How Does R & D Evolution of the Notebook Company in Taiwan – Based on the Company C

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ABSTRACT

The Notebook constituted about 50% of the global output of notebooks in 2002, 60% in 2003, and 70% in 2004. Apparently, notebook producers have outperformed other competitors in the field of notebook production. How did notebook manufacturers accomplish such success in Taiwan? Company C in Taiwan is the notebook manufacturer in the world, showing that the strategy supported by a well-managed R&D system is the key. This paper carries out this research on the subject R&D of Company C, which was to become a fit of model.

Keywords: R & D strategy, Environment uncertainty, Technological capabilities

INTRODUCTION

As notebook companies such as: HP, Dell, Toshiba, IBM, NEC, Acer and Apple Inc., are all engaged in competition in the global notebook market; more than 70 percent of their products are produced by notebook producers based in Taiwan. Dell and HP were the first two companies in 1999 to notice the competitive advantage of notebook outsourcing production jobs to Taiwan, which is capable of delivering customization products to end users in less than 48 hours from putting together hardware, to installing software, to testing product, and shipping.

This editorial commentary on a Dell computer represented a prime example of the concept of “globalization” as postulated by Friedman (2006). Essentially, all states belonging to international supply chains will be out-sourcing jobs, from businesses ranging from small to medium-sized accounting companies to high-tech call centers that handle everything from simple computer repairs, to complex commercial transactions through Dell’s R&D. Friedman (2006) argued that this process has now reached warp speed, and will likely obliterate many traditional boundaries between nations.

This paper submits that the notebook industry in Taiwan is uniquely poised to help confront what may be the greatest economic challenge of the twenty-first century. The notebook industry in Taiwan provides the vast majority of basic and applied research efforts in this regard, setting the foundation for creative and innovative approaches to economic challenges and questions. From finding cures for diseases to increasing levels of partnership with the notebook industry in Taiwan, R&D will be the central point for the innovation and strategies that will be central to creating a sustainable economy.

Company C in Taiwan is the notebook manufacturer in the world, showing that the strategy supported by a well-managed R&D system is the key. Based on the competitive advantages created by cluster collaboration networking for in-house resource design and business development, Company C as well as other competitors can concentrate on notebook product research and design as its core competence, which was to become a fit of model. The purpose of research is: (1) how does R&D evolution of the notebook company in Taiwan? (2)What is the best fit/ link of business strategy related to resource-base and uncertain environment factors? (3)How did notebook industry accomplish such success in Taiwan?

LITERATURE REVIEW AND THE CONCEPT

R&D strategy and environmental uncertainty

Two typical approaches to business strategy can be identifies in the literature (Mansfield, 2002). One approach examines components of strategy, typically including scope, goals and objectives, resource deployment, identification
of competitive advantages and synergy (Hofer & Schendel, 1978; Walker, Boyd, Mullins & Larreche, 2003). Another approach, called generic strategy or strategy typology, premises that each business strategy type is internally consistent (Porter, 1980, 1985) and develops classifications of business strategies.

Miles and Snow’s (1978) Organizational Strategy, Structure, and Process have had considerable influence on the fields of strategic management and organization theory (Hambrick, 1983). Miles and Snow’s typology classified companies into four distinct groups, i.e. defenders, prospectors, analyzers and reactors, based on how a company responds to three major problems facing it, i.e. entrepreneurial, engineering, and administrative problems. According to them, the entrepreneurial problem defined an organization’s product-market domain; the engineering problem focuses on the choice of technologies and process for production and distribution; and the administrative problem involves the formulation, rationalization and innovation of an organization’s structure and policy processes (Miles et al., 1978).

While each of these typologies has their merits, Miles and Snow’s approach was chose in this paper as the theoretical framework. Abell’s (1980) typology also challenged its failure to differentiate the strategy-less stuck in the middle venture and the ventures that used cost leadership strategies (Chrisman, Hofer, & Boulton, 1988). Compared with other classification schemes for generic strategies (Abell, 1980; Porter, 1980, 1985), the Miles and Snow have been widely supported because of its strong theoretical orientation and generalization (Chrisman, Hofer & Boulton, 1988; Doty, Glick & Huber, 1993; Smith, Guthrie & Chen, 1989; Zahra & Pearce, 1990).

Gupta and Goyal (1989) asserted that organization theory could be separate into its environmental creative aspects and environmental adaptive aspects to explore the proactive relationships between environmental uncertainty and firm strategy. The creative aspect focuses on the extent to which the core capacity has been actively changed in response to the environmental uncertainty in order to create the best state of business operation. In contrast, the adaptive aspect focuses on the extent to which a manufacturer adopts a passive strategy to respond to changes in environmental factors. Most of past researches discussed the latter adaptive aspect, a one-way causal relationship from environmental uncertainty to the enhancement of firm strategy.

Duncan (1972) advocated the characteristics of organizational environment; the internal environmental factors were composed of customer demand, supplier, competitor, and product technology. Hitt, Ireland and Palia (1982) applied product technology, customer demand, competitor’s price and quality, and supply as environmental uncertainty factors to explore the fit between business strategies and functional department importance. Bachko (1994) proposed supplier, customer demand, and competitor as the three dimensions to assess environmental uncertainty measures. This is consistent with several other scholars’ points of view (Burns & Stalker, 1961; Duncan, 1972; Downey & Sloucm, 1975; Gerwin, 1993; Pagell & Krause, 1999; Covin & Slevin, 1989). Business strategy literature provided various approaches for measuring environmental uncertainty. Some studies suggested the use of objective measures (Dean & Snell, 1996; Kotha & Orne, 1989; Wernerfelt & Karnai, 1987). For example, uncertainty could be measured based on four dimensions: demand, supply, competitive and external. On the other hand, some researchers propose the perceptual measure of environmental uncertainty (Duncan, 1972; Swamidass & Newell, 1987). They suggested that the perceptions of the environment are more important than the actual environment. Managers will make decisions based on their perceptions of the degree of environmental uncertainty.

The concept of fit has been used to explore the relationship between strategy and organizations (Venkatraman & Camillus, 1984; Mintzberg, 1978). However, the author proposed that fit can also be applied to the relationship between a technology and organizational purpose. The term fit can be defined in many ways (Zigurs & Buckland, 1998; Venkatraman & Prescott, 1990). This paper will preliminarily explore the concept of strategic fit as it applies to businesses, especially to this research around technology as a core feature. The paper will examine the conceptual underpinnings of notebook technology and propose some models based on these concepts that will seek to explain the fit of this technology to some business models and strategies and lack of fit to others.

**Concept Conceptual Framework**

This study describes the concepts and presents the propositions based on these concepts. First, the concept of R&D strategy and technological capabilities are defined. Company C is in a pre- eminent position in regard to approaching R&D strategy in the notebook industry in Taiwan. The following main concepts are used: (1) R&D
strategy and its sub-concepts, R&D strategy represents the actual way a business carries out its operations in practice. (2) Perceived environmental uncertainty and its sub-concepts, Perceived environmental uncertainty, which indicates what kinds of the fit of R&D strategy, is necessary and how different generations R&D interaction. (3) Resource Base View (RBV) with technological capabilities. Technological capabilities structure describes the participants in R&D and what kinds of processes exist between the participants.

R&D in industry is defined as work that tries to find new fits and processes or to improve existing ones. Within the scope of this study, R&D is considered as a broad concept containing technical capabilities and business viewpoints, as well as their interactions.

**METHODODOLOGY**

The domain of this research is a notebook company in Taiwan and discussed. The working definition of R&D strategy is one that gives their businesses develop the opportunity to have the benefits associated with strategic fit operations.

**Case and data selection**

The selection of case to study should depend on the research process. For model building, although a poor set of cases may not hamper the model building process it can weaken the theory that flows from it. The single-case study is an appropriate design under several circumstances.

Following by Yin (2003) the rationale for a single case is, when it represents the critical case in testing a well-formulated theory (again, note the analogy to the critical experiment. To confirm, challenge, or extend the theory, a single case may meet all of the conditions for testing the theory. The single case can be used to determine whether a theory’s propositions are correct or whether some alternative set of explanations might be more relevant. Co. C striving for economies associated with mass production, evident from the design of their products and operations profit, and confirmed by R&D intensity, establishment over 20 years that compete for companies.

From its beginnings as a supplier of computer peripherals in 1984, firm has relied on professional management and strong R&D to grow to its present scale. Today it is one of the world leading manufacturers of computer notebooks, its computer monitor products are well known for high quality, and it steadily expanded into web communication and portable products of digit field. Co. C was one of the first Taiwanese notebook/ PC manufacturers to shift its production to China following the elimination by the Taiwan government, in December 2001, of restrictions which prohibited Taiwanese manufacturers from producing notebook/ PCs in China. The currently produces all of its notebook PCs, display products and most of its mobile communications devices in its production facilities in China and it expects to continue to shift its mobile communications device production to China.

In order to successfully perform the case study, full and complete case access is vital. In this context, “random selection is neither necessary, nor even preferable” (Eisenhardt, 1989). Thus, following the identification of suitable cases, access is negotiated via researcher. In addition, this research objectives and the direct contribution in tangible and intangible terms that the research could make to the studied case should clarify boundaries relating to the research before it commences.

An overriding concern of this research is that the mere collection of in-depth case data does not provide theory concepts in and of themselves. This point is articulated by Zuboff (1988) who stated that while observation could be considered first order constructions, researchers rely on good theory and insightful analysis for second order concepts in order to induce theory. Miles and Huberman (1994) suggested that conceptual frameworks can be used as boundary devices in this context, while Janesick (2000) recommended the development of working models and theories in action that explained the behavior under study. Therefore, variables were identified early in the case and joint into a loose conceptual framework to focus the case investigation. Thus a framework’s latent legitimacy value is significant, particularly if the underlying case purpose is to provide a basis for theoretical replication.
Definitions of variable

Environmental uncertainty This paper uses Wernerfelt and Karani’s (1987) as a basis of the definition for discussion of a conceptual framework with four sub dimensions: customer, supply, competition and technology. This paper not include the three uncertainty dimensions (union, public view and government regulations) suggested by Duncan (1972), since they are unfit for a notebook industry in Taiwan. Customer demand uncertainty can be defined as unpredictable events that occur in the downstream supply chain. Competitor uncertainty can be defined as competitive environment, competitor’s strategy, and available technology of changes. Supply uncertainty can be defined as unpredictable events that occur in the upstream supply chain, e.g. late delivery from a supplier or supply part shortage. The technology uncertainty can be defined as new technology solutions which may or may not prove to be commercially viable in the notebook industry.

Technological capabilities Technological capabilities include investment, production, and linkage capabilities. Investment capabilities can be defined as investment in R&D resources to support a firm’s business growth, including in-house R&D activities and joint development with certain major customers. Production capabilities range from basic skills like quality control, operation, and maintenance to more advanced ones like adaptation, improvement, or equipment “stretching” to the most demanding ones of research, design, and innovation. Linkage capabilities consist of linkages which are supportive to, or which influence, the development and utilization of a firm's internal capabilities.

R&D strategy The Miles and Snow’s strategy described specifically the four different types of strategy used in the environment as follows. Prospector can be defined as the most extroverted and opportunistic type, displaying an interest in new product and market opportunities. Analyzer can be defined as tending to maintain a stable and limited domain, while at the same time cautiously moving into a new domain only after prospectors have proven its viability. Defender can be defined as an organization with this orientation that tends to have a narrow product/market domain. The firm will try to create and maintain a niche with a limited range of products or services. The reactor strategy is excluded from the continuum since it represents an organization having no specific strategy identified, which is likely to impede organizational benchmarking.

CASE ANALYSIS

In this paper, it refers to the model of the “Second Generation R&D” created on the empirical observation of the management of R&D in multi-divisional firms by Roussel, Saad & Erickson (1991). This study identifies R&D’s characteristics in Company C and then develops a model of generation R&D in the notebook industry of Taiwan, using time frame of scenario analysis.

Since 1985, Company C which produced and assembled CRT monitors in Taiwan used an OEM strategy. Company C has benefited a lot from implementation. It did not have to invest any money in R&D to create an internal R&D based to develop notebooks. The firm’s strategy was to acquire technology from foreign firms and learned to incrementally improve by imitation. Company C was focused on transfer product technologies and in acquiring a few product design capabilities.

It is very important to learn many of technological skills under OEM arrangements. Most production embodied little original R&D, and Company C had closed much of the technological gap with competitors through learning how to absorb and adapt advanced foreign technology and to modify, re-engineer and re-design for different types of customers. In 1989, Company C started to produce notebooks and had an opportunity to learn technological methods and capabilities when building notebook designs and development. Encouraged by the experience of OEM strategy, Company C started exporting notebooks to its customers. However, Company C considered the possible high R&D costs, so still did not change to a new business mode resting on the manufacturing and assembling of notebooks. In this period, there was no formal R&D activity or organization. Company C still continued to rely on OEM to some extent, despite their improvement in technological capabilities and involvement with its customers. Company C’s R&D strategy can be defined as a reactor.
First-generation R&D in 1990s – 1999s

The “First generation R&D” occurred to the 1990s and can be characterized by a lack of a long-term strategic framework for the management of R&D. There is no explicit link between business, technology and R&D strategy. R&D is treated as an overhead cost and a line item in the firm's budget. In this generation, R&D was organized into cost centers. R&D activities were centralized and concentrated at the firm level, whereas incremental R&D was conducted by the business units. The main characteristics of this first R&D generation were the lack of linkage between R&D and business strategy as well as the centralized R&D activities on a firm level.

Customer uncertainty In time, some OBM turned to Company C for manufacturing, partly due to lower costs and also to avoid dependence on Japanese partners who could become competitors. The Company C gradually developed specialized engineering skills and began to take over product development as well. In 1994, Company C formally established R&D by Dell’s push. The OBM were able to enter the notebook market by working with R&D in Company C on design and development, taking advantage of capabilities nurtured by their competitors. In the interview, Company C often did not charge explicitly for development, but did it in order to win production contracts. Once Company C had a contract, the relationship created incentives for the customer to work with the same ODM for future upgrades and enhancements to the product. There was a great deal of tacit knowledge created in the development process that was known only by the R&D. Also, the close linkage of development activities to manufacturing and the feedback to design from manufacturing and sustaining support, created linkages that favored continuing the ODM relationship in order to reduce costs and improve quality.

Competitive uncertainty This was a hard period in the notebook industry of Taiwan. Plummetsing notebook prices were turning manufacturing into a low-margin, high-volume game. Firms were seen to offer complicated inventory and distribution services to keep clients in Taiwan. Instead, they were moving nimbly to outflank global rivals in the hot market for notebook PCs. In 1998, Taiwan’s notebook exported soared 36% in a market that grew just 8.5% in this year, firms were set to topple. Japanese firms became rivals and world market leaders by grabbing a 46% share.

Supply uncertainty In 1994, Company C changed its strategic direction from OEM to ODM with a new business model. The organization created R&D and implemented business units for its product. Consequently, Company C purchased components (hard disk drive, CD-ROM, DVD-ROM, CPU, main board, LCD monitor, and so on) from other manufacturers, and concentrated themselves on selecting appropriate components and assembly techniques. Company C’s R&D advantage in acquiring core components was also conditioned by its superior resource base. However, Company C’s superior supply chain was not entirely based on resources. The ability to catch up with Japan and other technologically advanced countries in a short period in such areas as LCD and CD-ROM drivers was inherent in Korean electronics firms. This can explain the evolution of such ability as being a case of learning-by-learning (Cohen & Levinthal, 1990), in which past experience of learning facilitates new learning.

Technological uncertainty At the development stage, a variety of engineering skills are required, primarily in mechanical, electronic and electrical engineering, PCB layout, and software engineering. For notebooks, specialized technologies were needed in thermal dissipation, EMC, acoustics, shock and vibration, power management, materials, and radio frequencies. These required a combination of formal training and experience working in a particular specialty. The firms interviewed reported that increasing shares of R&D jobs are in software engineering. More software engineering was needed because more functionality in many products was being located in software rather than hardware, and even in hard disk drives, where drives are customized for different customers with software rather than hardware.

Investment capabilities Before 1994, Company C R&D focused on monitor development and production capability. After 1994, the major investment to acquire foreign technology acknowledged that the original objective was to build up notebook design and development in Taiwan. In this period, investment capabilities can be defined as investment in upstream and downstream resources to support business growth, including in-house R&D activities and joint development with certain major customers. Such resources focused on: developing new notebook products, a search for technology sources; detailed engineering; training and recruitment of skilled personnel; and equipment procurement.

Production capabilities At the production stage, the skills required are mainly industrial engineering, quality assurance, manufacturing management, and logistics. In addition, there is sustaining engineering, which involves
supporting products after they are in volume production to handle mid-life upgrades (e.g. adding a faster processor), end-of-life components, or problems that show up in the field. For Company C R&D, which design-for-manufacturability is very important, it is valuable to be able to build and test prototypes on the actual final assembly line. Also, the time frame for ramping up to mass production has been cut dramatically along with overall product cycles as firms try to introduce new technologies quickly and avoid product obsolescence. This means that critical manufacturing processes and equipment (particularly tooling equipment) must be in place at the manufacturing site to begin volume production almost immediately after the design is finalized. A key decision is whether or not to move expensive testing equipment to the factory. It is cost effective to move more development as well, even if this means bringing in experienced engineers from Company C’s R&D for a year or more to lead development teams.

Linkage capabilities Some OBM’s had set up their own design centers in Taiwan, thus off shoring some detailed system design, while keeping concept design and system architecture in-house R&D. The motivations were multiple: lower cost engineers and programmers, faster development by having test facilities nearby, availability of experienced engineers, government tax incentives, and closeness to emerging markets in Asia. Also, by being close to Company C, the design center could send personnel to the Company C R&D for problem solving and use Company C’s testing facilities. As for Company C, they have engineering work in Taiwan along with manufacturing. Their design teams in Taiwan were still responsible for the development of advanced technologies and new products that provided competitive advantage. As these products mature, development of product variations, incremental improvement, and life cycle support needed to be close to manufacturing to take advantage of lower costs. In addition, R&D in Company C tends to keep development of new product generations in Taiwan, where they had close working relationships with key component suppliers such as Intel.

R&D strategy The “first generation R&D” was the dominant model at a time when R&D management was shaped by the computer technology-pull view. Company C’s R&D was assumed to be the main driving force behind innovation and decisions about the technology that would be used by the enterprise. The main characteristic of this first generation R&D were the pre-eminence of the professional ideology, which stresses specialization and autonomy of the R&D professionals. R&D activities in the “first generation model” took place behind a screen of impenetrable science and were isolated from business problems and the rest of corporate activities. In other words, “resource” and “environment” were treated as two separate domains.

Second-generation R&D in 2000s – present

The “second generation of R&D” was a transitional stage towards the third generation and was the beginning of a strategic framework for R&D and the stronger linkage between business and R&D strategy in the 2000s. A supplier and customer relationship was established between R&D as supplier and the various businesses as customers. Fundamental R&D was centralized on a firm level and incremental R&D was distributed to the business units. Matrix and project management were actively used. Project managers get more responsibility. However, since plans for R&D were formulated on a project-by-project basis, separately and independently for each business unit and the corporation, there was a lack of integration between R&D and business strategy.

Customer uncertainty In 2001, one OBM announced that it would voluntarily recall approximately 284,000 batteries used in two of this notebook computer series due to battery safety concerns. The firm that manufactured these notebooks for one OBM could be liable for the costs of such a recall as well as the costs associated with any damage that has occurred as a result of such a product defect. The firms have reached an agreement under which the Japanese supplier of the recalled batteries would indemnify a substantial portion of any costs associated with the defective batteries. However, there can be no assurance that Dell will be able to recover any losses incurred in respect of the defective batteries from the Japanese supplier, or would be able to recover any losses incurred as a result of product liability in the future from any third party. Further it was established that defects in the products sold by the firm, regardless of whether it is responsible for such defects or not, would not adversely affect its reputation in the marketplace or result in monetary losses and have a material adverse effect on business, financial condition and results of operations.
**Competitive uncertainty** The notebook industry in Taiwan has been characterized by periodic oversupply of products, price erosion, rapid technological change, short product life cycles and cyclical market patterns. A firm’s ability to compete depended on factors both within and outside its control, including product pricing, product functionality, performance and reliability, successful and timely product development, success or failure of customers in marketing and products, component and supply costs and general economic conditions. Some of the competitors have substantially greater financial, marketing, manufacturing, R&D and technological resources, greater brand-name recognition and larger customer bases than this firm. The principal factors which affected gross margins include price competition among ODM/ OEM manufacturers of notebook PCs, fluctuations in the supply and demand for principal components and raw materials.

**Supply uncertainty** A shortage in any of key components generally increases prices, and may depress the firm’s margins to the extent that they were unable to pass these higher component prices on to customers. However, these shortages could quickly end and result in over-supply as suppliers ramp up production following capital expenditures to increase capacity. As there was a shortage of LCD panels from the end of 2001 to the second quarter of 2002, this resulted in higher costs of this key component. However, there quickly was an over-supply of LCD panels in the market. Such volatility in supply of LCD panels as well as other components may adversely affect a firm’s business if it cannot manage the supply of such components and react quickly to market changes.

**Technological uncertainty** In this period, the notebook industry was also characterized by rapidly changing technologies and user preferences, evolving industry standards and the frequent introduction of new products and enhancements. As a result, the average selling prices of the notebook products tended to decline over the products’ life cycles, reflecting product obsolescence, decreased costs of input components, decreased demand and increased competition as more manufacturers were able to produce similar products in large volumes. The manufacturing process for notebook products was continuously being updated in an effort to improve efficiency and to reduce product defects and unit manufacturing costs. There was a technology uncertainty for manufacturing process technology. Sometimes, there will be production difficulties that could cause delivery delays and reduced output. There would be no assurance that the firm will not experience manufacturing problems in achieving acceptable output, and product delivery delays in the future as a result of, among other things, capacity constraints, construction delays, difficulties in upgrading or expanding existing facilities, difficulties in changing its manufacturing process technologies or delays in delivery of equipment, any of which could result in a loss of future revenues.

**Investment capabilities** Beginning in late 1999, the firm began to diversify business operations through a series of strategic investments. In 2001, the firm merged with Technology Co. P, to engage in the development and manufacture of PDAs and other IAs. Such investments in new product lines that have expanded were subject to rapid technological changes and intense competition. The firm would, on an ongoing basis, require more advanced technologies in order to respond to competitive industry conditions and customer requirements. This may require that it makes significant expenditures to acquire and develop technologies. In the wireless handset business, a firm’s success depended on identifying and acquiring rapidly developing cellular technologies and recruiting and retaining experienced R&D engineers. With respect to the manufacture of IAs, firms continued to invest in R&D in order to design and manufacture more complex products such as PDAs and pocket PCs. With respect to the manufacture of LTPS TFT-LCD panels, Company P is developing the necessary production capabilities. Company P was formed as a joint venture, and to pursue other opportunities in joint ventures with third parties. In this period, investment capabilities could be defined as investment in R&D upstream resources to support its business growth. Such resources focused on search for LCD technology sources; detailed engineering; and equipment procurement.

**Production capabilities** Frequent new product introductions in the notebook industry can result in a decline in average selling prices and the stated value of inventory, which placed significant demand on inventory management. The firm was establishing a full provision for any raw materials not utilized for a period of three months. With respect to other types of inventory, they established a provision for inventory loss based on the difference between the costs of inventory and the market price. Since establishing the firm’s global logistics delivery network in 1999, it has assumed part of the inventory risks of certain of its major customers, as incomplete notebook products were first shipped to hubs it established in Asia, Europe and the United States based on customers’ rolling forecasts, for onward delivery to, and
final configuration by, customers only after a firm order has been placed. It may have an adverse impact on the firm’s inventory management because it results in it bearing the inventory risk with respect to such products longer than if such incomplete notebooks were shipped to its customers and held as part of inventory before being configured.

**Linkage capabilities** To ensure a stable supply of input components at competitive prices, the firm generally sourced each major input component from at least two to three different suppliers. It generally maintains relationships with a number of suppliers so as to retain maximum flexibility and pricing advantages. However, the firm was dependent upon Intel as supplier of processors and static random access memory and Microsoft for various software products. In selecting and linkage suppliers, it considered the supplier’s production capacity and ability to commit such capacity, technological capabilities and capacity to meet costs and quality requirements. In acquiring the majority of its raw materials and components from suppliers on the approved vendor lists, typically, the prices for such raw materials and components would be pre-agreed between its key customers and be comparable to technology transfer and prices that it would be able to obtain from other third-party suppliers.

**R&D strategy** In this period, Company C’s R&D’s strategy was as defender. The defenders tended to stick to one or a few customers, enjoying their strong links with the local markets. While they seldom significantly differentiated their products from others, the projects were often attractive. The analyzers were seen as “balanced players” in the industry, often following a second-but-better strategy in both local markets and markets in other areas. Other competitors in Taiwan, who have no consistent strategy, could be categorized as reactors. They were opportunists and are usually set up to pursue particular projects.

The “second generation R&D” was a transition stage towards the third generation. It began in the early 2000s when the technology-push view was overruled by the market-pull view. The most distinctive feature was the corporate focus on forging a strong link between business and R&D management. This was achieved through de-centralization of R&D to business units, and the formation of a market relationship between R&D (as suppliers) and business divisions (as customers). This was a model dominated by managerial and commercialism where academic specialists gave way to generalists, and short-term R&D reduces the organization’s ability to cope with technological changes. In this period, R&D strategy as prospectors seek opportunities in a broad market domain and firms were usually pioneers of “new ideas” in the market. Thanks to newer designs, more aggressive promotions and better services, a firm’s properties usually enjoyed higher prices than a competitor did.

**CONCLUSION**

Along with under the globalization and the demarcation line increasingly fuzzy tendency, the new generation’s R&D strategy, must be able to let R&D strategy and business strategy linkage closely, unscrambles the whole world market development, carries on the technical competitive power analysis, the construction links the enterprise strategy and the R&D organization, with global layout R&D resources. The notebook industry of Taiwan could succeed in the past the reason, is not “the innovation”, but already does others the thing which, developed to do well. But the case company faces with the intense reforming competition, the urgent need will have to be able to R&D strategy promotion to the business strategy level and then creation technology competitive advantage in the world. As previously described, the various elements of the notebook industry’s technology are developed and combined according to the capabilities of the R&D strategy. Depending on the composition and overall efficiency of this process, varying types of technology will be produced in different time frames.

Overall, analysis of these two models indicates some intentions. First, most literature on networks, transaction cost theory and other approaches support this shift in conceptual thinking. The second deals with the firm’s growth driven by science-push or demand-pull. The new cognitive model destroys this simplistic confrontation of views and establishes an integrative view. Both forces are highly interlinked and interaction of the R&D strategy. Third, technology and investment should be part of the corporate and business unit strategy. However, both models do not tackle the extent and challenges of the internationalization of technology investment-related activities. This study aims at establishing a series of R&D’s benchmarks on the strategic management of technology from the personal point-of-view of the senior R&D or technology officers of the notebook industry’s most technology-intensive
corporations, as is Company C. The described models draw this conclusion from results at the beginning of the nineties showing the scale and scope of the notebook industry of R&D and the organizational forms taken to optimize the international generation of R&D that were analyzed.

Referring to Roussel et al. (1991), this paper explains the next generation R&D for the notebook industry in Taiwan. This study follows technology and product evolution of Company C to develop a generalized model of R&D. The “Third generation R&D” seeks to balance the R&D portfolio strategically across the whole corporation. General and R&D managers jointly assess and decide upon the aims, the strategy, the content and the budget of R&D. Technology or R&D strategies are integrated into the business strategies. Targets of R&D are selected by setting fundamental research in a business context and funds are allocated according to short-, medium-, and long-term needs of the business units and the corporation. Centralized and decentralized R&D is coordinated by matrix organization. There is a resource-allocation principle for a strategic balancing between radical and incremental R&D activities. Company C’s R&D approach is shown in the following Table 5-1-1.

<table>
<thead>
<tr>
<th>items</th>
<th>dimensions</th>
<th>1st generation (1990s ~ 1999s)</th>
<th>2nd generation (2000s ~ )</th>
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<tbody>
<tr>
<td>environmental uncertainty</td>
<td>customer</td>
<td>demand competitor’s product, price, process</td>
<td>capacity for duties marketing and products, component and supply costs and general economic</td>
</tr>
<tr>
<td>supply</td>
<td></td>
<td>key components drives by advanced countries</td>
<td>key components shortage in marketing</td>
</tr>
<tr>
<td>technological</td>
<td></td>
<td>combination between computer science and electrical engineering</td>
<td>manufacturing process technology</td>
</tr>
<tr>
<td>investments</td>
<td></td>
<td>upstream and downstream related to notebook technology, equipment procurement from foreign sources</td>
<td>upstream related to display technology, equipment procurement from R&amp;D surveyed supplier.</td>
</tr>
<tr>
<td>production</td>
<td></td>
<td>process engineering</td>
<td>product engineering</td>
</tr>
<tr>
<td>linkage</td>
<td></td>
<td>link to production</td>
<td>link to development</td>
</tr>
<tr>
<td>R&amp;D strategy</td>
<td>Prospector: new ideas in the marketing</td>
<td>Defender: link with customer</td>
<td></td>
</tr>
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</table>

In 2005, Company C announced a proposed restructuring of its mobile communications business, pursuant to which the company will transfer the business of its personal mobile computing and communications division and the related assets and liabilities to C Communication, Inc. One of the most important causes of this interaction problem was the fact that key technologies were systems and therefore require multiple integrated component technologies and complex organizations to implement and manage R&D strategy (examples include factory automation and communication networks). Unfortunately, R&D of company C was shifting away from more radical objectives, which typically required both complex and multidisciplinary R&D. Such R&D was distinctly different from the dominant (in terms of funding) applied R&D. This difference means that the conventional corporate investment decision process does not work well.

The above results arising from technological complexity and its effects on corporate decision making are made worse by shifts in corporate strategy and industry structure in response to growing global competition. As more firms adopt R&D strategies which entail both external technology acquisition and internal technology development, more competitors for mobile communications industries are appearing. This increased competition is good for consumers because it provides a wider range of new products and services. Also, with more companies worldwide investing in technological innovation, the products and services appear sooner.

Since the 1990s, the historical relationship between Taiwan and Japan and the influence of Japanese management style focused on quality manufacturing as a priority. It was one of the competitive advantages of notebook industry in Taiwan. This has built up many high-quality workers with strong know-how. Through the foundation and interaction with companies of U.S., Taiwan’s firms have accumulated a strong capability to allocate capital and gained knowledge as a basis to develop their unique position in notebook industry.
The companies should focus on R&D in order to develop high-quality products. The more quality we focused upon, the higher cost advantage gained. Customers are willing to pay more to get higher quality. As long as the standard of quality increases, firm have more customers and then gain cost advantage. This principle has been the first rule in the Taiwan notebook industry. From the OEM to the C&D (copy and development) and to the ODM, Company C has devoted time and money in R&D to develop high quality products. This gives Taiwan companies experiences that confirmed quality is the most important thing and that R&D is the fundamental to increase quality standards to attract customers.

The structure of the industry is an important factor in determining whether it is appropriate to develop that certain industry in Taiwan. The most important competitive advantage is that “vertically disintegrated” in the notebook industry of Taiwan. In Taiwan, there are independent notebook designing companies, manufacturing companies, assembly companies, and testing companies. Together, they provide a complete spectrum to fill the orders from OBM and other main corporations. It can get every component needed to assemble computers in a very short time. It takes only few hours to ship components to clients. This proximity certainly gives an advantage to speed the process of manufacturing, and definitely increases the efficiency of services.

**Future research and limited**

This research should lead to several propositions. The interaction between the strategic type of the environment uncertainty and the resource profile, which has never been investigated before, will be examined. It will provide an explanation of R&D behavior that relies on both transactional characteristics and intrinsic organizational properties. It will also provide new insights on R&D strategy types.

There are some limits as following: the case company influences because of the prosperous and depressing pressure, cause the running off of the achievement and personnel the goal, cause some unable depth interview with single-hearted devotion, and then influence the course that the experiment gets involved. In addition, the limited to work force is unable to carry on extensive experiment, observation and interview.

**REFERENCES**


