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Transition from Imitation to Innovation: Lessons from a Korean Multinational Corporation

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ABSTRACT

It is critical for companies in developing countries to transform themselves to innovation from imitation in globalisation. This paper introduces a research exploring the evolution process of a high technology company in Korea from 'imitator' to 'innovator'. It identifies some key characteristics of 'imitators' and 'innovators' and describes the development of different capabilities and their priority through the evolution. The nature of these capabilities is discussed together with assessment of their inter-dependence and impact. Based on detailed case studies in three strategic divisions of the Korean company, the paper categorises the transition process from imitation to innovation into four stages – external learning, internal learning and generation, dependent external performance, and independent external performance. It also finds that production capability is closely coupled to business innovative capability.

JEL: *O31, O32, O33*

Keywords: *Imitation and innovation; Product and process innovations; Manufacturing capability*

I. INTRODUCTION

Globalisation has caused intensified debates on its re-structuring of the world economy, especially, the possible development of the third world. It has been an increasing challenge for not only the developing nations to make breakthrough from the boundaries of imitation but also for many multinational corporations (MNCs) to enhance innovation capability through co-evolution with companies in the third world. These debates have lead to some discussions about the transformation that is taking place from imitation to innovation in a few countries such as Japan (Tarsuno, 1990) and Korea (Kim, 1996). They have improved the understanding of these transformations especially at national level. The discussions, however, rarely go into detail about the transformation process at company level, and many companies in the developing world are still struggling to find a way of transforming themselves from a imitator to innovator. In the Western academic world, the mainstream of the research is focused on the early stages of technology transfer, but it rarely addresses the challenging issues faced by either the companies or by the local subsidiaries of MNCs in these developing countries after they have received transferred technology.

The research work introduced in paper seeks to develop a process helping companies, especially in developing countries, to transform themselves from imitation to innovation, based on detailed case studies in a successful Korea company. The company chosen for the case study is a latecomer in electronics industry when Western and Japanese companies have been developing products in this sector for very long time. But as the technology develops very fast, the case study has demonstrated that newer generations of product and manufacturing process provide good opportunities for new comers to adopt a catching-up strategy. The key challenge is how to develop its proper strategy, capability, and learn faster. The paper introduces a transformation process to pursue innovation after receiving external technology.

This paper also summarises the major differences between imitation and innovation. Based on the five-process model of technology management – identification, selection, acquisition, exploration, and protection (Gregory, 1995), the research finds that there are clear different priorities in the imitation-to-innovation transformation in the case company. From theoretical perspective, the new task identification in the five-process model enriches understanding of technology management in developing economies. The research also extends the knowledge of technology transfer by providing new framework helping company to embed new technology into their existing system and to provide new opportunities for developing innovation capabilities.

II. LITERATURE REVIEW

Freeman (1982) defines invention as an idea, a sketch or model for a new or improved device, product, process or system. He also notes an interesting point of view that inventions may often be patented, but they regularly do not lead to technical innovation. “Innovation is accomplished only with the first commercial transaction involving the new product, process, system or device.” (Freeman, 1982). As innovation is so critical to company, the field of innovation studies is very broad covering perspectives from innovation and new product development (NPD) processes, strategy and organisation, to manufacturing and management issues.

Abernathy & Utterback (1975; 1978) proposed that the life-cycle model is developed on the basis of a relationship between process and product innovation. They argue that innovation involves not only product-based technology but also process-based technology. Product innovation corresponds to the introduction into the market of a new or improved product, whereas process innovation closely relates to the sequences and nature of the production process.

Innovation is thought to be based substantially on technology capability. However, Olsen (1974) argues that the most innovative and successful companies were those that invested most heavily in advanced manufacturing capability. This is a very interesting proposition because not many people dealing with the innovation issue were interested in manufacturing capability; and even fewer think that it could be one of the most important factors for innovation. Hayes and Wheelwright's (1984) stages in the evolution of manufacturing's strategic role would also influence the innovation process. The emerging question would thus be, "Is innovation influenced more by product-based technology or process-based technology?" Fry (1982) suggests that the balance between product and process technology emphasis is closely linked to the entire technology improvement. Hayes and Wheelwright (1984) suggest that manufacturing capability can play at least four major roles in stages of development in a firm's competitive strategy.

Iansiti and West (1997) identified in their work several differences in development processes between US, Japanese, and Korean semiconductor firms. In the 80s, semiconductor market leaders such as NEC, Hitach, and Toshiba gained substantial advantage by developing new production technology and investing heavily in technology-integration and manufacturing capability. Meanwhile, many Korean scientists and engineers who had work experience in the US returned to Korea with the latest knowledge in lithography, etching, and transistor design to help Korean companies enter the semiconductor industry. Samsung Semiconductor focused fully on developing its manufacturing process and finally became market leader in the DRAM market by the early 1990s. In doing so, Samsung Semiconductor spearheaded a path for other Korean companies to follow. "Meanwhile, U.S. and European companies fell years behind in the development of production-process technology, which put them at a tremendous disadvantage, particularly in DRAM business, where most of the profits are made the year after a new generation of process technology introduced".

Pisano and Wheelwright (1995) stressed the importance of manufacturing even though "few managers of high-technology companies view manufacturing as a primary source of competitive advantage". They explained that most companies want to avoid the risks of investing in expensive manufacturing plants and losing sight of product research and development, which they saw as their true source of advantage. They did not appreciate the potential of process development and process innovation, because process benefits such as lower manufacturing costs are not particularly important to executives in high-tech industries. But those executives are ignoring other considerable benefits. These include accelerated time-to-market for new products, rapid production ramp-up, enhanced product functionality, and a stronger proprietary position.

A question remains that if process development and innovation were as important as Pisano and Wheelwright (1995) mentioned, why did imitators in high-tech industry not focus on improving processes in order to gain competitive advantage? Pisano and Wheelwright (1995) suggested that innovative process technologies are protected by patents or difficult to duplicate which can block or stymie an imitator's push into the market.

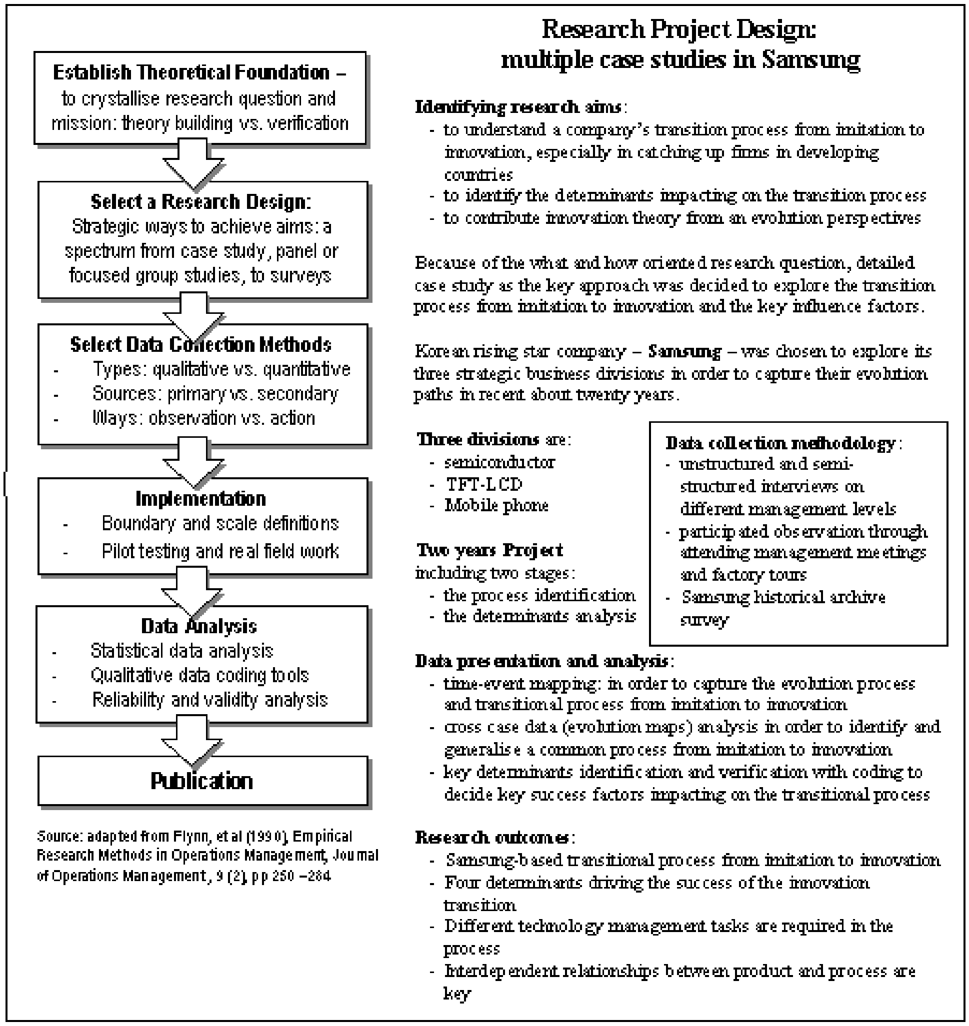
In summary, this part has provided the background to the research by focusing on the relationship between product and process innovation. Innovation is a huge concern for companies in the high-tech industries, especially with the increasing rate of technology changes witnessed in the world today. Many companies are still imitators and are struggling to become innovators in their own right. However, besides the interaction relationship between product and process in innovations are not crystallises yet, the existing literature also provides little guidance on how an imitator can become an innovator, especially for those companies from developing countries. It is not clear what the major factors for innovation are in catching-up context. Furthermore, while it has been suggested in certain parts of the literature review that factors such as organisational structure, manufacturing process and NPD process could be important for innovation, there are still gaps to be filled. The most important issues is a lack of research on how these factors could influence an imitator's transformation to an innovator. Secondly, as these factors have usually been studied in isolation, it is also not clear how they might interact through the entire innovation process. As such, the literature review had mainly focussed on the general topic of innovation, touching briefly on the key factors.

III. RESEARCH DESIGN

Following Flynn's research process (1990), the research approach can be illustrated as the Figure 1 which briefs the reasons why multiple case studies were adopted and what data analysis techniques were used.

The case studies for this research focus on Samsung Semiconductor, TFT-LCD, and Mobile phone sector, in particular on the development process through which it achieved such success in the short period of time it entered new industries. The case study on CDMA mobile phone system will observe the entire development process from TDX-10 development in ETRI to the commercialisation of CDMA mobile phone system at Samsung. From the observation of development evolutions, important factors and patterns of development process that had influenced innovation will be found. Samsung was chosen as the case study company because the main purpose of research is to investigate the transition from imitator to innovator and find out the major factors that influence the innovation process. Samsung Electronics has truly become an innovator, in particular in the Semiconductor, TFT-LCD, and Mobile phone sectors. It is thus apparent that that by observing the evolution of development in these three industries through in-depth case studies, the key factors behind Samsung's success can be revealed.

Figure 1
Research methodology consideration and research design



IV. RESEARCH FINDINGS

A. Samsung's Semiconductor Development

Korea's semiconductor industry took its first steps in the mid-1960s, when several semiconductor firms began assembling discrete devices in Korea to take advantage of cheap labour costs. The main operations were simple packaging processes. After a six-year plan formulated by the Korean government in 1975, many ‘Chaebol’, the Korean version of Japanese 'Zaibatsu’, were enthusiastic about entering the semiconductor industry, but most of them withdrew plans because they faced two difficulties. One was obtaining foreign technology and the other market risk associated with short product life cycles. But Samsung Semiconductor continued to put its efforts into developing a memory chip set. Finally, in 1983 the company successfully developed the 64K DRAM (Dynamic Random Access Memory) chip, making Korea only the third country in the world to produce DRAM chips after the U.S. and Japan. More importantly, it motivated the entry of other Korean Chaebol into the semiconductor industry.

Today Samsung Semiconductor is one of the world’s-leading computer chipmakers. In the ten years starting from 1983, when they developed the 64K DRAM memory chipset, they have become the market-leader. Table 1 shows Samsung Semiconductor’s position in the world market share rankings from 1988 to 1992. After the DRAM success, Samsung Semiconductor became capable of producing many other microchips. Afterwards, the company achieved significant success throughout the semiconductor industry. In July 2002, IC Insights Inc ranked Samsung as the 2nd largest semiconductor supplier worldwide for the first half of 2002.

A key strand of this research is aimed at understanding the factors that lie behind this success. Appendix 1 demonstrates Samsung’s semiconductor development path.

Table 1
Samsung Semiconductor’s ranks in world market share from 1998 to 1992

Rank	**1988**	**1989**	**1990**	**1991**	**1992**
1	Toshiba	Toshiba	Toshiba	Toshiba	**Samsung**
2	NEC	NEC	**Samsung**	**Samsung**	Toshiba
3	Fujitsu	TI	NEC	Hitachi	Hitachi
	Samsung (7th)	**Samsung (5th)**			

Source: Inhub research report (2001)

B. Samsung’s TFT-LCD Development

At the end of 1989 when Samsung entered the TFT-LCD industry, a group of Japanese companies dominated the market with more than 90 percent of the world market share. Given the tremendous technical difficulties Samsung also needed to resolve, there were serious doubts as to the viability of Samsung’s LCD business. Nevertheless, by 1996 Samsung LCD gained the top global market share, and held onto that position for six consecutive years. Many Korean companies also joined the industry after observing Samsung’s success, and some of them achieved a similar level of success. Appendix 2 illustrates Samsung’s TFT-LCD evolution path.

C. Samsung's Mobile Phone Development

The Korean national laboratory, the Electronics and Telecommunications Research Institute (ETRI), took the initial step in developing the Korean mobile phone system when they developed the TDX-10 DSS (Digital Switching System) technology in 1991.

After deliberating the choice of communication standards, the Ministry of Information and Communication (MIC) adopted Qualcomm's CDMA technology, which at the time was only used with modems, not mobile systems. The MIC suggested that ETRI adapt CDMA technology for its DSS-based mobile phones. ETRI embarked on a project in collaboration with the four Chaebol (Samsung, Hyundai, LG, and SK telecom), and in 1995 successfully introduced CDMA technology in mobile systems – the first of its kind in Korea. Before 1998, GSM was considered the universal mobile technology standard given that 95 percent of the world used the GSM system. Since then, CDMA technology has been increasingly adopted as the standard. In 2002, GSM was used in only 70% of mobile systems while CDMA was used in 30%. Many researchers predict that more than 90% of countries worldwide will use the CDMA system as their mobile technology standard within the next 10 years when IMT-2000 system is settled. CDMA technology has now become the base technology of the worldwide standard IMT-2000, giving these Korean companies a head start versus its global competitors.

Samsung Electronics has been particularly successful in expanding its mobile phone business worldwide by selling not only CDMA mobile phone and its server system (DSS), but also GSM and Digital Cellular mobile phone and DSS.. Nokia, Motorola, and Ericsson, called the "Big three" had been holding on to their positions as leaders in the mobile phone industry for the last two decades. In the 4th quarter of 2001, Samsung finally broke through the ranks and became the third largest mobile phone manufacturer in the world. While there were four Korean companies who had joined the project of developing CDMA technology for mobile systems, only Samsung has achieved significant success. What factors led Samsung to achieve this success? How was Samsung's research and development unique? This chapter will illustrate that ETRI's initial efforts in developing the DSS was instrumental in allowing Samsung to adapt CDMA for ETRI's server system and the major factors for change? As the before, the Appendix 3 shows Samsung another successful innovation path.

D. What We Can Learn from the Samsung's Developments

The Samsung case studies brought new insights into the process of becoming an innovator. Certain steps of technology development were identified:

1. External learning
2. Internal learning and generation
3. Dependent external performance
4. Independent external performance

Figure 2
The transition process from imitation to innovation

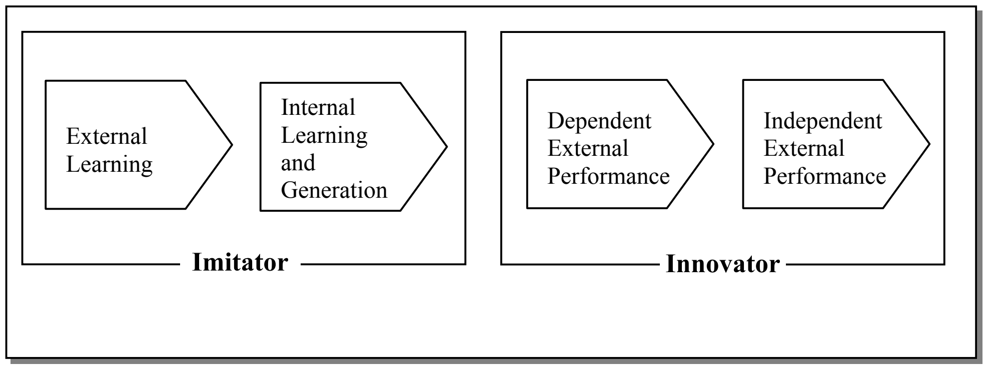


Figure 2 shows the transition from imitation to innovation. Four different stages can be identified, with two stages in each of the imitator and innovator categories. Support from outside such as product-based or process-based technology is called here "external learning". "Internal learning & generation" involves generating new knowledge from what has been gained externally and generating the technology to improve its internal capabilities. After building sufficient internal capabilities in both product-based and process-based technologies, the imitator makes attempts to be an innovator with dependent external performance.

Based on the Appendixes and using coding technique, there are many activities under the five general categories that Samsung has considered to improve its innovative capability in both product-based and process-based-technologies. The five categories of determinants to the Samsung's transitional processes are strategy, R&D activities, organisational structure, NPD process, and manufacturing process.

In summary, the Figure 3 combines the Samsung's innovation transitional process and the determinants during the process together, illustrating different capabilities built up during the transitional process and strong learning mechanisms.

The important characteristics of each stage from imitator to innovator are summarised in Figure 3. In the external learning stage, the major concern would be to access technologies. In the following internal learning and generation stage, the imitator would want to internalise the newly gained technology and build on it. This is the tangible part of the process. In addition to that, the innovator-to-be would also need to develop the intangible aspects such as organisational learning and designing suitable NPD process. The progression to the third stage is considered successful only when the internally generated capabilities yield satisfying results. If the results were not satisfying, the shortcomings would be fed back to the second stage for further improvisation. Finally, fine-tuning will take place in the fourth stage where the most conducive conditions for innovations should be attained.

Figure 3
Characteristics of each stage in the process from imitation to innovation

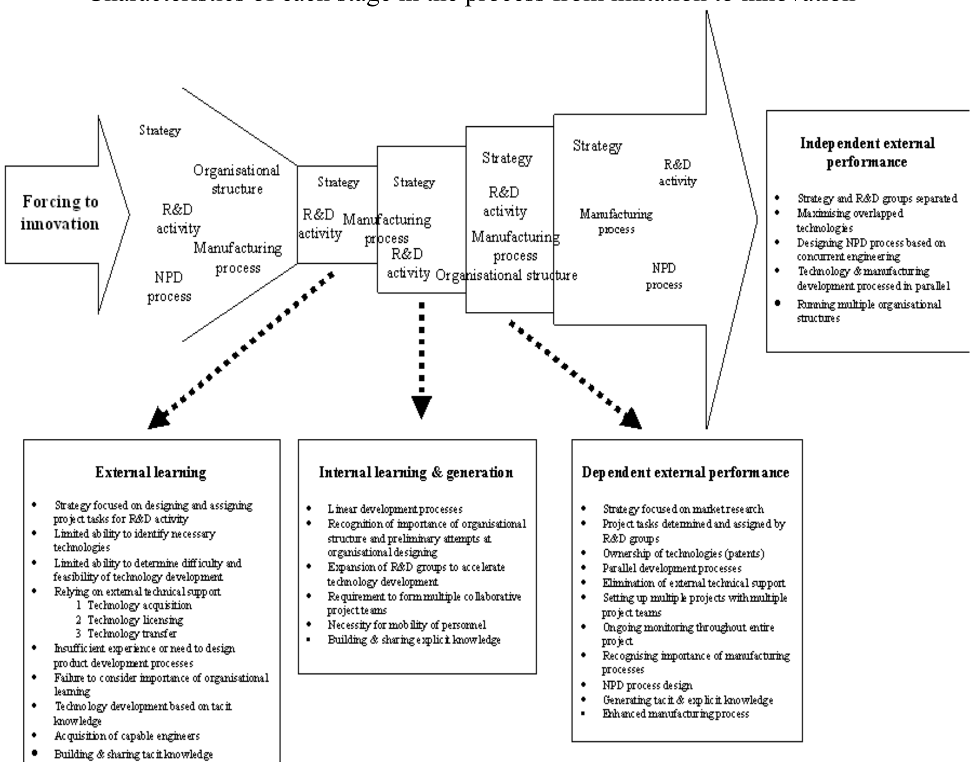


Figure 4
Developing Product-based and Process-based Technologies in parallel

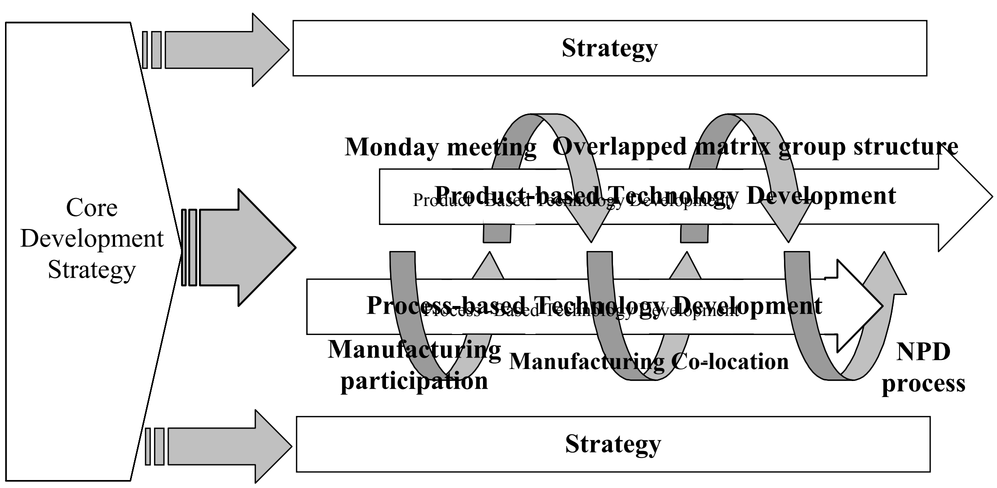


Table 2
Efforts taken by Samsung to facilitate the parallel progress of product-based and process-based technologies, and the results

	Efforts	Results
R&D Activity	- Parallel project process with manufacturing process - Project collaboration with manufacturing group - Monday meeting	- Reducing project lead-time - Early product launching - Technological support for improving process-based technology - Breaking technological gap between product-based and process-based technologies
Organisational Structure	- Mobility of personnel - Collaboration of teamwork - Monitoring by manufacturing group - Overlapped matrix group structures	- Decision-making for problem solving - Reducing project lead-time - Early product launching - Understanding interactions between product-based and process-based technologies - Breaking technological gap between product-based and process-based technologies
NPD Process	- NPD processes based on one process	- Reducing project lead-time - Early product launching - Understanding interactions between product-based and process-based technologies - Breaking technological gap between product-based and process-based technologies
Manufacturing Process	- Training workers - Manufacturing participation - Job rotation - Kaizen (suggestion scheme) - Parallel project process with R&D group - Manufacturing co-location - Prototype manufacture - Organising internal virtual manufacturing group	- Reducing project lead-time - Early product launching - Understanding interactions between product-based and process-based technologies - Technological support for improving product-based technology - Increase product yield ratio - Reducing production cost - Just-in-time manufacturing

V. DISCUSSIONS

From Samsung development, it is clear how important to understand how both product-based and process-based technologies can be pursued concurrently. Samsung enforced a highly coherent structure, processes and strategy that emphasised this parallel development.

Contrary to common belief that a company should concentrate more on either its product-based technology or process-based technology, the cases presented so far demonstrated that a firm can dramatically improve performance in areas such as product development time by focusing on both types of technologies concurrently.

As illustrated by Figure 4, Samsung was able to succeed in the three cases studied, chiefly by developing its product-based and process-based technologies in parallel. The company managed to accomplish this by adjusting its strategy, organisational structure and NPD process over time. The objective is to use all the general development categories to tie the development of product-based and process-based technologies closely together and support their concurrent progress. Table 2 shows the process that Samsung has used to keep those two developments in parallel.

As shown in Table 2, all the efforts from R&D activity, organisational structure, NPD process, and manufacturing process had influenced Samsung's accomplishment in developing product-based and process-based technologies. This has in turn translated to faster product launches, better products, and lower production costs, that culminate to give the company a competitive edge over its rivals. Since 1994, Samsung Semiconductor has produced new generations of memory chipsets 6-12 months faster than its nearest competitors. Since 1996, Samsung LCD has achieved similar technology leadership over its competitors. Samsung Mobile Phone has also embarked on a similar trajectory by using internal virtual manufacturing.

Samsung's development of process technologies helped generate unique innovations exceedingly difficult for competitors to understand and imitate. This greatly accelerated the ability to compete against established companies, to match their lead in product technologies. Furthermore, Samsung's superior rate of technological development, a result of its willingness to look beyond product innovation, means that once this technological parity and eventual superiority, is reached, Samsung's relatively stronger process orientation cements its lead by shortening the product life cycle, forcing other firms to compete on its own terms.

From Samsung's case studies, it is clear that manufacturing capability had played an important role in Samsung's success. But why is it that other competitors are not able to improve their manufacturing capability as much as Samsung Semiconductor did?

The answer lies in the difficulty in doing so. As evident in the evolution of Samsung Semiconductor, there are three major challenges that firms face when they try to improve manufacturing capabilities.

1. Long time commitment
2. Requirement of numerous new technologies and techniques
3. Fierce protection of process-based technologies

Firstly, improving one's manufacturing capability can be a long and painful process. It took Samsung a great deal of time and effort to bring its manufacturing capability to the level it is today. Results are usually not seen in the short term. For example, it takes at least one and a half years for results to become apparent for products in Samsung Semiconductor and .two years for products of the TFT-LCD division.

On the semiconductor and TFT-LCD shop floor, all the necessary equipments must be set up before the engineers could install the necessary software for operating them. There are many different software systems. The 2 major ones being used are Manufacturing Execution system (MES) and Statistical Process Control (SPC) that collecting machine status data, and control uncertainties such as vibration, voltage, magnetic field, altitude, temperature, and humidity. IBM and Brooks Automation produce MES, but they are unable to pre-configure the software for a particular production platform because every company has different shop floors and equipments. The proper configuration of MES normally takes between 4 to 12 months depending on the type of shop floor. The configuration of SPC would take another 3 to 6 months. The major difficulty in such configurations lies in the specificity of the data for each individual equipment. For instance, if an equipment had a serial number of xxxx1 and the other has xxxx2, one would normally think that they should work with similar configurations. However, this was not to be the case due to the extreme sensitivities of these machines. This means that data needed to be collected for each machine and it takes up to a year to a decent database to be built up. It should be highlighted that there are hundreds of equipments in one fabrication plant and if these equipments are moved to another plant, new sets of configurations will be required because of the different uncertainties introduced in the new environment. Similar requirements apply if the equipments were used to produce a product different from what they were initially configured for. These are the reasons why the time commitment is long. It is simply impossible to build up an internal database within a short period of time.

Secondly, many more new technologies and techniques are required for improving a manufacturing process than for improving a product-based technology. In the case of Samsung, their R&D engineers only needed to change 5 configurations to turn 256M DRAM into 516M DRAM. However, to produce 516M DRAM memory chips with the same yield and yield ratio as the 256M DRAM, manufacturing engineers needed to develop more than 40 different new technologies and techniques. A further example could be found in TFT-LCD panel. No product-based innovation was required to turn a 13.3 inch TFT-LCD panel into a 14.1 inch one. However, the manufacturing engineers needed more than 130 different new technologies and operation techniques to produce the 14.1 inch TFT-LCD panel with the 4-masking process. This shows that many different kinds of process-based technologies are needed for improving manufacturing capabilities. Furthermore, the ability of improve manufacturing capability actually rest on the ability to access different fields of technologies. This is so because without the knowledge of product-based technologies, it is impossible to prepare an appropriate advanced production shop floor. It is for this reason that the Samsung manufacturing engineering groups are structured with R&D and other science based engineers as well as manufacturing experts. In short, a firm needs to be capable of organising inter-disciplinary learning in different fields such as electronics, physics, chemistry, and so on if it wanted to improve its manufacturing capability.

Finally, in a high-tech industry, advanced product-based technologies can often be found out by reverse engineering. However, competitors are normally prevented from imitating or copying those technologies even if they were able to do so because those technologies are protected by patents. Thus, no one can imitate or copy them unless they have established a licensing contract or acquired the technologies from the inventors. This also means that companies that need to use those technologies can use them if they were willing to pay the fees for licensing or acquiring. The story is considerably different for process-based technologies. Most new operation techniques and many technologies that influence higher productivity cannot be protected by patents. Hence, a company who has developed some new production techniques and technologies would usually fiercely protect them by hiding them from the competitors. Even if the competitors manage to find out about a few techniques, they may still be unable to improve their manufacturing capabilities because of the interdependence with other techniques and technologies where they do not have access.

This can be better appreciated by taking the line of the resource-based theory, which contends that valuable, rare and difficult to imitate resources or capabilities can provide a firm with its rent-generating ability that in turn gives rise to the firm's competitive advantage (Barney, 1986 and 1991). Furthermore, for a firm to sustain the competitive advantage created, there must be barriers to imitation and replication available to secure the firm's existing rent-generating capability, which may come from certain isolating mechanisms (Peteraf, 1993). For Samsung Semiconductor's case, as shown, the division managed to achieve success by having a mix of different resources and capabilities which are closely intertwined with one another. Hence, it is this causal ambiguity, which Rumelt (1984) identified as the principal isolating mechanism, which had provided the company with a sustainable competitive advantage. In other words, there was no easy way for a competitor to reach Samsung Semiconductor's level of manufacturing capability by imitating what it has done. The same argument can be applied to the two other cases: TFT-LCD and Mobile phone. In particular, due to the relative complexity of producing TFT-LCD panels, it was important that the company possess sufficiently developed manufacturing capability. The high cost of making TFT-LCD panels also meant that manufacturing capability is crucial in bringing production costs down by achieving a high yield ratio.

VI. CONCLUSIONS

Innovation ability and innovation process have become critical competences for firms to compete in all areas of the global market. The transition from imitation to innovation, however, is not fully understood.

This research provides new insights into the transition from imitation to innovation and identified factors that influence innovation. For instance, organisational structure and NPD process could have an important role in integrating product-based and process-based technology development.

Furthermore, it has been found from the cases that combining product-based and process-based technologies development could provide a firm with significant competitive advantages. This finding has highlighted the importance of process innovation. Process innovation could help shrink product life cycle and by this virtue, a company can potentially amass more profits and starve off competition as well. Innovation risks can also be reduced in the process.

It has been argued that the concepts developed through this thesis provide the basis valuable practitioner tools and new ways of thinking about manufacturing capabilities. In particular ideas of overlapping groups, technology cascading and internal virtual manufacturing may be worthy of further development.

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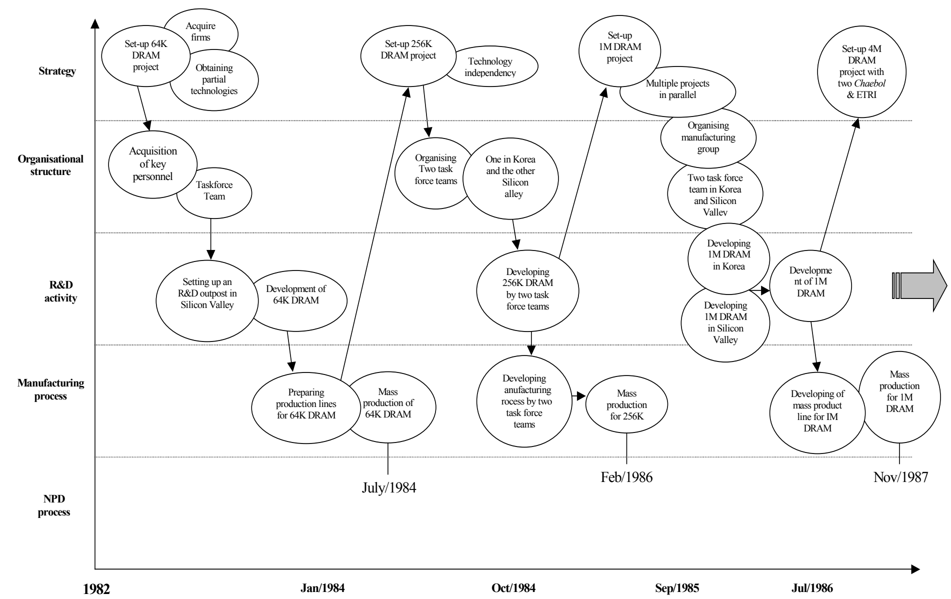
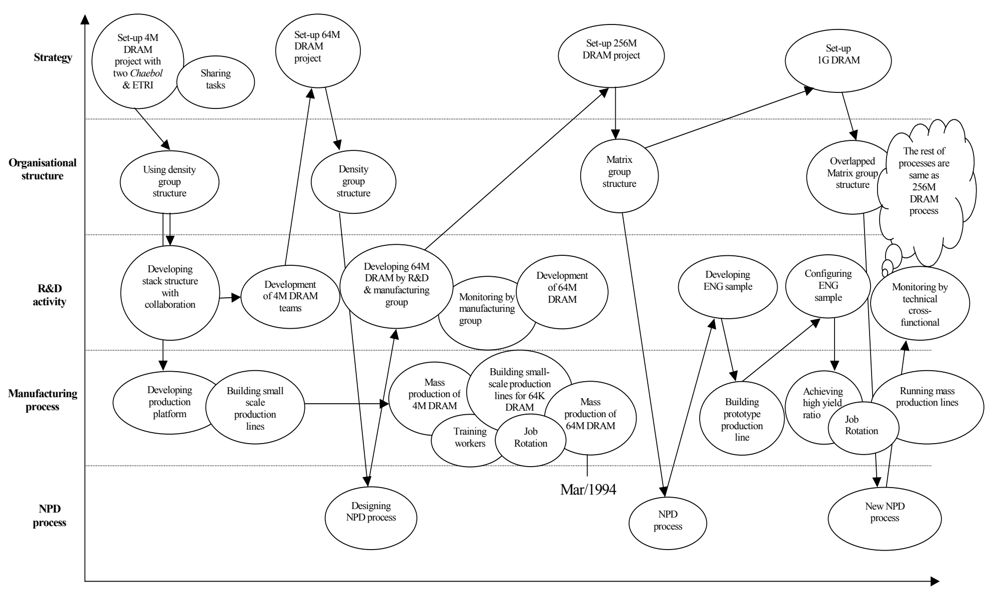
Appendix 1

Mapping chart of Samsung DRAM developments

1982–1987



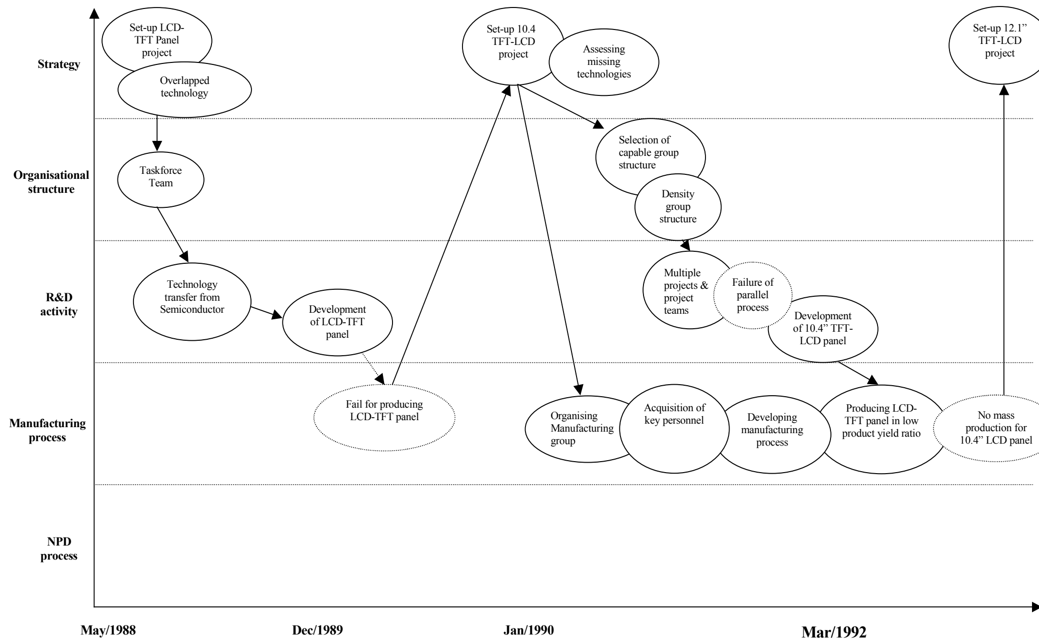
1987–1994



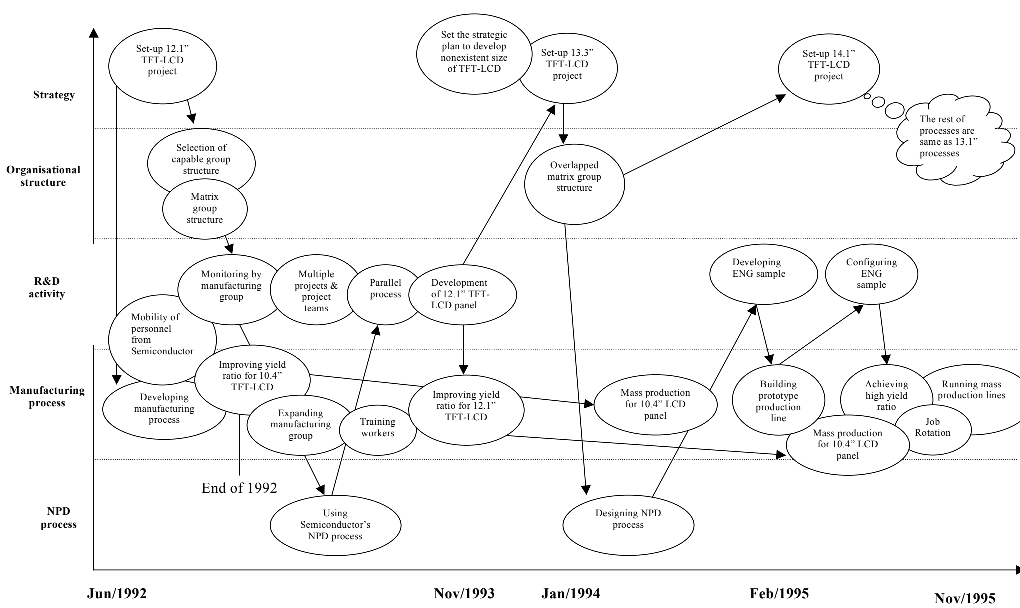
Appendix 2

Mapping Chart of Samsung TFT-LCD developments

1988–1992



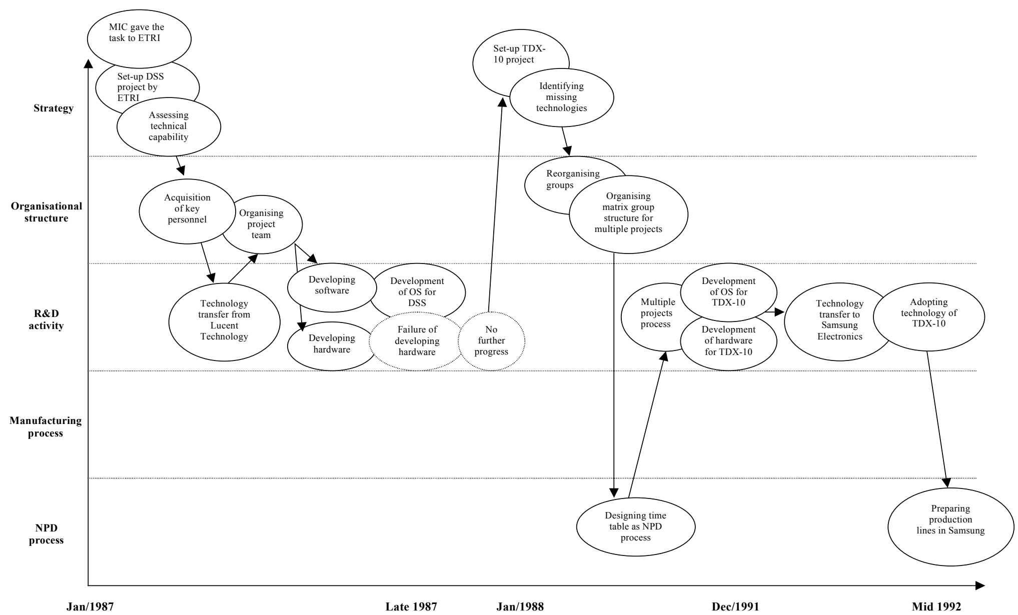
1992–1995



Appendix 3

Mapping Chart of TDX-10 and CDMA mobile system developments

1982–1987



1987–1998