.6. Change in Culture | 21 |
| 2.7. Venture trial..... | 23 |
| 2.8. Analysis | 25 |
| 3. Background of NTT | 28 |
| 3.1. Overview..... | 28 |
| 3.2. NTT R&D organization | 28 |
| 3.2.1. History about NTT | 28 |
| 3.2.2. Basic R&D and Applied R&D | 29 |
| 3.2.3. Basic R&D structure and mission | 30 |
| 3.3. Severe environment of NTT R&D..... | 32 |
| 3.3.1. View from industry technology change..... | 32 |
| 3.3.2. View from industry service trend change..... | 36 |
| 3.3.3. View from competition and finance | 39 |
| 3.3.4. Mission of NTT Basic R&D..... | 43 |
| 4. NTT R&D organization analysis..... | 45 |

| | | |
|----------|--|----|
| 4.1. | Overview..... | 45 |
| 4.2. | Organization analysis..... | 45 |
| 4.2.1. | Internal and external organizational factors | 45 |
| 4.2.2. | Internal organizational factor: Marketing..... | 49 |
| 4.2.3. | Internal organizational factor: Management’s decision making policy..... | 54 |
| 4.3. | Comparison with Bell Labs case | 56 |
| 5. | Proposal to NTT | 60 |
| 5.1. | Overview..... | 60 |
| 5.2. | Option1: Establishing marketing department | 60 |
| 5.2.1. | Role of marketing department..... | 60 |
| 5.2.2. | The characteristics of Marketing and R&D..... | 63 |
| 5.2.3. | How to collaborate between Marketing and R&D | 67 |
| 5.2.4. | Marketing approach..... | 74 |
| 5.2.4.1. | Definition of R&D term | 74 |
| 5.2.4.2. | Marketing approach for each term..... | 75 |
| 5.2.4.3. | Lead user approach..... | 77 |
| 5.2.4.4. | Lead user project | 78 |
| 5.2.5. | Organizational power | 80 |
| 5.3. | Option2: Integration of R&D..... | 82 |
| 5.3.1. | Overview | 82 |
| 5.3.2. | Integration of Short term R&D..... | 82 |
| 5.3.3. | Integration of Middle term R&D..... | 85 |
| 5.4. | Summary of Options..... | 86 |

| | |
|--------------------|----|
| 6. Conclusion..... | 89 |
| References | 93 |

1. Introduction

Providing profitable products for corporate business success is an important mission for the Research and Development (R&D) organization. R&D has become increasingly business-oriented. Although good organization design may not guarantee corporate business success, it can be a critical factor to determining a company's ability to extract value from its R&D spending [1]. This thesis focuses on organizational factors to improve profitable product development capability.

Considering organizational design, there is no fixed "one best model" [1]. Each company has to build an appropriate organizational design based on its business environment. The subject of this thesis is the R&D organization in Nippon Telegraph and Telephone Corporation (NTT). NTT is a holding company of NTT Groups, which are Japan's largest telecommunication service providers. The NTT's R&D environment has changed dramatically due to recent technology and service trend changes, reorganizations that resulted in the current holding company and subsidiary business corporations, severe competition within the telecommunication industry, and financial difficulties of subsidiary business corporations. It is a challenge and responsibility for NTT's R&D organization to provide profitable product in such a tough and changing environment.

The purpose of this thesis is to propose appropriate R&D organizational reform measures for NTT in order to provide profitable products. NTT's R&D organization refers to the R&D department in NTT holding company. In Chapter 2, the case study of Bell Labs organizational reform and many parallel features will be explained and analyzed. Bell

Labs' external environment change is similar to NTT R&D's. The R&D field of Bell Labs is in the same industry as NTT, and Bell Labs has also shifted away from university style R&D to business oriented R&D due to its parent company's financial difficulties and the telecommunication industry downturn. I will describe and analyze the organizational structure transition, new concepts about business oriented research, changes in culture, and venture trial. In Chapter 3, I will explain the current severe environment surrounding NTT R&D. NTT organization structure transition, technology and industry trend changes, competition and financial difficulties, will be explained especially from the point of view of the fixed line service field. In Chapter 4, I will analyze issues with NTT's R&D organization and how it relates to providing profitable products. Internal and external factors will be discussed, and also compared to the Bell Labs' case study. In Chapter 5, I propose some organizational reforms for NTT R&D to solve these issues. Two options are proposed and evaluated. One option is the establishment of a marketing department in the NTT holding company. The method of interaction between this new marketing and other organizations, and the appropriate marketing approach regarding R&D terms are also included. Another option is an integration of R&D from the holding company into the Applied R&D in subsidiary business corporations. Integration regarding R&D terms is proposed. Finally in Chapter 6, I will give my conclusions about the appropriate organizational reform for NTT R&D to provide profitable products.

2. Bell Labs Case study

2.1. Overview

Bell Labs is part of the Laboratories of Lucent Technologies Inc., one of the global telecommunication manufacturing companies in the U.S.A. It was considered America's national treasure and to be one of the greatest research labs of the twentieth century, especially in the fields of advanced science and technology. Founded in 1925, forty-thousand inventions have been generated since 1925. Bell Labs invented and developed key communications technologies including transistors, digital computers, digital networking and signal processing, lasers and fiber-optic communications systems, communications satellites, cellular telephony, electronic switching of calls. Many new software and appliances innovations also came out of the Bell Labs like the Unix operating system, the world's most widely used computer programming languages, fault-tolerant software, software-based communication services, speech synthesis and recognition, stereo sound, the fax machine, touch-tone dialing, and modems [2]. Bell Labs scientists and engineers have earned thousands of awards including eleven researchers' Nobel prizes.

However, its organization has changed dramatically because of the marketplace, competition, and economic conditions, and has been receiving negative press. In this chapter, I describe the result of research about Bell Labs organization change and then analyze the case.

2.2. Bell Labs organization change [3]

Foundation of Bell Labs: Figure 2-1 shows a time line of the organization changes involving Bell Labs. Bell Telephone Labs, the predecessor of the current Bell Labs, was founded in 1925 as a separate company of AT&T, which was a mega carrier in U.S.A. It was formed to be a joint venture between AT&T and AT&T's subsidiary, Western Electric. The president of AT&T at that time was Walter Gifford. Gifford's objectives to create a separate entity are listed below.

1. He believed that one central R&D facility would be more efficient and economical than having multiple R&D facilities.
2. He wanted to eliminate internal competition for credit between the two R&D organizations in the Bell Labs System, and the engineering departments of Western Electric and AT&T.
3. He thought that a visible and separate R&D organization would help to protect AT&T's monopoly status by demonstrating to its critics that AT&T was not only stifling innovation but also actually encouraging innovation.

AT&T divestiture: AT&T operated as a government regulated monopoly since 1913. Because the monopoly maintained high long distance call rates in a way that was not beneficial to customers and potential competitors, the US government filed an antitrust lawsuit against AT&T in 1974. In the settlement, AT&T agreed to divest its subsidiaries, spinning off seven "Baby Bells" (or RBOCs, the Regional Bell Operating Companies) in 1984. Bell Telephone Labs became a division of AT&T and was renamed AT&T Bell

Labs. Because the new Baby Bells also needed some R&D capability, they established a shared research facility called Bellcore. AT&T shrunk by about two thirds as a result of the divestiture. But because AT&T considered Bell Labs important for its future, Bell Labs Research was only shrunk by about 10%. The released people were transferred to Bellcore. Figure2-2 shows the change in number of researchers.

AT&T trivestiture: As AT&T entered into a more competitive age, conflict developed between the services and telecommunication equipment businesses. Outside competitors and even the Baby Bells, which tried to enter lucrative long distance market as rivals of AT&T, were increasingly buying telecommunication equipment from not AT&T but AT&T competitors such as Nortel and Alcatel. Also, AT&T's computer business was not going well. Therefore, in 1996, to unlock the value of AT&T's business, AT&T split up into three companies; AT&T, which became a telecommunication company, Lucent Technologies, which became a system and equipment company, and NCR, which became a computer company. Because research was considered more important for a system and equipment company than for a service company, Bell Labs became an entity of Lucent Technologies. Lucent's Bell Labs kept 75% of the researchers while 40% of the old AT&T employees moved to Lucent. A quarter of Bell Lab's researchers were assigned to the new AT&T Labs. NCR did not get any part of Bell Labs because it had been with AT&T for only a few years and there was no further history of interaction between Bell Labs and NCR.

Lucent divestiture: AT&T spinning off Lucent led increase of sales and stock value in the onset. However in 2000, Lucent's stock dropped drastically when the telecommunication market shrunk and revenues and earnings fell below market expectations. In response, Lucent spun off its non-core business to further unlock the value of Lucent's assets. Two companies were formed in 2000/2001; Avaya, which engaged in enterprise business, and Agere, to focus in the microelectronic business. Lucent Technologies maintained its coverage of the telecommunication equipment business. Thus its areas of potential research became more narrow and specialized. Bell Lab also was split. 4% of the total went Avaya, 21% went Agere, and 75% stayed within Lucent.

Downsizing: Early in 2001, Lucent's financial condition became desperate. Budgets were cut and the number of employees in Lucent was reduced for the first time. Bell Labs was forced to give up its "job for life" culture. The Bell Labs research facility in Silicon Valley, which had opened in July 1998, closed in February 2001. All but one of Bell Labs' remote locations in Greece, India, UK, and Illinois were also closed. The exception was China, where it was a necessity to Lucent's business. In addition, Bell Labs Research was also shrunk by active encouragement of voluntary early retirement. At the end of the downsizing, there were only 500 researchers in 2002.

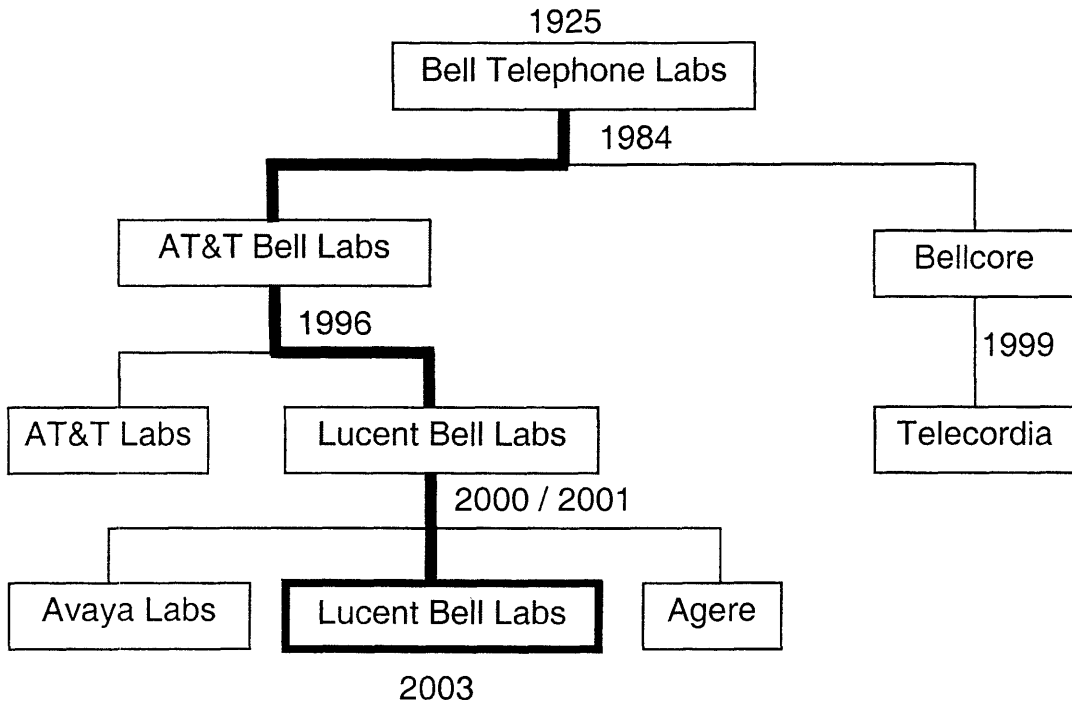
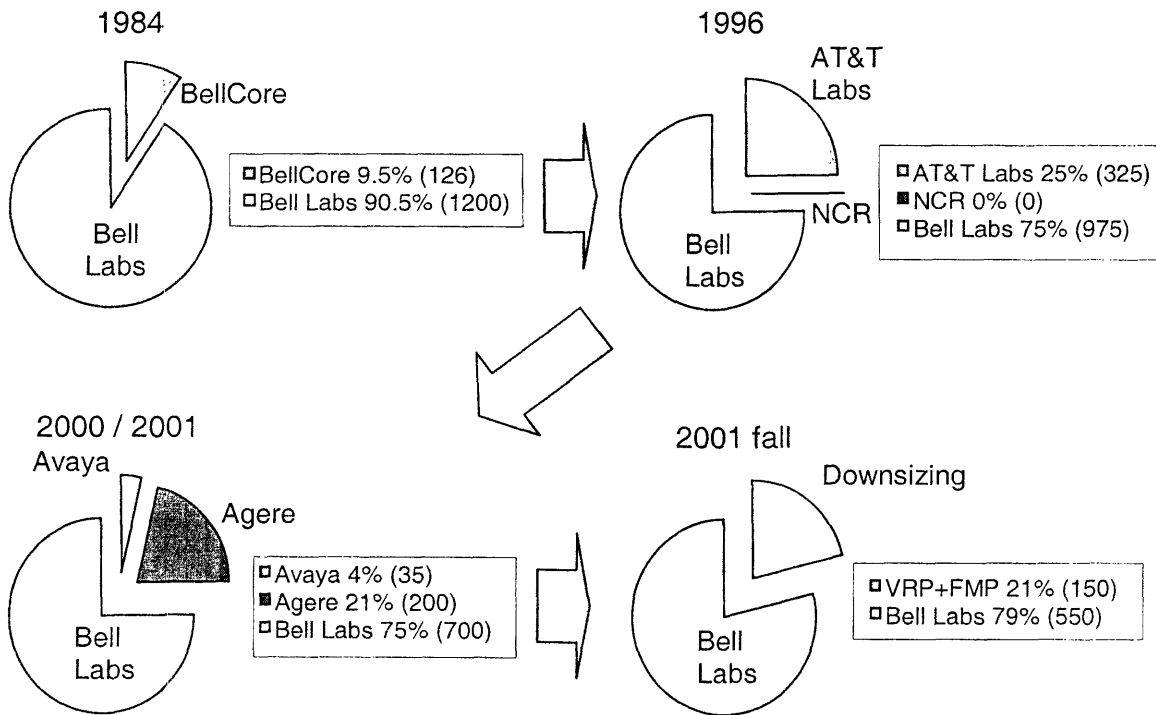


Figure2-1 Bell Labs Organization Changes [3]



Numbers in parentheses represent approximate number of researchers

Figure2-2 Change in Number of Researchers [3]

2.3. Bell Labs in Lucent [3]

Figure 2-3 shows Lucent's current organization structure. After all of the divestitures and downsizing, it has a research group and business units. Bell Labs is divided into two organizations, Research and Advanced Technologies. Advanced Technologies is an internal contracting organization. The business side was organized into two business units, Inter Networking Systems (INS) and Mobility Solutions. The former provides products and services for wire line service providers while the latter do the same for wireless service providers. Lucent focuses on providing product and services to a more narrow set of approximately thirty large service providers, due to its financial difficulties. Bell Labs also reduced its research spectrum to areas such as computer science, communications software, physical sciences, data networking, and optical networking.

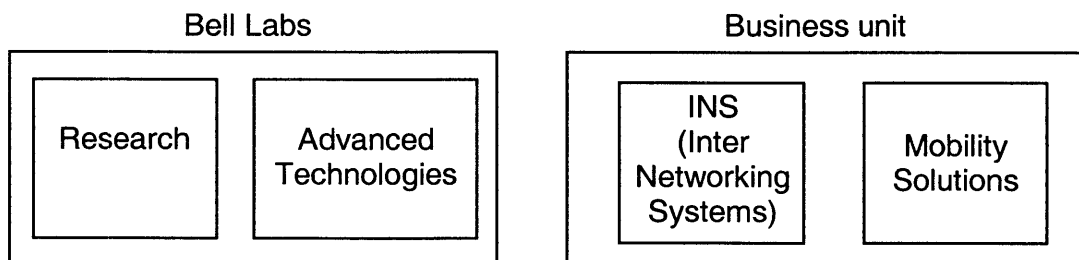


Figure2-3 Lucent Organization

Because Bell Labs' parent corporation has always centrally funded Bell Labs Research, the business units have never had direct control of Bell Labs' research direction. When Lucent was established after spinning off, the R&D budget was 1% of Lucent revenue. After the financial difficulties, the R&D budget decreased to 0.75% of Lucent revenue, which also dropped because of difficult telecommunication market conditions.

The following Figure 2-4 describes Bell Labs management hierarchy in 2002. A department has about 10 to 15 researchers on the average. A center has about 5 or 6 departments. A division has 4 centers.

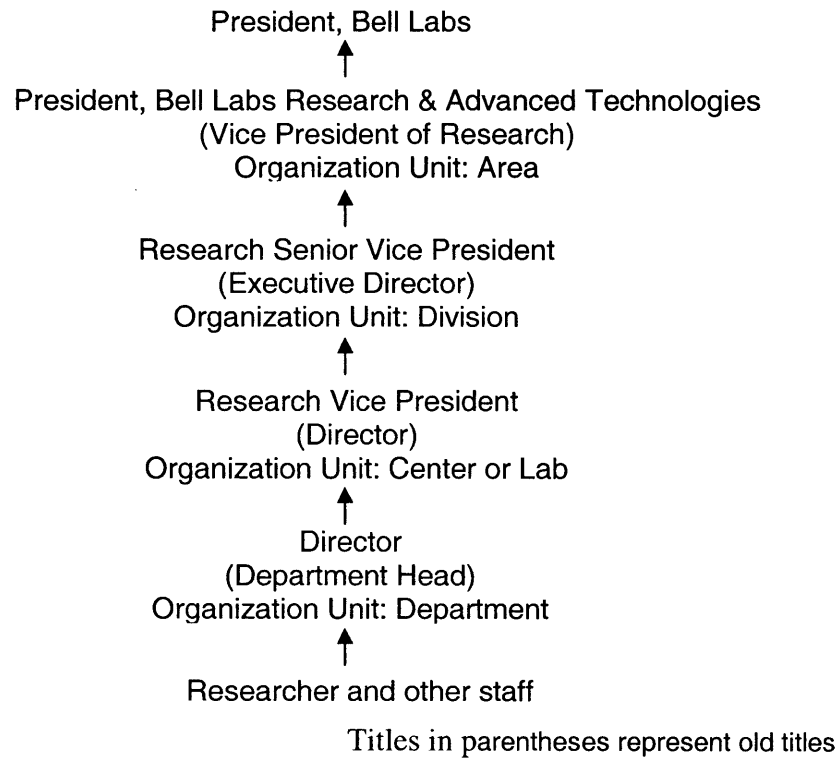


Figure2-4 Bell Labs Management Hierarchy [3]

2.4. Shift towards market oriented research [3]

In its lifetime, Bell Labs went through three different research styles. They are Market-oriented Research, System-oriented Research, University-Style Research. The general characteristics of each style are summarized below.

- **Market-oriented Research:** This research is focused on development of new products and services. The research organization structure is based on product and service lines. This model is found especially during times when the company is fighting to grow or maintain its revenues. The culture is more corporate than collegial, since the researchers are working on projects that address the immediate competitive needs of the company.
- **System-oriented Research:** This research is more conservative in that it focuses on incremental improvements to enhance the company's current products and services. The research organization is more dispersed to serve the various organizations in the company. This model is usually found when a company is financially comfortable. Also in the relaxed setting, a collegial culture is developed. Individual researchers may have a great deal of freedom to pursue their own research interests.
- **University-Style Research:** Research may be oriented towards advancing science in the long term, or conducting basic research. Here the organization may be structured like university departments and the researchers tend to interact more with university colleagues than with their business colleagues.

The following Figure 2-5 shows change in research style in Bell Labs. Bell Labs' Research orientation change is categorized into the following four periods.

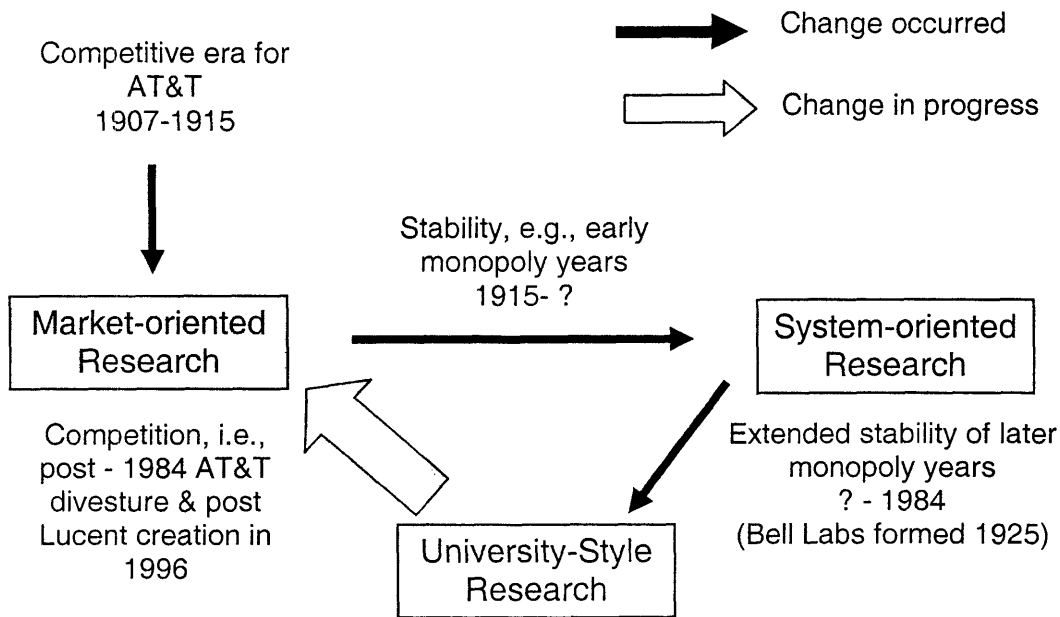


Figure2-5 Research Paradigm [3]

- 1907 – 1915: Competitive era for AT&T with research in AT&T following the market-oriented research model.
- 1915 – 1984: Monopoly era for AT&T. Bell Labs was founded in 1925. Bell Labs’ research model first shifts towards the system-oriented research and then over several decades it shifts to university-style research focusing on basic research.
- 1984 – 1995: Competitive era for AT&T and Bell Labs slowly shifts away from university-style research towards market-oriented research.
- 1996 – Present: AT&T hands Bell Labs to its offspring Lucent in 1996. Change in Bell Labs towards market-oriented research continues at a faster pace. Lucent’s financial difficulties further accelerate this change.

Switching from university style research to market-oriented research is generally more difficult than switching from market-oriented research to system-oriented research. Going from system-oriented research to university-style research is relatively easy, because researchers enjoy increased freedom to choose their research topics and less pressure about product deadlines. In order to speed up the transition towards market oriented research, Lucent performed two key actions, urgent innovation and new leadership at Bell Labs. First, Lucent installed new management at Bell Labs in 2001, to align Bell Labs with Lucent's business strategy and marketing efforts. O'Shea, Lucent's executive vice president of strategy and marketing, added President of Bell Labs to his previous responsibilities. He had 30 years experience in AT&T and Lucent's business units and understood all aspects of business. The advantage of O'Shea was that he did not have cultural or emotional ties to Bell Labs. Thus he was able to take aggressive steps to change research's direction and culture. He intended to strongly connect Bell Labs Research with the company's business strategy and its customers. Bell Labs developed a Bell Labs wide strategy document that defined what was important for Bell Labs researchers and managers to work on from a business perspective.

2.5. Bell Labs New Concept for business oriented [3]

After AT&T faced severe competition and financial difficulty, Bell Labs applied concepts of business oriented research to involve AT&T business units. The main concepts were Breakthrough projects, Startup model, and Collaboration.

Breakthrough projects: In 1996, Bell Labs president and vice president of research devised the concept of “breakthrough” project to promote cooperation with the business units. If the Vice President of Research at Bell Labs and a business unit President agreed that a research project was both innovative and important for the business unit, then it would be designated as a Breakthrough project and would be jointly sponsored. Research would contribute researchers and additional resource as appropriate, while the business unit would provide development and business resources.

Startup model: The Startup model was also attempted. Instead of first developing the technology or a prototype and hoping that the business units would make it into a product, Bell Labs developed the product and while working directly with potential customers. Only after customers were in place would Bell Labs hand over the research project to a business unit. The researchers worked with customers from the very beginning during the specification process, the design and implementation process, and field trials. It was also possible that they could take their system to initial commercial deployment. This approach bypassed the several processes which usually took a long time in the business unit. Consumer field trials were a faster substitute for such business unit processes. Although the research teams also worked with marketing staff in business units, the projects were officially under the Bell Labs. Three good examples of this approach are PacketStar, PathStar, and Softswitch. The technology developed in these projects was considered very innovative and disruptive. These three projects represented a radical change in the traditional Bell Labs research model, away from the traditional way of doing research. The researchers were involved in all phases of product building, from conception, meeting

customers, requirements, development, field trials, to initial deployment. The leaders of these projects were motivated and teams pushed themselves to be the first to the market. Unfortunately, these projects were not ultimately successful for reasons beyond the researchers' control. First, due to Lucent's acquisitions, product lines became overlapped. Also, the telecommunication market downturn caused many Competitive Local Exchange Carriers (CLECs), which were customers, to go bankrupt. Although the projects were canceled, the researchers had shown that they could change with the times. Bell Labs adapted its research model to better meet the needs of its parent company.

Collaboration: Sometimes, depending on the technology and business needs, simple collaboration between Bell Labs and the business units also gave effective results. One successful example was OCELOT, a software system for optimizing wireless networks. The wireless business unit and the mathematicians and computer scientists from Bell Labs teamed up to work on a problem that was identified by the business unit. Another example was LambdaRouter, an optical router that works with tiny mirrors. However, LambdaRouter project was cancelled during the telecommunication market downturn, when carriers cut equipment purchases. Other example was MetaComm, a system for integrating data from various telecommunications devices. This project was a success from both business and research perspectives. In addition to real product success, two research papers were published and one patent was filed. After identifying a potential area where in which Research could help the business unit, the research team worked to establish a collaborative relationship with the business unit before starting the project.

2.6. Change in Culture [3]

Because Bell Labs Research was physically as well as organizationally separated from the business units until 1984, a wide culture gap developed. Some of the differing characteristics are listed in Table 2-1. The researchers of Bell Labs Research, out of reach from business unit control, were given the freedom to work on next generation technologies. They had little or no interaction with the business units until the 1990s, almost as if two organizations were different companies. The business units did not involve the researchers or their managers in planning strategy, defining the product road map, customer sales visits, etc.

Table2-1 The Cultural differences

| | Bell Labs Research | Business units |
|-------------------------------------|---|--|
| Task | <ul style="list-style-type: none"> • Chose research topics by themselves | <ul style="list-style-type: none"> • Business needs |
| Motivation | <ul style="list-style-type: none"> • Freedom to work on topics of their own choosing • Inventing something new • Establishing professional reputation • Publishing papers • Being on conference program committees • No raises and promotions | <ul style="list-style-type: none"> • Promotion is important |
| Goal | <ul style="list-style-type: none"> • Long-term research goal | <ul style="list-style-type: none"> • Short-term goal |
| Pressure | <ul style="list-style-type: none"> • No short-term pressure (No or soft deadline) | <ul style="list-style-type: none"> • Under constant pressure (Deadlines) |
| Measuring contributions objectively | <ul style="list-style-type: none"> • Difficult (intangible) | <ul style="list-style-type: none"> • Easy (deliverables are more tangible) |
| Raises, bonuses | <ul style="list-style-type: none"> • Success in the academic pursuits | <ul style="list-style-type: none"> • Whether or not they meet their deliverables • Operated in revenue, profit, and goal |

| | | |
|-------------------------|---|--|
| Direction and guidance | <ul style="list-style-type: none"> • Free | <ul style="list-style-type: none"> • Strong |
| Number of projects | <ul style="list-style-type: none"> • Multiple simultaneously to hedge bets | <ul style="list-style-type: none"> • Focus on single |
| System produced | <ul style="list-style-type: none"> • Generally prototypes (“proof of concept” system) not for real users, lacked many necessary attributes • Develop by themselves | <ul style="list-style-type: none"> • Developed using focus groups, concept demos, customer meetings, code reviews etc. • Preferred to acquire new technologies |
| Communication | <ul style="list-style-type: none"> • Preferred e-mail | <ul style="list-style-type: none"> • Preferred voicemail |
| Management | <ul style="list-style-type: none"> • tradition of egalitarianism • open and frank relationship • Rank is not an issue when it comes to research and technical opinions | <ul style="list-style-type: none"> • Hierarchical, many level of management processes |
| Favorable Research type | <ul style="list-style-type: none"> • “Push” Research (push its technology into the business units) | <ul style="list-style-type: none"> • “Pull” Research (to work with researchers) |

Bell Labs’ becoming a division of AT&T was the start of a procedure to eliminate organizational barriers between Bell Labs and the business units. Also locating Lucent’s headquarters into main location of Bell Labs initiated the process to reduce the physical barriers between them. When Lucent spun off in 1996, it represented itself as a Silicon Valley type company. So there was great urgency on the Lucent business units to deliver new products and services to achieve revenue targets. This pressure increased the collaboration between Bell Labs and business units.

At first, the researchers and the business units’ people did not understand each other’s roles and mismatched their expectations. Netravali, who was the 9th president of Bell Labs from 1999 to 2001, started shifting Bell Labs away from science and long-term research and more toward the company business. Researchers had to justify their research topics and contributions were evaluated for their business value. Thus, publishing and building of

professional reputations became limited. If researchers worked on topics which are not related business needs, the research was expected to produce super-significant results, such as Turing Award quality.

Leaving Bell Labs was an option if researchers did not accept above research type change. However, when the survival of both Lucent and Bell Labs was at stake, leaving Bell Labs was no longer an option for many researchers because the telecommunications and software industries were in a downturn and many companies were downsizing. Therefore, most researchers were happy just to have jobs and were quite willing to work on business unit related projects.

Another characteristic of Bell Labs is that firing a researcher explicitly for poor performance was a rare phenomenon at Bell Labs until recently.

2.7. Venture trial [3]

In Junly of 1998, Bell Labs established a new research organization, BLRSV (Bell Labs Research Silicon Valley), in Silicon Valley. The purpose was to take advantage of Silicon Valley's quick moving culture [4]. Lucent wanted to introduce new products in the telecommunication market quickly. BLRSV was planned in the following way.

- Operating like a Silicon Valley incubator that nurtures and launches companies that quickly convert the research ideas into products.

- Non traditional research organization. The culture was very different from Lucent's east coast more traditional, hierarchical style.
- More product focused organization. It was treated as "internal venture" in order to motivate employees in a similar manner to the Silicon Valley startups. Researchers received virtual "phantom" stock options for each Lucent project. BLRSV would help the researchers to create the internal ventures by providing them with the necessary financial, technical, and business resources and expertise.
- External connections as well as internal connections. BLRSV would hire the best, entrepreneurial researches and people with business skill, in Silicon Valley for its internal ventures.

However, BLRSV closed in February 2001. It was first ever closing of a Bell Labs facility. The reasons about failure in BLRSV management are explained as follows. It was concluded that the BLRSV model of internal ventures was not workable within the context of Lucent. So Lucent decided to give up the idea of BLRSV, shut it down and save money.

- Internal venture model issues: It did not make sense to the business units to pay to acquire the internal ventures, especially since the internal ventures were already funded by Bell Labs, which was in same company. Furthermore, business units did not agree to spin off some internal ventures nor acquire them, although the internal ventures in which business units was not interested should have spun off.
- Disadvantages for Potential founders: Joining BLRSV to create a Lucent internal venture was disadvantageous for founders compared to starting an independent

company. There was less independence under Lucent's constraints and culture and less equity stake. Furthermore, if Lucent was not interested in the internal venture, it would be spun off as a separate company.

- **Human resource:** Hiring and retaining entrepreneurial people with innovative ideas were difficult in the Silicon Valley. The culture of the west coast was different from the east coast. People were more fluid. Furthermore, after the co-heads, Schmidt and Coughran, left the company due to frustration with some of the above issues, several key employees also left, which reduced BLRSV's morale at a critical infancy stage.
- **Financial difficulty:** Lucent financial difficulty in early 2001 caused to major cuts to Bell Labs budget. Bell Labs was not able to invest the several million dollars needed to run BLRSV and put it BLRSV back on track.

Thus, the experiment of BLRSV was not successful due to misaligned motivations, expectations and bad timing with the telecommunication downturn.

2.8. Analysis

Now I will analyze Bell Labs from the prospective of its ability to provide profitable product. Actually through most of its history, Bell Labs was not well positioned to provide profitable products to its business units. While some concepts between Bell Labs and business units worked well, three main factors caused failure.

1. Acquisitions by Lucent: As a result of Lucent's several acquisitions, product lines were overlapped. Although some of Bell Labs projects were working well, the product overlapped with the product which was provided by the acquired company. Therefore, the Bell Labs projects were canceled.
2. Defect in business model: The BLRSV model of internal ventures did not work well because of defects in business model. There was a fundamental lack of incentive to both the researchers and the business units to get involved in the new ventures.
3. The telecommunication market turndown: Some Competitive Local Exchange Carriers (CLECs) went bankrupt, causing write off. And most carriers geared down investing in telecommunication infrastructure.

Items 1 and 2 are organizational factors (internal factor), and Item 3 is an environmental factor (external factor). Item 3 is beyond the control of Bell Labs management, and would have been difficult to avoid. However, Items 1 and 2 could have been avoided by management. From the view of Bell Labs, Item 1 was management mistake by Lucent's business units. The business units must have evaluated the acquisition and should have understood about the product overlaps. Bell Labs wasted a large sum of money and human resource for the projects. The business units did not, and should have considered the technology strategy in advance. For Item 2, the blame should be shared between the management of both Bell Labs and the business units. They should have investigated and proved the validity in business model of internal venture.

The concepts which worked well were “collaboration” and “startup model”, while “breakthrough project” is normal concept to be business oriented. Bell Labs provided what the business units needed by collaborating with business units. Collaboration changed Bell Labs researchers’ culture to help Lucent businesses. The Startup model demonstrated that Bell Labs could work directly with customers, develop what they needed, and accelerate the development period. This addressed the business units’ needs in the end. If the above three factors of failure had not existed, the projects in which “collaboration” or “startup model” were introduced might have been successful.

Bell Labs should exclude internal failure factors at first. However, this case also showed that R&D organization is influenced by external factor “industry market turndown” much. What R&D organization should be done to provide profitable product under industry market turndown is critical issue.

3. Background of NTT

3.1. Overview

Nippon Telegraph and Telephone Corporation (NTT) is the largest telecommunication service provider in Japan. Its predominant businesses are in regional communications, long distance and international communications, mobile communications and data communications services. In this chapter, I will give an overview of NTT and its R&D organization. Then I will discuss the technology and service trends and increasing competition in the telecommunication industry and how it is related to NTT R&D.

3.2. NTT R&D organization

3.2.1. History about NTT

In 1985, the Japanese government privatized NTT. This was the first step towards a long term goal of deregulation. Data Communications Systems, Japan's largest systems integrator, was formed in 1988, and NTT DoCoMo was formed as its mobile carrier in 1992. In 1999, the remaining portions of NTT were reorganized, breaking up into NTT holding company and three carriers, two regional local phone providers -- NTT East and NTT West -- and a long-distance and international carrier called NTT Communications. The Figure 3-1 gives an updated illustration of the current NTT group companies' structure. As of March 31, 2003, NTT operates through 450 subsidiaries and 110 affiliated companies [5].

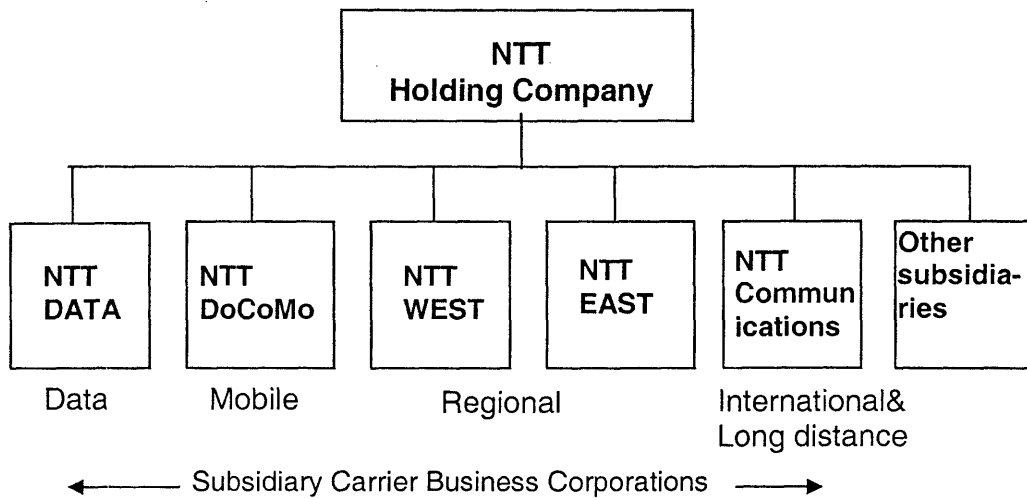


Figure3-1 The Structure of NTT Group Companies

3.2.2. Basic R&D and Applied R&D

NTT holding company assumed responsibility for the “Basic R&D” of all the group companies in 1999. Number of employees engaged in Basic R&D is approximately 3,000. The R&D budget is mainly based on funds invested by subsidiary carrier business corporations. The main customers of and investors for R&D organization in NTT holding company are the three carrier business corporations that were reorganized in 1999, NTT East, NTT West, and NTT Communications. In addition, various subsidiaries carry out “Applied R&D”. Basic R&D refers to basic and foundation technologies that can benefit the future business of the entire NTT Group [6]. Some examples are network technologies and relevant element technologies. The Applied R&D that is conducted in the subsidiaries is the additional technology development that is needed to directly link their businesses and services, including integration or customization of market products [7] [8]. Figure 3-2 gives a block diagram of the relationship between the subsidiary business corporations and the holding company. Also because Japanese authorities prohibited NTT from

manufacturing to encourage competition among equipment suppliers, NTT holding company and subsidiary carrier business corporations do not have manufacturing department. Instead, they work with vendor companies to develop the systems that are needed.

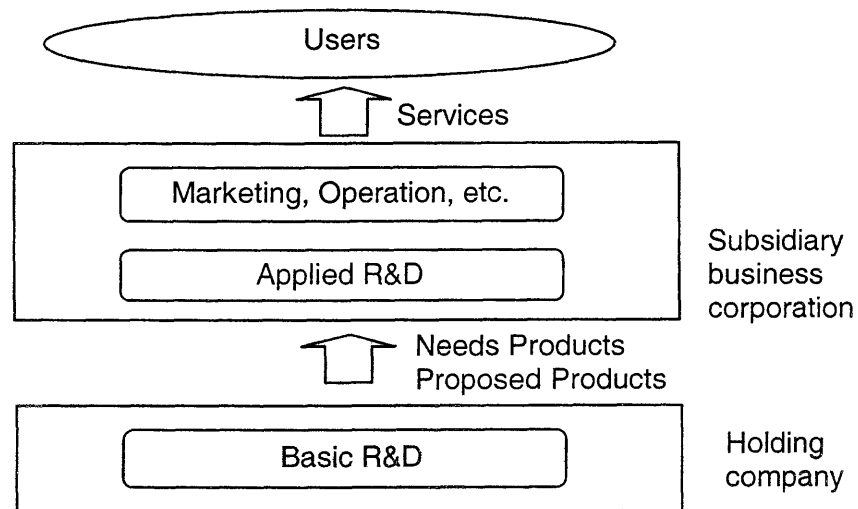


Figure3-2: Relationships about R&D

3.2.3. Basic R&D structure and mission

R&D activity in NTT holding company is conducted in three laboratory groups, the Cyber Communications Laboratory Group, the Information Sharing Laboratory Group, and the Science and Core Technology Laboratory Group. The area of focus and activities of each laboratory group are described below [6]. Figure 3-3 shows the structure of the 3 laboratories. Core Technology Laboratory Group engaged in long term R&D with a ten-year time horizon.

- Cyber Communications Laboratory Group: Network appliances and content software for people-friendly interfaces. The provision of content distribution services. Element technologies for community collaboration services.
- Information Sharing Laboratory Group: Network infrastructure for transferring and distributing information. Common functions such as security measures and account settlement functions. Human environment-friendly information sharing systems.
- Science and Core Technology Laboratory Group: The creation of new principles and concepts that will revolutionize telecommunications. Technologies that have a low impact on the global environment and human beings.

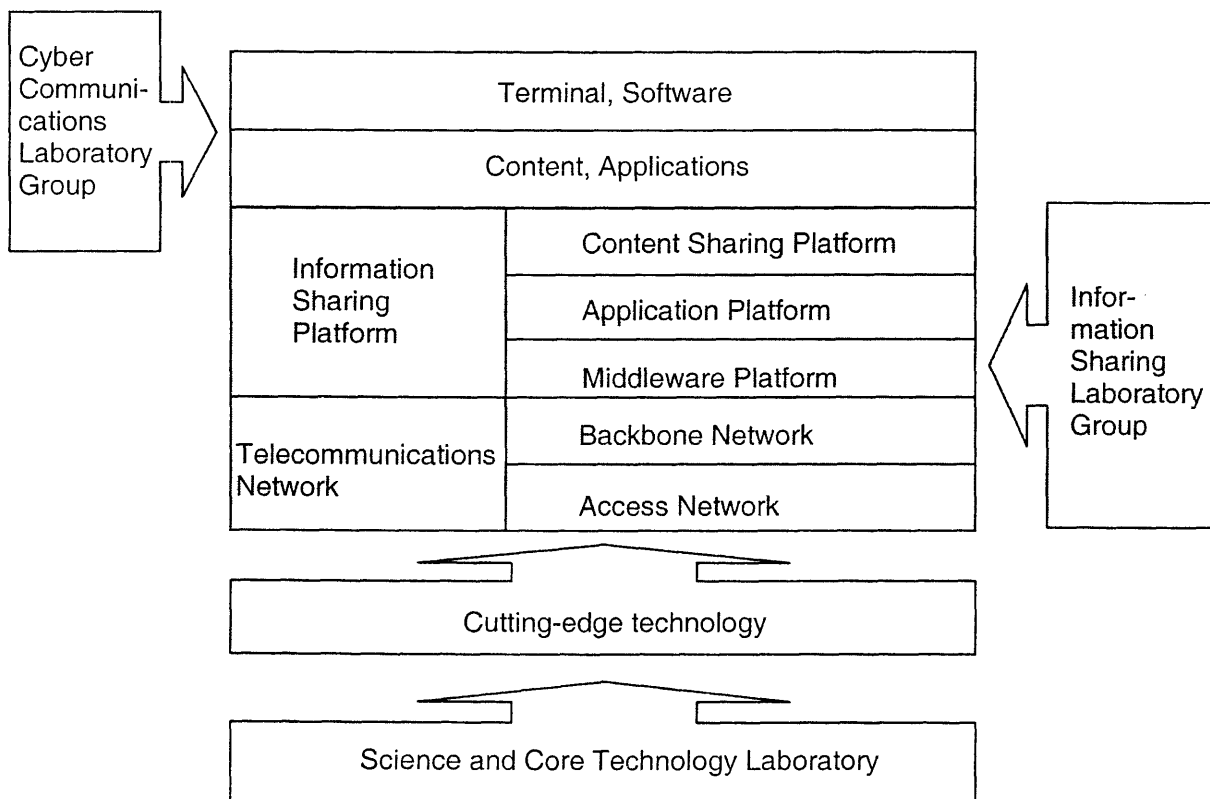


Figure3-3 Structure of Three Laboratory Groups [6]

Especially, the current main focus on R&D department is to build “REsonant communication Network Architecture (RENA)” through research into basic technologies for the next-generation network architecture and services. The Resonant communication environment is a convenient future environment in which people around the world will be able to communicate safely, reliably and simply with anyone, anytime, anywhere via interactive broadband communication. RENA has following three characteristics [6].

- Broadband: Support for interactive communications
- Ubiquitous: Ability to communicate anytime, anywhere, with anyone
- Usability: Ability to communicate safely, reliably, and easily

3.3. Severe environment of NTT R&D

3.3.1. View from industry technology change

The main products of NTT holding company’s R&D department are telecommunication equipment, including service software. The customers of NTT holding company’s R&D department are its subsidiaries. The largest customers and investors, NTT-East, NTT-West and NTT Communications are in fixed line service field. Therefore, I will analyze technology and industry related to the fixed line service field, especially products for fixed line services.

Telecommunication technologies and industries have changed dramatically in the last several years. In terms of technology, computer network based technology has replaced conventional telecommunication technology such as PSTN (Public Switched Telephone

Network), due to the advent of “IP telephony” and “Internet connection technology through fixed line”. NTT R&D department had no competitor in the area of Japanese telecommunication carrier grade equipment development until about six years ago. NTT single-handedly determined most specifications for the Japanese telephone network. In contrast, IP telephony, which is based on the computer network, is a disruptive technology of conventional telecommunication technology. The Internet connection technology through fixed line is also basically part of computer network based technology. Because these are high cost effectiveness and specifications tend to be determined by de facto standard, the R&D departments of the telecommunication carriers have been impacted greatly. Figure 3-4 shows the S-curve [9] of telecommunication technology for fixed line services. Table3-1 gives the technology characteristics. The S-curve shifted from PSTN telephony to IP telephony. IP telephony has finished its ferment period and is now its take-off period. Quality and function improvement as well as its original advantages in technology and cost all combined to accelerate the onset of the take-off phase.

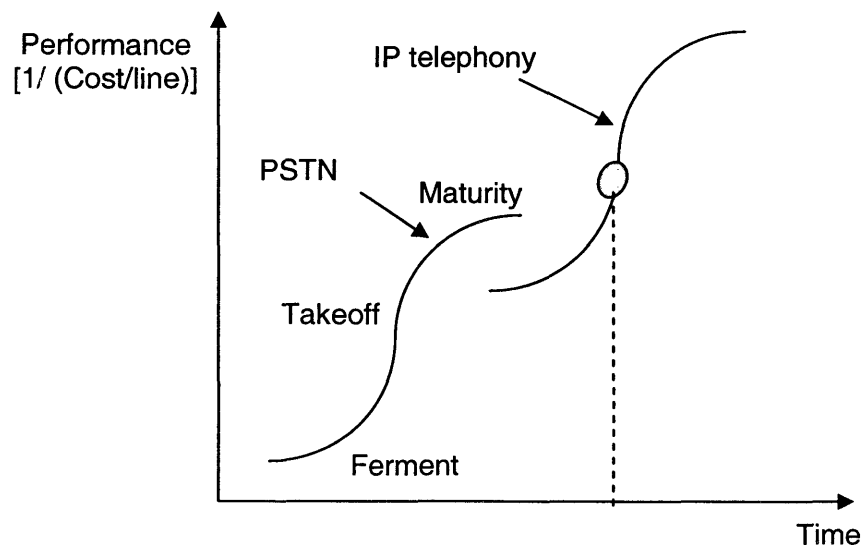


Figure 3-4 S-curve Transition of Technology for Fixed Line Services

Table3-1 The Comparison of Telecommunication Technology Characteristics

| | PSTN telephony | IP telephony and Internet connection technology |
|-------------------------------|---|--|
| Innovation cycle | <ul style="list-style-type: none"> • Slow (because of matured technology and specific) • Development period is longer | <ul style="list-style-type: none"> • Rapid (Many vendors adopt new technology and release new products in a short cycle) |
| Specification | <ul style="list-style-type: none"> • Mixture of NTT original and ITU standard (ITU: International Telecommunication Standardization Sector) | <ul style="list-style-type: none"> • De facto standard (Standardization might change rapidly) |
| Cost | <ul style="list-style-type: none"> • Expensive (both R&D cost and manufacturing cost) because of specific technology and low competition | <ul style="list-style-type: none"> • Cheap (because of computer network based technology, and severe competition) This means service providers can reduce service charges. |
| Characteristics of technology | <ul style="list-style-type: none"> • Circuit switching based • Voice based network • Narrow band (mainly 64kb/s) | <ul style="list-style-type: none"> • Computer network based (Packet communication) • VoIP (Voice over IP) technology • Multimedia network (Integrated with voice, data and video) |

The emergence of these two technologies has dramatically changed the telecommunication equipment for the fixed line service industry. Figure 3-5 and Figure 3-6 show the situations before and after the advent of the two technologies, using the Porter's five forces framework [10]. In the before situation, this industry was not considered competitive. Figure 3-5 shows that four of the five forces were very low. Also, even though the threat of substitutes such as mobile network equipment is high, this threat existed in the long term. During this period, NTT R&D products had no competitor. NTT requested and deployed

its own products. However, the two new technologies forced NTT R&D's products into a more competitive environment. As Figure3-6 shows, all five forces are high. In terms of the buyers bargaining power, NTT subsidiary carrier business corporations have the options to choose whether they want to buy or customize market products or use the R&D developed products. Furthermore, competitive differentiation is difficult because the market development period and cost reduction cycle moves at a faster pace than NTT R&D. The time and cost factors are an additional severe challenge for NTT R&D department's competitiveness with the market products.

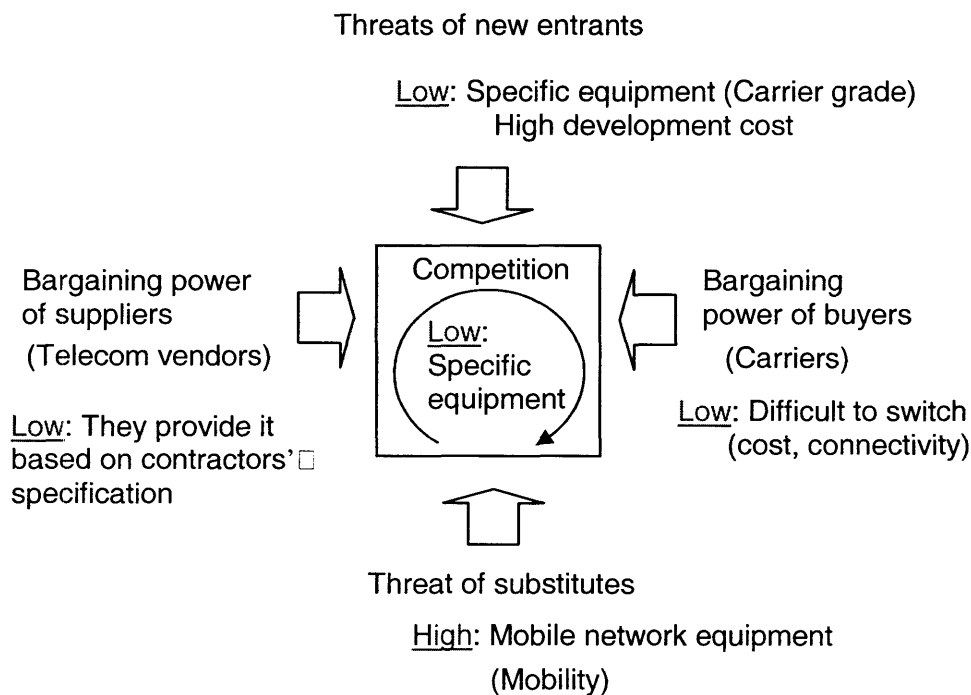


Figure3-5 Porter's Five Forces about Telecommunication Equipment Industry before the Advent of IP Telephony and Internet Connection Technology

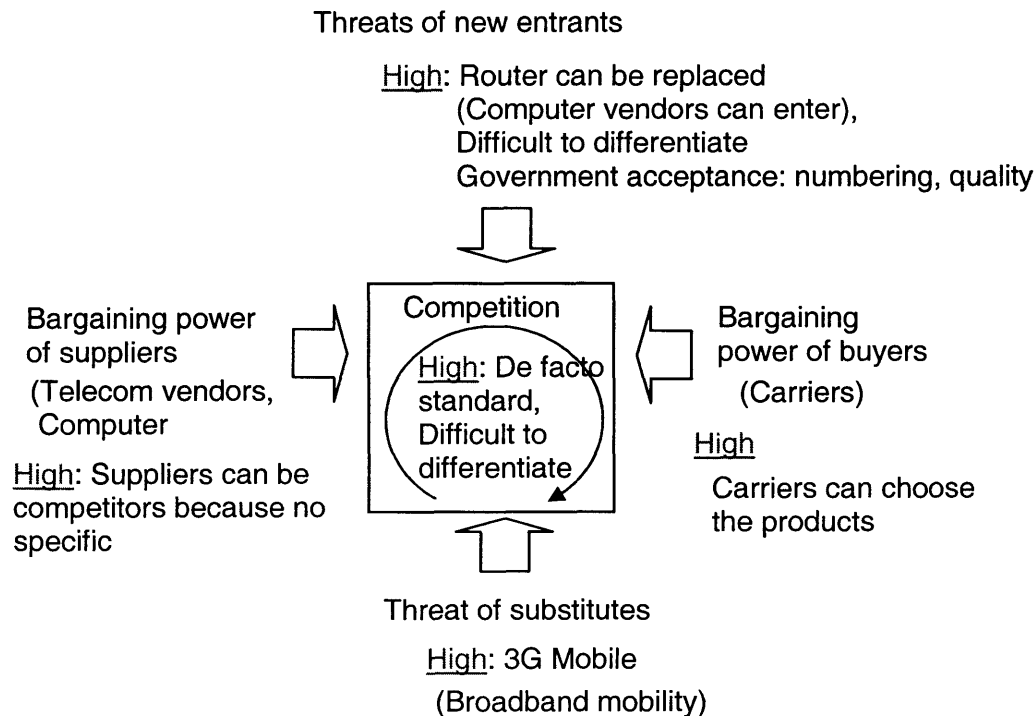


Figure3-6 Porter's Five Forces about Telecommunication Equipment Industry after the Advent of IP Telephony and Internet Connection Technology

3.3.2. View from industry service trend change

The telecommunication fixed line services have also changed dramatically in the past six years. Figure3-7 presents some statistics about the total number of subscribers in fixed line telephone services in Japan. Fixed line telephone services mean telephone services and ISDN (Integrated Service Digital Network) services. As this figure shows, number of subscribers had already matured and is now decreasing. The main reason of for the contraction of the fixed line telephone services is expansion of the mobile communication market. Demand had shifted from fixed telephones services to mobile phone services. Furthermore, the number of IP phone service subscribers began increasing, because the government allowed assignment of IP phone numbers in 2002 fall such that IP phones

could then be called from fixed line telephones and mobile phones. The IP phone services still have some limitations compared with fixed line telephone services. For example, the IP phone cannot connect to the police or ambulance. However, it is believed that the lower service charge of the IP phone services will continue to promote the service growth and which in turn will cannibalize the fixed line telephone market.

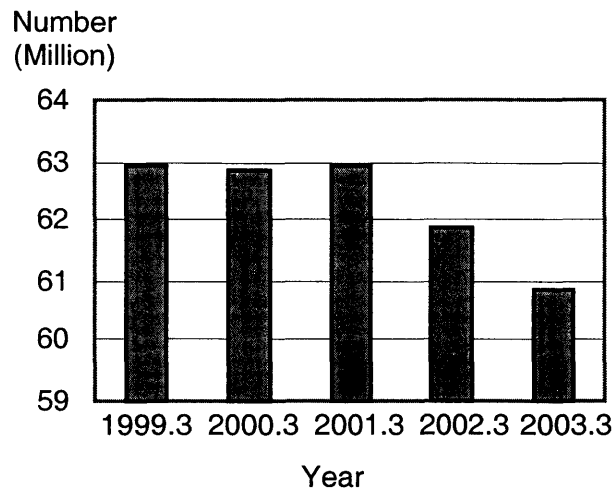


Figure3-7 The Total Number of Subscribers in Fixed Line Telephone Services [7] [8]

Another recent trend is the expansion of the broadband market. ADSL (Asymmetric Digital Subscriber Line) service, which uses the existing copper telephone lines, continues to fuel market expansion. Users' demands for high speed and low flat rate Internet connection have driven the increasing number of ADSL subscribers. Also, lower service prices due to competition between service providers have also contributed to the increasing number of subscribers. Figure3-8 shows total number of ADSL subscribers from year to year, including a forecast between 2004 and 2008. It is expected that the number of subscribers will reach over 14 million in 2005.

However, ADSL's long term potential is considered limited. It uses the old copper telephone lines as the transmission media, so ADSL has more technological speed bumps than fiber optics and slower upstream data transmission rates. For these reasons, NTT believes that users will want to shift to optical access services in the future [12]. The following Figure3-9 shows total number of FTTH (Fiber To The Home) subscribers. The numbers between 2004 and year 2008 are estimates. The total number will increase gradually and reach more than 10 million in 2007. It is expected that some of this growth will come from ADSL subscribers shifting to FTTH service gradually. When optical fibers are used for infrastructure instead of copper wires, the interactive transmission of large volumes of data becomes possible, enabling the advent of a truly broadband era.

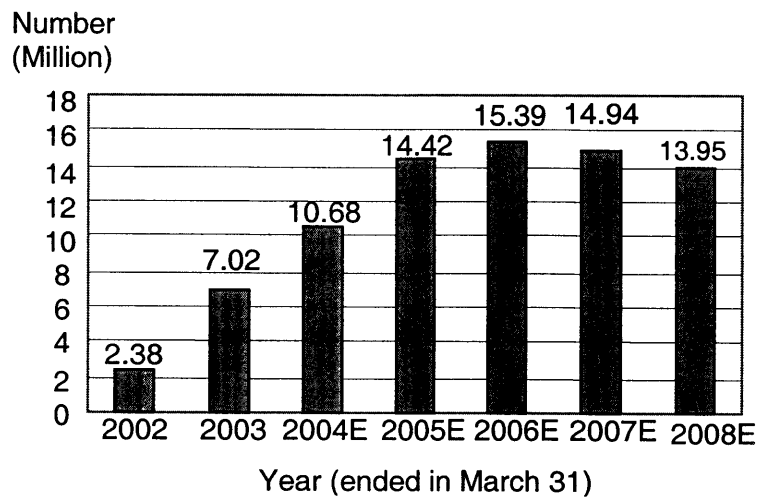


Figure3-8 Total Number of ADSL Subscribers [11]

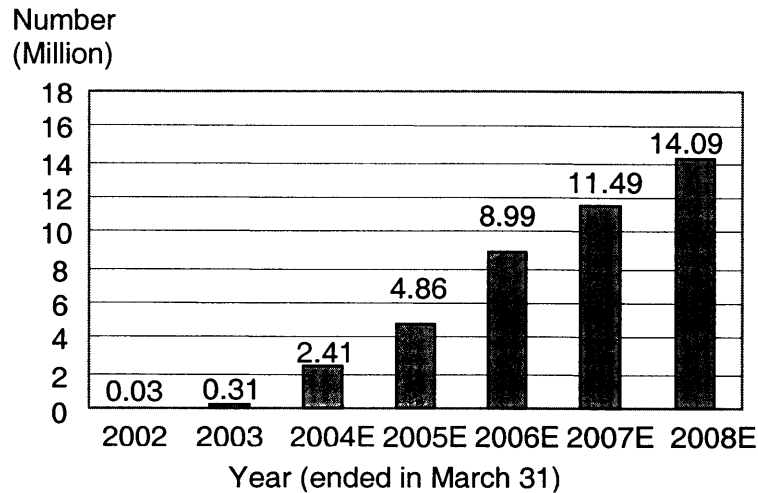


Figure3-9 Total Number of FTTH Subscribers [11]

In the fixed line service industry, the trend has been shifting away from the matured fixed telephone network services to the growing broadband network services. The carriers need a new profitable platform infrastructure to adopt these environment changes. NTT is re-positioning itself as a broad band business in order to capture the new source of revenues [12]. However, even in this growing industry, competition is becoming severe and prices are going down. As the number of subscribers matures, there is a danger that the infrastructure which provides the services will also be commoditized, like for the fixed telephone network. Therefore, NTT has to create not only the infrastructure for the broadband network, but also provide value added or killer application services in order to differentiate itself from the competitors.

3.3.3. View from competition and finance

As Figure3-10 shows, the operating revenues from fixed line voice communications in NTT group have been decreasing. This is due only in part to the fixed line telephone

market contraction (Figure3-7). The prices of the call rates and access charges to other carrier networks has also decreased and along with market share. Figures 3-11 and 3-12 show how the price of a single telephone call has changed over the years. Figure3-11 shows a local, 3 minute call made in the daytime and Figure3-12 shows a 3 minute long-distance call between Tokyo and Osaka, also made in the daytime. Severe competition has resulted in a call rate decrease of 25% for local calls and 92% for long distance calls. Thus the fixed line telephone service infrastructure has dramatically commoditized. In addition, Figure3-13 shows NTT's market share of local calls and Figure3-14 shows its market share of long-distance calls. Market share of NTT has also been eroding every year due to the severe competition. Thus, the fixed line telephone business in the subsidiary business corporation has been losing basic source of revenues.

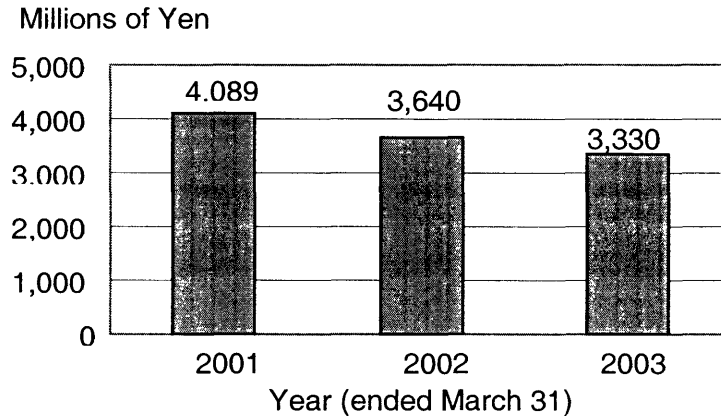


Figure3-10 Operating Revenues of Fixed Line Voice Communications in NTT Group[13]

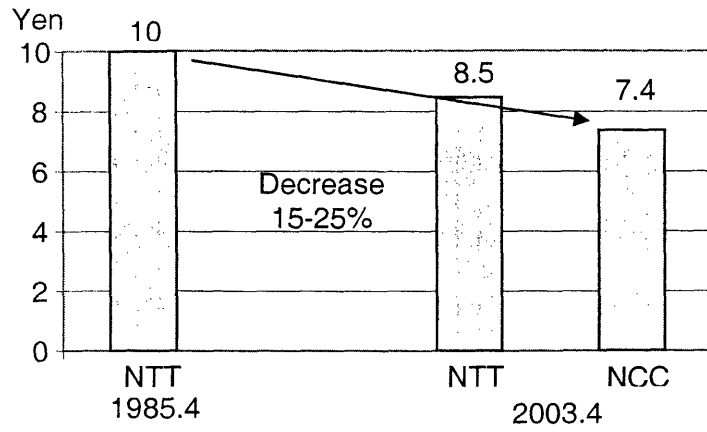


Figure3-11 Local Call Rate in Japan (Daytime 3minutes) [13]

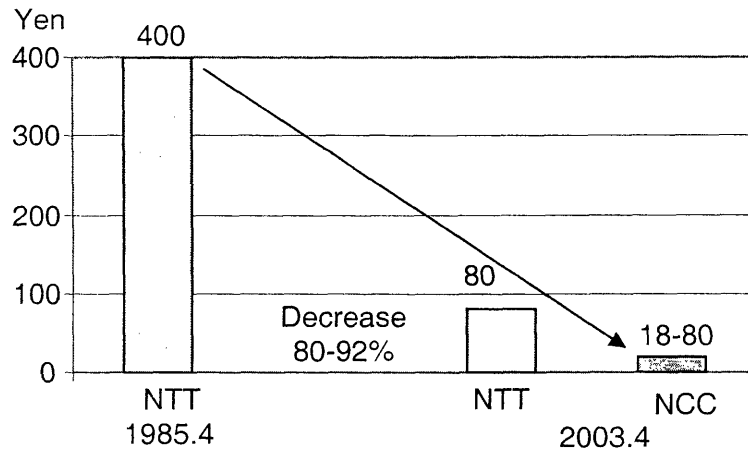


Figure3-12 Long-distance Call Rate in Japan (Tokyo-Osaka Daytime 3minutes) [13]

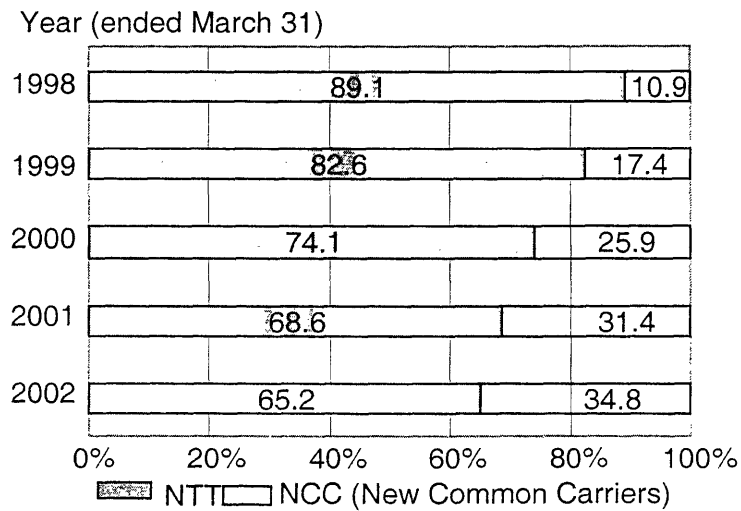


Figure3-13 Market Share about Local Call (Number of Calls) in Japan [13]

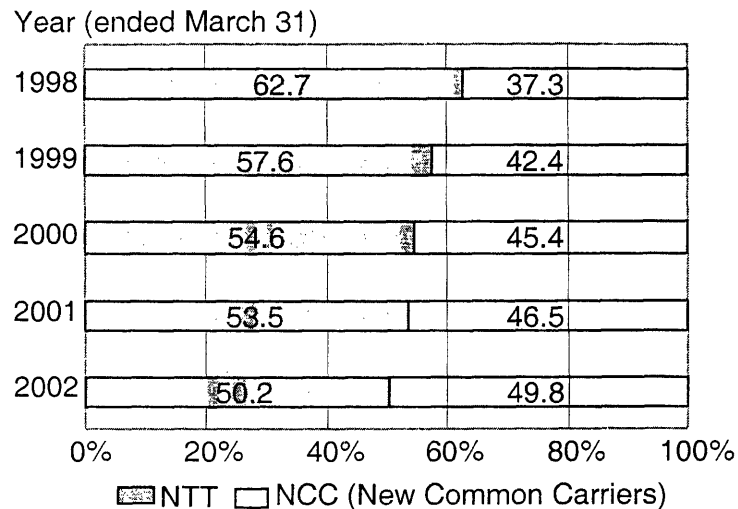


Figure3-14 Market Share about Long Distance Call (Number of Calls) in Japan [13]

NTT has taken several steps to respond to the tough operating environment characterized by the shrinking fixed line telephone businesses. NTT reduced its costs by a sweeping outsourcing program, restructuring its workforce through retirement packages and reemployment initiatives, and constraining capital investment related expenses [12]. The following Figure 3-15 shows how the cost-cutting mindset has affected the overall R&D budget of NTT holding company. The R&D budget, invested by the subsidiary carrier business corporations, has been gradually decreasing, although it is still huge amount. Investing such a huge R&D budget in spite of the tough operating environment means that subsidiary carrier business corporations have high expectations for Basic R&D, and that Basic R&D has a high responsibility to provide profitable products to contribute the businesses of the subsidiaries.

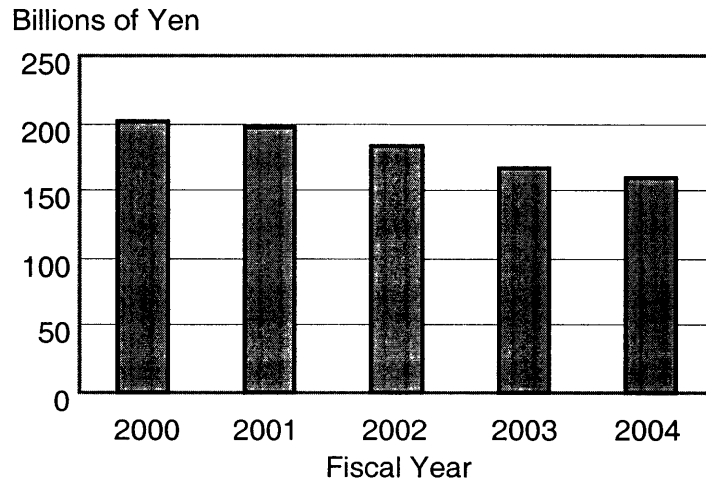


Figure3-15 NTT Holding Company's R&D Budget [14]

3.3.4. Mission of NTT Basic R&D

Basic R&D has become business oriented because of severe environment change. As described in previous three sections, 3.3.1, 3.3.2, and 3.3.3, the R&D department in NTT holding company has the following missions.

1. To make superior market products in order to compete in the severe market environment, with the understanding that they may tend to become de facto standardized and that their innovation cycle is rapid.
2. To create killer applications as well as infrastructure in new, growing environments such as broadband networking.
3. To contribute to the subsidiaries' businesses because the subsidiaries invest the Basic R&D budget, even under financial hardship.

If basic R&D cannot provide profitable products in the severe competitive product market, the subsidiary business corporations might decrease the Basic R&D budget and buy market products instead. What is needed from the R&D organization in NTT holding company? In the following chapter, I will analyze the current R&D organization issues and propose solutions from the point of view of organizational reform.

4. NTT R&D organization analysis

4.1. Overview

Having discussed the competitive external environment surrounding NTT's R&D, I will now analyze the issues that NTT holding company's R&D organization faces in order to provide profitable product. First, I will present the organizational issues using a System Dynamics model [15]. Then, I will propose how NTT R&D organization should apply the lessons learned from the Bell Labs case study described in Chapter 2.

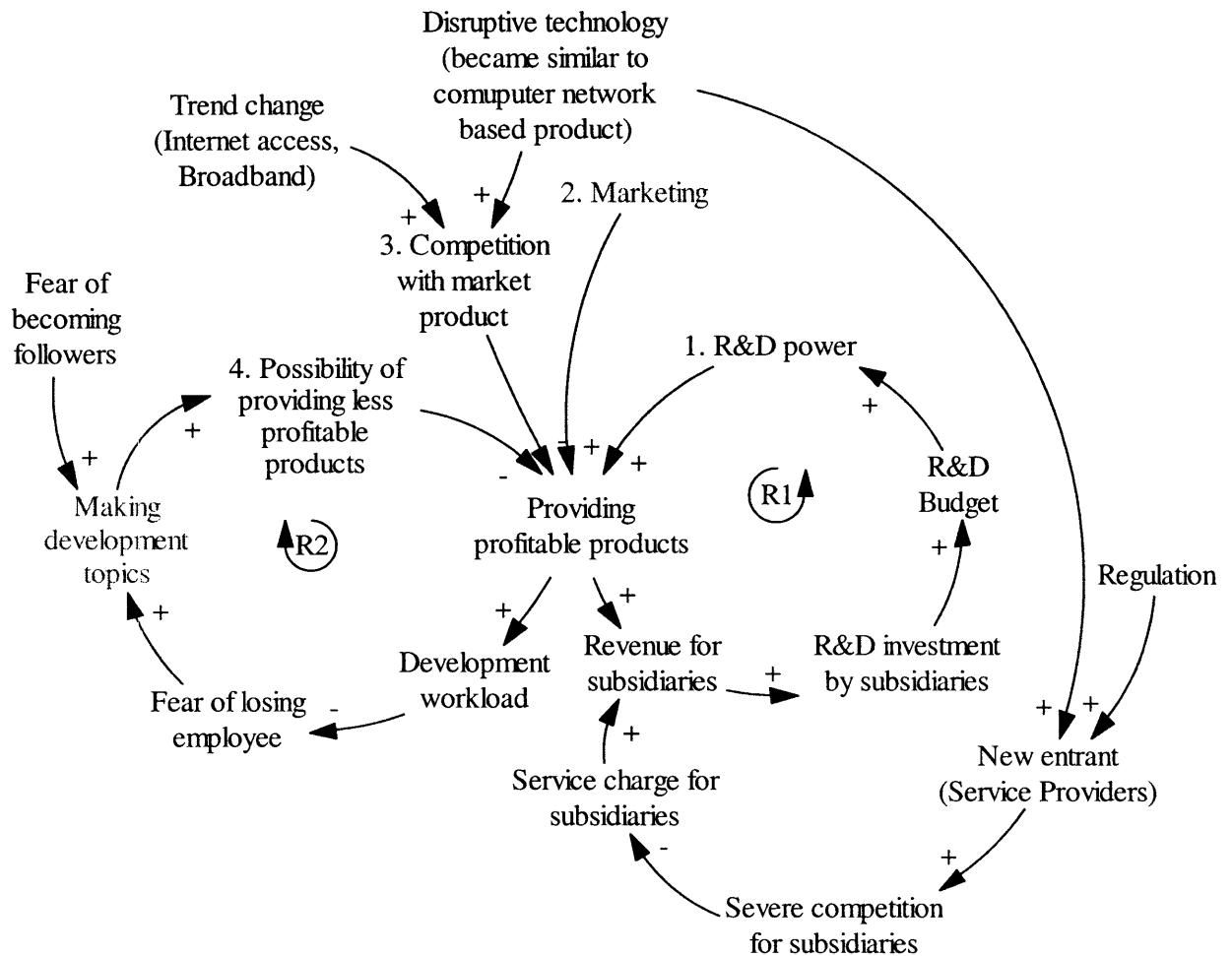
4.2. Organization analysis

4.2.1. Internal and external organizational factors

There are many interrelated factors involved in the dynamics of NTT holding company's R&D. In Figure 4-1, I have identified the relationships between major factors in which the measured output and goal is providing profitable product. The four main factors of focus will be R&D power, Marketing, Competition with market products, and Management's decision making policy.

1. R&D power: R&D power represents the strength of the organization to conceive and develop the products ideas. The R&D budget is a positive factor that contributes to greater R&D power. Having a bigger budget allows the company to provide adequate resource support to the projects.
2. Marketing: Marketing is the ability to match a company's product to the needs of the customer. In the current organization, there is no official or professional marketing expertise. Marketing efforts are uncoordinated.

3. Competition with market products: Competition in the marketplace affects the success of the product. As described in Section 3.3.1, because of the advent of new disruptive technologies like IP telephony, telecommunication technology has become similar to computer network based products. Furthermore, the service trend has changed from telephone services to Internet access and broadband communication. Thus R&D products face severe competition with market products.
4. Management's decision making policy: Sometimes a company organization or policy issues can lead to management's decisions to pursue less optimal projects. Two factors of such issues are shown in the figure as Fear of losing employee and Fear of becoming followers. Fear of losing employee means that a manager could fear that number of his or her subordinates may be reduced if his or her project workload is not maintained. Fear of becoming followers means that a manager may fear that another project group within the company might adopt some trendy topic ahead of him or her and a chance is lost to adopt or implement the related topics. These two factors might cause a manager to make development topics within his or her project at any rate, causing possibility of providing less profitable products.



(R1: R&D investment loop, R2: Management's decision making policy loop)

Figure4-1 Factors Related with Providing Profitable Products

It is important to distinguish between external environmental factors and internal organizational factors, so that focus can be directed towards enhancing the ability to produce profitable products. Within Figure 4-1, Factors 1 (R&D power) and 3 (Competition with market products) are external environmental factors. Factors 2 (Marketing) and 4 (Management's decision making policy) are internal factors.

Regarding the two external factors, clearly, Factor 3, competition with market products is an external environment factor. Unless there is a monopoly, the extent or severity of marketplace competition is not something that can be determined by a single company. Technology improvements or innovations by other companies are also outside the boundaries of control. Factor 1, R&D power is also external factor. Following the causal loop R1, the R&D funding is not determined internally. Investment in R&D is made by the subsidiary business corporations. The R1 loop (right side of Figure 4-1) is a negatively reinforcing loop, because subsidiaries competition is becoming more severe, which should lead to a negative effect on R&D funding.

Regarding the internal organizational factors, 2 (Marketing) and 4 (Management's decision making policy), in order to produce profitable products, marketing should be strengthened and the making of development topics due to fear of losing employees or fear of becoming followers should be stopped. If making development topics for fear of losing employee and fear of becoming followers is reduced, the reinforcing loop R2 (left side of Figure3-1) works positively, which should lead to an increase in the company's ability to produce profitable products.

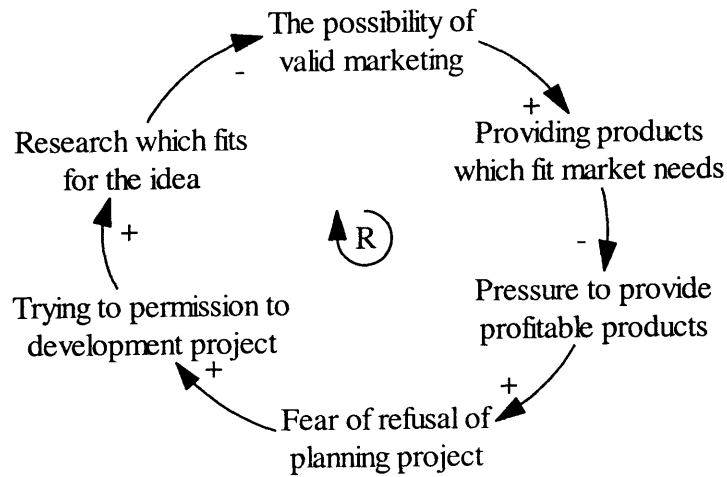
Changing external factors is difficult because it involves change on a large scope like at the economics or industry level. Instead, the organization should try to offset the negative external factors by positive internal factors. In the next section, I will focus on ways to strengthen the internal factors to improve the ability to provide profitable products.

4.2.2. Internal organizational factor: Marketing

Attention to internal factor “marketing” could be the most effective place to begin, especially because there is no formal marketing within the organization now. There are three ways that marketing power can be improved.

1. Marketing by R&D engineers: When engineers plan new development products, they could consider marketing scope as well as technology scope.
2. Collaborating with the subsidiary business corporations’ marketing department: Each subsidiary business corporation has its own marketing department. It could make sense to leverage the structure and expertise that already exists.
3. Establishing own marketing department: Because there is no marketing department now, a marketing department could be established which collaborates with the holding company’s R&D department.

Figure4-2 shows the difficulties with Item 1. The cycle starts when the engineer thinks up the product idea, and starts to develop it. He or she will be motivated to promote the project’s success. Product feasibility checks may not be valid due to lack of proper marketing training and or personal biases based on attachment to the technology. Because of this negative reinforcing loop, marketing by engineers is not the best way to provide profitable products.



(R: Marketing by engineers loop)

Figure4-2 Factor of Marketing by Engineers

Regarding Item 2, the relationship between the subsidiary business corporations and the holding company's R&D department is illustrated in Figure 4-3. There is a Spatial Barrier as well as an Organizational Barrier [16] between the holding company's R&D and the subsidiary business corporations. These two barriers, the Spatial Barrier and the Organizational Barrier, contribute to a communication barrier, which weakens the communication flow efficiency. Furthermore, there is less direct connection between the subsidiaries Marketing Departments and the Holding Company R&D department due to the subsidiary business corporations' following policy.

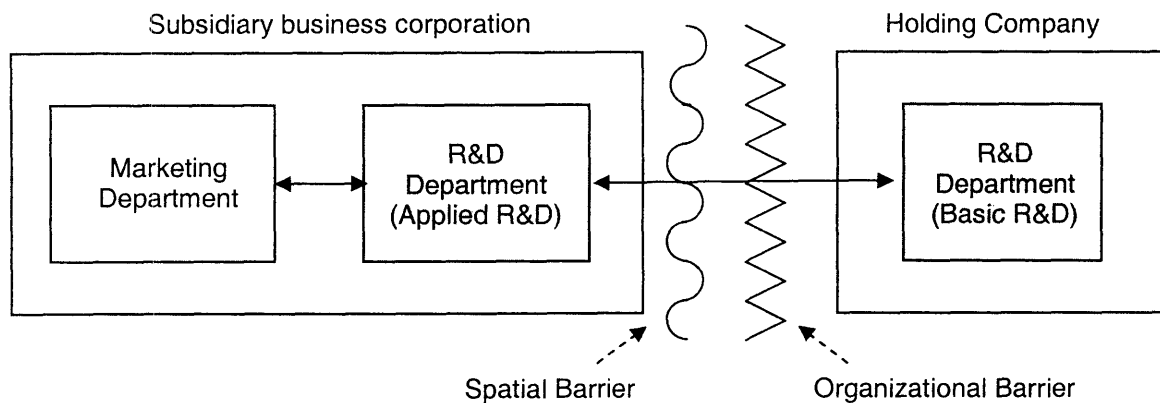
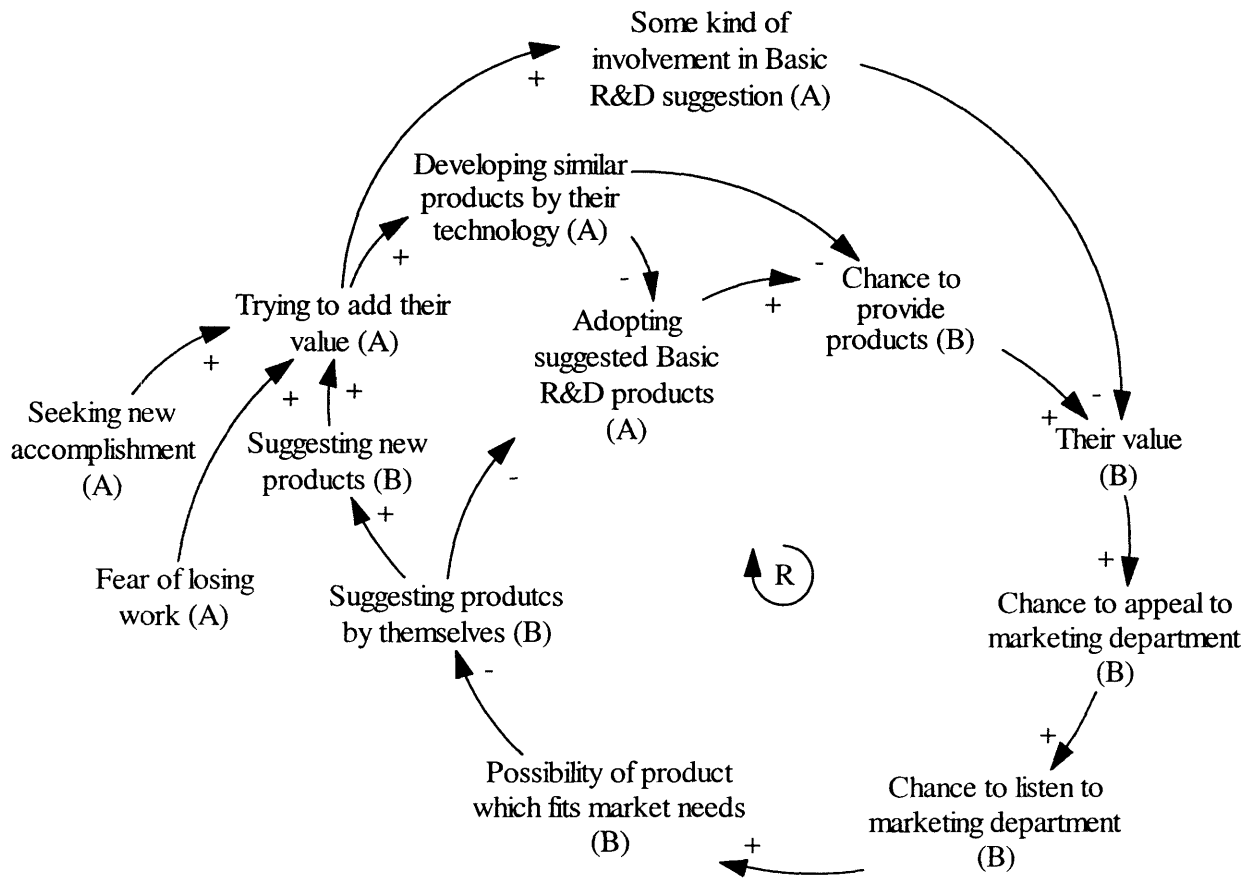


Figure4-3 Relationship with R&D and Marketing department

- To reduce channels for marketing department: From the point of view of the marketing department, a single R&D channel is more effective. The Applied R&D department interacts with the Basic R&D department in the holding company about requests to Basic R&D and assessment of Basic R&D proposals.
- Technical interpretation by Applied R&D Department: The Basic R&D engineers in the holding company are more deeply engaged in technology than the Applied R&D engineers; thus it is easier for the marketing department to communicate with the Applied R&D engineer in terms of language. The Applied R&D department has a role to understand Basic R&D and explain it to the marketing department.
- The possibility of split work: Sometimes both R&D departments split up the work to develop one system. The boundaries are usually based on the technical difficulties, Applied R&D develops the application specific parts, and the holding company's Basic R&D department develops the more basic parts of the system.

Also, the marketing department has another option of not using R&D products at all, and using market products instead. R&D products need to be advantageous considering cost, lead time, function, quality and so on.

The following Figure4-4 shows some of the dynamics of the relationship between the subsidiary business corporations and the holding company. Considering the barriers and policy described above, a negative reinforcing loop works for the holding company's R&D department as the figure shows. The Applied R&D department is also under stress due to severe competition with market products. Therefore, the Applied R&D department seeks new accomplishments, causing it to try to add its own value to the processes of Basic R&D's products or ideas when Basic R&D department suggests the products or ideas. This effort might be partly favorable for the subsidiary business corporations, but takes time and is not necessarily favorable from the holding company's point of view. The holding company also loses the opportunity to appeal its own products or ideas and to listen to the marketing department, and may suggest products more by themselves without considering marketing department's requests. Thus, the ineffective negative reinforcing loop exists for the holding company's R&D department. Because the holding company's R&D department cannot collaborate directly with the marketing department, it is difficult to strengthen marketing power in the holding company's R&D department. This situation is not good for the entire group companies' efficiency.



(R: Suggesting product by Basic R&D loop)

A: Applied R&D in subsidiary business corporation, B: Basic R&D in holding company

Figure4-4 Relationship between Subsidiary Business Corporations and Holding Company

To solve the problems, I propose the following two options for organizational reforms. First, a marketing department should be established within the holding company. Figure 4-5 shows an Organizational bond between both marketing departments and a Spatial bond in holding company. This option corresponds to Item 3 in this section. The second option is integrating a part of Basic R&D into the subsidiary business corporations' R&D department. As Figure 4-6 shows, an Organizational bond and a Spatial bond between

both R&D departments are removed. The extent of integration is an important secondary issue and will be discussed further in Chapter 5.

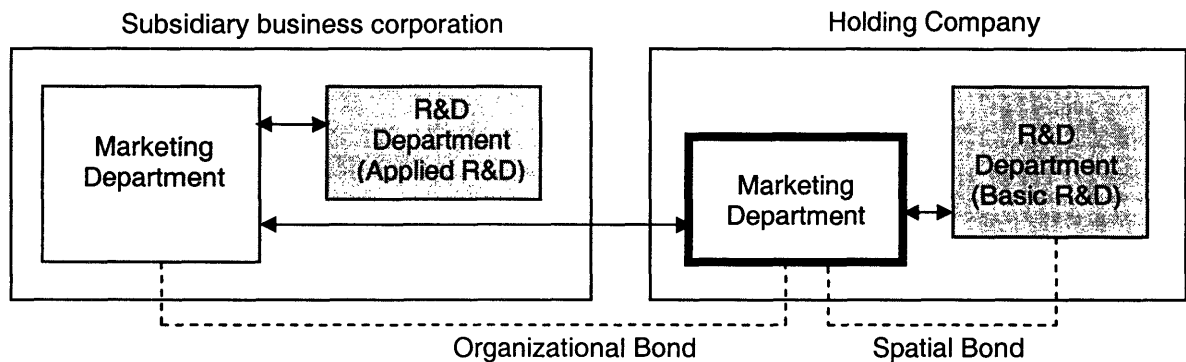


Figure4-5 Establishing Marketing Department

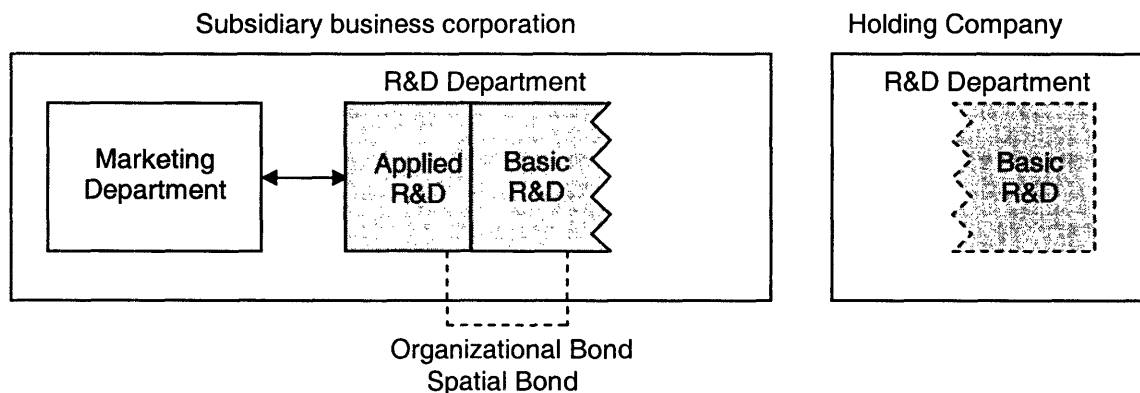
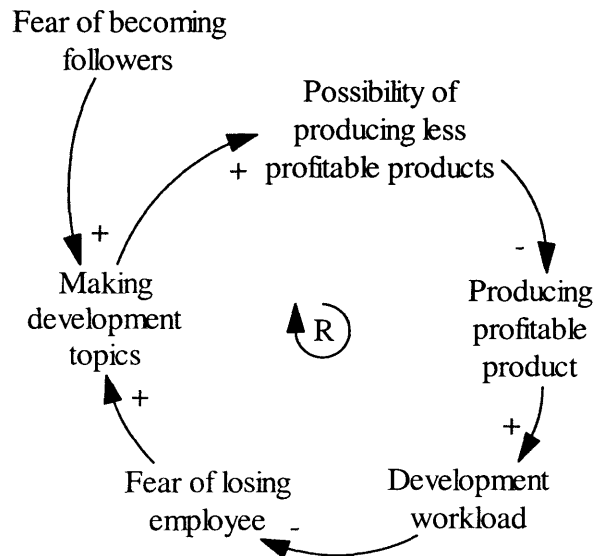


Figure4-6 Integrating R&D Department

4.2.3. Internal organizational factor: Management's decision making policy

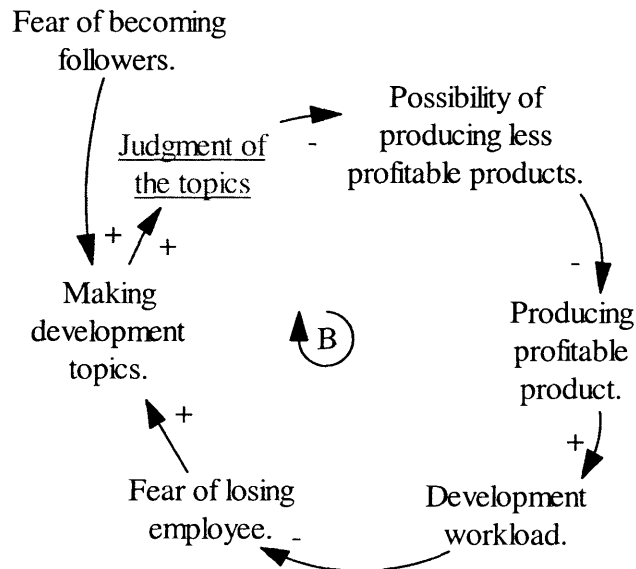
Figure 4-7 is the R2 loop “Management’ decision making policy loop” in Figure 4-1. Providing profitable products has been difficult recently. Therefore, this reinforcing loop tends to work negatively. To avoid this tendency, the following two measures are considered.

1. Reduce “Fear of becoming followers”.
2. Add “Judgment of the topics” as a variable between “Possibility of producing less profitable products” and “Making development topics” as Figure 4-8 shows.



R: Management’s decision making policy loop

Figure 4-7 Making Development Topics



B: Management’s decision making policy modified loop

Figure 4-8 Judgment of the topics

Item 2 might be more effective than Item 1. Regarding Item 1, actually, the negative reinforcing power of R2 may be stronger than any reduction in the fear of becoming followers. Furthermore, reducing the fear of becoming followers is difficult because all project groups are competitive and seek new accomplishments. Even if each project is categorized, the boundaries in new trendy technologies or emerging ideas are not clear and groups tend to try to prove that the technology or idea is related to them.

On the other hand, Item 2 is realizable by establishing a judgment authority which executes valid judgment. Although this step adds one more stage into the loop, the benefit is that it can reduce the negative factor by changing the loop to a balancing loop as Figure 4-8 shows. I will focus on evaluating Item 2 in more detail in the next chapter.

4.3. Comparison with case Bell Labs case

In order to assess the Bell Labs case and apply its lessons to NTT, it is first important to distinguish the major types of differences between the two. Table 4-1 was constructed to highlight the differences in industry and organization between Lucent and NTT. While both industries are same, telecommunications, the type of business, customers and organization structure are different. The main customers for the R&D products are different. While the main customers of Lucent's R&D products are 30 global large service providers, NTT's main customers are its subsidiary carrier business corporations. Also, while acquisitions and spin offs were regular responses to technology acquisition or financial difficulties in Lucent, these seldom happen at NTT. NTT tries to maximize usage of the internal resources in its group of companies.

Table 4-1 The type of difference between Lucent and NTT

| | Lucent | NTT |
|-------------------------------|---|--|
| Industry | Telecommunication (U.S.A) | Telecommunication (Japan) |
| Type of business | Telecommunication equipment manufacture | Telecommunication service provider |
| Organization structure | Independent company | Group company (The holding company and subsidiaries) |
| R&D organization | A part of Lucent | A part of the holding company* |
| R&D Funding | Directly from Corporate fund | Subsidiary carrier business corporation fund* |
| Main Customers of R&D product | 30 global large service providers | Subsidiary carrier business corporations |
| Acquisition | Often | Rare |
| Spin off | Often (spin off as independent company) | Rare (spin off as subsidiary) |

*: This thesis focuses on R&D organization in the holding company, although subsidiaries have R&D organization.

The conclusions from the Bell Labs case analysis in Section 2.8 are analyzed to see if they should be applied to benefit NTT holding company's R&D department. Table 4-2 gives an overview.

Table 4-2 Application for NTT R&D case about Bell Labs case

| | | Bell Labs case | Application for NTT R&D case* |
|---------------------------|-----------------|--|--|
| Causes of failure | Internal factor | 1. Acquisitions by Lucent (Product line overlapped) | NTT does not have acquisition culture. Product line should not be overlapped anyway. |
| | | 2. Defect in business model (BLRSV model of internal ventures) | BLRSV model should not be introduced. New models should be investigated in advance. |
| | External factor | The telecommunication market turndown in U.S.A. | Market situation is similar in Japan too. |
| Good examples of concepts | | 1. Collaboration | Should apply |
| | | 2. Startup Model | Should apply |

*: This thesis focuses on R&D organization in the holding company, although subsidiaries have R&D organization.

Regarding the causes of failure, the external factor of “Telecommunication market turndown” is similar in Japan. It is difficult to change this factor because so many external factors in economics and industry are involved and beyond the scope of the R&D’s organization. Therefore, R&D organization should focus on the other factors to ameliorate or respond, as already explained in Section 4.2.1. Regarding the internal factors of (1) Lucent’s acquisitions and subsequent product overlapping, and (2) defective BLRSV business model, these situations should be avoided. When a product line is overlapped by acquisition, it creates huge losses in money and human resources, as well as morale loss. Fortunately, this factor is not of critical concern for NTT because acquisition is not part of NTT’s culture. One of the NTT’s main issues is making efficient use of group companies’ resources. Secondly, the BLRSV model is not recommended. This model caused conflicts of interest between and among the Bell Labs business units. When new business models are introduced, they should be investigated well in advance. In the case of NTT, it is important to minimize conflicts of interest between the holding company and the subsidiary business corporations.

There were a few good concepts to be learned from the Bell Labs case. While Bell Labs’ “breakthrough project” shown in Section 2.5 is normal way and NTT has already adopted it, “Collaboration” and “the Startup model” may be applied to the R&D department in NTT holding company. If so, the background such as shown in Table 4-1 should be considered. In terms of “collaboration”, collaboration between R&D department in NTT holding company and Applied R&D in subsidiary business corporations already exists. However,

there are still spatial and organizational barriers as explained in Section 4.2.2. As Bell Labs tried to do with its business units, the R&D department in NTT holding company should collaborate with other business associations like marketing. Also as explained in Section 4.2.2, establishing marketing department or integration R&D department (See Figure 4-5, 4-6) could be helpful. The target customers in the “Startup model” should also be considered. While Bell Labs R&D products’ target customers are large service providers because Lucent is equipment manufacturer, NTT R&D products’ target customers are subsidiary business corporations because NTT is a service provider. Bell Labs can target startup model customers among various service providers. However, the other service providers are rivals for NTT. The R&D department in NTT holding company cannot target rival carriers as startup model customers. Therefore, this startup model cannot applicable for NTT R&D directly. However, some parts of the good concepts like working customers directly or understanding customer needs should be considered for adapted application.

Bell Labs is still struggling to provide profitable product under Lucent’s financial difficulties and telecommunication market turndown. NTT faces a similar situation. What an R&D organization should do to provide profitable products in such severe environment is critical issue for NTT R&D organization as well. NTT’s R&D organization has to find solutions from the analysis in Section 4.2 as well as learn from the lessons of Bell Labs. I propose the solution in the following chapter.

5. Proposal to NTT

5.1. Overview

I will explore some organization solutions to improve NTT R&D's ability to provide profitable product in this chapter. According to the analysis in Chapter 4, establishing a marketing department, and integrating a part of Basic R&D in Holding Company into Applied R&D in subsidiary business corporations are options. In this chapter, I will explain two options with consideration to the validity of judgment of the development topics and the ideas of "collaboration" and "Startup model", which were extracted from the Bell Labs' case study.

5.2. Option1: Establishing marketing department

5.2.1. Role of marketing department

The new marketing department in the holding company should have the following three interactions to increase the marketing ability in the R&D department in order to help provide profitable products. Figure 5-1 illustrates the interactions between the New Marketing and: the marketing departments in subsidiary business corporations, the general market, and the R&D department in the holding company.

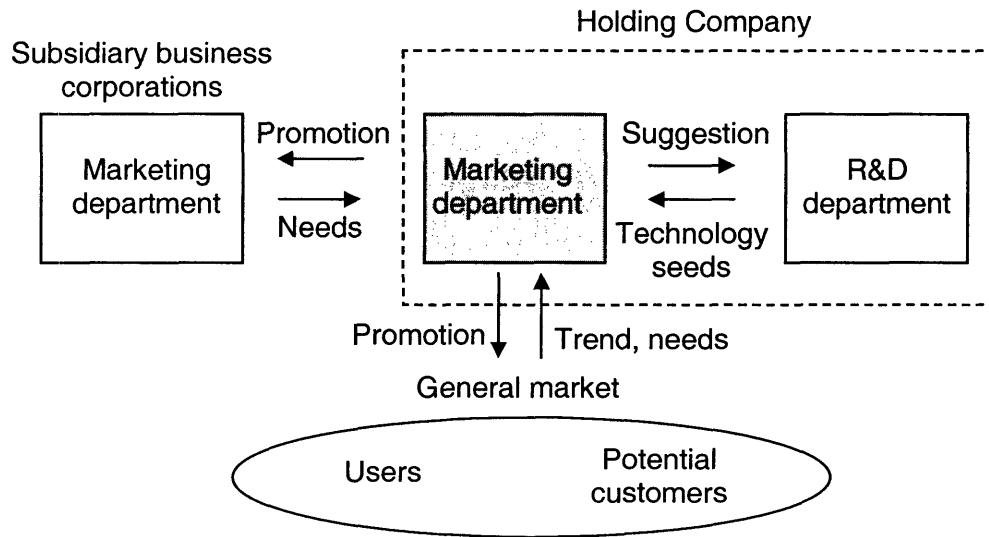


Figure 5-1 The Relationship of Marketing Department

1. Interaction between the holding company marketing department and the marketing departments of the subsidiary business corporations:

As Figure 5-1 shows, establishing a marketing department in the holding company should strengthen the organizational bond with the marketing department of subsidiary corporations. Because both marketing departments have similar characteristics in personality, cultural thought world, language, and organizational responsibilities, it will be easier to discuss with and understand each other and cooperate and work together. The mission of the marketing department in the holding company should be to promote the holding company's R&D products, and to understand and anticipate the subsidiary business corporations' needs and requests.

2. Interaction between the holding company marketing department and the general market:

The new marketing department should research and analyze market trends, and understand current and future users' needs. Here the definition of "users" is a general one that includes anyone who uses or would use communication services. I will explain more about marketing approaches in Section 5.2.4. Furthermore, the marketing department in the holding company should also engage promoting a better understanding of market requests and needs in outside companies, not just the subsidiary corporations. This means an expansion of target customers. Because most customers of the R&D department in the holding company are the subsidiary business corporations, the products are carrier grade and not easily adaptable to fit general customer needs. This situation creates the negative reinforcing loop in Figure 5-2. The other customers will buy market products. However, if the products are developed from the beginning to reflect the other market needs, as well as the subsidiary corporations, they have a higher possibility of selling. This change could lead to new business opportunities with new sources of profit for the same or similar R&D products. This means reinforcing loop works positively in Figure 5-2.

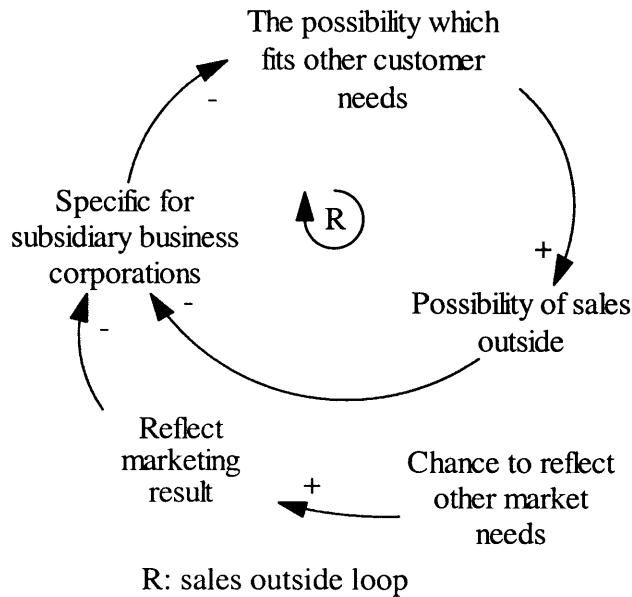


Figure 5-2 Possibility of Sales Outside

3. Interaction between the holding company marketing department and the R&D department in the holding company:

The marketing department should grasp the technology trend and seeds as well as the market trend and needs, and after understanding both points of view, it should suggest new product or service ideas. In order to be able to understand the technology trend and seeds, and to utilize NTT R&D technology, it is important to have effective collaboration with the R&D department. The model for such collaboration will be discussed further in Section 5.2.3.

5.2.2. The characteristics of Marketing and R&D

In order to promote effective collaboration between marketing and R&D, it is important to understand the differences in their characteristics. In this section, I will explain the differences as well as their causes.

Marketing and R&D organizations have many differences, but five obvious characteristics are: Personality, Cultural thought worlds, Language, Organizational Responsibilities, and Physical location [17]. Big differences in these characteristics might cause barriers against cooperation and communication between the marketing and R&D organizations.

1. Personality

Table 5-1 shows differences in the inherent traits of Marketing vs. R&D. As this table shows, the traits are quite different. Personality and stereotype barriers may be the most difficult of all communication barriers to reduce or eliminate [19].

Table 5-1 The Inherent Traits of Marketing vs. R&D [18]

| | R&D Traits | Marketing Traits |
|-----------------------|--|--|
| Goals and aspirations | <ul style="list-style-type: none"> 1. Knowledge as a source of value to mankind 2. Research for research's sake 3. Peer evaluation and recognition | <ul style="list-style-type: none"> 4. Organizational survival and growth 5. All activities relevant to firm's objectives 6. Organizational recognition |
| Needs | <ul style="list-style-type: none"> 7. Autonomy 8. Peer recognition, creative environment 9. Continuing education and development 10. Support for advancing knowledge in society | <ul style="list-style-type: none"> 11. Plans, procedures, policies, rules 12. Organizational recognition 13. Team work 14. Increased organizational status |
| Motivation | <ul style="list-style-type: none"> 15. Service to mankind 16. Publications 17. Professional recognition 18. Patents with name attached 19. Freedom to solve problems, and advance knowledge | <ul style="list-style-type: none"> 20. Rewards and sanction system with pay and advancement through organization |

2. Cultural Thought Worlds

Some of the differences in thinking come from different education backgrounds. In Japan, most marketing personnel majored in the school of humanities whereas the R&D personnel studied in the school of science and engineering. The school of humanities gives training in economics, law and so on. The school of science and engineering focuses on numerical analysis, technical problem solving and so on. These backgrounds promote different cultural thought worlds. Some of these dimensions are listed in Table 5-2.

Table 5-2: Marketing and R&D Differences (adapted from [17] [20] [21] [22])

| Dimension | Functional Position | |
|--------------------------|---------------------|------------|
| | Marketing | R&D |
| Time orientation | Short | Long |
| Projects preferred | Incremental | Advanced |
| Ambiguity tolerance | High | Low |
| Departmental structure | Medium | Low |
| Bureaucratic orientation | More | Less |
| Orientation to others | Permissive | Permissive |
| Professional orientation | Market | Science |
| Professional orientation | Less | More |

3. Language

In addition to different cultural thought worlds due to training, words themselves can also form another barrier layer. Marketing and R&D personnel each uses its own technical terms and sometimes does not understand each other. Furthermore, the perspectives are different. Marketing focuses on market share or product benefit while R&D cares about technical specifications or performance. These differences

sometimes cause misunderstanding. Even if the two camps are talking about same things, the outputs might be different.

4. Organizational Responsibilities

In terms of organizational responsibilities, the marketing organization is often measured by market share while R&D organization is often measured by number of paper and patents. Thus, motivating both groups to collaborate effectively together is a challenge.

5. Physical location

Usually, marketing departments are located near the company headquarters, in the city for business convenience. Traditionally, R&D does not need such immediate location convenience. Thus, R&D departments are usually located in the suburbs or the countryside in a tradeoff decision between workers' quality of life vs. location business convenience. Many facilities make the same tradeoff decision, in the U.S. and even Japan, which is small country. However, this physical separation decreases the chance of informal meetings and information transfer, causing possibility of decision making delays.

It is important that these inherent differences between marketing and R&D are properly addressed in order to obtain smooth and effective collaboration.

5.2.3. How to collaborate between Marketing and R&D

It has been well recognized that a good Marketing-R&D interface is a critical factor to successful delivery of new products. The effectiveness of collaboration between R&D and Marketing teams has been discussed by many researchers. Griffin and Huser [17] distinguish six type of integrating mechanisms to overcome the collaboration barriers between marketing and R&D. Leengers and Wirenga [23] add a seventh mechanism, called “Information and communication technology (ICT) “. These mechanisms are designed to give a positive effect on the collaboration between Marketing and R&D, in order to overcome barriers such as physical separation, differences in responsibilities, and different thought-worlds.

1. Relocation and physical facilities design
2. Personnel movement
3. Informal social systems
4. Organizational structure
5. Incentives and rewards
6. Formal integrative management processes
7. Information and communication technology (ICT)

I will now discuss how these mechanisms could work in NTT holding company’s R&D organization.

1. Relocation and physical facilities design

Because communication drop off rapidly with distance, one solution is to relocate people to reduce the distance between marketing and R&D. Co-locating these two function increases marketplace success by providing a higher level of information transfer across the interface, overcoming the barrier of physical separation [17].

When the proposed marketing department is established in NTT holding company, it should be co-located with the R&D department in order to avoid the barrier of physical separation. Although NTT holding company's R&D is conducted in several locations throughout Japan, most laboratories which are not for long term research are located in two locations, Musashino, which is near central Tokyo, and Yokosuka, which are near Tokyo. It is advisable to establish marketing departments in at least these two buildings. Although there is still separation between the two sites, the fields of research are different, "Information Sharing Laboratory Group" vs. "Cyber Communications Laboratory Group". Thus, it would not be redundant to allocate marketing capability to each location. These locations can also interact conveniently with other organizations, including the marketing departments in the subsidiary business corporations, and headquarters in the holding company. The traveling time of such business trips is only half a day. Therefore, it should be relatively easy to introduce this change.

2. Personnel movement

Human movement between functional group is one technique to improve flows across functional boundaries [24] [25] [26] [27]. Moving personnel across functions increases marketplace success and decreases time to market by decreasing thought world, language, and physical barriers between the functions, increasing

information utilization and cross-functional coordination, and decreasing technical uncertainty [17].

In the case of NTT holding company, it would need to recruit marketing staff in order to establish a marketing department. Of course people who have marketing skills and experiences should be recruited. But in addition, it is advisable to include some R&D engineers in order to realize the benefits of personnel movement, which is described above. Also, people with marketing skills and experiences should be assigned to the R&D department from time to time.

The most important issue is where the holding company will recruit its new marketing staff from. Currently, there is no one who has such marketing skills and experiences in the holding company. Most of the employees in the holding company are R&D engineers in R&D department, and corporate strategists at headquarters. There are two possible options to recruit people who have marketing skills and experiences. The first option is to recruit from subsidiary business corporations. The subsidiary business corporations have marketing departments with skillful marketing staff. However, it may be unlikely that the subsidiary business corporations are willing to relinquish its staff when competition with other carriers is so severe and marketing talent is so key to survival. Board level agreement among the group companies would probably be necessary in order to establish the marketing department from among the subsidiary companies personnel. The second option is recruiting from the outside. However, because the

holding company seldom recruits from the outside, it needs to establish a competitive salary and compensation system for intermediate recruitment.

3. Informal social systems

Developing informal cross-functional networks reduces the language, thought world, and physical barriers to integration, enables more information to be communicated and utilized, increases coordination and decision-making, and decreases project uncertainties, leading to higher success on all three measures [17].

In the case of NTT holding company, informal social systems are important too. Open communication, and personal informal connection will make project work more smoothly. To make informal social systems work well, informal communication areas like coffee lounges, refresh room, and items like black/white boards, and marketing/engineering magazines should be provided. The underlying assumption here is that the R&D engineers and marketing staff will work in the same buildings based on Item 1 "Relocation and physical facilities design".

4. Organizational structure

The structure that is most directly related to the marketing – R&D interface is the cross-functional project team. Project teams encourage information exchange, provide a degree of structure, and encourage cooperation by providing a forum in which conflicts are resolved without intervention from management [23].

In the case of NTT holding company, application of cross-functional teams should be explored. As mentioned in the quote, a cross-functional project team would

include marketing staff and R&D engineers. The Lead user project, described in Section 5.2.4 can be a good vehicle for this mechanism.

5. Incentives and rewards

Performance evaluations, which recognize the interrelated rewards to marketing and R&D, based on ultimate product-development profits (or indicators thereof) decrease the inherent barriers between the functions due to differing organizational responsibilities and lead to increased profits by encouraging cross functional decision-making and task completion and by providing incentives for resolving conflicts between the two functions [17].

Salary, compensation and career opportunities have to be coordinated and perceived as equivalent to the marketing staff and R&D engineers.

In the case of NTT holding company, because the salary, compensation and promotion systems are almost the same as in the group companies, equality will work well. However, evaluation standard of personnel should be coordinated. In terms of R&D department in the holding company, evaluation is based on papers, patents, and product profit prediction. Product profit prediction might be related with coordination evaluation. But at the moment, this prediction is usually done by the R&D engineers, because there is no marketing organization now. So there is no feedback about the actual marketplace results like revenue and number of subscribers after product release. When market department is established, product profit should be predicted by the marketing department, and marketplace results should also be fed back to the R&D engineers as salary or compensation or

promotion, even after the R&D project is finished and even if the engineers are engaged in new projects.

6. Formal integrative management processes

A simple phase-review process improves a subset of the factors that affect the marketing/R&D interface. As the complexity of the development process increases from a phase-review process to stage-gate and/or PACE (Product and Cycle-time Excellence), the number of affected interface factors increases and the outcome dimensions improve. Each improvement to the phase-review process results from coupling additional integrating mechanisms to a formal process. Stage-gate adds a cross-functional team (and reorganizes the order of some steps). PACE adds a permanent coordinating group. QFD (Quality Function Deployment) provides an information structure in which the cross-functional teams operate. These additions improve the operation of the marketing/R&D interface; however, they do so at the expense of increasing the overall complexity of managing the product-development process. The development process used should match the complexity and degree of innovativeness of the project and should be framed in such a way as to legitimize its use [17] [28].

In the case of NTT holding company;

Phase-review and Stage-Gate processes: While Phase-review processes are only done by the R&D department, Stage-Gate process meetings are usually conducted with additional input from group companies' executive or senior management. Phase-review includes design, making, and testing phases. Stage-Gate processes include development start review. Important Phase's reviews like design specification completion review or quality test review should be done by both the Marketing and R&D departments when the marketing department is established. Also, Stage-Gate processes should include market needs reviews, commercial manufacturing reviews, and periodic reviews if the research or development phase

is long term. These reviews should be done by including the marketing department. PACE (Product and Cycle-time excellence), which is a facilitator-implemented stage-gate process [29], may be another option, although it is said that “further research is needed” [17].

Quality Function Deployment (QFD): QFD is “one of Japan’s most potent tools” [30]. QFD has already been done between the marketing department in the subsidiary business corporations and the internal Applied R&D department. They have a study group. In the study group, the Marketing department shows their service specifications and requirements. Applied R&D makes a design specification to satisfy the service requirements. Both departments meet together periodically in a study group until the design specification is completed. Sometimes other related departments such as the network operation department or the equipment deployment department may also join the study group to decide their related specifications for equipment operation or installation specifications. The QFD relationship between the marketing department and R&D department had been built prior to NTT reorganization and has worked well. Therefore, when the marketing department is established in the holding company, a QFD system similar to the one in subsidiary business corporations should be introduced.

7. Information and communication technology (ICT)

Technologies such as e-mail, video conferencing and intranet provide an opportunity for contacting people easily and finding, processing, and sending information in an effective way. Recent studies suggest that new ICT expedites communication among

people who might otherwise communicate infrequently or not at all. When applied to the marketing – R&D interface, we argue that ICT provides an infrastructure that leads to more integration between marketing and R&D and ultimately more NPP (New Product Performance) [17].

In the case of NTT holding company, the ICT environment is especially well constructed. All employees possess their own PC and e-mail account, and they can access both the Internet and company Intranet. Telephone conference and video conference facilities are also provided. Because NTT is the leading company in telecommunication field, ICT environment is not a concern. This strength of this environment should be used continuously for Marketing – R&D collaboration. Although the teleconference equipment might not be needed if the marketing and R&D departments are co-located, it might be useful for communication with the subsidiary corporations, like NTT-West, which are further from the R&D department in the holding company. It takes about 5 hours by train to go to NTT-West from the R&D department in the holding company.

5.2.4. Marketing approach

5.2.4.1. Definition of R&D term

The time frame of an R&D project is a distinguishing characteristic. I will define three terms according to the R&D engagement time frame, and explain the differences in their nature. They are, Short-term R&D, Middle-term R&D, Long-term R&D. Figure 5-3 shows the durations and characteristics of each term of R&D.

Short-term R&D has an expectation that 1 to 2 years is needed for R&D to provide products. In NTT, products which is developed by the request of the subsidiary business corporations are included in this term. Middle-term R&D means that it takes 3 to 5 years for R&D to provide products. These products tend to be developed first and then proposed to the subsidiary business corporations. Because subsidiary business corporations do not request product beyond the short term, the R&D department needs to research, develop, and propose products by themselves. Long term R&D means that it takes 6 to 10 years for R&D to provide products and that research is mainly pure and core technology basic research. The aim is not product, but to seek novel approaches and advance technology in the world. Because long term R&D does not provide products in the near future and applicable technologies will eventually pass through to the Middle term and Short term R&D, in this thesis, I will focus on Short and Middle term R&D and their efforts to provide profitable product.

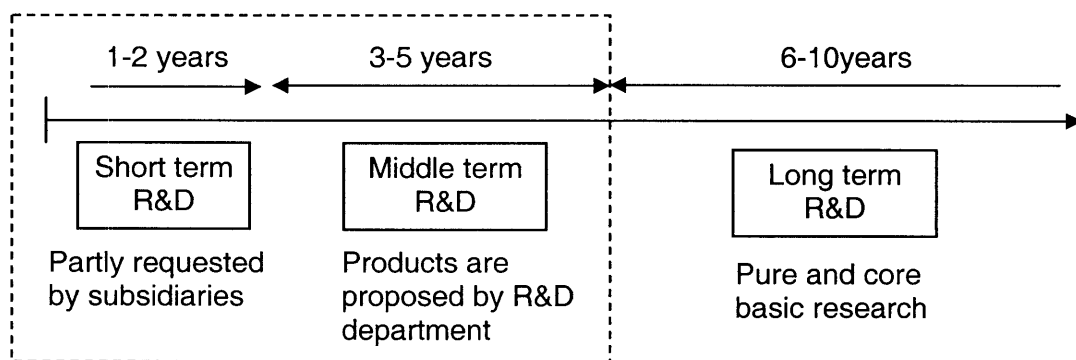


Figure 5-3 The Definition of R&D Term

5.2.4.2. Marketing approach for each term

There are several conventional marketing research approaches such as similarity-dissimilarity ranking and focus group [31]. Conventional market research targets the

existing demands of the majority adopters. (See Figure 5-4) These approaches are effective for short-term R&D products because short-term R&D products target the immediate future and demand in the immediate future usually reflects majority adopters well. On the other hand, predicting demand in the middle term is difficult because demand in the middle term may not yet be clearly understood or even visible, and not reflect majority adopters. Conventional marketing demand should not be used for middle term market research. After 3 to 5 years when Middle term products are provided, the results of the conventional market research may be obsolete and the category of majority users might even have changed.

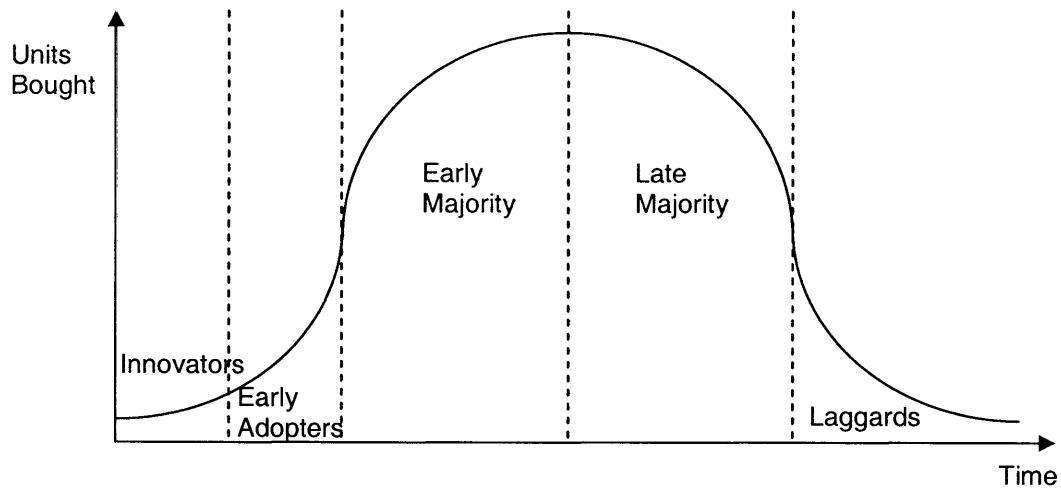


Figure 5-4 Adopter Categorization on the Basis of Innovativeness [32]

I propose that the lead user method is appropriate for middle term market research. This method is developed by Dr. Eric A. von Hippel at MIT Sloan School of Management, and is described in [30]. The Lead user method forms new products and services of likely value to providers, and is especially effective in the rapidly moving high tech industry. Lead users tend to be users that have needs that can foreshadow a general demand in the

marketplace that could occur months or years in the future and to be users who expect to obtain a great benefit/profit from the solution that meets their needs. Thus, this method can be effective for Middle term R&D products, in determining which services to provide to the majority of users in a 3 to 5 year time frame. Figure 5-5 categorizes the types of Lead users.

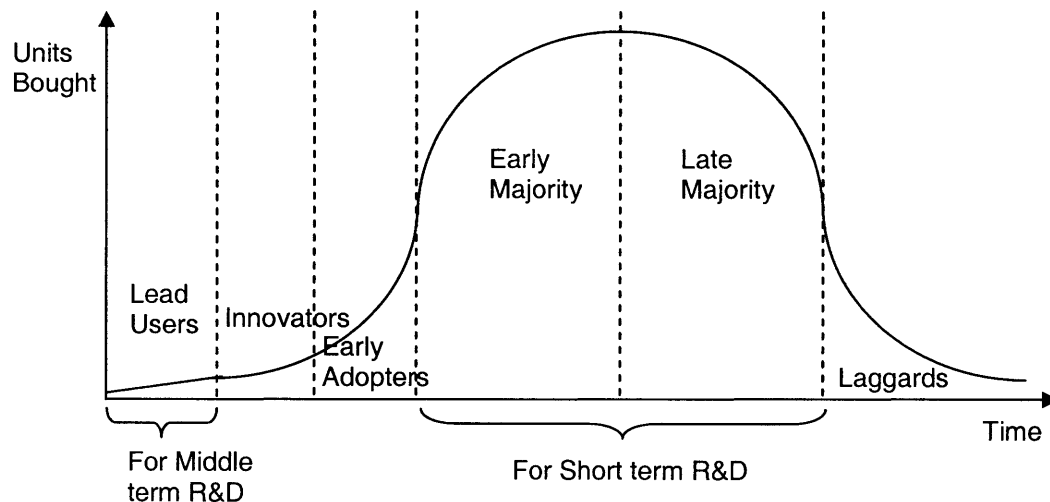


Figure 5-5 Marketing Category for Short Term and Middle Term R&D

5.2.4.3. Lead user approach

An excellent example of a telecommunication company that successfully used the lead user method is NORTEL Networks. NORTEL Networks is one of the top global telecommunication equipment vendors in North America and provide core switching, wireless, and optical systems for telephone carriers and data service providers worldwide. NORTEL Networks had success in developing the Digital Information Transfer (DIT) concept for future wireless Internet services by using the Lead user approach. DIT enabled information access and intelligent processing to occur while in motion, and the Lead user technique offered an opportunity to establish first-mover advantage in future market places

[33]. This success demonstrates that the lead user approach can be effective in telecommunication industry too. The following is a summary of the lead user approach.

1. Define the objectives and the landscape, detail the trends of technology, device, and services.
2. Define the application space, which leads to understanding the characteristics of the lead users.
3. Find the lead user candidates who have expressed an extreme need for one or more of the characteristics. Interview them to identify their critical needs, and determine the degree to which they innovate to meet those needs.
4. Bring in the lead users and work together collaboratively.
5. Search through all of the true lead users, and look for the commonalities across multiple domains.

In this method, one of the biggest challenges is to find true lead users. If the company makes a mistake in their choice of lead users, it could possibly be limiting its focus to niche markets. Thus, the company needs to be careful in identifying important trend and predicting future trend.

5.2.4.4. Lead user project

Some common success factors of lead user projects are “Team of the best people” and “Strong and active support of senior managers”. According to [34] source, the following project team composition is preferred.

1. 4-5 people
2. Expertise in each area critical to the study
3. Experience in each area critical to project success
4. Experience in the business and industry

Considering these factors, I propose that the marketing department should build a cross-functional team with engineers from the R&D department as well as Lead users as following Figure 5-6 shows. Because Lead users sometimes have technical request, a team made up of only marketing people may miss finding the potential Lead users. Although the marketing department may have staff from the R&D department due to personnel movement collaboration, and it may be possible to form a Lead user project team entirely from within the marketing department, choosing expertise directly from the R&D engineering pool will work more effectively Items 2 and 3, and for a more excellent Lead user project.

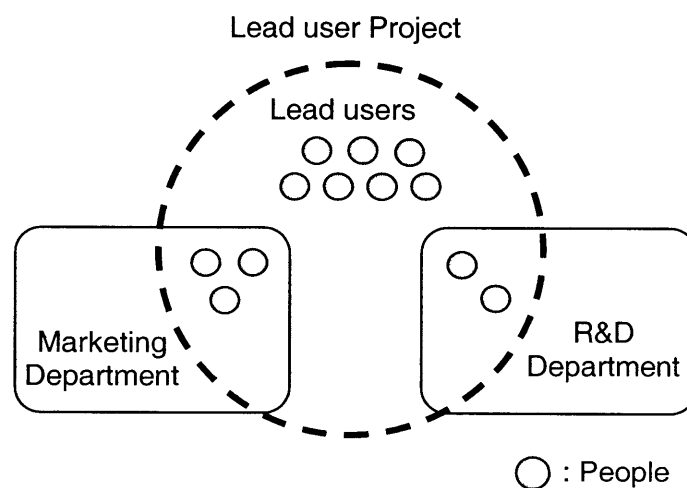


Figure 5-6 Lead User Project

5.2.5. Organizational power

Once the marketing department team and the Lead user project have been established, deciding their organizational power level is important. The ability to judge impartially and act on that judgment is important during project selection. Minimizing bias due to sentiment or other agendas is a challenge. Due to these considerations, I suggest that the marketing department and Lead user project be separated and given autonomous power.

This proposal can also be substantiated using Christensen’s framework for determining the appropriate organizational structure and home [35] [36]. Resources, Processes, and Values in the marketing department and Lead user project are as following Table 5-3 shows.

Table 5-3 RPV for Marketing Department and Lead User Project

| | Marketing department | Lead user project |
|-----------|---|---|
| Resources | New: Marketing staff | New: Expertise and its experience in each area critical to the study (Marketing staff, R&D engineers, and Lead users) |
| Processes | New: Marketing processes, collaboration with R&D department | New: Lead user project process |
| Values | New: Strengthen market oriented R&D | New: Targeting Lead users (not majority) |

As this table shows, all three factors for the marketing department and Lead user project need to be changed. These processes and values are a poor fit with the current organization’s processes and values. The marketing department and Lead user project are should be located in region “C” in Figure 5-7. This region corresponds to the need for an autonomous organization and heavyweight teams. Therefore, marketing department

should be autonomous organization, which means that it is independent of the R&D department. And the Lead user project itself should also be an autonomous project. It is said that, “In the start-up stages of an organization, much of what gets done is attributable to its resources – its people, and the addition or departure of a few key people can have a profound influence on its success” [36]. Therefore, the key people from the marketing department should be excellent managers and staffed with expertise and many experiences in marketing field. Also, lead user project team should consist of talented members, as described previously in Section 5.2.4.4.

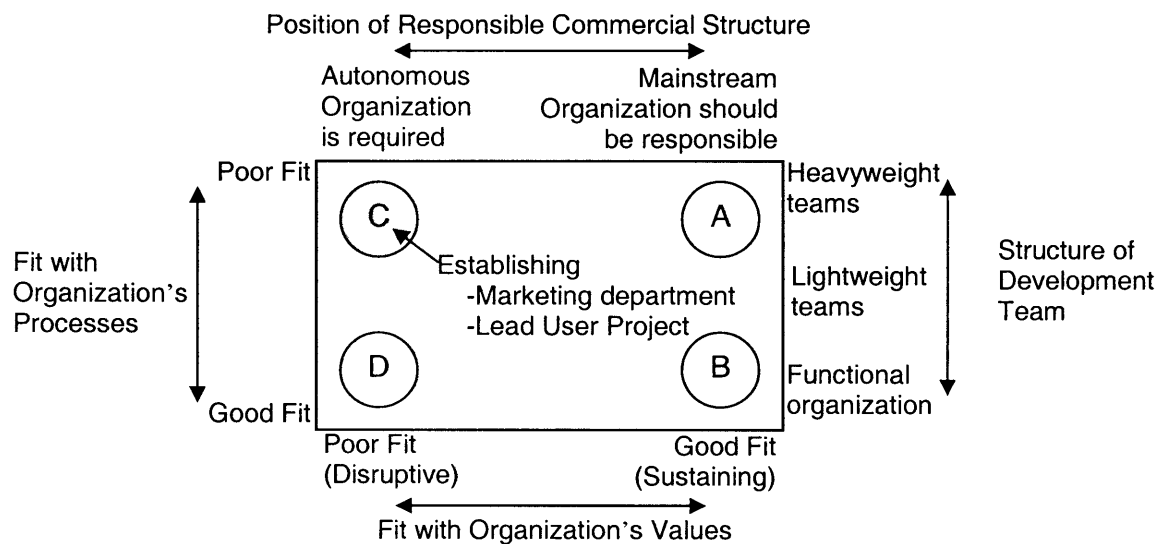


Figure 5-7 Organizational Structure for Marketing Department and Lead User Project

Regarding the validity of “judgment of the topics”, which was first raised as an issue in Section 4.2, the power to judge the development topics should be given to an external organization outside of the R&D department in order to maintain objectivity. Because impartiality is an important factor to providing profitable product, the judgment should be

executed with primary consideration to the market needs. Judgment should not be confined to within the internal R&D organization, if the market needs factor is critical. Separation and balance of power is important. Therefore, I propose that the marketing department should wield the judgment power. This measure is necessary to balance out the current tendency of a “R&D first” mentality. To be an autonomous organization which has the power of judgment, the organizational power of marketing department should not be weaker than that of the R&D department.

5.3. Option2: Integration of R&D

5.3.1. Overview

Another option is integration of R&D between the holding company and subsidiary business corporations. In the integrated model, the centralized and decentralized R&D are combined and organized to focus on the company’s overall strategy. This model may allow product development and basic science research to be conducted in an effective manner, and is considered an “excellent starting point for most firms” [1]. In this section, I will analyze this idea with consideration to the term of the R&D. Each term of R&D has distinct characteristics, and I will focus on short term R&D and middle term R&D. As I mentioned in Section 5.2.4.1, long term R&D organizational reform is outside the scope of this thesis.

5.3.2. Integration of Short term R&D

The Figure 5-8 shows an R&D reorganization which integrates the Basic short term R&D from the holding company into the subsidiary business corporations’ R&D department. By

using the Resource, Process, and Value framework (RPV framework), which is organizational capability framework [35] [36], the effect of each factor is analyzed.

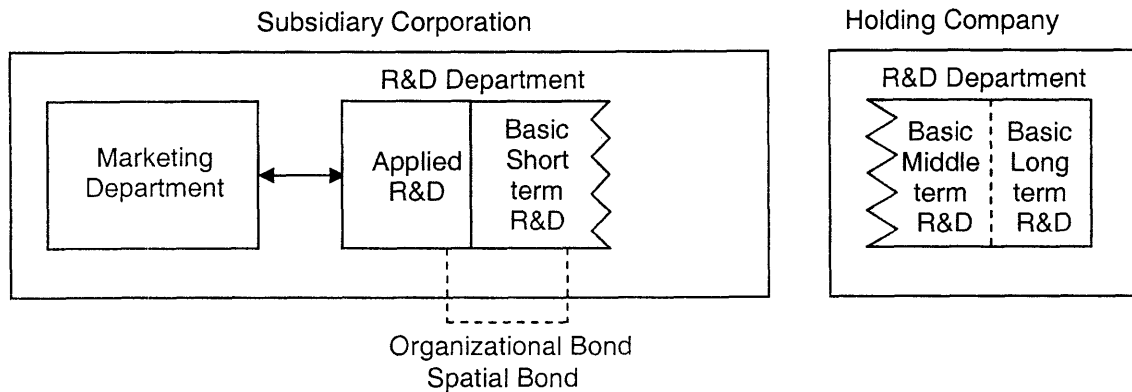


Figure 5-8 Integration of Basic Short Term R&D

From the point of view of the subsidiary business corporations, this integration would work well. The benefit can be explained by analogy to “creating capabilities through acquisitions”.

If the company’s resources were the primary rationale for the acquisition, then integrating the firm into the parent can make a lot of sense – essentially plugging the acquired people, products, technology, and customers into the parent’s processes, as a way of leveraging the parent’s existing capabilities.[35]

In this integration, “parent company”, “the company”, and “resources” correspond to the subsidiary business corporation, the holding company, and Basic short term R&D resources such as engineers and technology, respectively. The “resources” is the main reason for the integration, and the subsidiary business corporations’ processes and values can and should be used to produce profitable product in the short term. Actually, the Basic

short term R&D process itself and its values, which is business oriented, are familiar and correspond with those found in the subsidiary business corporations' R&D.

On the other hand, from the point of the view of the holding company, this integration could have a negative effect on the holding company's R&D. By this integration, holding company will lose not only its R&D resources such as engineers and technology which are capable of practical development, but also face the danger that the processes and values associated with Basic short term R&D influences could be lost. An example of one such process is the current connection for short term R&D between the subsidiary business corporations and the holding company. If the function of Basic short term R&D goes away, the holding company needs to build a new strong connection for middle term R&D. But because subsidiary business corporations are more interested in short term R&D than middle term R&D to seek immediate future profit, it might be harder. An example of values is that Basic short term R&D has driven business oriented value in the R&D department in the holding company. The R&D department in the holding company would have to maintain or even strengthen its middle term R&D for survival.

In this integration, the resources that would be allocated to subsidiary business might face the need to be divided because there are more than one subsidiary business corporations. The engineers for specific project to specific subsidiary can be moved to the subsidiary R&D department. However, if the project is for more than two subsidiaries, transition for shift is needed. The engineers can stay in the holding company until project termination, or can move one subsidiary and other subsidiaries should co-develop or license the product.

Thus, integrating Basic short term R&D into R&D department in subsidiary business corporations is an option, with some disadvantages from the point of view of the holding company. The holding company might face challenges to keeping its business oriented values, maintaining connections with the subsidiary business corporation, and being compensated for practical development resources. One possible solution could be for NTT holding company to establish a marketing department for its middle term R&D. This idea is discussed in Section 5.2.

5.3.3. Integration of Middle term R&D

Next I will discuss the idea of integrating Basic middle term R&D as well as Basic short term R&D into the subsidiary R&D department. The following Figure 5-9 shows the R&D reorganization that integrates Basic middle term R&D in addition to short term R&D from the holding company into the subsidiary business corporations' R&D department.

From the point of view of the subsidiary business corporations, this integration would not work well. Current subsidiary business corporations' processes and values which aim for short term profit are not as suitable for Basic middle term R&D. In terms of resources, as the R&D term becomes longer, centralized R&D is more effective. Actually, most characteristics of projects in Basic middle term R&D tend to not have been targeted for a specific subsidiary and may be difficult to allocate to a specific subsidiary, while Short term R&D projects tend to be specific to a subsidiary.

It is also better to keep middle term R&D centralized from the point of view of the holding company. Basic middle term R&D has a role to continue to research to utilize the results of Basic long term R&D. Thus, it is most advisable for Basic middle term R&D to be centralized and not be integrated into subsidiary business corporations' R&D organization.

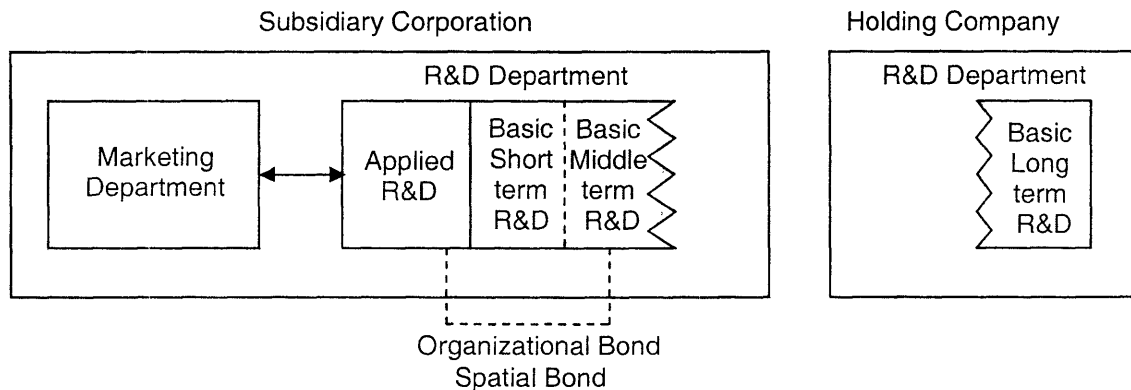


Figure 5-9 Integration of Basic Middle Term R&D

5.4. Summary of Options

I will summarize the results of analyzing the two options in this chapter. Table 5-3 is the summary of Option 1 "Establishing marketing department". Horizontal columns mean that how these factors which were analyzed in Chapter 4 have been considered.

Table 5-3 Summary of Analysis Result of Option 1

| | Bell Labs' good examples | | Analysis issue | etc. |
|--|--|---|--|--|
| | Collaboration | Startup (Working with customers) | Judging Topics | |
| Option 1: Establishing Marketing department | <ul style="list-style-type: none"> Marketing and R&D collaboration Lead user project (cross functional team) | <ul style="list-style-type: none"> Lead user project | <ul style="list-style-type: none"> Autonomous organization Equal power with R&D department | <ul style="list-style-type: none"> Reflection of other market needs |

In addition to communicating with the marketing departments in the subsidiary business corporations, the new marketing department in the holding company should collaborate with the R&D department and work towards breaking down the barriers due to their characteristics differences in personality, cultural thought worlds, language, and organizational responsibilities. Effective collaboration can be realized by putting both groups in the same physical location, encouraging personnel movement between both sides, encouraging an informal social system, using cross-functional teams, establishing similar incentive and rewards, adopting a formal integrative management process, and making use of Information and Communication Technology (ICT).

The Lead user method, which focuses on working directly with users to develop product ideas, should be applied as marketing approach for Basic middle term R&D while the conventional marketing approach to target the majority may be sufficient for Basic short term R&D. The Lead user project becomes more effective by building cross functional team, R&D as well as marketing and Lead users. On the other hand, reflecting other market needs on R&D products as well as the subsidiary business corporations' needs leads to new opportunities to sell products to other customers, as well. In terms of organizational power, the marketing department should be given authority to judge the development topics, and to be an autonomous organization, independent of R&D. The ability to judge market needs impartially is critical.

In the case of Option 2, only the Basic short term R&D can be integrated into subsidiary business corporations while the Basic middle term R&D remains centralized. This option

strengthens subsidiary business corporations' R&D. However, the holding company might encounter more difficulty in maintaining its business oriented values, connection with the subsidiary business corporations, and being compensated for its practical development resources. Establishing its own marketing department for Basic middle term R&D may help to get out of this severe position.

6. Conclusion

The objective of this thesis has been to propose appropriate R&D organizational reform measures in order to increase NTT R&D's organization ability to provide profitable products. First the issues of NTT's R&D organization were presented. I also researched Bell Labs, another R&D organization, which has been through a very similar experience. Based on the Bell Labs case study and some organizational frameworks, I proposed some options for NTT's R&D organizational reform.

In Chapter 2, the Bell Labs case study focused on its attempts at organizational reform. Bell Labs' external environment changes were similar to NTT R&D's. By researching about the organizational structure transition, new concepts about business oriented research, changes in culture, and the venture trials, it was found that Bell Labs was not well positioned to provide profitable products to its business units due to three main factors; (i) acquisitions by parent company which caused product overlapping, (ii) defect in business model such as BLRSV (Bell Labs Research Silicon Valley) model of internal venture, and (iii) the telecommunication market downturn. However, the concepts of "collaboration" and "startup model" seemed to work well to shift to business oriented research.

In Chapter 3, I explained the current severe environment surrounding NTT's R&D, especially in the fixed line service field. Regarding the industry technology, the advent of "IP telephony", which disrupted the conventional telecommunication technology, and "Internet connection technology through fixed line", which is basically part of computer network based technology, created a severely competitive environment for NTT's R&D

products against the market products. The industry service trend has been shifting away from the matured fixed telephone services to the growing broadband network services. NTT has to not only create infrastructure for the broadband network, but also provide value added or killer application services in order to differentiate itself from competitors. Regarding competition and finance, the subsidiary business corporations are also fighting in a tough operating environment; increased competition has led to decreases in market share and service rates. Since the NTT reorganization in 1999, NTT holding company has become responsible for “Basic R&D” for the subsidiaries, and the R&D budget is based on funds invested by the subsidiary business corporations. Such large investments in R&D by the subsidiary business corporations means that the holding company’s R&D has a big responsibility to provide profitable products to contribute the businesses of the sponsoring subsidiary business corporations.

In Chapter 4, I analyzed the issues that NTT R&D organization has to provide profitable products. Two internal organizational factors were identified, which should be improved to provide profitable products; marketing, and judgment of the development topics. Also, I recommended that two of Bell Labs organizational reforms measures, “collaboration” and “startup model” should be applied to NTT.

Based on the analysis in Chapters 2, 3, and 4, I proposed to establish a marketing department in NTT holding company, in order to solve the problems in Chapter 5. The new marketing department in the holding company should not only communicate with the marketing departments in the subsidiary business corporations, but also collaborate with

the R&D department in holding company. Regarding collaboration between marketing and R&D, the following measures should help; locating at the same physical site, encouraging personnel movement between both sides, encouraging an informal social system, using cross-functional teams, establishing similar incentive and rewards, adopting a formal integrative management process, and making use of the Information and Communication Technology (ICT). In terms of organizational authority, the marketing department should be given the power to judge the development topics. It should be an autonomous organization, independent from R&D. The ability to judge market needs impartially is critical.

The conventional marketing approach which targets the majority may be sufficient for Basic short term R&D. But the Lead user method may be especially well suited as a marketing approach for Basic middle term R&D by building cross functional teams, which include R&D as well as marketing and Lead users.

Reflecting other market needs on R&D products as well as the subsidiary business corporations' needs leads to new opportunities to sell products to other customers.

Another option which was discussed is the integration of Basic short term R&D can be into the subsidiary business corporation. Basic middle term R&D would remain centralized in the holding company. This option would strengthen the subsidiary business corporation's R&D. However, the holding company might encounter difficulty in maintaining its business oriented values, communicating with the subsidiary business corporations, and

being compensated for its practical development resources. Therefore, even in this option, establishing a new marketing department in holding company for Basic middle term R&D is recommended.

Thus establishment of a new marketing department in NTT holding company for R&D is recommended in order to improve its ability to provide profitable products.

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