CREATING DISCONTINUOUS INNOVATION: THE CASE OF NINTENDO'S WII

MU SHIFENG

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SUMMARY

An abundant amount of research has discussed the declining performance of well-established companies in the face of discontinuous innovations. As a type of technological innovations, discontinuous innovations destroy the usefulness of existing architectural knowledge and the technical skills of established incumbents who are bounded by traditions, existing technological paradigms, sunk costs, internal political constraints and have difficulties acquiring and applying new knowledge and skills. In order to help established incumbents overcome the difficulties of dealing with discontinuous innovations, several counterexamples are studied. Based on their resources and competencies, it is still possible for established incumbents to either recapture their previous market or technological positions, or remain leaders while confronting discontinuous innovations. These competencies include market competencies, inter-firm collaborative relationships with technology providers, incorporating internal complementary knowledge, learning from unique historical conditions and environment turbulence. However, we still don't know whether established incumbents are able to create discontinuous innovation initiatively.

Based on the literature review, we raised the following research questions.

- How do "inferior-technology" incumbents win over their "superior-technology" competitors through discontinuous innovation?
- What kinds of competencies are needed for established incumbents to create discontinuous innovation when they are technologically inferior to their peers?

An in-depth case in the video game industry is carefully studied to address those questions. Nintendo, a historical player in this industry, successfully shifted its innovation direction along the traditional path and won over its "high-performance" competitors with its new generation game console "Wii", a product of discontinuous innovation. Through the secondary data and patent analysis, we discussed Nintendo's heterogeneous competencies as well as Wii's strengths and weakness in comparison with it competing products, PlayStation 3 and Xbox360. We also extend the comparisons to the previous generations. Based on these discussions, we draw the following conclusions to provide useful suggestions to industry managers and researchers in the area of technological innovation management.

- "Inferior-technology" incumbents can win over their "superior-technology" competitors through discontinuous innovation along secondary features.
- Cooperative competencies, including market competencies, collaborative relations, incorporating internal complementary knowledge, and learning the experiences from unique historical conditions and environment turbulence, are needed for established incumbent to create discontinuous innovation when they are technologically inferior to their peers.

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Chapter 1 Introduction

1.1 Motivation

In 1995 Christensen released his bestselling book *The Innovator's Dilemma* to the world, igniting the now popular discussions about the failure of established incumbents to stay atop their industries when confronted with certain types of market and technological changes. Christensen offers an explanation to the puzzle of why these incumbents who are characterized by good management practices and widely-recognized advanced technological innovation abilities suddenly become inhibitors to other types of technological innovation, commonly known as discontinuous innovation.

Abundant examples in the business world have demonstrated the repeated and intriguing phenomenon of incumbents being beaten by "inferior technology" entrants. Often, the incumbents are beaten by products made from off-the-shelf components rather than those developed by state-of-the-art technologies. Usually, incumbents who focus on the most lucrative customer segmentation lose their market share and profits to late entrants who target latent customers and expanding customer populations. A well-known case is how Apple, then a new start-up in the early 1980s, was able to attack DEC's and HP's minicomputer market with a simpler, lower-performing desktop personal computer. The personal computer, although originally designed to be a toy to be used in the home, changed the perception of computers in the workplace as they had previously been operated only by trained technicians (Christensen 1997). The personal computer market grew rapidly yet was ignored by minicomputer manufacturers. The dominance of established minicomputer manufacturers was soon replaced by new entrants with simple and cheap technologies. Termed 'disruptive technologies' by Christensen, these provide a different technology-product-market paradigm and offer new value appreciated by new customers (Bower and Christensen, 1995). Disruptive technologies make the existing technological paradigms of established incumbents obsolete and bring new experience to customers. According to Veryzer's framework (1998), the innovations are both technologically and commercially discontinuous. Thus, the examples mentioned above can be categorized as one type of discontinuous innovations.

Industrial examples have inspired much broad and in-depth research from academia. Various studies have been conducted to investigate the declining performance of well-established companies in the face of discontinuous innovation. Discontinuous innovations destroy established incumbents' competencies in product and process improvement, thereby increasing environment turbulence (Tushman & Anderson, 1986). They also destroy the usefulness of the existing architectural knowledge and technical skills of established incumbents who find it difficult to acquire and apply new knowledge and skills (Henderson & Clark, 1990). Path dependency simultaneously enhances and inhibits innovation, especially for established incumbents (Leonard-Barton, 1992). When the paradigm changes, it is difficult for established companies to recognize the shifts and acquire new knowledge to adapt to the new environment due to their traditional bounds, existing technological paradigms, sunk costs and internal political constraints (Tilton, 1971; Hannan and Freeman, 1977). By contrast, new entrants to the industry who tend to be smaller in size, have shorter (path-dependent) histories and fewer commitments to the old value networks, are better suited to developing and commercializing emerging technologies (Astley, 1985; Abernathy and Clark, 1985). Discontinuous innovation is regarded as an effective means for new entrants to overcome their weakness in existing technology paradigm (Tilton, 1971; Hannan and Freeman, 1977; Abernathy and Utterback, 1978; Henderson & Clark, 1990; Christensen, 1997).

However, another group of scholars reveal several counterexamples which demonstrate that established incumbents are still capable of recapturing their previous market or technological positions and remaining leaders while discontinuous innovations occur (Ahuja and Lampert, 2001; D Methe, Swaminathan, Mitchell and Toyama, 1997; Rosenbloom and Christensen, 1998; Rothaermel, 2001). Based on the previous literature, various competencies have been proposed for incumbents' continued leadership in face of discontinuous innovation: persistent market competencies of shedding unique insights about customer needs or identifying new markets (Abernathy and Clark, 1985), inter-firm collaborative relationships with technology providers (Mitchell and Singh, 1996, and Rothaermel, 2001), incorporating internal complementary knowledge (Tripsas, 1997) and learning from unique historical conditions and environment turbulence (Barney, 1991; Hill, 2003).

However, it has never been addressed whether established incumbents can take an initiative in discontinuous innovation. After incumbents have acquired how to respond to and defeat the attacks of discontinuous innovation, it is more important that they can adopt it as a competitive strategy initiatively and effectively, especially for those "inferior-technology", who are relatively weaker than their competitors in terms of technology development. Established incumbents have successfully pursued the path of continuous innovation for long time, and the recent industry history suggests that "in a competitive technology-intensive global market, advantages are built and renewed through the more discontinuous form of innovation" (Lynn, Morone and Paulson, 1996, pp10). We aimed to find out whether discontinuous innovation can serve as an effective strategy for established incumbents among the technology-intensive competition, and whether the competencies (e.g. market competencies, inter-firm collaborative relationships, incorporating internal complementary knowledge and learning from unique historical conditions and environment turbulence) that help incumbents successfully adapt to discontinuous innovation can become active drivers stimulating the adoption of this strategy.

As for technology-intensive competition among established incumbents, company competencies and capabilities have been regarded as a black box for a long time. Although technological competencies represent an important advantage in technologically competitive markets (e.g. Carey, 1992; Nelson, 1991), not all firms with advanced technological competencies have super performances (Teece, 1986; Teece, Pisano and Shuen, 1997). To open this black box in the broadest sense and help "inferior-technology" incumbents overcome their weaknesses in technological competencies, we try to address our research questions from a resource-based view.

1.2 Research Objectives

Inspired by the limitations of the studies in dynamics between established incumbents and discontinuous innovation that were discussed above, we looked at and screened existing industrial events as our research object. A living case that fits with our interest in the dynamics of discontinuous innovation and established incumbents is the video game console industry. Over the past two decades, the video game industry has grown into a respected entertainment medium with annual sales rivaling box office receipts for the movie industry. Nintendo, as a historical player in this industry, successfully shifts its innovation direction along the traditional path. Most recently, Nintendo won over its "high-performance" competitors with the new generation game console "Wii", a product fitting the category of discontinuous innovation.

The video game industry, especially the U.S, is often cited as an example of network effect and radical technological innovation (Schilling, 2003, Gallagher & Park, 2002, Clements & Ohashi, 2005, Shankar & Bayus, 2003). However, after Sony replaced Nintendo as the dominant player and the software giant Microsoft entered the market, product standards seem to be instituted. Now, with its new generation machine "Wii", Nintendo is trying to reclaim its place as the benchmark in video gaming and redefine the boundary of mainstream customers, making it a valuable case for discontinuous innovation research.

Based on industry observations and a literature review, we raise the research questions of how "inferior-technology" incumbents win over their "superior-technology" competitors through discontinuous innovation, and what kind of competencies are needed for established incumbents to create discontinuous innovations when they are technologically inferior to their peers. We try to address these questions through an in-depth case study and empirical analysis of Nintendo's Wii. The research focus centres on an analysis of the product development process in discontinuous innovation, as well as the company-specific competencies that can compensate for weakness in technology development, thereby stimulating the creation of discontinuous innovation. This study is neither an attempt to generalize how established companies take initiatives to create discontinuous innovation nor an offering of normative prescriptions (Hill and Rothaermel, 2003). Our research objective is:

- To identify the ways in which incumbents are able to initiate discontinuous innovation when they are technologically inferior to their peers from a resource-based view.

1.3 Thesis Structure

The remainder of this thesis is organized as follows.

Chapter 2: Literature Review

This chapter mainly reviews the literature on technological innovation management. It covers the definition of technology and technological innovation, classifications of technological innovation and the varied performance in front of different types of technological innovation for established incumbents and new entrants, e.g. incremental innovations, radical innovations, disruptive innovations. It is followed by an extensive review of the literature relating to incumbents' survival in the face of discontinuous innovation. Those strategies then guide our research focus to company-specific competencies. We regard the competencies as heterogeneous company-specific resources, accumulated through an idiosyncratic history and difficult for competitors and followers to emulate. This assumption leads us to further review the theories relating to company competency from a resource-based view. This chapter is concluded by offering a couple research questions based on the literature review that was conducted.

Chapter 3: Research Methodology

The literature review chapter is followed by a research methodology chapter which explains the reasons why we adopted a single case study as our research method rather than any other research strategy. The case study is a primary candidate for research on discontinuous innovation because such work can provide critical insights and also lay a foundation for further research (Veryzer, 1998). According to Yin (2003), case studies are suitable for answering who, why, how and what questions, while the data is principally collected from interviews, expressed both verbally and literally. A careful study of a single case may lead researchers to see new theoretical relationships. This fits well with our research objective of unraveling the process through which established incumbents initiatively create discontinuous innovations.

Chapter 4: Data and Analysis

In the next chapter an in-depth case study of Nintendo and its latest game console Wii is presented. This illustrates how a discontinuous innovation is initiatively created by an established company, helping the historical player with inferior technological competencies win back its predominance within the industry. Although Nintendo has been in the shadow of its superior-technology competitors for a number of years and the future of the industry is uncertain, the achievement Nintendo has gained so far and the significant changes it brings to the whole video game industry is undoubted. This chapter describes how we collect data from diverse sources, e.g. magazines, newspapers, company official websites and established electronic game websites. Data collection and analysis are divided into three parts: the industry level, company level and product level.

Chapter 5: Discussion

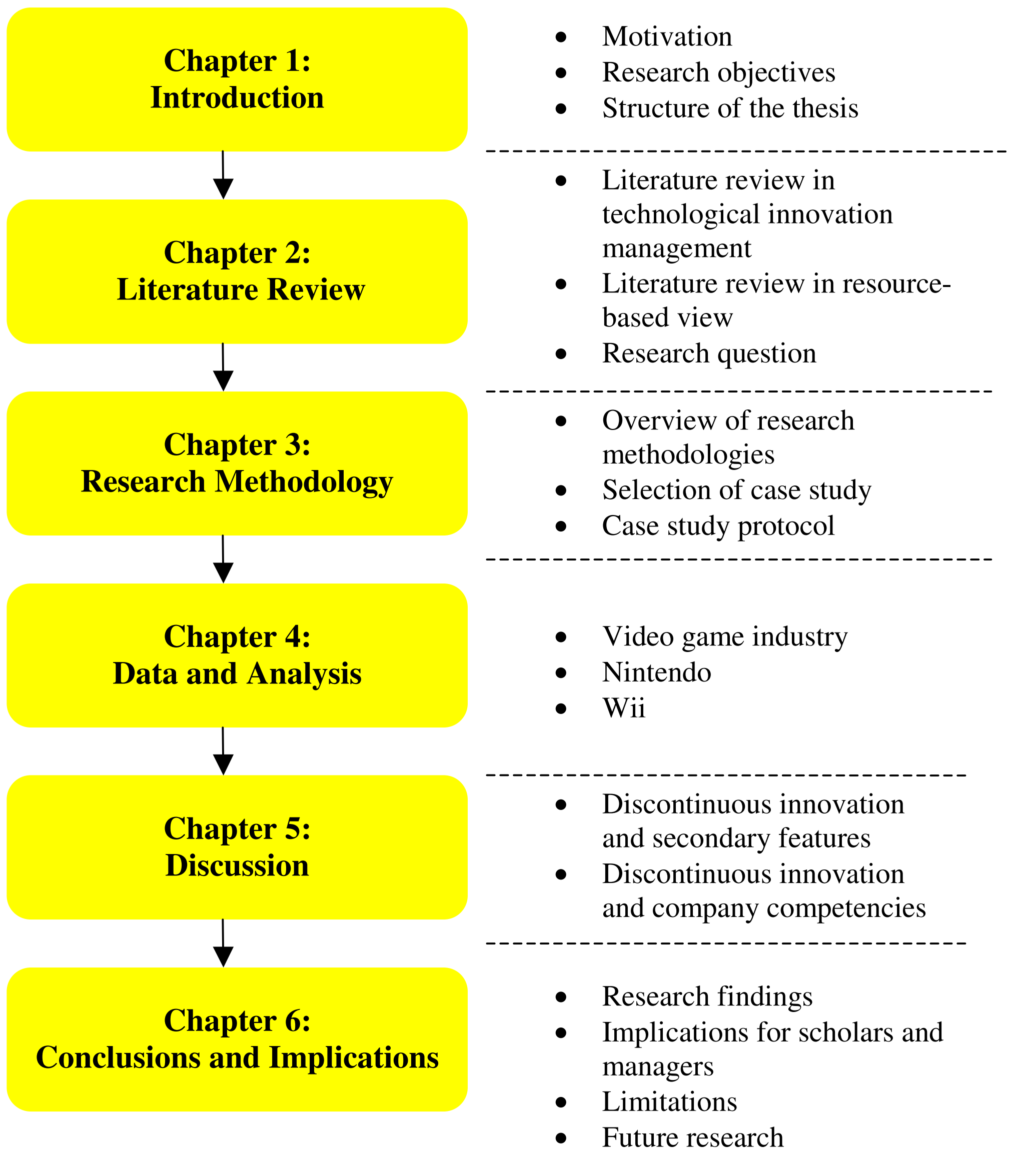
In the subsequent chapter we draw out our analytical discussions and conclusions. The research questions are addressed and the research findings are presented according to the data collected and the analysis conducted previously.

Chapter 6: Conclusions and Implications

We end the whole work with summaries of our research findings as well as their implications for scholars and managers. The implication for established comapnies include how to overcome the difficulties of inferior R&D abilities and technological competencies, how to initiate discontinuous innovation, how to develop new products and create non-existing markets despite traditions, existing technological paradigms, sunk costs, and resource constraints. Finally, we discuss the limitations of this study and the future research it may bring forward.

The flow of our research and the basic structure described above are illustrated in Figure 1.1

Figure 1.1: Structure of the thesis



Chapter 2 Literature Review

2.1 Introduction

In order to study the new linkage between established incumbents and discontinuous innovation, we first conducted a review of the technological innovation management literature to give us an overview of the research in this area and identify unresolved problems. The introduction to technological innovation management begins with definitions and classification and is then followed by a description of various company performances in the face of different types of innovations. Technological innovations are categorized as continuous innovations or discontinuous innovations. Since our focus is on discontinuous innovation, we have dedicated specific sections to describing the association between discontinuous innovation and disruptive technology, as well as established incumbents' declining performances in face of discontinuous innovations. After briefly explaining how and why established companies always face greater difficulties in adjusting to discontinuous innovations, we expand the view with some counterexamples describing how incumbents can recapture their technological and market dominance in spite of discontinuous innovations introduced by new entrants. Since the strategies proposed for incumbents who face discontinuous innovations can be analyzed through companies' heterogeneous competency and resource sets which are accumulated through their idiosyncratic history and difficult for competitors and followers to emulate, the literature relating to the resource-based view is reviewed. This chapter ends by identifying the research gap and proposing research questions formulated after the literature reviews.

The main sources of our literature are leading technology and management journals. They include the Academy of Management Review, Administrative Science Quarterly, IEEE Transactions on Engineering Management, International Journal of Technology Management, Journal of Product Innovation Management, Strategic Management Journal, R&D Management and Research Policy as well as the Harvard Business Review and Sloan Management Review. In addition, we reviewed some textbooks to obtain a comprehensive understanding of technological innovation management. The textbooks included *Strategic Management of Technological Innovation* by Schilling (2005) and, in order to be familiar with popular ideas among practitioners, some bestselling books. These best sellers included Moore (1999)'s *Crossing the Chasm: Marketing and Selling High-Tech Products to Mainstream Customers* and *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail* from Christensen (1997). These sources allowed us to learn classic and new theories as well as principles and tools to enrich our understanding of technological innovation management and build a preliminary structure to address the research questions.

2.2 Technological Innovation Management

2.2.1 Introduction

Technology is defined as the practical application of knowledge, especially in a particular area, or a capability created by the practical application of knowledge (Greisler and Stupak, 2006). It can be divided into process technology, referring to the tools, devices and knowledge that mediate the process of converting input to output, and product technology, which creates new things, either tangible products or intangible services (Rosenberg, 1972). Technology usually refers to a cluster of technologies that, when applied in a specific area, determine the particular problems, procedures and tasks. This technological cluster is also called a "technological paradigm". This is analogous with "scientific paradigm" which refers to "a model and a pattern of solution of selected technological problems, based on selected principles derived from natural sciences and on the selected material technologies" (Dosi, 1982, pp 152).

Innovation can be stimulated by changes in technology or the technological paradigm (Abernathy and Clark, 1985), either driven by technological genius (Taton, 1958; Schumpeter, 1961) or a function of economic demand and growth (Schmookier, 1966; Merton, 1968). We refer to this technological innovation as the "act of introducing a new device, method or material for application to commercial or practical objectives." Studies show that firms consider technological innovation to be their most important driver of competitive success (Schilling, 2005). During the 1950s and 1960s, technology was recognized as the primary driver of technological innovation. Numerous models have been constructed to describe the innovation process for activities like invention or technology improvement, commercialization an invention or technology by a set of engineering and manufacturing activities and delivering the final product to its customers or end-users by intensive marketing. Later on, clearly identifying customer needs was recognized to be increasingly influential on the success of a technological innovation. Researchers within an organization develop technology in efforts to meet changing customer needs. Rather than restricting discussions to whether technological innovation is driven by technology or market, the studies in technological innovation are expanding to other domains. Scholars and managers are racing to develop a better understanding of technological innovation. A wide range of work on this topic has emerged and flourished, such as the classification of different types of technological innovation (e.g. Tushman and Anderson, 1986; Henderson and Clark, 1990), strategic management of technological innovation process (e.g. Teece, Pisano, and Shuen, 1997), organization theory (e.g. Daft, 1978; Miller and Friesen, 1982), economics (e.g. Rosenberg, 1982) and sociology (e.g. Gopalakrishnan and Damanpour, 1997).

The flourishing research in technological innovation management had led to numerous works on how to measure the different degrees and directions of the radicalness of an innovation. In reviewing the literature, various bases have been used. There are many innovations falling into this continuum from "improving and refining" at one end to "disrupting, destroying and making obsolete" at the other end, as well as all points in between (Abernathy and Clark, 1985). From an incumbent's perspective, technological innovation can be divided into two categories. One is commonly used by incumbents to entrench their predominant market position, including introducing changes to the existing product, building improvement on existing know-how, and exploiting the potential of the established paradigm. Established companies usually enjoy advantages in this type of innovation under the names of incremental innovations (Nelson and Winter, 1982; Ettlie, Bridges, and O'Keefe, 1984; Dewar and Dutton, 1986; Tushman and Anderson, 1986), competency-enhancing innovations (Tushman and Anderson, 1986), modular innovations (Henderson and Clark, 1990) or technological evolutions (Ehrnberg, 1995). Contrarily, the other type of technological innovation is usually favored by new entrants, resulting in declining performances among incumbents. Because it is based on new sets of engineering and scientific paradigms and requires new skills and knowledge to operate, the new technologies are fundamentally different from the existing paradigms (Olleros, 1986; Hamilton and Singh, 1992). Radical innovations (Dess and Beard, 1984; Ettlie, Bridges, and O'Keefe, 1984; Dewar and Dutton, 1986; Utterback and Kim, 1986), architecture innovations (Henderson and Clark, 1990), competency-destroying innovations (Tushman and Anderson, 1986) and technological revolutions (Ehrnberg, 1995) fall into this category.

To unify the terminologies used later in this thesis, we use "continuous" and "discontinuous" to differentiate these two types of technological innovations (Robertson, 1967; Anderson and Tushman, 1990; Kotabe and Swan, 1995; Veryzer, 1998; Ding and Peters, 2000). Discontinuous innovation is regarded as an effective solution for new entrants to overcome their weakness in the existing technology paradigm and defend their existence in the industry.

Discontinuous/continuous innovations can also be linked with technology and market when they are defined as the major drivers of technological innovation. Four different strategies for new entrants and established incumbents can be generated from these linkages. They are continuous innovation/market-pull strategies, continuous innovation/technology-push strategies, discontinuous innovation/market-pull strategies and discontinuous innovation/technology-push strategies (Walsh, Kirchhoff, and Newber, 2002). Continuous innovation is linked to the outcomes of evolutionary technology while discontinuous innovation is defined as evolving from disruptive technology. Based on a survey conducted in the MEMS (Microsystems technologies or Micro Machined Technologies) industry, Walsh, Kirchhoff and Newber concluded that whether driven by technology or market, established incumbents had their advantages in creating continuous innovations due to strong marketing groups, solid customer relationships and reliable suppliers along the established supply chain. They are always targeting existing customers, either providing them with superior substitutes for existing products that offer cost saving and/or quality advantages or educating them to use a new product whose technological base is similar to an existing product. On the other hand, for new entrants, especially those creating discontinuous innovation, the commercialization process is risky, costly and requires an uncertain time period. Therefore, they are encouraged to develop market competencies which can help them identify potential customers in multiple industries and, finally, to modify their technology so it can improve or replace the existing products of established competitors.

2.2.2 Discontinuous innovation and disruptive technology

"In a competitive technology-intensive global market, advantages are built and renewed through the more discontinuous form of innovation." (Lynn, Morone and Paulson, 1996, pp10) Discontinuous innovations are no longer the exclusive weapon of new entrants. The dynamics between discontinuous innovations and established incumbents greatly inspire researchers' and managers' interests. Before we go deeply into this relationship, we will first try to achieve a better understanding about discontinuous innovation and the related disruptive technology, which we define as an important form of discontinuous innovation.

Discontinuity may occur in technology or customer utility, or both. Based on Veryzer's work (1998), we adopt the matrix shown in Figure 2.1 as our analytical tool for classifying innovation. Two critical dimensions, the technological capability and commercial capability, are used to delineate the various levels or degrees of change in a product. The technological capability dimension refers to the degree that a product involves expanding technologies which determine the way product functions are performed (Veryzer, 1998). Technological discontinuities take place when a new capability appears that is beyond the existing boundaries and cannot be achieved by the extension of companies' existing technologies. The commercial capability dimension describes the benefits of the product as perceived and experienced by the customer or user. Commercial discontinuity can result in changes to existing customers regarding the way a product is perceived and used. Alternatively, it can create a completely new market where those who were previously interested in this product become profitable customers.

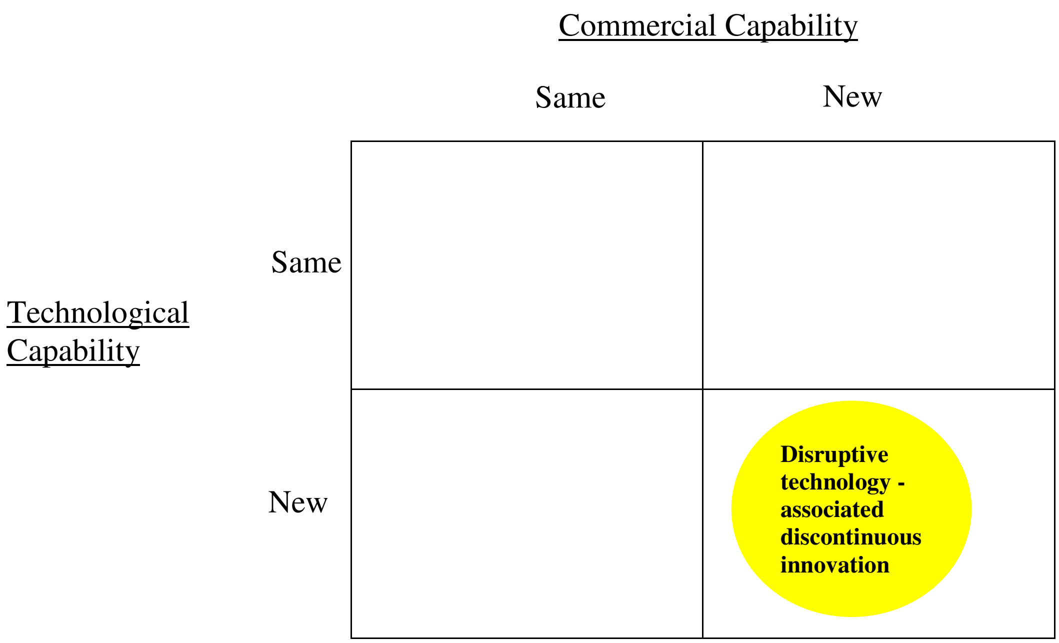
Figure 2.1 Types of technological innovation

Technological Capability \ Commercial Capability	Same	New
Same	Continuous	Commercially Discontinuous
New	Technologically Discontinuous	Technologically and Commercially Discontinuous

Source: Veryzer, 1998

Discontinuous innovations are usually associated with disruptive technologies (Walsh and Linton, 2000). A variety of perspectives have emerged on the definitions of discontinuous innovation and disruptive technologies, and no single view is widely accepted (Carroad and Carroad, 1982; Meyers and Tucker, 1989; Mckee, 1992; Bower and Christensen, 1995; Ehrenberg, 1995; Walsh, 1996; Veryzer, 1998; Moore, 1999). Disruptive technology provides a technology-product-market paradigm (Bower and Christensen, 1995) that differs from established incumbents' existing technological trajectories, the rate and direction of technology improvements, diffusion and other aspects (Schilling, 2005). Disruptive technology offers new value to new customers for new application, which often has lower margin opportunities and is unappreciated by established incumbents' existing customers (Christensen, 1997). The new technology and new application result in both technologically and commercially discontinuous innovation. According to Veryzer's framework (1998) that we adopted earlier, we claim that innovation based on disruptive technologies is one important type of discontinuous innovation, as shown in Figure 2.2.

Figure 2.2 Relationship between discontinuous innovation and disruptive technology



Christensen coined the term "disruptive technology", (Bower and Christensen 1995) based on the concept of creative destruction (Schumpeter, 1942). This term was needed in order to address the consistent but interesting business pattern that companies who stay atop their industries always suffer when confronted with certain types of market and technological changes. It has been emphasized that this pattern is not about the failure of simply any company, but rather of good companies whose management practices and innovation abilities are greatly admired and emulated by their industry peers. This pattern is essentially in line with what we discussed regarding the characteristics of discontinuous innovation.

Christensen didn't provide a clear-cut definition of disruptive technology, but explained it as "typically simpler, cheaper, and more reliable and convenient than established technologies" (Christensen, 1997, pp 190). Different definitions of disruptive technology have emerged since Christensen published his best-seller *The Innovator's Dilemma* in 1997. Kassicieh (2002) describes disruptive technologies as scientific discoveries that possess a disruptive power to disturb or destroy common product or technology capabilities by providing a new competitive technological paradigm. In Erwin Danneels' 2004 work *Disruptive Technology Reconsidered: a Critique and Research Agenda*, he concluded that the core nature of disruptive technology is to change the basis of competition by changing the technology/product performance metrics along which firms compete. Govindarajan and Kopalle (2006) proposed that disruptive technology-related innovations are the introduction of a different set of features, performances and price attributes relative to the existing product that, although they are unattractive to mainstream customers, they may be valued by a different customer segment. They expand the discussion of disruptive technology-related innovation to include high-end technologies with a higher price, which are also unacceptable in the mainstream market. Schmidt (2004) establishes a model to predict the moment of disruption. Two parameters of this model are the traditional attributes of the product, which overshoot the market demand, and the secondary attributes, which are under-served. Disruptive technology successfully satisfies the requirements of the secondary attributes while sacrificing traditional performances. When the performances of the traditional set improve over time and finally move up to the mainstream market, disruption occurs. Other scholars attribute the emergence of disruption to decreasing marginal utility to existing needs and the newly appreciated marginal utility to latent needs (Adner, 2002; Paap and Katz, 2004). This perspective relies on how customers evaluate technology and how this evaluation may change. Exploring the latent needs of current customers and the needs of future customers means not just emphasizing what customers ask for, but focusing on what they really need. These latent needs may not even be realized by customers themselves and they can change over time, as the environment they live in also changes. It has been argued for a long time that listening too much to existing customers may restrict the innovation progress along the existing technological trajectories, therefore reducing the chance of making a substantial breakthrough (Slater and Narver, 1998; Chandy and Tellis, 1998; Day, 1999).

According to different forms of disruption, Christensen categorized disruptive technologies into two types. They are "low-end disruptions", cheaper and simpler with an inferior performance, and "new-market disruptions", which he described as an "innovation that enables a larger population of people who previously lacked the money or skill now to begin buying and using a product" (Christensen and Raynor, 2003, pp 102). The view of disruptive technologies has been expanded and the types of disruption have bee re-categorized by other researchers. For example, Utterback and Acee (2005) have drawn a map of possible competitive advantages due to technological changes using the three parameters "cost, traditional performance, and ancillary performance" derived from disruptive theory. Similarly, in their recent work published by the *Journal of Product Innovation Management*, Schmidt and Druehl (2008) offer new terminology and a framework to differentiate different types of disruptions. Focusing on diffusion types, they divide "new-market disruptions" into "fringe-market low-end encroachment" where customer preferences are incrementally different from those on the low end of the current market, and "detached-market low-end encroachment", where the customer preferences are dramatically different from those on the low-end of current market. In the same fashion, the substitute for "low-end disruptions" is "immediate low-end encroachment", where encroachment starts immediately in the low end of the current market.

Research in disruptive technology has brought forward a common pattern characterized by providing new features that are favored by a few new and uncompetitive markets but, at the same time, neglected by the dominant customers who always value improvement along the mainstream dimensions. Based on the literature review of disruptive technology, product attributes are basically analyzed from two dimensions: one representing traditional performance, appreciated by existing customers, and the other representing ancillary features, unvalued by existing customers. Different phrases are used to describe these two dimensions: "traditional attributes and secondary attributes" Schmidt (2004); "traditional performance and ancillary performance" (Utterback and Acee 2005); and "mainstream dimensions and niche dimensions" (Adner, 2002; Govindarajan and Kopalle, 2006; Tellis, 2006). However, no specific, concrete definitions are provided and most of the terminologies are based on the customer's perspective rather than the product's.

2.2.3 Discontinuous Innovation and Established Incumbents

In the flood of continuous and discontinuous innovations, performances from well-established incumbents and new entrants vary due to their different company-specific resources and competency sets. Numerous studies have been done and significant progress has been achieved on how and why established companies always face greater difficulties in adjusting to discontinuous innovations (e.g. Abernathy and Utterback, 1978; Henderson and Clark, 1990; Tushman and Anderson, 1986; Anderson and Tushman, 1990; Leonard-Barton, 1992; Christensen and Rosenbloom, 1995; Christensen, 1997). Established companies have well-developed systems for supporting ideas to invest in technologies, or the embodiment of these technologies, along the direction that their existing customers appreciate; killing these divert from traditional technological paradigms and existing customers' preferences (Henderson & Clark, 1990). Path dependency simultaneously enhances and inhibits innovation, especially for established incumbents (Leonard-Barton, 1992). When the paradigm changes, it is difficult for established companies, who are bounded by traditions, existing technological paths, sunk costs and internal political constraints, to recognize the shifts and acquire new knowledge to adapt to the increased uncertainty and environment turbulence (Tilton, 1971; Hannan and Freeman, 1977; Tushman and Anderson, 1986). Discontinuous innovations may disrupt the usefulness of the original infrastructure, information filters, communication channels and information-processing structures that embody old architectural knowledge, thereby eliminating the advantages that established companies have over new entrants (Astley, 1985; Abernathy and Clark, 1985). Meanwhile, new entrants regard this kind of change as a new opportunity to open up new markets or potential applications. With a smaller size, shorter (path-dependent) histories and fewer commitments to the old value networks, new entrants are better suited to develop and commercialize emerging technologies and are able to enter previously impenetrable markets by exploiting these fundamentally different skills (Tilton, 1971; Hannan and Freeman, 1977; Astley, 1985; Abernathy and Clark, 1985; Henderson and Clark, 1990; Christensen, 1997).

Tushman and Anderson (1986) used longitudinal data from three diverse industries (airlines, cement and minicomputers) to test their proposition that technology evolves through periods of incremental change punctuated by technological breakthroughs (either competencies-enhancing discontinuity or competencies-destroying discontinuity). Innovations which significantly advance the technological frontier through new and competency-destroying knowledge or skills are more likely to be initiated by new entrants. In contrast, the liabilities of age and tradition plague established incumbents when confronting competency-destroying innovations. The most vivid examples took place in the minicomputer industry. When the technology evolved from vacuum tubes and transistors to integrated circuits and semiconductor memory, "only the few firms explicitly founded to make minicomputers were able to make the transition. By 1965, almost every firm that produced early minicomputers had exited the product class." (Tushman and Anderson, 1986, pp461) Although different terminologies have been adopted, in our analysis, competency-destroying innovation falls into the category of discontinuous innovation, as it is appreciated by new entrants rather than established incumbents.

Christensen's two bestselling books, "*The Innovator's Dilemma*" and "*The Innovator's Solution*", mention many well-known examples of established incumbents' failures when faced with discontinuous innovation. In the hard disk drive industry, where Christensen did a longitudinal in-depth study over a 17-year history, this pattern consistently repeated itself: new entrants like Shugart Associates, Micropolis, Priam and Quantum introduced 8-inch drives and invaded the market previously dominated by 14-inch drives; Seagate Technology pioneered the new application of 5.35-inch disk drives and wiped 8-inch drives out of the minicomputer market; Rodime, a Scottish entrant, developed the 3.5-inch drive which grew strongly competitive in the emerging portable computer market and attacked the mainstream 5.35-inch market; and most recently, new entrants like Longmont, Colorado and Prairietek announced the arrival of 2.5-inch drives. Similarly, there are several good examples from other industries. In telecommunications, Cisco, a new entrant with packet-switching technology, disrupted the industry leaders such as Lucent, Siemens and Nortel who were using circuit-switching technology. In the steel milling industry, mini-mills successfully attacked the established integrated steel companies. In the mechanical excavators industry, new entrants with hydraulic excavators took over the general excavation contracting market. In the photocopier market, Canon and Ricoh introduced low-speed, poor-resolution desktop photocopiers to compete with market leader Xerox's high-speed machine. Finally, in the electronics industry, large TV and radio manufacturers pushed vacuum tube technology as their dominate design for its high sound fidelity, but Sony captured their dominance with low sound fidelity transistor technology (Christensen and Raynor, 2003). To sum up, all of these industrial examples illustrate established incumbents' declining performance when confronted by innovations caused by disruptive technology. In our analysis, these innovations are important types of discontinuous innovations.

2.2.4 Expanded View of Discontinuous Innovation and Established Incumbents

Several counterexamples do exist that demonstrate how established companies are still capable of either recapturing their previous market or technological position or remaining industry leaders while discontinuous innovations occur (Ahuja and Lampert, 2001; Methe, Swaminathan, Mitchell and Toyama, 1997; Tripsas, 1997; Rosenbloom and Christensen, 1998; Rothaermel, 2001).

Most of these examples take different organizational strategies or approaches, either splitting up an autonomous unit to develop new processes and values within it or creating an independent organization whose processes and technologies are a close match with the new value network through acquisition (Christensen, 1997). Macher (2004) has illustrated these organizational approaches with three empirical studies in the telecommunications, computing and imaging industries. Motorola, IBM and Kodak, each one the established incumbent in their industry, were able to gain profits from disruptive technologies in emerging markets either through either internal ventures or joint ventures. These autonomous actions imply the importance of open culture, a robust internal ecology and organic organizational structures (Burgelman, 1994), which are more likely to be accumulated from experiences in instable environments (Burns & Stalker, 1961). Earlier in their work, Barney (1991) and Hill and Rothaermel (2003) mentioned the importance of experience through unique historical events and environment turbulence. Therefore, learning lessons from unique historical conditions and environment turbulence is a crucial type of competency in order for incumbents to sustain competitive performance in the face of discontinuous innovation.

Several researchers (e.g. Peters, 1996; Tripsas, 1997) have argued that cooperation between established companies and new entrants is an important mechanism for incumbents to adapt to discontinuous technological change through the combination of the new entrants' competencies in exploring new technologies and the established incumbents' competencies in exploiting complementary assets, e.g. specialized manufacturing capability, access to distribution channels, service networks and complementary technologies (Peters, 1996; Tripsas, 1997). Strategic alliances between incumbents and new entrants can be established to fulfill incumbents' specific knowledge and skill requirements for divergent technologies and discontinuous product development (Ding and Peters, 2000). In order to gain the competencies that lay beyond incumbents' existing boundaries and experiences, they embark on "short-term relationships, or dalliances, with new and unfamiliar suppliers" (Phillips, Lamming, Bessant and Noke, 2006). Phillips, Lamming, Bessant and Noke (2006) drew this conclusion based on their work on supplier relationships and discontinuous innovation, as well as from a 15-month empirical study of UK companies from a variety of business sectors. While new and small entrants provide emerging technologies in these technical alliances, incumbents provide their complementary assets to facilitate the commercialization process (Tripsas, 1997; Rothaermel, 2001). Regardless whether the technological innovation is continuous or discontinuous in nature, incumbents' ownership of complementary assets can benefit the manufacturing and marketing process (Teece, 1986). For example, unique insights about customer needs and the application of technologies are usually accrued through unique historical events experienced by incumbents. When the technologies are generally available, the key technique lies in grabbing new market opportunities (Abernathy and Clark, 1985). Through their studies of biotechnology and typesetter industries, Tripsas (1997) and Rothaermel (2001) provided concrete evidence that incumbents' exploitation of complementary assets can prevent them from suffering due to an inferior technology position. Therefore, the competencies of inter-firm collaboration, marketing and incorporating internal complementary knowledge play critical roles in incumbents' survival in the face of discontinuous innovation.

Apart from autonomous organizational entities and collaborative relations, some scholars try to break the paradox of "capability-rigidity" (Leonard-Barton, 1992) by experimenting with and intimating technologies that companies lack prior experience in, have newly developed or cannot achieve by simply extending their existing technologies (Ahuja and Lampert, 2001). Developing technological competencies in multiple directions may be critical for incumbents to create discontinuous innovation. However, the process of how to support and mold efforts to this kind of technological competency is still regarded as a black-box (Teece, 1997; Eisenhardt, 2000; Nelson and Nelson, 2002).

Based on the previous literature, we have identified several competencies from the proposed strategies for incumbents' survival in the face of discontinuous innovation. These competencies include persistent market competencies of shedding unique insights about customer needs or identifying a new market (Abernathy and Clark, 1985), inter-firm collaborative relationships with technology providers (Mitchell and Singh, 1996, and Rothaermel, 2001), incorporating internal complementary knowledge (Tripsas, 1997), learning from unique historical conditions and environment turbulence (Barney, 1991; Hill, 2003) and developing diversified technologies (Ahuja and Lampert, 2001).

2.3 Company Competency: A Resource-Based View

We regard these competencies as the companies' heterogeneous resources that have been accumulated through their idiosyncratic history and difficult for others to emulate, which exactly fits the assumptions of the theory of a resource-based view. Therefore, analyzing the company-specific competencies from a resource-based view is appropriate and may shed unexpected light on how incumbents deal with discontinuous innovations.

2.3.1 A Resource-Based View

From the firm's perspective, resources and products are two sides of the same coin and this is reflected in the literature on strategic management. The traditional concept of strategy is actually resource-based, phrased as strength or a weakness (Andrews, 1971). Unlike the analysis of a product or the external competitive environment, the analysis of the impact of idiosyncratic firm attributes on a firm's competitive position relies on two specific assumptions. First, it assumes that firms within an industry are heterogeneous in terms of the strategic resources they control. Second, it assumes that these resources are not perfectly mobile across firms, thus heterogeneity can be long-lasting (Barney, 1991). Throughout history, firms have accumulated their unique resource sets and different intangible organizational assets. These assets, which result from unique historical conditions, are ambiguous and socially complex. (Tyler, 2001)

Firm resources, in the language of traditional strategic analysis, are equivalent to firm strengths which can be used to conceive of and implement strategies (Learned, Christensen, Andrews and Guth, 1969; Porter, 1981). The idea of looking at a firm as a set of broader resources, beyond the confined boundaries of labor, capital and land, goes back to the seminal work of Penrose (1959). Yet, due to its unpleasant properties for modeling purposes, little formal attention has been paid to those works with the exception of Rubin (1973). A more comprehensive concept proposed by Daft (1983), defines firm resources as all assets, capabilities, organizational processes, information, knowledge, firm attributes, etc. controlled by a firm. There are numerous possible firm resources: brand name, in-house knowledge of technology, employment of skillful personnel, trade contact, machinery, efficient procedure, capital and so on (Wernerfelt, 1984).

The heterogeneity of capabilities and resources in a population of firms is one of the cornerstones of resource-based theory (Peteraf, 1993; Hoopes, Madsen, and Walker, 2003). Since Barney (1986a, 1986b, 1991) and Wernerfelt (1984) published their original papers on the resource-based view, and Teece (1997), later on, proposed his dynamic capability theory to supplement the resource-based view on a dynamic premise, a distinction between resources and capability has emerged. "A resource is identified as an observable (but not necessarily tangible) asset that can be valued and traded, such as a brand, a patent, a parcel of land, or a license. A capability, on the other hand, is not observable (and hence necessarily intangible) and cannot be valued and traded." (Hoopes, Madsen and Walker, 2003, pp890) Based on Teece's (1997) definition, capability represents a firm's ability to integrate, build and reconfigure internal and external competences to address rapidly changing environments. Herein, our focus is not on the dynamic process by which resources are developed and adjusted in order to sustain a competitive advantage in a changing environment. Rather, we use capabilities to represent all assets and resources at the company level. Tyler (2001) differentiated competency from capability by defining it as the resources and assets surpassing those of most competing companies, a subset of capability. Also, in order not to confuse readers about the analysis of company level and product level, we respectively use competency for company and capability for product.

2.3.2 Classification of Company Competencies

Most of the competencies mentioned above that help incumbents successfully survive when faced with discontinuous innovations, e.g. market competencies, inter-firm collaborative relationships, incorporating internal complementary knowledge and learning from unique historical conditions and environment turbulence, are a subset of the organizational and strategic routines embedded in the organization (Eisenhardt, 2000). These routines refer to a firm's abilities to integrate, coordinate or synthesize internal and external resources. In contrast, developing diversified technologies is categorized as a technological competency, mainly defined as the in-house knowledge of technology. Although technological competencies represent an important source of competitive advantage in technologically competitive markets (Hofer and Schendel, 1978; Wernerfelt, 1984; Carey, 1992; Nelson, 1991), not all firms with advanced technological competencies have super performances (Teece, 1986; Teece, Pisano and Shuen, 1997), and cultivating a competitive advantage doesn't necessarily mean outspending rivals on R&D (Prahalad, and Hamel, 1990).

The competencies needed to integrate, coordinate or synthesize internal and external resources are increasingly being used by academics to explain the differences in competitive advantage and performance between firms (e.g. Jones and George, 1998).

Similar ideas can be seen in the work of Kogut and Zander (1992). They use the term "combinative capabilities" to describe firm's capabilities which "rest in the organizing principles by which relationships among individuals, within and between groups, and among organizations are structured" (Kogut and Zander, 1992, pp384). Nelson and Sampat (2001) have developed another mechanism to differentiate between organizational and strategic routines and in-house technological know-how. The former one is called "social technology", also known as "institutions", and represents the mode of coordination, while the latter competency is labeled "physical technology". Herein, we adopt the terminology "cooperative competencies", coined by Tyler (2001), to relate to successful cooperation within and between firms thus allowing them to fully exploit their technical competencies.

In particular, of the competencies discussed in the above section on the "expanded view of established incumbents and discontinuous innovation", market competencies (Abernathy and Clark, 1985), inter-firm collaborative relationships with technology providers (Mitchell and Singh, 1996, and Rothaermel, 2001), incorporating internal complementary knowledge (Tripsas, 1997) and learning from unique historical conditions and environment turbulence (Barney, 1991; Hill, 2003) can be grouped into the category of cooperative competencies while developing diversified technologies (Ahuja and Lampert, 2001) can be labeled as technological competencies, referring to the in-house knowledge of technology. Market competencies and inter-firm collaborative relationships represent a company's competencies in external resource exploration and utilization, e.g. customers, social environment, components makers, external complementary technology providers, etc. On the other hand, incorporating internal complementary knowledge and learning from unique historical conditions and environment turbulence are the indicators for internal resource exploration and utilization, e.g. internal complementary technology providers, previous generations, organizational culture, etc. The definition for each competency is summarized in Table 2.1.

Table 2.1 Definitions of company competencies

Competency	Definition
Market competencies	Company's ability in discovering the changes in customers needs, the opportunities of a new market or the changes in social environment
Collaborative relations	Company's ability in utilizing the technologies and ideas provided by other companies, e.g. component makers, suppliers.
Incorporating internal complementary knowledge	Company's ability in integrating knowledge from internal complementary technology providers
Learning from unique historical conditions and environment turbulence	Company's ability in benefiting from previous successful and failed experiences, including the organizational culture.

2.4 Conclusion

After reviewing the literature in technological innovation as well as the basic theories of the resource-based view, we have gained an understanding of the reasons why incumbents usually face greater difficulties when confronted with discontinuous innovations. We have also identified the necessary competencies that help incumbents adopt useful strategies to make full use of their advantages as incumbents and overcome their weak positions in emerging technologies. However, whether established incumbents can create discontinuous innovations, especially when they are technologically inferior to their peers and if these competencies can be turned from passive solutions into active drivers are still unresolved questions for us.

On the other hand, company competencies and capabilities have been regarded as a black box for a long time and opening this black box, in the broadest sense, has become an important topic, evident by a recent call from the Organization Science Winter Conference to be held in 2009 (Colorado, February 3-8, 2009). Following this, our interest is to understand any company competencies that can contribute to the creation of discontinuous innovation by incumbents.

Based on the discussions above, our research questions are phrased as below:

- How do "inferior-technology" incumbents win over their "superior-technology" competitors through discontinuous innovation?
- What kinds of competencies are needed for established incumbents to create discontinuous innovation when they are technologically inferior to their peers?

We try to address these questions from a resource-based view that regards these competencies as heterogeneous resources that a company possesses.

Chapter 3 Research Methodology

3.1 Introduction

In this chapter we explain our choice of research methodology. Case study is a primary candidate for research on discontinuous innovation because such work can provide critical insights and lay a foundation for further research (Veryzer, 1998). Careful study of a single case may lead researchers to see new theoretical relationships. This fits well with our research objective to unravel the process of established incumbents initiating discontinuous innovations. We begin this chapter with a brief introduction to the different types of research methodologies followed by the concrete reasons why we selected case study as our major research strategy in this particular context. We will end this chapter with a brief description of the case study protocol, illustrating the flow of our data collection.

3.2 Overview of Research Methodologies

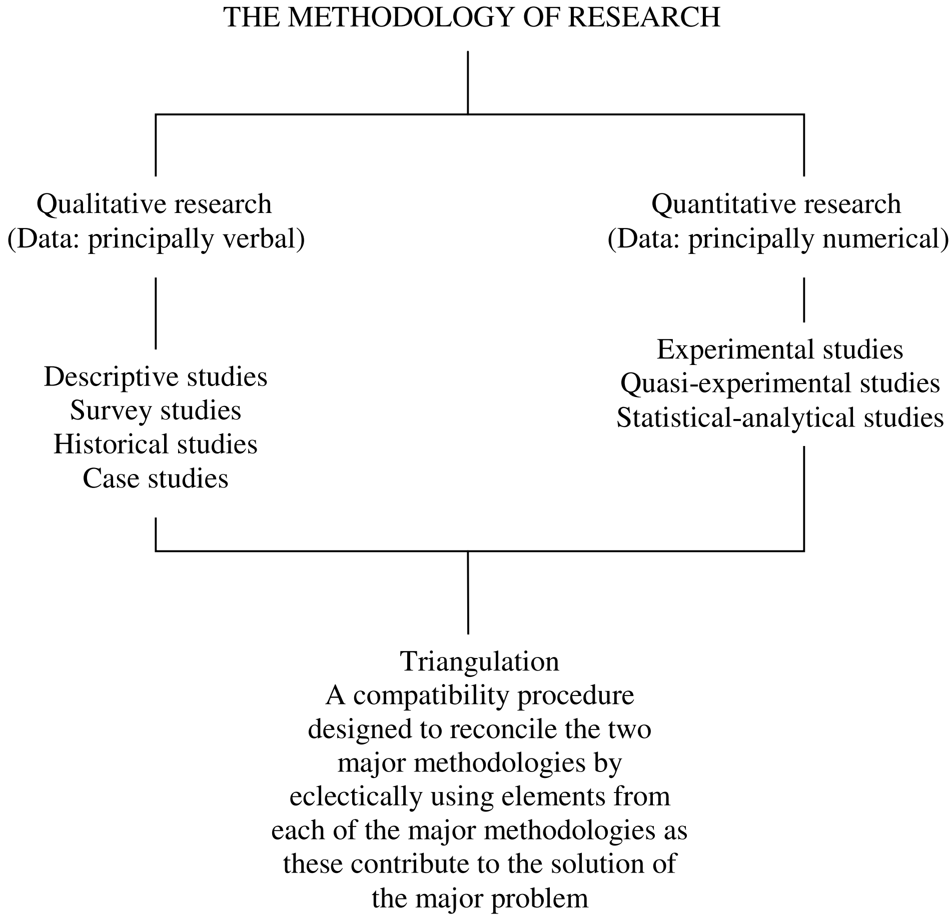
There are various classifications of research methods. Over the past few decades the dominant research methodology has been rationalism. Rationalism is concerned with explaining what happens and how, in order to achieve some goal or end. According to rationalism, the relationships and observations are considered to be independent of the theories. On the other hand, a case/field study takes an alternative research approach, known as interpretivism. This approach uses multiple tools to collect data from observations and communications in a single, natural setting that considers the temporal and contextual aspects of the contemporary phenomenon under study, but without experimental controls or manipulations. It focuses more on process or means and helps the researcher comprehend why certain characteristics or effects occur or not (Meredith, 1998).

Another classification of research methodology is qualitative versus quantitative, depending on whether the data is textual or numerical. For a qualitative study, six features are outlined (Eisner, 1991):

1) Field focused. The investigators usually go out into the field, observe and talk with their research objectives.
2) Subjective perception. It is not a matter of checking behaviours, but rather of engaging the investigator in the situation, making sense of it, perceiving the presence and interpreting the significance.
3) Interpretive character. Qualitative inquirers aim to uncover the meaning of the event for those who experience it, beneath the manifest behaviour.
4) The use of expressive language and the presence of a voice in the text.
5) Attention to the particulars.
6) Coherence, insight and instrumental utility. Criteria for judging the contributions of the qualitative research are needed.

Following this classification, Figure 3.1 graphically summarizes the two major branches of research methodology, The case study is one of the research strategies employed by qualitative research.

Figure 3.1 Classification of research methodologies



Source: Adapted from Leedy, 1974

3.3 Selection of Case Study

As a research strategy, a case study focuses on an understanding of the dynamics present within single settings, typically combining data from archives, interviews, questionnaires and observations (Eisenhardt, 1989). The dynamics within a single setting are consistent with what Meredith (1998) has described as "a temporary, single and on-going background".

Three conditions are outlined to determine the different situations where each strategy should be used: a) the type of research question posed, b) the extent of control an investigator has over actual behavioral events and c) the degree of focus on contemporary rather than historical events. Based on these conditions, a case study is applied when "how" or "why" questions are being posted, when the investigator has little control over the events or when the focus is on a contemporary phenomenon within some real-life context (Yin, 1988). The table below explicitly displays the classification according to the conditions mentioned above.

Table 3.1 Relevant situations for different research strategies

Strategy	Form of Research Question	Requires Control Over Behavioral Events?	Focuses on Contemporary Events?
Experiment	how, why	yes	yes
Survey	Who, what, where, how many, how much	no	yes
Archival analysis	Who, what, where, how many, how much	no	yes/no
History	how, why	no	no
Case study	how, why	no	yes

Source: Adapted from Yin, 1988

As for our study of Nintendo's Wii, three concrete reasons are stated below in terms of why the strategy of a single-case study was selected.

Firstly, the purpose of this study is to unveil how "inferior-technology" incumbents win over their "superior-technology" competitors through discontinuous innovation. Solely depending on the data from the previous literature, common sense and experience have become less convincing as the academic world has advanced. It is an intimate connection with empirical reality that permits the development of a testable, relevant and valid theory (Glaser and Strauss, 1967).

Secondly, as the bedrock axiom says, the nature of the data and the problem of the research dictate the research methodology. Besides the fact that one of our main research questions begins with "how", another convincing rationale is that our data was principally collected from personal interviews and professional documentations expressed both verbally and literally. These two features lead to the adoption of the case study as our research method.

Lastly, Dyer and Wilkins (1991) argue that the careful study of a single case can lead researchers to see new theoretical relationships. They objected to Eisenhardt's point of view that focused on comparisons within the same organizational context. Furthermore, they displayed the trade-off between the deep understanding of a particular social setting and the benefits of comparative insights. Since our aim is to unveil the process of innovation creation and to describe it as richly as possible, involving too many cases may distort the picture or lead the investigator to draw superficial conclusions. Thus, we have selected a single-case study as our main approach.

In summary, a single-case study is the most appropriate research method to fulfill our research objectives given the nature of our data. However, our work will not be isolated to just the study of the Wii as a single product case. We will make proper comparisons with Nintendo's competitors and also with the Wii's predecessors in the home video game console industry to help us gain a wider understanding and generate more insightful ideas.

3.4 Case Study Protocol

3.4.1 Case Study Overview

A living case in the video game console industry is selected as our primary study unit. Over the past two decades, the video game industry has grown into a sizable industry with annual sales that rival box office receipts for the movie industry. Nintendo, as a major incumbent in this industry, successfully shifts from the traditional path where innovation is towards "flashier and faster" products and won over its "super technological" competitors with its new generation game console the "Wii". According to the comments of video game industry experts, the Wii is trying to reinstitute the benchmark in the video gaming market and to redefine the boundary of mainstream customers. Data collection was conducted immediately after the literature review. We sourced our information from the Internet, academic journals, industry magazines and business press news.[1] We also paid greater attention to exclusive documentation for Nintendo as well as other documents for Sony and Microsoft, the other two major players in the video game industry. In order to have a basic understanding of Nintendo's competencies and the Wii's development processes we extracted the figures, facts and process descriptions from annual reports, interviews and internal discussions.

1. At the early stage of the study, we approached the senior management of Nintendo for interviews. Unfortunately, this request was turned down by the company.

3.4.2 Research Design

Nintendo publicized the Wii's development process through various interviews and public reports. These rendered secondary data to sufficiently support our analysis in terms of depth and width. We also obtained some patent information from the United States Patents and Trademark Office (USPTO) website to supplement our analysis based on secondary interview sheets, expert reports and other documentation. Our data collection ranged from the industry level to the company level, and was eventually narrowed down to the product level.

At the industry level, we collected data based on previous literature, professional industry reports produced by professional organizations (e.g. Entertainment Software Association, NPD groups and Famitsu (famitsu.com), a specialized Japanese video game magazine) and from Wikipedia.org, the biggest multilingual free-content encyclopedia on the Internet.

At the company level, except for the same sources as the industry-level data collection mentioned above which provided the history and current status of the company, we carefully examined the internal interview archives posted on its official website named "Iwata Asks". Based on these internal interview archives, we categorized the important statements according to the competencies identified by which are deduced from the previous literature review chapter. These competencies are market competencies, collaborative relations, incorporating internal complementary knowledge and learning from unique historical conditions and environment turbulence. Marketing competencies refer to Nintendo's capability in discovering changes to customer needs and the opportunities of a new market. Collaborative relations describe Nintendo's competencies in utilizing the technologies and ideas provided by other companies within or beyond the video game industry, including cooperation with component makers, peripheral makers and third-party software developers. Incorporating internal complementary knowledge refers to Nintendo's ability in incorporating the knowledge from internal software development groups into the hardware development process, reflected in the collaboration between hardware development groups and internal game design groups. Finally, the competencies of learning from unique historical conditions and environment turbulence refer to Nintendo's ability to benefit from its successful and failed experiences with previous generations of game consoles as well as the organizational culture. We also extracted useful information from the USPTO website and related patent analysis software.

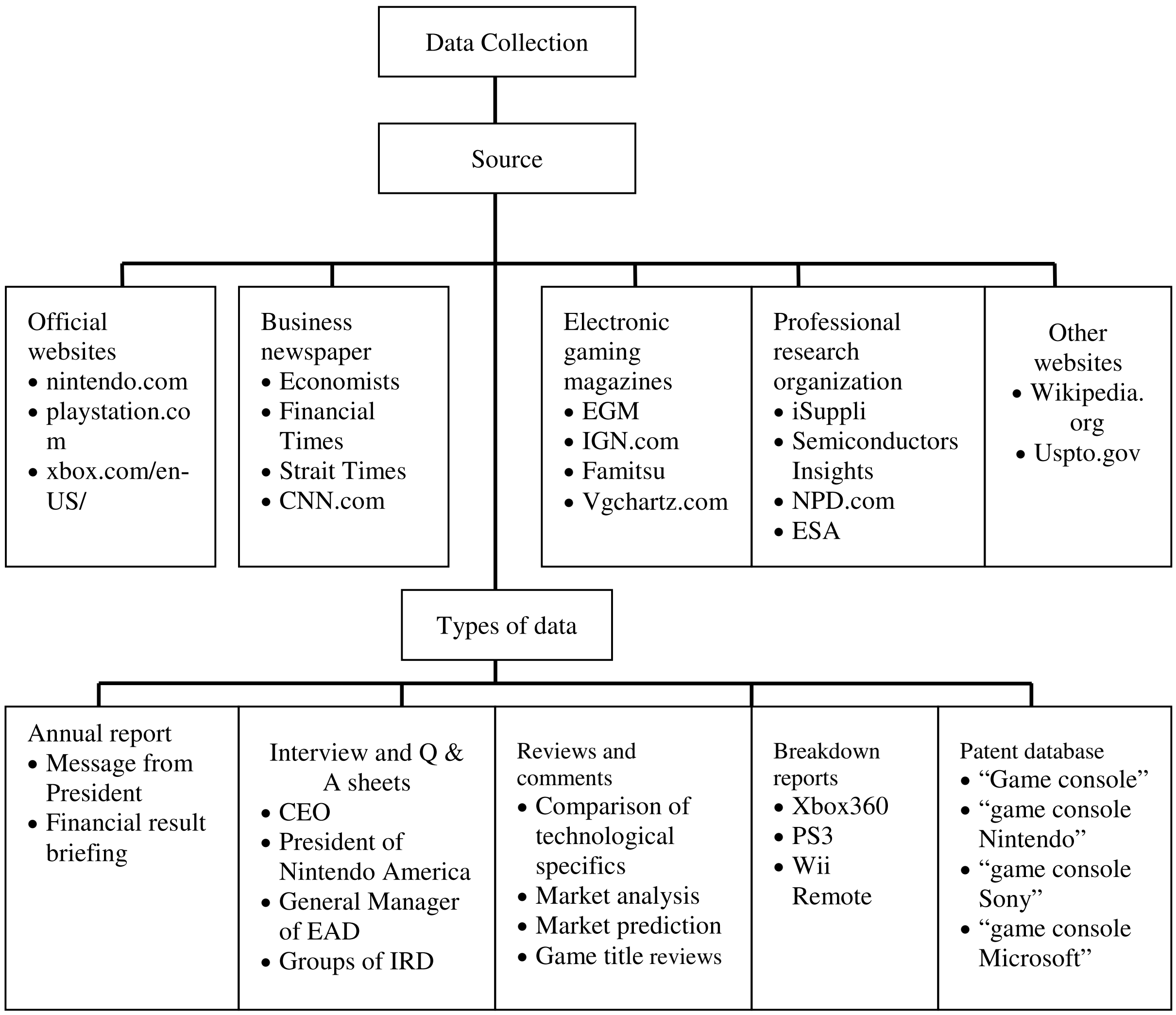
At the product level, we first looked at the Wii's development process, paying close attention to the design and development of the Wii Remote, the key to its success. Next, we deconstructed the Wii and its competing products according to Gavin's framework (1987). Four critical dimensions best suited to our context are proposed: performance, features, aesthetics and perceived quality. The definition of each dimension is articulated in Table 3.2. In particular, the concepts "performance" and "features" have been explicitly shown to correspond with the two dimensions in the theory of disruptive technology from the product's perspective. For example, in the automobile industry, primary performance includes traits like acceleration, handling, speed and comfort, or, for a television set, the primary performance refers to sound, graphics and the ability to receive signals from distant stations (Gavin, 1987). The quality of performance usually involves measurable attributes. The line separating primary performance characteristics from secondary features is often blurry. The quality of feature usually depends on objective individual needs. Data collection at this level is not only restricted to a single generation, but also involves comparisons with previous generations.

Table 3.2 Four dimensions of product

Differentiation	Definition
Performance	Primary operating characteristics, which differentiate one class of product from another.
Features	Secondary aspects of performance, the "bells and whistles" that supplement their basic functioning.
Aesthetics	How a product looks, feels, sounds, tastes, or smells
Perceived Quality	Consumers do not always have complete information about a product's or service's attributes; indirect measures may be their only basis for comparing: images, advertising, and brand names

The structure of the data collection process is illustrated in Figure 3.2

Figure 3.2 Structure of data collection



3.5 Conclusion

In summary, after reviewing the various research methodologies, we selected a single-case study as our research methodology. This decision was based on the characteristics of our research questions and the creative and insightful theory we aimed to achieve. Finally, based on our research context, we developed a case study protocol to guide our data collection.

Chapter 4 Data and Analysis

4.1 Introduction

As the main body of the thesis, this chapter displays the data we have collected, our analysis based on previous literature and the practical data. In order to provide a better understating of the context of our single case, we first introduce the background of the video game industry. This data is based on literature about the gaming industry and information from Nintendo's official website and annual reports. The 2001 article titled *Note on Home Video Game Technology and Industry Structure* by Professor Coughlan from the Harvard Business School provides an excellent review of the industry's components and structure. The historical overview is followed by a review of current status of the video game industry.

At the company level, key products from Nintendo's history are presented. This is then followed by Nintendo's general innovation strategy and some management practices. This section ends with a comprehensive patent analysis based on the data collected from the United States Patents and Trademark Office (USPTO) website.

At the product level, a brief introduction describing the Wii is presented. We subsequently introduce the Wii's development process and product profile as well as its competing products, based on various secondary data sources.

4.2 Video Game Industry

4.2.1 Video game industry structure

The video game industry is often used as a typical example of network externality effects, where products must be connected in a network with complementary items to fully benefit the customers (Gallagher and Park, 2002). In general, a video game system consists of the game console (hardware), which also refers to the platform provider, and the game titles (software).

The performance of game consoles are mainly measured by three basic technical factors: data width (in bits), clock speed (in MHz) and the amount of RAM (in bytes). Data width determines the size and complexity of the instructions that the CPU can process, clock speed is a measure of how many instructions can be processed per second and the amount of RAM acts as a temporary storage for the instructions to be kept in memory at any one time (Clements and Ohashi, 2005).

Increasingly, software is playing a crucial role in determining the success of video game systems (Huffstutter, 1999). The development of game software depends on two major features, the format and the compatibility. The format of storage measures the capacity and speed for instruction processing. By the end of the 1990s, online capability had become another important format for video games. Good online capability depends on low latency, broad Internet bandwidth, cheap hardware prices and low Internet access costs. These elements are important for speedily delivering instructions and large graphic files online, as well as for the gamers' positive feelings about the attractiveness of playing the game online. For software, compatibility refers to whether the software is designed for a single video game system. In other word, it means that whether the software is incompatible with other competitive systems, or it can be played on multiple systems, like other video game consoles or altogether different platforms such as mobile phones and personal computers. When compatibility is applied to hardware, it refers to the backwards compatibility which enables the new machine to play the existing games designed for the manufacturer's previous generation console.

In total, there are six parties (hardware and software) who are involved in the value chain of the home video game industry:

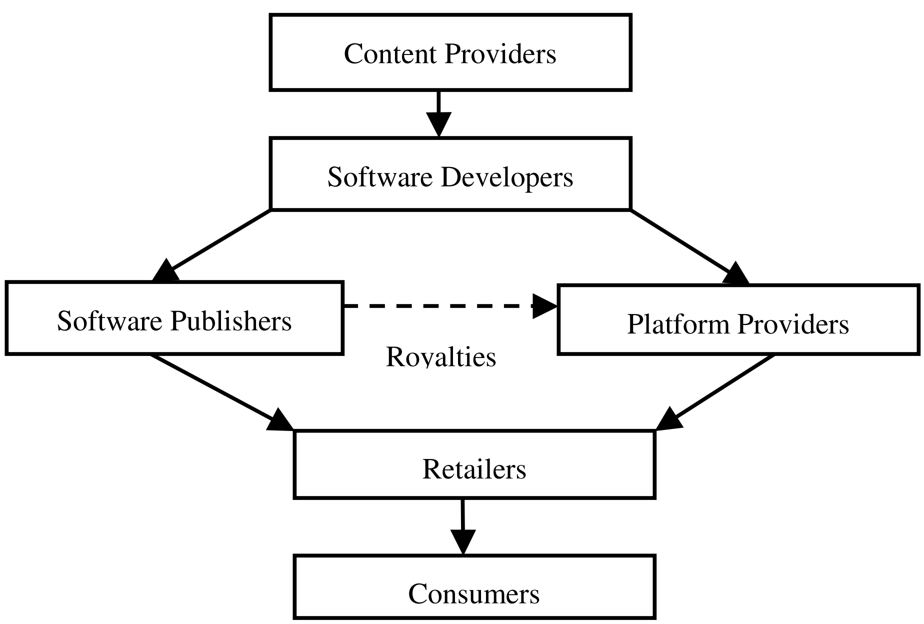
1) Content providers: the providers of the original ideas, names, characters, storylines and other intellectual content of games. They are usually licensed from other industries such as film, TV or cartoons. This licensed content helps software publishers differentiate their games in a crowed marketplace.
2) Software developers: the creators of games and the core of the video game industry. They are either employed by console manufacturers (platform providers), separately employed by software publishers or independently run by themselves. As the complexity and the capability of the hardware technology greatly increase, as well as the gamers' expectations, software development requires more complex programming abilities in order to develop game titles. Except for the programming ability, they also require stronger support and tools from the console manufacturers and building up larger development teams for game developing.
3) Software publishers: the third-party publishers. They pay platform providers a royalty

fee for each copy of a game sold, which becomes a large part of platform providers' revenue.

4) Platform providers: the home video game console manufacturers. They perform three primary business activities: designing, manufacturing and marketing game consoles, developing and publishing game titles for game consoles and managing relationships with third-party software publishers.
5) Retailers: the software or electronics specialty stores, toy stores, supermarkets and online stores.
6) Consumers: the game players. They have different preferences among the large games library. While the historical target market for the home video game industry was 10-17 year old boys, the proportions for females, adults and seniors have changed dramatically.

Figure 4.1 illustrates the structure of home video game industry.

Figure 4.1 Structure of video game industry



Source: Coughlan, 2001

4.2.2 History of Video Game Industry:

Following Schilling (2003) and Gallagher and Park (2002), we view the history of video game industry comprising seven generations.

Beginning of the video game era: the very first home video game system was Odyssey, introduced in 1972 by Magnavox. However, in the same year, Nolan Bushnell founded Atari and introduced "Pong". This console and game proved to be much more successful and promoted video game systems as a vibrant and viable industry. There were lots of major players during that time, and there was no clear boundary to differentiate the first and second generations. The major players were Fairchild Channel F released by Fairchild Semiconductor, the Magnavox Odyssey2, the Game Vision produced by Texas Instrument, Intellivision released by Mattel, Atari 5200 and so on. Atari's 1977 introduction of the Atari Video Computer System (VCS) dominated the market until Coleco released the Coleco Vision video game system in 1982.

In the mid-1980s, profits for video game makers began to decline due to rapid proliferation and unauthorized games and the market was regarded as saturated. However, two new entrants from Japan instilled new energy to this dying industry and led to the beginning of modern video game combat. These two players were Nintendo and Sega.

Third generation: the beginning of the modern video game industry is marked by video game history's third generation. Nintendo dominated the market with the Nintendo Entertainment System (NES) and outsold Sega's Master System and Atari's 7800 in 8-bit game consoles. Nintendo's success lied in its high security and strictly exclusive licensing policy. A security chip was used to verify the authenticity of the compatible cartridges and a limited numbers of licensees were issued to develop the game titles. Furthermore, third-party developers were prohibited from making the game available for any other competing system for two years. Nintendo also benefited from its intensive and efficient marketing and distributing management.

Fourth generation: in order to destroy Nintendo's predominance, Sega and NEC turned to substantial technological innovation. In 1989, Sega and NEC introduced their 16-bit consoles, Genesis and Turbo Grafix-16, respectively, representing the arrival of the fourth generation of video game consoles. Sega built up its momentum with better color, digital sound, popular game characters and fewer restrictive licensing arrangements with third-party game developers. Although Nintendo finally introduced its own 16-bit Super Nintendo Entertainment System (SNES), it was too late to catch up with the Genesis in either the variety of game titles available or the number of hardware units sold.

Fifth generation: the three major players of the fifth generation are Sony's PlayStation, Sega's Saturn and the Nintendo 64. Despite the entry of the fifth-generation consoles, Nintendo continued to develop popular game titles for its SNES by incorporating additional graphics abilities and it continued to outsell the more advanced fifth-generationconsoles until Christmas 1996, making Nintendo a latecomer in the fifth-generation console war. Thus, when the Nintendo 64 was eventually released, Sony had already established its installed base, a variety of compatible game titles and had reinstituted the dominant design by providing two new features, a high capacity CD drive and optional memory cards that let gamers save a game in progress. Neither Sega nor Nintendo were able to reclaim their dominance over the video game industry.

The CD-ROM had already become the dominant design in the market, and the Nintendo 64 was the last mainstream home video game console to use cartridges as the medium to store its games. The limited storage capacity of cartridges constrained the development of a game's content, putting off lots of players and game developers.

Sixth generation: the sixth generation of consoles began when Sega introduced its Dreamcast system in 1999. Yet, due to intensive competition, Sega left the video console business in 2001 and began concentrating on software development for multiple platforms. This era also marked the entry of the software giant Microsoft into the industry, who intended to take a large share of this lucrative market with its personal computer technology. This generation was characterized as the era of the 128-bit console, and Sony's PlayStation 2 (PS2), Microsoft's Xbox and Nintendo's GameCube were the three dominant players. The success of the original PlayStation established a good image for Sony's later products and the PlayStation 2 continued to dominate in this round, achieving a market share of 70%.

Seventh generation: the beginning of the seventh generation of home consoles came on November, 2005 with the release of Microsoft's Xbox 360 and continued a year later with the release of Sony's PlayStation 3 and Nintendo's Wii. Who will be the winner is still uncertain.

4.2.3 Statue quo of Video Game Industry

Many professional gaming organizations conduct surveys and interviews of gamers and experts to study new trends in the video game industry. For instance, according to a survey conducted by Famitsu (famitsu.com), a popular Japanese gaming magazine, although an important trend in the video game industry is to evolve from 2D graphic to 3D graphic games, 2D games have not faded away as expected. Gamers comment that 2D games feel friendly opposed to 3D's resemblance to reality. 2D still gets significant support in terms of more useful simplifications, e.g. a simpler representation, can often zoom out better, etc. Customers seem to have grown exhausted with the complex control systems and steep learning curve of certain video games, and the pendulum has swung to more enjoyable and easily playable games. 57.7% of respondents to the survey mentioned above prefer easy games to complex games. Although some of them admit that they enjoy the feeling of achievement when playing complex games with tricky gateways, the depression caused by the difficulties of complex games makes them still in favor of the easier ones. When playing a game, over 70% of respondents claim that they prefer relaxed and enjoyable styles rather than speedy and ambitious ones. These changes have also appeared in recent software development. Since the video game industry has grown from niche past-time to mass medium, companies that are making games more accessible are growing while those latched onto hard-core gamers have stagnated. Established software development companies have successively launched individual divisions for casual gamers, e.g. Electronic Arts, Ubisoft. (EGM: Electronic Gaming Monthly, September 2007, No. 219).

As the video game industry continues to grow, the public perception of video games changes. As evident by statistics from the Entertainment Software Association, the demographic of the gaming population have changed: 35% of American parents say they play computer and video games. Further, 93% of gamer parents say they play video games with their kids and 66% feel that playing video games has brought their families closer together. More and more non-gamers have begun to appreciate the joy brought by playing video games: the percentage of senior players over the age of 50 has increased from 9% in 1999 to 26% in 2007. Also, the gender/playing time gap has narrowed. In 2007 the average adult woman played video games for 7.4 hours per week and the average adult man played for 7.6 hours per week, while in 2004 males spent an average of 6 more minutes per day playing games than their female counterparts and, in 2003, they spent 18 minutes more each day doing so.

4.3 Nintendo

4.3.1 Nintendo's History

Nintendo, one of the most powerful companies in the video game industry, has the distinction of historically being both the oldest intact company in the home video game market and one of the largest and well-known console manufacturers.

Nintendo started as a small Japanese card company near the end of 1889. During its long history, Nintendo diversified into the transportation, hospitality, television, and toy industries. After it exited completely from the cards business, toy manufacturing activity became the main focus. The experience gained from playing cards helped Nintendo survive in the competitive Japanese toy industry, but it still remained a small enterprise.

Because of the short product life cycle for toys, the company had to constantly introduce new products. As their R&D department significantly grew, they employed opto-electronics and introduced electronic technology into the toy industry for the first time in Japan. This established Nintendo's solid foundation for the coming electronic era.

Listed below are the key products that Nintendo developed after it became an important video game company, including the home video game console line and the portable hardware line.

Color TV Game:

Figure 4.2: Color TV Game

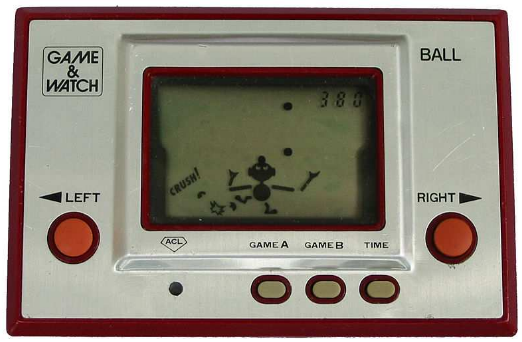
Source:news.bbc.co.uk/nol/shared/spl/hi/pop_ups/07/technology_the_evolution_of_game_controllers/img/1.jpg

In 1975 Nintendo cooperated with Mitsubishi Electric to develop the first video game system using an electronic video recording (EVR) player.

In 1977 Nintendo developed its first home video game machines, TV Game 15 and TV Game 6. They came as a single unit containing a single kind of game played in many different ways. Each of them was a success in Japan, paving the way for Nintendo's eventual dominance of the home videogame market with the home-based video game.

Game & Watch:

Figure 4.3: Game & Watch



Source: www.brianapps.net/tossup/screenshot.jpg

In 1980 Nintendo of America Inc. in New York developed and started selling their GAME & WATCH product line. These were the first portable LCD video games with a microprocessor and are considered as the prototype of the Game Boy. The Game & Watch titles could run on a single watch battery and not only told the time, but also provided simple-yet-addictive gaming challenges.

Nintendo Entertainment System:

Figure 4.4: Nintendo Entertainment System and Nintendo Family Computer

Source: en.wikipedia.org/wiki/NES

In 1983 Nintendo released its 8-bit console Family Computer in Japan. Two years later the Nintendo Entertainment System (NES), the U.S version of the Family Computer System, was released in U.S. The NES game Super Mario Brothers became a smash hit around the world. NES was the most successful gaming console of its time in both Asia and North America. Its astounding graphics were far superior to any home-based console that came before it, and it went on to sell over 60 million units worldwide. The NES set the standard in subsequent console design from game development to controller layout. It was also the first console open to third-party developers.

Game Boy:

Figure 4.5: Game Boy

Source: en.wikipedia.org/wiki/Game_Boy

In 1989 Nintendo introduced the Game Boy, its first portable, hand-held game system with interchangeable games, in Japan and the U.S. It was the most successful video game system ever developed, evolving over the years with the Game Boy Pocket in 1996 and the Game Boy Color in 1998.

Super Nintendo Entertainment System:

Figure 4.6: Super Nintendo Entertainment System and Super Family Computer

Source: en.wikipedia.org/wiki/Super_Nintendo_Entertainment_System

In 1990 Nintendo entered the 16-bit console market with the release of its Super Nintendo Entertainment System (SNES) in Japan and, one year later, in the U.S. The SNES featured true stereo sound, multiple scrolling backgrounds and almost twice the internal memory of its competitors.

Nintendo 64:

Figure 4.7: Nintendo 64

Source: en.wikipedia.org/wiki/Nintendo_64

In 1996 Nintendo launched the Nintendo 64 in Japan and the U.S. The console featured 32 bit and 64 bit data width, but the performance was no longer mainly dependent on this aspect. The N64 was Nintendo's first console designed to use 3D graphics technology and was also more powerful than any other console on the market at the time. However, Nintendo's dominance in the video game industry was taken over by Sony in this generation with its PlayStation. According to the figures from the two companies' official websites, 102.49 million units of PlayStation had been shipped out worldwide as of 31 March, 2007, while the corresponding figure for N64 systems was just over 32 million.

GameCube:

Figure 4.8: GameCube

Source: en.wikipedia.org/wiki/Nintendo_GameCube

In 2001 Nintendo introduced the GameCube, which was the first Nintendo console to use disc-based media. As the successor to the Nintendo 64, the Nintendo GameCube proved to be a failure. As of March 31, 2007, Nintendo had sold a total of 21.6 million Nintendo GameCube units worldwide, compared to 117.89 million PlayStation 2 units shipped and over 24 million Xbox units sold.

Game Boy Advance:

Figure 4.9: Game Boy Advance (GBA)

Source: www.n-sider.com/media/database-hardware-gameboyadvance01.jpg

In 2001 the Game Boy product line further evolved into the Game Boy Advance (GBA), boasting graphics and sound comparable to the Super NES. The GBA was also compatible with Game Boy and Game Boy Color games. This system underwent two revisions without changing its game-playing functionality: Game Boy Advance SP, which was the first Game Boy to include a back-lit screen and rechargeable battery, and an even smaller version called the Game Boy Micro, with a higher-quality back-lit screen.

Nintendo DS:

Figure 4.10: Nintendo DS

Source: news.filefront.com/wp-content/uploads/2007/05/nintendo-ds_lite.jpg

In 2004 the hand-held Nintendo DS, which opened up a new style of entertainment with its dual screens, touch control, wireless communication and voice recognition technology, was released in Japan and the U.S. Learning from Nintendo's annual report 2006 & 2007, the Nintendo DS was the first tangible product that came from Nintendo's new strategy "to expand gaming population regardless of their age, gender or cultural background". In 2006 the Nintendo DS Lite was launched, a smaller and lighter version of the Nintendo DS equipped with a brighter screen. The Nintendo DS and Nintendo DS Lite have sold 40.3 million systems as of March 31, 2007, outselling its main rival the PlayStation Portable by about 14.9 million units.

Wii:

Figure 4.11: Wii

Source: www.nintendo.com/wii

Under the working title of Revolution, Nintendo launched its new home video game console the Wii In 2006. Rather than simply following a traditional model of better graphics for same style games, the Wii provided many unique features besides the normal improvements to its predecessor.

4.3.2 Nintendo's Innovation

Having experienced industry turbulence in the industry for two decades, Nintendo has developed a culture of constantly searching for something new, believing in the need to keep entertainment fresh and always having the ambition to do new things. According to a ranking of the top 30 innovations in the history of video game industry by Game Applied Technology, 2008 (Vol. 1, pp 48-51), only Nintendo is listed as the current major hardware manufacturer. Nintendo was the first manufacturer who designed a controller with an Analog Stick and this was applied in its third home video game console, the Nintendo 64, for both North American and international markets. Nintendo invented the Battery Back-up Save System which was first offered on its exclusive game title the "Legend of Zelda" on NES. The Wii Remote's three-axis motion signal-processing technology is also included in the Top 30 as the newest invention. It is the only technology included from the "next-generation" of video game consoles. According to the article "As Gaming Turns Social, Industry Shifts Strategies" in New York Time (February 28, 2008), Nintendo's advertisement activities for the Wii vividly illustrate the company's innovation strategy. Unlike normal video game advertisements which just show the content of the games, Nintendo's advertisements for the Wii are shot from the perspective of players' backs to emphasize the movement of players.

Inspired by both their successes and failures from previous generations of home consoles and the portable game machines, Nintendo has started to pursue a new innovation path that aims for superior accessibility rather than high-technology performance. Nintendo has taken an important lesson from the worldwide success and spread of the NES: it is so easily operated that everyone can play. "In the end, our premise was to make a design that's accessible to everyone. Only then will we be able to introduce people to a variety of software," said Mr. Shigeru Miyamoto, the legendary designer of Nintendo regarded as the "father of modern video gaming", who played a decisive role in determining the path of Nintendo's future development. Following this lesson from the NES, the Wii was born as "a design accessible for everyone". This strategy is also supported by Nintendo's market observations. The general public seems to be unable to differentiate between the graphical powers of the GameCube and PlayStation2 on one hand, and the Nintendo64 and PlayStation on the other. This implies that the improvement of video game technology along the primary performance dimensions, e.g. processing speed and graphics, have already exceeded the customers' demand. Mr. Satoru Iwata, CEO of Nintendo mentioned this viewpoint in Nintendo's FY2008 Mid-term Financial Results Briefing when answering the question of how Nintendo was capable of developing machines with such a good balance between hardware and software. In fact, this point has been repeatedly mentioned. In the "Iwata Asks" internal interviews, which we introduced before as our major data source, Iwata said "Conventional path would eventually lead to a battle of sheer brute force with competitors and fewer and fewer consumers would able to keep up". Mr Takeda, the General Manager of Integrated Research and Development Division who oversaw and coordinated the whole Wii project, also expressed the same view: "if we had followed the existing roadmaps we would have aimed to make it 'faster and flashier.'"

However, early in the Wii project, "we came to realize the sheer inefficiency of this path when we compared the hardships and costs of development against any new experiences that might be had by our customers."

One possible driver for Nintendo's pursuit of this innovation path is its "software-driven" mindset. "I've never encountered ID (Industry Design) so closely connected to software until I started at Nintendo," Said Kenichiro Ashida, who was in charge of designing the controller and the console. This statement clearly demonstrates the contribution of the software team during the process of hardware development. In contrast, both Sony and Microsoft rely mainly on third-party developers and have less than 10% of first-party development (vgchartz.com). Nintendo is able to enjoy the advantages of its 20-year history of acclaimed performances in software development. Since the NES, over 50% of the million-seller titles for each generation were published by Nintendo itself and over 40% million-seller titles for the Wii were developed by Nintendo. Intense cooperation with software developers during hardware development, both internally and externally, helps the hardware people see the urgent call for new ideas to attract the public and the constant conflict that game designers face: to make games simple and easily understandable or to make them complex and challenging. This dilemma is evident by statements from a professional gaming magazine, "Sometimes, when you have a team as big as the one working on Halo series, it's hard to have same flexibility and agility that you would have with small teams. And there is a lot of the fun in that flexibility." (EGM: Electronic Gaming Monthly, September 2007, No. 219, pp16). The software people not only provide insightful ideas and hints for hardware development, but also make significant contributions to hardware sales. The Nintendo CEO has said that the "video game hardware business is the business of momentum, so you must achieve a high volume of sales at launch…Wii has to rely upon its first-party titles to create launch momentum".

4.3.3 Patent Analysis of Nintendo and Its Competitors

Except for the qualitative data, we extract evidence from patents document as supporting material to demonstrate Nintendo's technological competencies, comparing with Sony and Microsoft. The patent search is based on the USPTO website, covering the entire database from 1970 to the present, using "game console" as key words in all fields and Nintendo, Sony or Microsoft as the "Assignee Name". 83 results are obtained for Nintendo, 61 for Sony and 165 for Microsoft. The earliest Nintendo patent we found was issued in 1991, while the earliest ones for Sony and Microsoft were issued in 2000 and 1998 respectively. The patent analysis tool PatentGuider 2.0[2] was used to identify the key classes involved and other related patent information, e.g. patent age, citation, etc. Generally, Nintendo has the largest self forwards citation number, the longest active years and the longest average patent age, as shown in Table 4.1. Although Nintendo's strengths in the number of citations, active years and patent age may be attributed to its longer existence in the video game industry than either Sony or Microsoft, after we normalize the number by dividing the year distance between the earliest and the latest patent, Nintendo still enjoys significant advantages.

2: PatentGuider is a useful software tool to conduct an analysis on industry patent information. It can access to the world's major patent databases and provides a user-friendly search interface. See http://www.ltc.tw/products/pg/pg.aspx for more information (in traditional Chinese).

3: Nintendo and Sony file their patents under different assignee names, while all the patents for Microsoft are filed under the assignee name of "Microsoft Corporation "

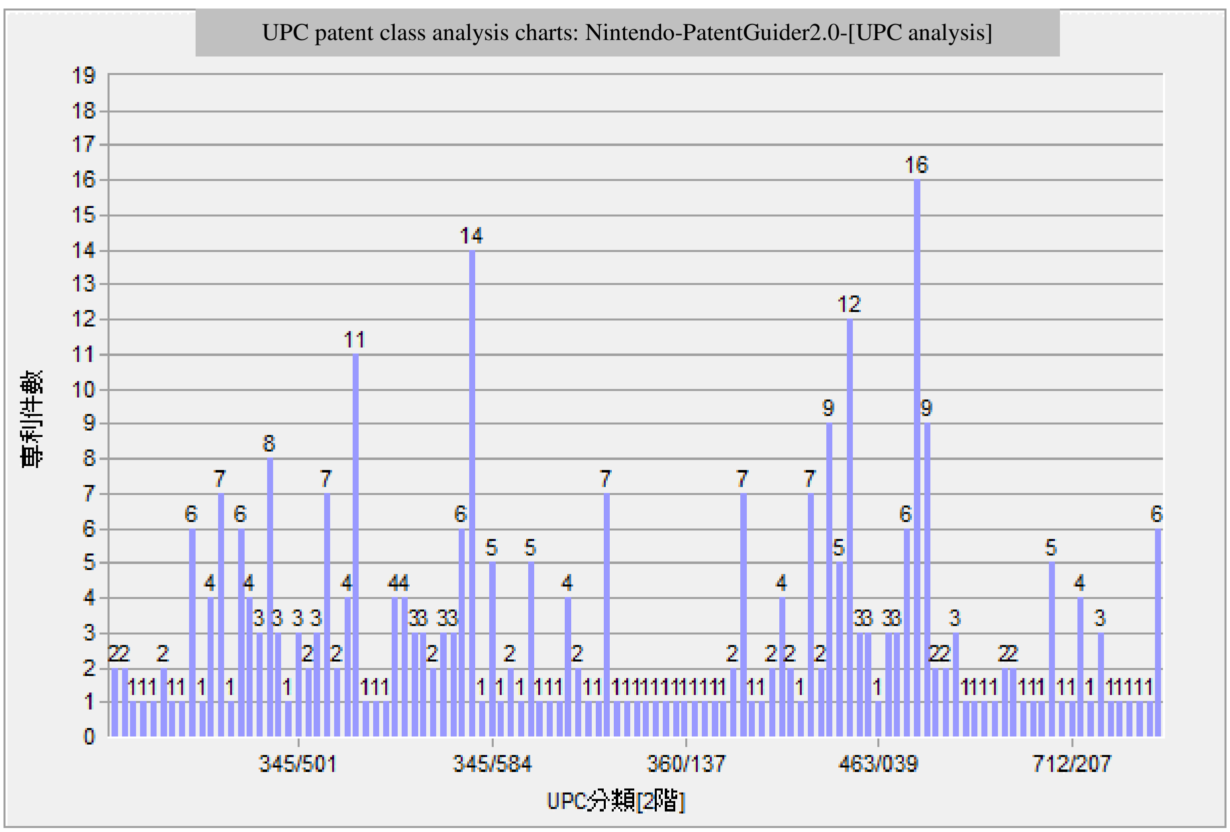
4: "Average" for "Self citation", "citation (others)", and "overall citation" indicates the total number divided by the number of years. For instance, the average self citation rate for Nintendo is 140/18 (Year 1991-Year 2008) = 0.23.

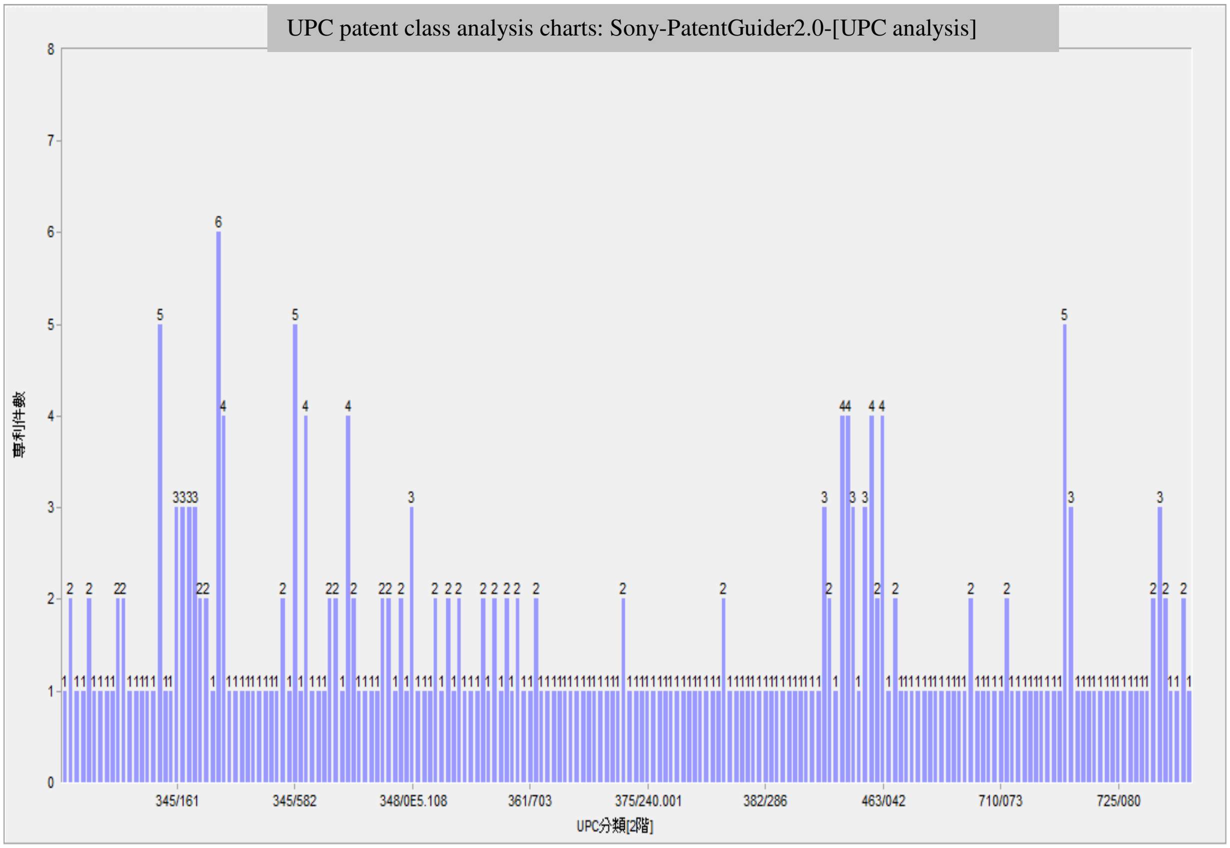
Table 4.1 Overview of patent data for three companies

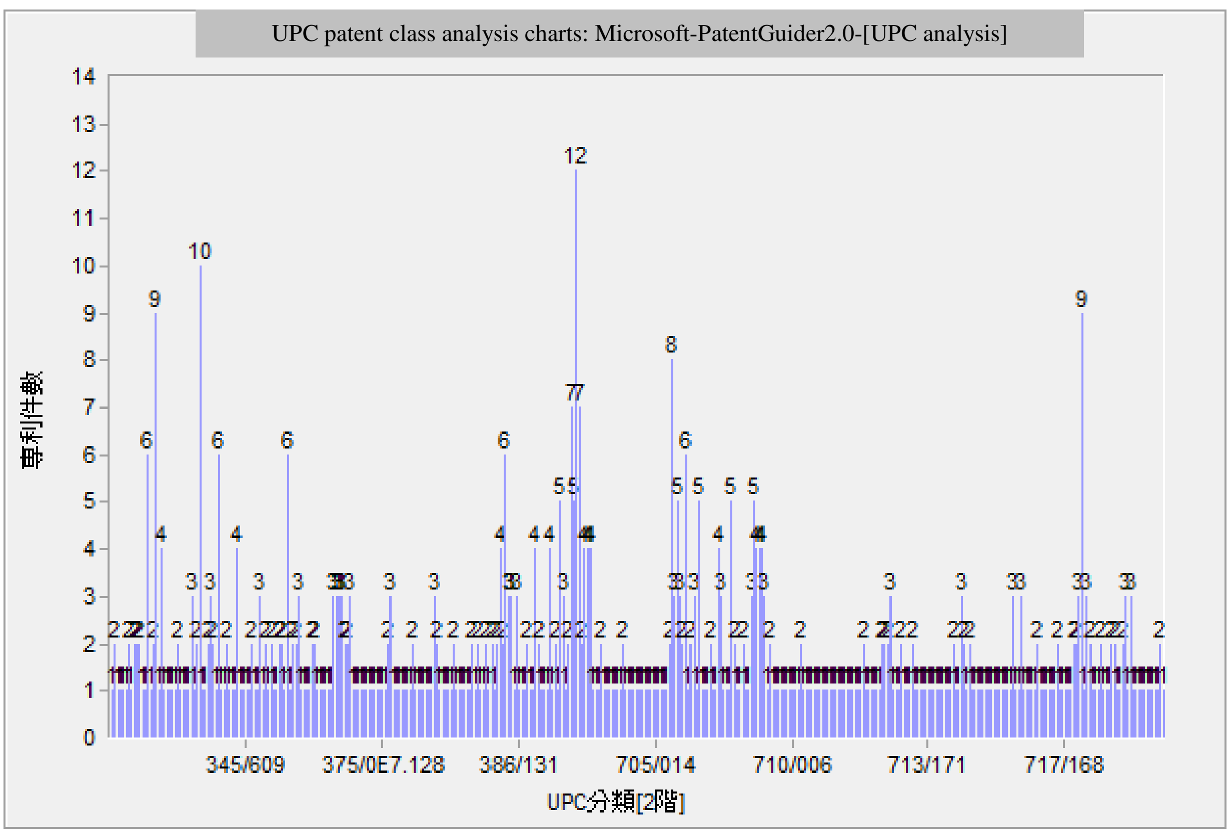
Company	Assignee[3]	Active years	Average Patent age	Self Citation	Citation (others)	Overall citation
Nintendo	Nintendo Co., Ltd.	11	8	140	2	142
	Nintendo of America, Inc.	7	10	0	2	2
	Nintendo Software Technology Corporation	1	9	0	0	0
	Total	19	27	140	4	144
	Average[4]	/	/	7.78	0.22	8
Sony	Sony Computer Entertainment America, Inc.	8	5	0	0	0
	Sony Computer Entertainment America, Inc. Co	7	6	2	1	3
	Sony Corporation	7	6	0	1	1
	Sony Corporation of America	1	8	0	0	0
	Sony Electronics, Inc.	6	6	0	1	1
	Sony Ericsson Mobile Communications AB	1	4	0	0	0
	Sony Europa B.V.	2	9	0	0	0
	Total	32	44	2	3	5
	Average	/	/	0.22	0.33	0.55
Microsoft	Microsoft Corporation	10	5	21	1	22
	Average	/	/	1.91	0.09	2

Next, we analyze the patent class of the three companies. Figure 4.12 shows the number of patents in each class when we use "game console" and the company name, e.g. Nintendo, Sony, Microsoft as the key words. The horizontal axis represents the types of the patent classes and the vertical axis represents the number of patents. The definitions of all these classes in the part of "patent analysis of Nintendo and its competitors" are indicated in Appendix A. In the search of "game console" and Nintendo, key classes are identified around Class 345 (relating to computer graphics processing) and Class 463 (including means for processing electronic data in video game). While Class 345 and Class 463 are also identified as key classes for Sony, the types of sub-classes are completely different. In Class 345, Sony not only has a number of patents related to graphics processing, but its patents also cover display peripheral interface input devices, which permit an operator to selectively control a display device in some manner, e.g. positioning a cursor. Except for Classes 345 and 463, the patents collected for "game console" and Sony have a broad coverage of other electriconic domains, such as television (generating, processing, transmitting or transiently displaying a sequence of images). For Microsoft, we didn't see Class 463 as one of the key classes. However, more electric data processing related classes are included. The US class beginning with the number "7" mostly corresponds to Class "G06F" in International Patent Classification system (IPC).

Figure 4.12 US Patent Class for three companies ("game console" & company name)

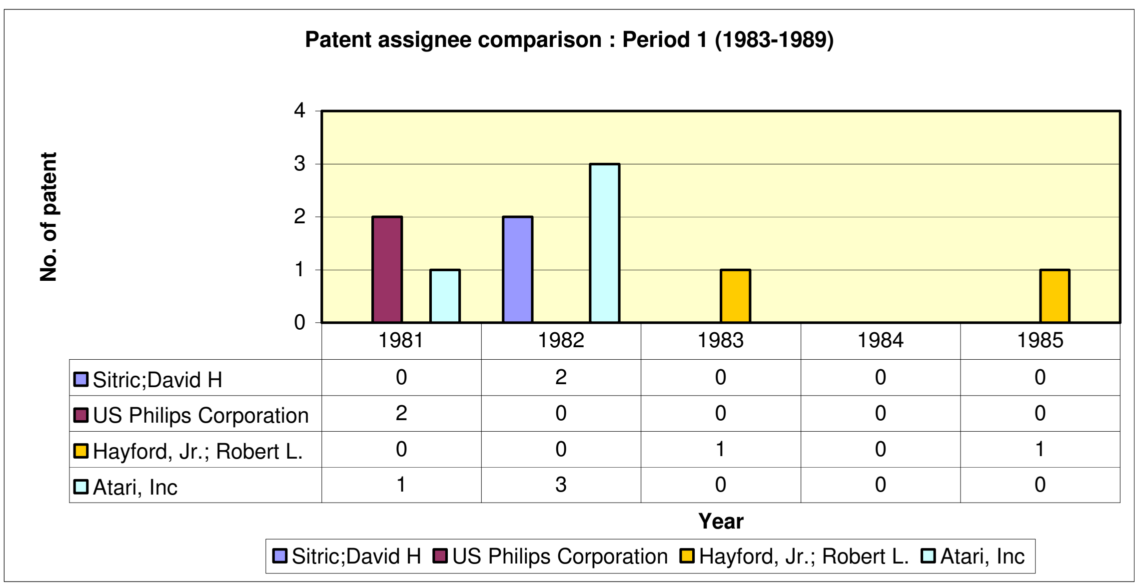



UPC patent class analysis charts: Sony-PatentGuider2.0-[UPC analysis]
專利件數
345/161
345/582
348/0E5.108
361/703
375/240.001
382/286
463/042
710/073
725/080
UPC分類[2階]

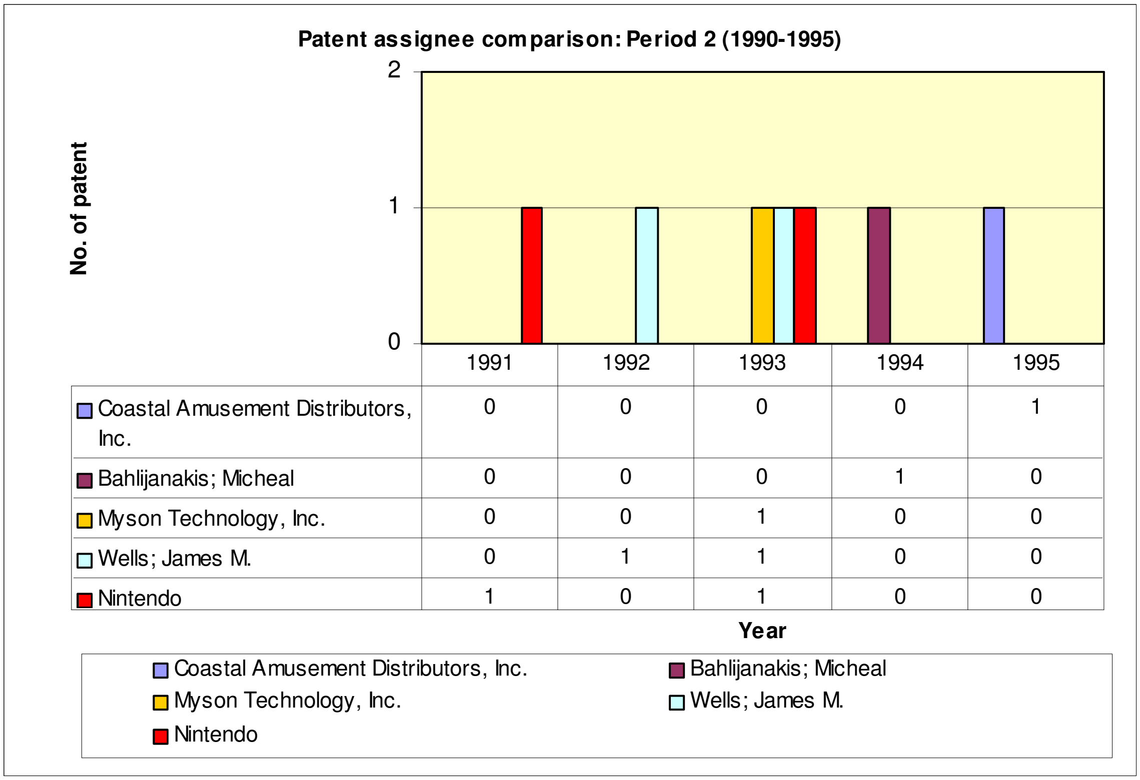

UPC patent class analysis charts: Microsoft-PatentGuider2.0-[UPC analysis]
專利件數
345/609
375/0E7.128
386/131
705/014
710/006
713/171
717/168
UPC分類[2階]

In addition to searching patents by using "game console" and the company names of Nintendo, Sony and Microsoft as the key words, we further examine the classes and the number distributions in a broader context by searching only for "game console" as the key words. According to the evolution of game consoles (Schiling, 2003; Gallagher and Park, 2002; Clements and Ohashi, 2005), we classify the time frame into five periods: Period 1 from 1983 to 1989, Period 2 from 1990 to 1995, Period 3 from 1996 to 2000, Period 4 from 2001 to 2005 and Period 5 from 2006 to the present. Each period begins with the year that Nintendo launches their new home video game console. The companies with the highest patent number are shown in Figure 4.13.

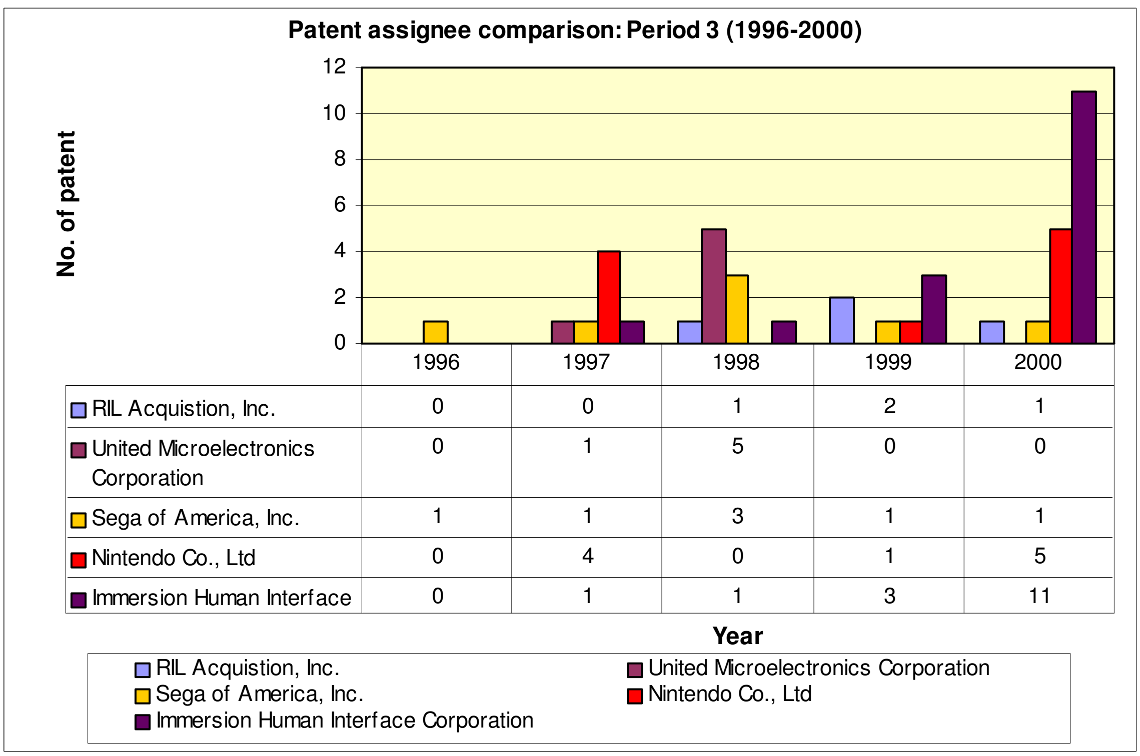
Figure 4.13 Patent No. of competitive companies



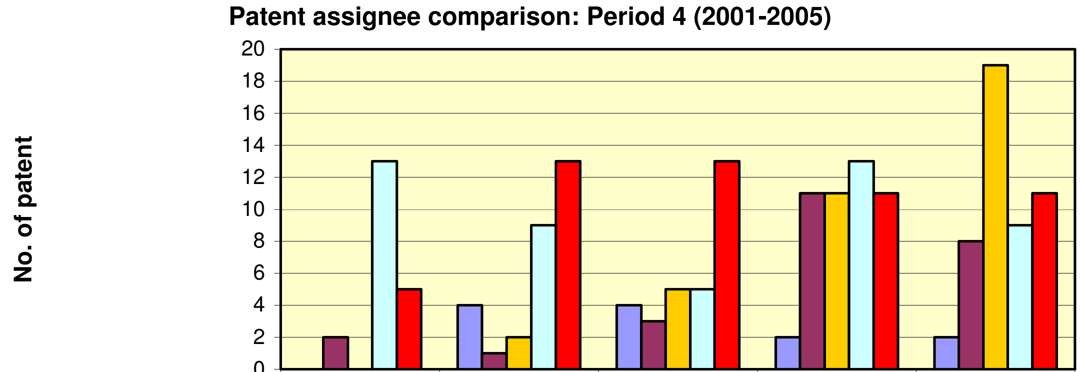
	1981	1982	1983	1984	1985
Sitric;David H	0	2	0	0	0
US Philips Corporation	2	0	0	0	0
Hayford, Jr.; Robert L.	0	0	1	0	1
Atari, Inc	1	3	0	0	0



	1991	1992	1993	1994	1995
Coastal Amusement Distributors, Inc.	0	0	0	0	1
Bahlijanakis; Micheal	0	0	0	1	0
Myson Technology, Inc.	0	0	1	0	0
Wells; James M.	0	1	1	0	0
Nintendo	1	0	1	0	0



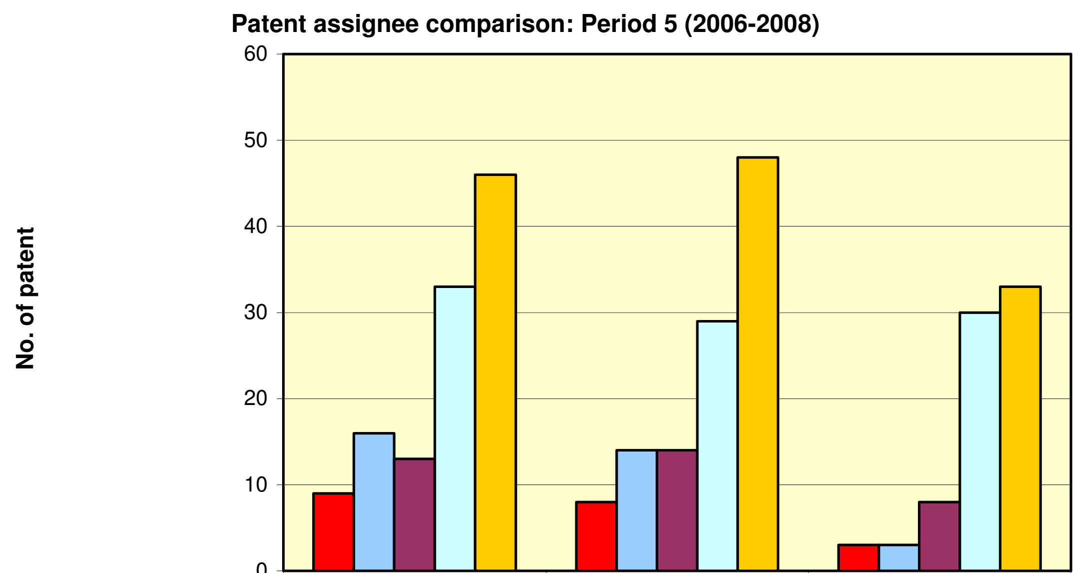
	1996	1997	1998	1999	2000
RIL Acquistion, Inc.	0	0	1	2	1
United Microelectronics Corporation	0	1	5	0	0
Sega of America, Inc.	1	1	3	1	1
Nintendo Co., Ltd	0	4	0	1	5
Immersion Human Interface	0	1	1	3	11



	2001	2002	2003	2004	2005
Sun Microsystems Inc.	0	4	4	2	2
Sony Corporation	2	1	3	11	8
Microsoft Corporation	0	2	5	11	19
Immersion Corporation	13	9	5	13	9
Nintendo Co., Ltd	5	13	13	11	11

Year

Sun Microsystems Inc. Sony Corporation Microsoft Corporation Immersion Corporation Nintendo Co., Ltd



	2006	2007	2008
Nintendo Co., Ltd	9	8	3
Immersion Medical, Inc	16	14	3
Sony Corporation	13	14	8
NVIDIA Corporation	33	29	30
Microsoft Corporation	46	48	33

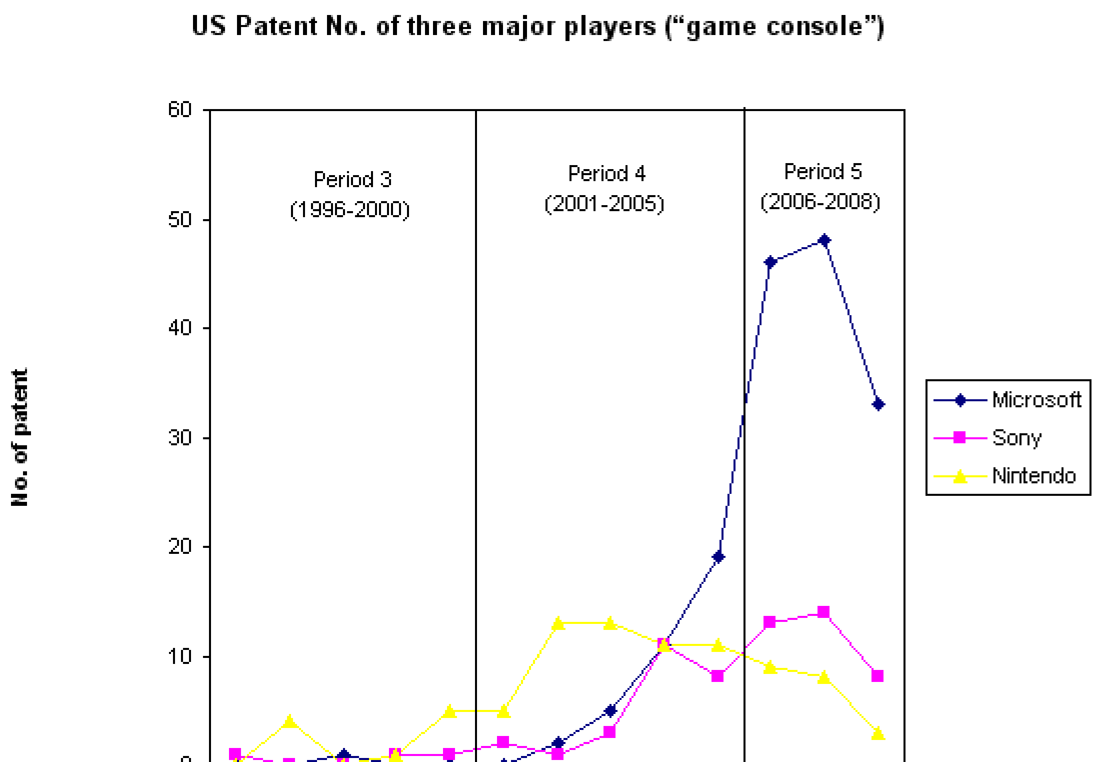
Year

Nintendo Co., Ltd Immersion Medical, Inc Sony Corporation NVIDIA Corporation Microsoft Corporation

Based on Figure 4.13, we see that in the first two periods, which represent the beginning of the modern video game era, there are no obvious technology leaders and the four companies differ greatly from Period 1 to Period 2. We haven't found the leading companies in Period 1 to have any patents after 1986, thus, we presented the patent numbers from 1981-1985 in the first chart. Similarly, in Period 2, no leading companies have patents in 1990. Nintendo has been listed as one of the top companies since Period 2, slightly behind Wells in Period 2 and Immersion in Period 3. Although the companies with the highest patent numbers vary from period to period, the variety seems to decrease as the industry evolves. Immersion appears from Period 3 and, since Period 4, Nintendo, Sony, Microsoft and Immersion keep their positions as the major players. Nintendo gradually gained the competitive advantages in technological competencies and became the leader in Period 4 with 53 patents, while Sony has 25 and Microsoft has 37. However, its dominance is soon replaced by other companies. In Period 5, Microsoft occupied the dominant position with 127 patents, followed by NVIDIA with 92, Sony with 35 and Immersion with 33. Nintendo only has 20 patents, falling far behind its competitors.

Additionally, we examine the number of patents and the key classes for these three major players, as shown in Figure 4.14. Since Sony and Microsoft become the major players after Period 3, we only compare their patents on the later three periods, 1996-2000, 2000-2005 and 2006-2008. In these three periods the pattern of key classes has changed compared with the previous periods. While in Period 1 and Period 2 Classes 463 and 273 are identified as the major classes, Class 345 replaces Class 273 and becomes the major class since Period 3. However, in Period 5, Classes 463, 345 and 715 become dominant. The number for Class 345, which provides means or apparatuses for computer graphics processing and selective visual display systems, grows from 52 in Period 3 (126 total patents) to 413 in Period 4 (441 total patents) and 569 in Period 5 (613 total patents). Class 715, which provides for data processing means or steps, appears in 128 patents in Period 5. Led by Sony and Microsoft, the technology development trend in the video game industry seems to have been broadly extended to the domain of electronics and data processing.

Figure 4.14 (a) US Patent No. of three major players ("game console")

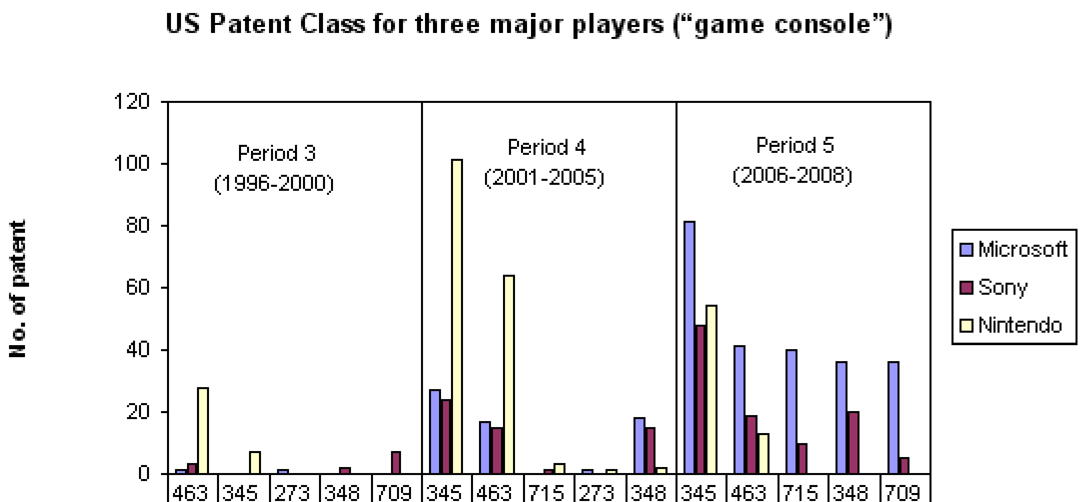


	96	97	98	99	00	01	02	03	04	05	06	07	08
Microsoft	0	0	1	0	0	0	2	5	11	19	46	48	33
Sony	1	0	0	1	1	2	1	3	11	8	13	14	8
Nintendo	0	4	0	1	5	5	13	13	11	11	9	8	3

Year

In Period 3 of Figure 4.14 (a), Nintendo has more patents than Sony and Microsoft, although the overall number is small in comparison with the following periods. In Period 4, the overall number has greatly increased and, although Nintendo is still ahead of Sony and Microsoft, both are clearly catching up. In 2004 all three companies have 11 patents and in 2005, the number from Microsoft exceeds the number from Nintendo. Nintendo's dominance is completely replaced by Sony and Microsoft in the last period, and the gap between Nintendo and Microsoft, the current leader, appears insurmountable. Nintendo seems to slow down its technological development since Period 4.

Figure 4.14 (b) US Patent Class for three major players ("game console")



	463	345	273	348	709	345	463	715	273	348	345	463	715	348	709
Microsoft	1	0	1	0	0	27	17	0	1	18	81	41	40	36	36
Sony	3	0	0	2	7	24	15	1	0	15	48	19	10	20	5
Nintendo	28	7	0	0	0	101	64	3	1	2	54	13	0	0	0

The patent classes for the three companies in the last three periods are then examined. In Period 3 and Period 4 Nintendo enjoyed overall dominance, especially in Class 345 (relating to computer graphics processing) and Class 463 (including means for processing electronic data in video games). Despite the overall performance, Sony and Microsoft surpass Nintendo in some other classes. For instance, in Period 3, Sony has the most patents in Class 348 (generating, processing, transmitting or transiently displaying a sequence of images) and Class 709 (relating to electrical computers and digital processing systems) and in Period 4, both Sony and Microsoft significantly exceed Nintendo in Class 348. In the last period of Figure 4.14 (b), Nintendo has completely lost its dominance in every Class. As for the classes that have appeared in both Period 4 and Period 5, the number for Nintendo decreases while the patent numbers for Sony and Microsoft dramatically increases. Microsoft enjoyed the leadership position in the last period.

In summary, we can draw the following conclusions from the patent analysis above:

1. Nintendo didn't show strong technology leadership in the history of the "technology-intensive" video game industry based on the patent data. As seen from Figure 4.13 along the five periods of time, the companies who are most superior in the technology competencies of game console development vary from period to period (when measured by their number of patents). Although Nintendo has been in the video game industry for two decades, we cannot identify evidence to demonstrate its dominance in terms of technology development relating to "game consoles".
2. Nintendo is weaker than Sony and Microsoft in its technological competencies. As indicated in Figure 4.13 and Figure 4.14, Nintendo has fewer patents than Sony and Microsoft in the latest period. When Sony and Microsoft entered this market as new entrants in 1994 and 2001 respectively, Nintendo enjoyed temporary advantages in technological competencies due to its longer experience. However,

after a period of growth, Sony and Microsoft soon replaced Nintendo's technological leadership in the area of "game consoles".

3. Nintendo is stronger than Sony and Microsoft in terms of learning from previous experiences in the technology development of "game consoles". This is indicated by the highest self citation rate and longest average patent age shown in Table 4.1.
4. The technology development trend for game consoles gradually expands to the areas of electronics and data processing, as indicated by changes in the type and number of patent classes during the five periods, as we have discussed above.

4.4 Wii

The Wii, pronounced 'we', released in late 2006, is Nintendo's new home video game console that represents a critical step into a new era of entertainment. The most unique aspect of its design is called the Wii Remote, a wireless and motion-sensitive controller. The ergonomic design links the player's movements and direction pointed at in space directly to the display and changes on the screen, acting as warrior's sword, artist's paintbrush or golfer's club, rather than the common combination of buttons and joysticks. As the most multifaceted gaming device ever, the Wii Remote plays into the conventional motions that a person makes everyday, offering an intuitive, natural way to play games. Except for the Wii Remote, the Wii is the only 24-hour sleepless machine ever. This allows Nintendo to send monthly promotional demos during the night to each Wii console in each household, tightly connecting Wii players to Nintendo. Satoru Iwata shared his thoughts on his ambitions for the "Wii" saying that "users would wake up each morning, find the LED lamp on their Wii flashing, and know that Nintendo has sent them something …The key merit here is having promotional material delivered to your home, instead of having to go collect it yourself." To promote their new strategy behind the Wii, a lot of video clips showing its different kinds of gameplay experiences can be downloaded from the Wii's official website. The most typical examples are shown in Figure 4.15, describing how the Wii can be played by seniors, when all family members are together or in parties and gatherings.

Figure 4.15 Experiences on Wii

Source: us.wii.com/experience_gallery.jsp

After the first launch in the U.S market on November 19, 2006, the Wii took off to an outstanding start with worldwide sales of 5.84 million units within the first five months. From Nintendo's financial result briefing for the mid-term of FY2008, there is a significant increase (132.5% and 143.7%) in sales and net profit thanks to sales of the Wii and DS Lite (Nintendo's portable hardware). Abundant evidence from newspapers, magazines and company annual reports illustrates that Wii has become the world's best-selling next-generation console. According to the console sales report for April 2008 released by NPD.com, a leading market research company, Nintendo's Wii and DS took the number one and two slots in hardware sales in April 2008, and the Wii outsold the PlayStation 2, PlayStation 3 and Xbox 360 combined. The Wii has successfully leapfrogged the Xbox360, even though Microsoft launched it a year ahead of Nintendo, and outsells the PlayStation 3 which features with its new Blue-ray technology.

4.4.1 Wii's development

We present data regarding the Wii's development process mainly based on interview transcripts "Iwata Asks", available from the official website. To mark the Wii's launch, Nintendo CEO Satoru Iwata conducted a unique series of interview where he revealed, in detail the creation of the Wii, including the Wii Hardware, Wii Remote, Wii Channels and the most popular million-seller game titles for the Wii. We selected the most influential statements from these interview sheets and interpreted them according to the company competencies we deduced from the literature review chapter. We categorized the statements into the four groups of company competencies and listed in Table 4.2. In addition to these documents, our data is collected from other secondary sources and public archives such as company financial statements, annual reports, expert electronic gaming magazines (EGM, Famitsu and IGN.com), business newspapers (The Economists and

Financial Times), technical and marketing reports from professional research organizations (iSuppli, Semiconductors Insights, and NPD.com) and Wikipedia.org.

5: Satoru Iwata, President and CEO, Nintendo Co. Ltd.
6: Shigeru Miyamoto, General Manager, Entertainment Analysis and Development Division
7: Genyo Takeda, General Manager Integrated Research and Development Division
8: Akio Ikeda, Integrated Research and Development Division, Product Development Department, Development Group No. 5
9: Kenichiro Ashida, Integrated Research and Development Division, Product Development Department, Design Group
10: Junji Takamoto, Integrated Research and Development Division, Product Development Department, Development Group No. 3
11: Kou Shiota, Integrated Research and Development Division, Product Development Department, Development Group No. 2
12: The website of Nintendo carries a series of interviews titled "Iwata Asks" on the development of Wii. See http://www.nintendo.com/wii/what/iwataasks/volume-1/part-1

Table 4.2 Data from interviews

Competencies	Types	Statement	Interviewee
Market competencies	Customer	Conventional path would eventually lead to a battle of sheer brute force with competitors and fewer and fewer **consumers** would able to keep up	Iwata[5]
		General public people couldn't tell the difference in the expression powers of GameCube and PS 2 on one hand, and N64 and PS on the other.	
		Only when we can make a design that's accessible to **everyone** will be able to introduce people to a variety of software.	Miyamoto[6]
		Human-machine interface: an intrinsic part of the whole developmental process	Takeda[7]
		Sheer inefficiency of the path "faster and flashier" when we compared the hardship and cost of development against any new experience that might be had by our **customers**.	
		Controller: the nearest thing to the **player**.	Ikeda[8]
		The age range of our **users** is changing: a toy VS a piece of AV equipment.	Ashida[9]
		Based on the kind of lifestyle our **customers** lead, and due to the fact that our controllers are wireless, I think we made the right decision.	Takamoto[10]
	Social Environment	**Society**'s bad image about games will change if **non-gamers** appreciate how enjoyable the games are, and it will be even easier to produce "traditional" games	Iwata
Collaborative relations	Third-party developers	Wii's controllers are perfectly suited **for FPS games**, as well as other area where rather sophisticated play control systems have already been established.	Iwata
		Immediately after **the external game creators** had a go on Wii, they started coming up with ideas, discussing what they could do and how they could do it	Ikeda
	Peripheral makers	One-handed controllers have definitely been released by **peripheral makers**. But it's not so easy for hardware makers to turn their back on the past and race in an entirely different direction.	Iwata
	Components makers	When this kind of **technology is eventually integrated into televisions**, there may no longer be any need for the **sensor bar** to reach reliability.	Miyamoto
		Development partners have naturally tends to present us with new technologies and ideas.	Shiota[11]
		The technologies that form the basis of **all semiconductors** are not different from each other. Yet, how these fundamental technologies are applied depends on the device.	

Competencies	Types	Statement	Interviewee
Incorporating internal complementary knowledge	First-party developers	Nintendo had to reply upon **its first-party titles** to create the momentum	Iwata
		Conflicts for the **game designer**: simple and easy to understand VS complex and challenging	Miyamoto
		The entire **software team** has been under constant pressure to come up with new ideas to attract the public	
		Many request and ideas received from **game creators** during hardware developers	Ashida
		The idea of Nunchuk is a request from the **development teams for Metroid**	
		Software titles ask for a new kind of controller using both hands, that can offer a new type of gameplay	
		I've never encountered ID so closely connected to **software** until I started at Nintendo	
Learning from unique historical conditions and environment turbulence	Previous Generation	**GameCube**: a single large button standing out to be accessible	Iwata
		Wii is turning all of Nintendo's history on its head while also going back to our roots	
		The dominance of "**d-pad** with two main buttons" interface proves what now appears quite unusual, may very well become the new standard.	
		GameCube was built as an extension of its predecessors while Wii takes a jump to a different dimension	
		The success of **NES** comes from its accessibility	Miyamoto
		Experience with the **DS** makes a breakthrough. People will try to make games simpler than they need to be.	
		Nunchuk is originally designed by one of the young developers involved in the project aimed at selling packaged peripherals with **GameCube** games	Takeda
		Specific teams were formed and given free rein to couple a dedicated controller or peripheral with a **GameCube** title.	
		"Pocket Pikachu" a **mobile game** using a pedometer	Ikeda
		"Kirby Tilt 'n' Tumble", a **Game Boy Color game** using an accelerometer	
		The **GameCube** controller was the culmination of all controllers that had come before it and it couldn't be improved via the traditional concept of simply adding to it.	Ashida
	Organizational Environment	This controller became a reality due to **our constant belief** in the need to keep entertainment fresh and our ambition to do new things	Takeda

Nintendo claims that it has applied advanced technologies in unprecedented ways. "Wii takes full advantage of state-of-the-art semiconductor technologies, but its application of them differs greatly from that of other devices," said Mr. Kou Shiota, who is in charge of the technological aspects of the Wii.

During the Wii's development, Nintendo mostly relied on off-the-shelf components and a host of technologies developed by other companies. According to Nikkei Weekly (February 25, 2008), the Wii's 729 MHz chip can be bought at Kmart. From the same article as well as Wikipedia.org, we learnt that the Nintendo Wi-Fi USB Connector actually uses a common chipset and functions as a standard wireless adapter produced by Buffalo Technology and Ralink. Datel has released a wired LAN adapter for the Wii which plugs into one of the USB 2.0 ports. Mitsumi Electric also provides the Wii's wireless LAN module and parts for its controllers, while helping assemble the machine. Nintendo's AC adaptor is produced by Tabuchi Electric. The Opera Software, who was previously responsible for the browser for Nintendo's handheld hardware, takes charge of the development of the browser for the Wii's Internet Channel. Even for the Wii Remote, the key to the Wii's uniqueness, its central technologies are provided by Analog Devices Inc. and ST Microelectronics Inc. Table 4.3 shows the various components of the Wii Remote, their producers and the estimated cost. Moreover, Nintendo outsources nearly all of the Wii's production to Taiwanese firms. In contrast to Nintendo's outsourcing strategy, Sony invests heavily to create their high-tech central processing unit "Cell" and produces nearly 40% of the console's components in-house, resulting in an unbearable loss. According to a report from iSuppli Corp., a market research company specialized in taking apart high-tech gears to see how they work, the loss on PlayStation 3 is more than $240 per console. A similar loss happens to Microsoft. Also based on iSuppli's report, the cost for each HDD-equipped Xbox360 console is around $470, excluding other accessories, which is much higher than the two selling prices at launch: $399 for Xbox360 Package and $299 for Xbox360 core. Although iSuppli didn't tear apart the Wii, the cheap price of Wii's Central Processor PowerPC Broadway and the cost breakdown for the Wii Remote undoubtedly lead to the Wii's lower cost. Toyo Economics TK newspaper has published a tear-down analysis of the Wii, and its cost is estimated to be around $160 (December 15, 2006). Since the Wii is priced at $250, Nintendo is the only home video game console manufacturer who stands to make money on the hardware rather than only on the royalty fees from software publishers. Normally, the royalty fee is the largest part of the hardware manufacturers' revenue (Southwest Securities, Interactive Entertainment Software: Industry Report, Fall 2000).

Table 4.3 Breakdown of Wii Remote

Name	Producer	Location	Function	Estimated Cost
Accelerometer	Analog Devices	Boston	Detects the 3-D movement of the Wii Remote	$2.50
Basic memory Chip	STMicroelectronics	Milan	Store basic data about the game in use	$0.25
Audio amplifier	Rohm	Japan		$0.50
Data converter	Microchip Technology	Aizona, Washington, Bangkok, or Bangalore	Changes the analog signals from the accelerometer into digital data and sends them to the Bluetooth chip	$0.50
Rumble pack	Various company	Asia	Creates vibrations, e.g., the thwack of a tennis ball getting hit	$2.50
Bluetooth chip	Designed in California by Broadcom, manufactured by Taiwan Semiconductor Manufacturing Co.	Taiwan	Provides wireless link to Wii console	$2.00
Audio translator	Rohm	Philippines and Japan	Converts analog data such as human speech into a digital data stream. This feature is unused now but will probably be employed in the future games.	$2.00

Source: http://money.cnn.com/magazines/fortune/storysupplement/wiiremote/index.htm

Sony and Microsoft also have their own strategic alliances. They partner with their world-class suppliers and fully utilize their rich experiences in the hardware development related industry. For example, Sony jointly creates the Cell Broadband Engine with Toshiba and IBM, which provides supercomputer-like processing power equivalent to eight individual microprocessors. The super-powerful graphics processor Reality Synthesizer is actually co-developed by Sony and the Nvidia Corp. Microsoft's successful entrance into the video game industry is grounded on solid partnerships with the semiconductor giant Intel, graphics specialist Nvidia and contract manufacturer Flextronics. There are several differences in the collaborative relationships between Nintendo and its component makers compared to the collaborative relationships of Sony and Microsoft. First, Nintendo takes great initiatives to instill its innovation strategy in its partners and encourages them to think and contribute in a "Nintendo style" manner. "Nintendo is always trying to do something new and different. This message has been spread not only within Nintendo, but to other companies as well. As a result, our development partners have naturally tended to present us with new technologies and ideas," said Mr Shiota, who is in charge of the technological aspects of the Wii. Second, Nintendo is good at exploring new partnerships beyond the boundaries of the industry. Nintendo's collaborations with Analog Devices Inc. and ST Microelectronics Inc. start with the Wii's development. MEMS accelerometers were originally used for crash air-bag deployment systems in automobiles, but Nintendo integrated MEMS technology to facilitate intuitive controls in an innovative way. Nintendo expanded their applications into more and more electronic products such as digital cameras, notebooks and mobile phones. Last but not least, rather than driven by the cutting-edge technologies provided by partners, Nintendo generates ideas based on its own experiences and company culture. As Nintendo has a history of being particular about its controllers, take the development of the Wii Remote as an example. According to a statement from Mr. Akio Ikeda, who is directly responsible for the design of controllers and other peripherals, controllers are the nearest thing to players and an intrinsic part of the whole hardware developmental process. As far back as the era of the GameCube, specific teams were formed and given free reign to couple a dedicated controller or peripheral with a GameCube titles. The GameCube's single large button implies that Nintendo has been trying to make the controller more accessible for a long time. "The single large button was the culmination of all controllers that had come before it and it couldn't be improved via the traditional concept of simply adding something", said Kenichiro Ashida. There are several examples which may illuminate the idea of a one-handed controller, such as the stylus pen of the Nintendo DS, a mobile game using a pedometer and a Game Boy Color game using an accelerometer.

In addition to the wireless motion-sensitive controller that allows players to operate with one hand, the Wii adds some other new features. For instance, the Wii has another type of controller called the Nunchuk. It can be held in the other hand, and used simultaneously with the Wii Remote. The combo of the Nunchuk and the Wii Remote offers the most immersive gameplay experience. A typical example to illustrate the collaboration of the Nunchuk and the Wii Remote is playing an American football game. The player can control an elusive quarterback with the Nunchuk controller while looking for an open receiver to throw to with the Wii Remote. The Wii's uniqueness can be also seen from its backwards compatibility and online capability. While the GameCube is only backwards compatible with the portable hardware the Game Boy, Game Boy Color and Game Boy Advanced, the Wii is backwards compatible with all official GameCube titles. Additionally, the Wii is able to play various game titles from even older game machines by providing downloadable games from previous Nintendo systems such as the Nintendo Entertainment System, Super Nintendo Entertainment System and the Nintendo 64, and even some non-Nintendo systems. Through partnerships with SEGA and Hudson, gamers are able to play classic titles from the Sega Genesis and TurboGrafx-16 on the Wii. This is realized through the Virtual Console, a special user-interface included in the Wii Channel that is a concept unexplored by any other console, and was developed as a part of the Initial Program Loader (IPL), the equivalent of what would be called the operating system on a personal computer. Different Channels have different functions but serve a common objective: helping Nintendo provide new services to customers and continue communicating with customers after their purchase, e.g. weather forecasts, a virtual letter box for each family member and a fresh way to view digital photos. It also opens the door of "price variety" for game titles. When traditional means of distribution seem hard to reduce titles' prices, this online shopping channel is likely to pave the way for lowering software costs. All of these discontinuous changes are achieved by Nintendo using state-of-the-art technologies provided by its technological partners.

4.4.2 Wii and Its Competing Products

While the mainstream competitive dimension in the video game market is led by Sony and Microsoft's high-end technological innovation strategy, advanced processing speeds and stunning graphics, the Wii tried to overthrow their dominance by discontinuous innovations in other aspects. For a home video game console, the processing speed, sound, graphics, memory, storage and media are taken as primary performances, while the secondary features refer to the controller, backwards compatibility, online capability and connectivity. The relevant data is shown in Table 4.4.

Table 4.4: Comparison of four dimensions

	Wii	**PlayStation 3**	**Xbox360**
Performance	• Broadway processor, clocked at 729 MHz • Stereo sound • 88MB main memory • SDTV resolutions • 243MHz GPU • DVD	• Cell processor, clocked at 3.2GHz • 7.1 Dolby Digital • 256MB main memory • HDTV resolutions • 550MHz GPU • Blue-ray	• Xbox360 processor, 3 chips clocked at 3.2GHz • 5.1 Dolby Digital • 512MB main memory • HDTV resolutions • 500MHz GPU • HD-DVD
Features	• Motional wireless controller • Online other service • Back compatibility • Connectivity 24-hour sleepless Wii Channel	• Wireless Controller • Online game • Back compatibility • Connectivity	• Wireless Controller • Online game • Limited back compatibility • Connectivity
Aesthetics	• Less than 51 mm (H) x 152(W) x 216mm (D) • About 2kg • Silver	• 98 mm (H) x 325 mm (W) x 274 mm (D) • Approximately 5 kg • Black & silver	• 83 mm(H) x 309 mm (W) x 258 mm (D) • 7.7 lbs • Black & silver
Perceived Quality	A design for everyone	Super computer entertainment system	

Since aesthetics and perceived quality vary from customer to customer and manufacturer to manufacturer depending on their subjective judgment, we will focus our analysis on primary performance and secondary features. To illustrate the Wii's technological and commercial discontinuity along these two dimensions, not only do we make comparisons among the major home video game consoles in the current generation, but also extend the comparisons to their predecessors (Table 4.5). The early success of the PlayStation convinced Sony to innovate through cutting edge technological development. To satisfy the taste of avid gamers, they put their money and resources into the dimensions of primary performance for game consoles. For the PlayStation 2, Sony developed a powerful processor that challenged cheap PCs as the entry-level device of choice for home access to the Web. Continually pursuing the high-tech path to super computer entertainment systems, Sony introduced the sophisticated next generation game console the PlayStation3, equipped with state-of-the-art technology such as the Cell microprocessor and Blu-ray format. The same mindset can also be seen in Microsoft who competes directly against Sony. Microsoft introduced its new next-generation console the Xbox360 with a triple core CPU, and an unprecedented amount of RAM (512 MB of 700 MHz GDDR3 RAM), features that appeal to the game developers. The most outstanding advantage of the Xbox series is the Xbox Live online services. The Xbox Live provides a platform for gamers to play with other gamers, regardless of location, via a broadband connection, gives users access to voice chatting and downloading new content to their systems. Although the emergence of Xbox Live is also new and discontinuous to the video game industry, Microsoft's strong technological competencies in game console development make it capable of heavily innovating along primary performances and directly fighting against Sony. Contrarily, Nintendo's technological competencies are inferior and the Wii's improvements along primary performances are relatively minor.

Table 4.5 Comparisons of primary performance and secondary features

Manufacturer		Nintendo		Sony		Microsoft	
Model		Wii	GameCube	PS 3	PS 2	Xbox360	Xbox
Performance (Primary)	CPU	729 MHz	485MHz	3.2GHz	294MHz	3.2GHz	733MHz
	GPU	243MHz	162MHz	550MHz	147MHz	500MHz	233MHz
	RAM	88MB	40MB	256MB	32MB	512MB	64MB
	ROM	Built-in flash memory	Memory Card	Detachable HDD	Memory card	Removable HDD	Internal HDD
	Audio	Stereo sound	Stereo sound	Dolby Digital 7.1 surround sound	Dolby Digital 5.1 surround sound	Dolby Digital 5.1 surround sound	Dolby Digital 5.1 surround sound
	Video	480p, 480i or 576i	480p, 480i or 576i	HDTV resolutions from from 480i up to 1080p	from 256x224 to 1280x1024	720p,1080i,1080p	480i, 576i, 480p, 720p and 1080i
	Disc Media	DVD	miniDVD	Blue-ray	DVD	HD-DVD	DVD
Feature (Secondary)	Online capabilities	Yes	Yes	Yes	Yes	Yes	Yes
	Connectivity	Wi-Fi USB, Bluetooth, LAN Adaptor	Broadband Adapter or Modem Adapter	Ethernet, IEEE 802.11b/g Bluetooth 2.0	IEEE1394, USB	Ethernet, IEEE 802.11 a,b,g	Ethernet
	Backwards Compatibility	Yes	Yes	Yes	Yes	Limited	N.A
	Controller	Wireless motion-sensitive controller	Analog Controller	Wireless Controller	Analog Controller	Wireless Controller	Analog Controller

To contrast the primary performance and secondary features of these game consoles, we plot their offering levels into three radar charts. This is shown in Figure 4.16 and represents the three generations in video game history since Sony entered the market. The primary performances are indicated by their technical specifications of CPU, GPU, max-resolution, ROM and RAM, which represent the offering levels of processing speed, graphics, storage and memory. We measure the offering levels for the primary performances according to their numerical figures. For instance, in the factor of CPU, both the PS3 and Xbox360 are 3.2 GHz, while the Wii is 729 MHz. We take the CPU for the PS3 and Xbox360 as 100%, which means that the Wii is about 23% (729/3200). As for the secondary features, the comparison relies mainly on subjective judgments. We collected the opinions from a specialized video game forum from China, as well as several graduate students in National University of Singapore and video game shopkeepers based in Singapore[13]. They were interviewed through telephones, emails or face-to-face talks. Finally, we got 5 respondents from forum, 6 respondents from NUS students and 16 respondents from video game shopkeepers. All these respondents are avid gamers who have been playing or keen on video gaming for over ten years. And in these video game shops, we saw all the three video game consoles and a variety of game titles in current generations, as well as some game consoles and video games for previous generations. During the chatting with the shopkeepers, all of them said that the Wii was the best seller so far. The respondents were asked to score consoles according to the following rules. For each factor, the best offering level is scored as 10 and is used as a benchmark to measure

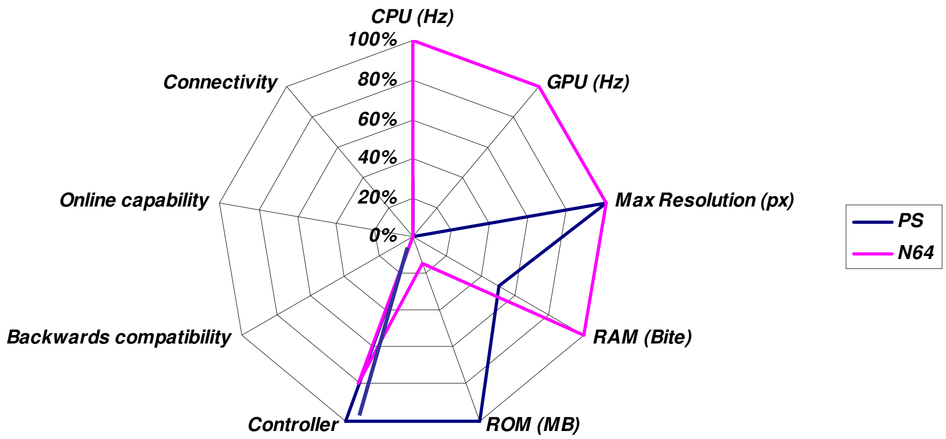
13: It is a limitation to study a global market with only data from Chinese and Singaporean gamers. However, the demographics for the video game industry traditionally focus on age and gender rather than ethnicity. Additionally, due to the emergence of massively multiplayer online games (MMOGs) (Novak, 2004), the boundary of nations are broken, and the impact of ethnicity and geography can be eliminated.

the offering levels of other products in the same generation. For example, if the Wii's controller is perceived as the best one, we score it as 10 and take the Wii's offering level as the benchmark. Then respondents might score the offering level of the controllers of the PS3 and Xbox360 at 8 and 9 respectively. The process and results of the secondary features analysis are summarized in Appendix B.

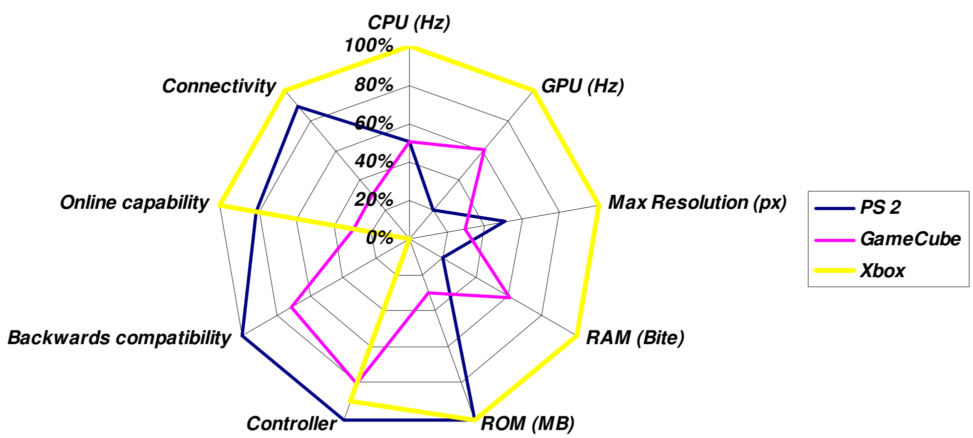
Both the PS3 and Xbox360 experience dramatic increases in terms of primary performances, e.g. they show nearly a 20 times increase in storage as measured by ROM, On the other hand, Nintendo's increase is very slight, within the same numerical magnitude. Along other performance factors like central processing speed, graphics, processing speed and the amount of RAM, Nintendo also falls far behind its competitors in terms of the degree of improvement. From these charts, we can easily see the shift in Nintendo's development focus. In the first radar chart, N64 enjoyed great technical advantages. In the second chart, when Microsoft entered this competition, Nintendo's dominance is completely replaced by Microsoft, although its offering level is still comparable with Sony's. The distinction of the innovation focus between Nintendo, Sony and Microsoft is most evident in the last radar chart. Sony and Microsoft continue to pursue the traditional path and compete head to head. In contrast, Nintendo is now far behind in primary performance, and mainly competes with Sony and Microsoft on secondary features. Although it is still hard for Nintendo to achieve extreme dominance in secondary features, it has already achieved significant success by providing a special controller that makes game-playing more accessible and user-friendly.

Figure 4.16 Historical comparisons of Nintendo, Sony & Microsoft

Year of Product Launch



1994
1996



2000
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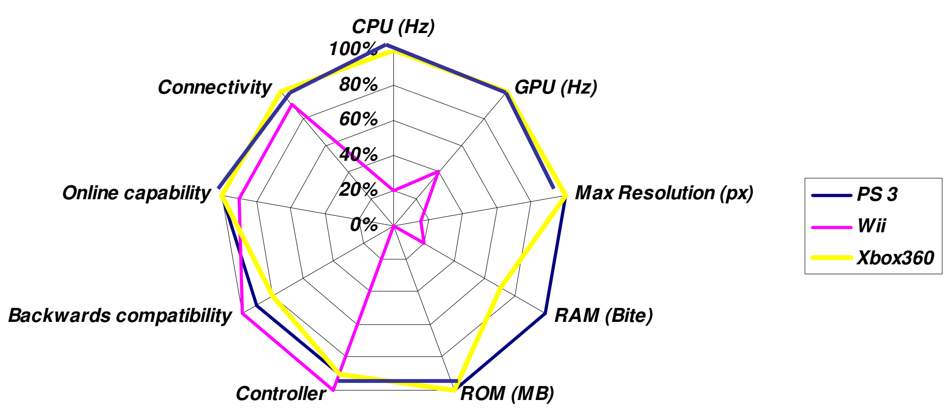


2006
2006
2005

4.5 Conclusion

While previous studies primarily focused on the history of the U.S. video game market (Gallagher and Park, 2002; Schilling, 2003; Clements and Ohashi, 2005), our approach was to look at a single company through a single product, which may contribute to a deeper and richer understanding. Following the background of the home video game industry, Nintendo and its Wii were introduced. The data was then presented according to these three levels: industry, company and product. We examined new phenomena in the current video game industry, Nintendo's new innovation strategy and the Wii's primary performances and secondary features compared with the PlayStation3, Xbox360 and also, their predecessors. We also undertook a comprehensive patent analysis. We tried to discover how Nintendo overcame its weakness in technological competencies and what kinds of company competencies played substantial roles during the Wii's development. The discussion based on the data we collected from various sources will be presented in the next chapter.

Chapter 5 Discussion

5.1 Introduction

After collecting data at the industry, company and product levels, we can now address the two research questions raised earlier: (1) how "inferior-technology" incumbents win over their "superior-technology" competitors through discontinuous innovation and (2) what kinds of competencies are needed for established incumbents to create discontinuous innovations when they are technologically inferior to their peers. This chapter summarizes the insightful research findings, not only answering the research questions we raised earlier, but also illuminating some directions for further research.

5.2 Discontinuous Innovation and Secondary Features

While most of the previous literature studying the relationship between companies and discontinuous innovation strategies drew a line between established incumbents and new entrants (e.g. Abernathy and Utterback, 1978; Henderson and Clark, 1990; Tushman and Anderson, 1986; Anderson and Tushman, 1990; Leonard-Barton, 1992; Christensen and Rosenbloom, 1995; Christensen, 1997), the line between "inferior-technology" incumbents and "superior-technology" incumbents was seldom discussed. In dealing with discontinuous innovations, both "inferior-technology" and "superior-technology" incumbents faced similar difficulties, e.g. being bounded by existing technological paths and the existing customer preferences (Tilton, 1971; Hannan and Freeman, 1977; Tushman and Anderson, 1986; Henderson & Clark, 1990). However, almost all of these studies overlooked that the degree of commitment to old technological paradigms varies from incumbent to incumbent according to their different technological competencies. Additionally, the difficulties and willingness to create discontinuous innovations also varied among established incumbents based on their different competency sets. Based on the patent analysis we conducted earlier as well as the radar chats we plotted in Figure 4.16, we can clearly see that Nintendo is much weaker than Sony and Microsoft in terms of technological competencies, and that the Wii is far behind the PlayStation3 and Xbox360 in terms of processing speed, graphics, storage and other primary performances. However, its outstanding sales figures, the significant increase in profit on Nintendo's financial report as well as the ranking of video game console sales conducted by NPD group strongly prove that Nintendo has gained undeniable success because of its new generation game console the Wii.

The Wii is defined as a discontinuous innovation based on Veryzer (1998)'s framework. However, the Wii is not discontinuously innovative on each product component but provides extraordinary value on certain parts. Figure 5.1 exhibits the positions of the Wii's performances and features using Veryzer's framework (1998). Each bubble denotes a specific attribute. The detailed illustration is explicated as below.

Primary performances: including processing speed, graphics, storage, audio, memory and media. From Table 4.5, we see a limited increase in these factors: less than a one-fold increase in the amount of CPU, GPU and RAM, two-fold increase in the amount of ROM, the same stereo sound, the same storage format, the same resolutions, and a simply upgraded disk media. We positioned them in the quadrant representing a continuous technological and commercial capability.

Secondary features: including online capability, connectivity, backwards compatibility and controller. From Table 4.5, the improvement along the secondary features of the Wii is significant, while the counterparts of the PS3 and Xbox 360 are relatively insignificant.

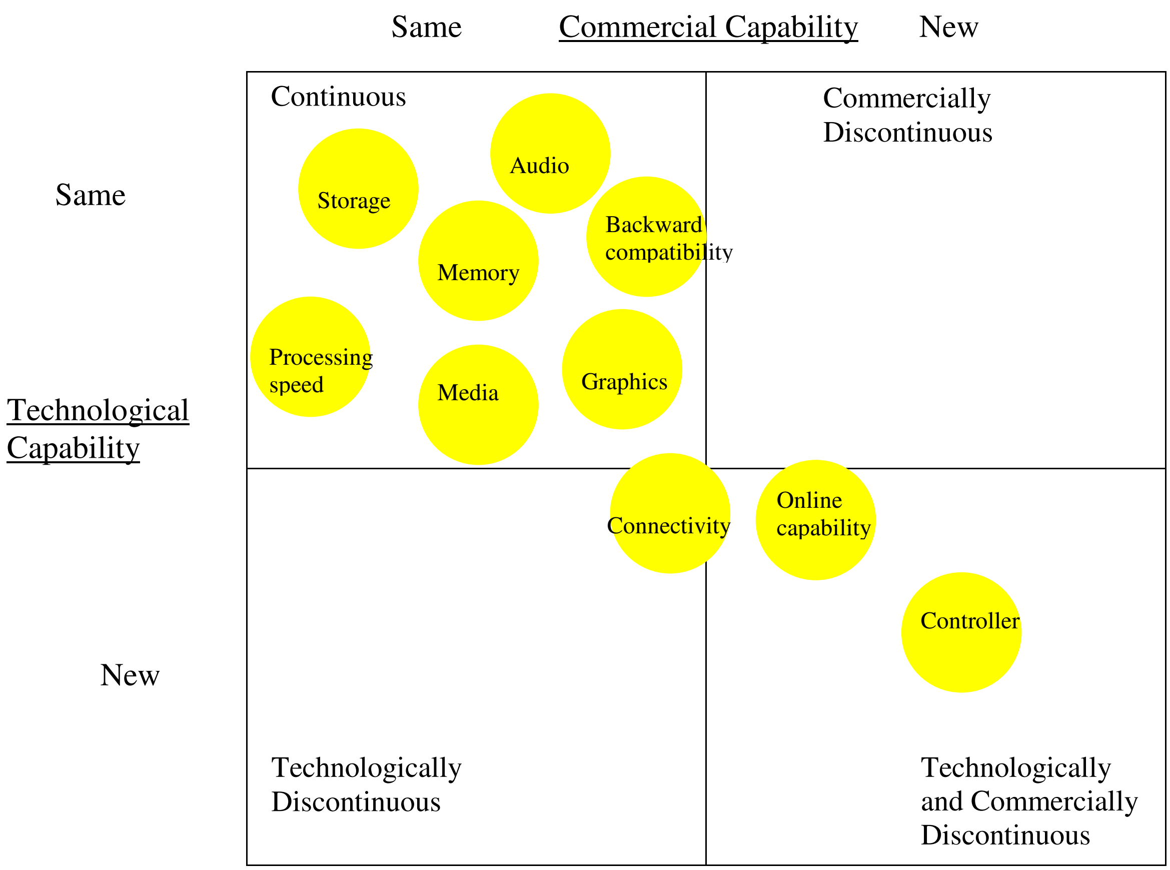
Online capability refers to the online services provided by the game console, including online game playing and other activities. Compared to the GameCube, the Wii significantly improves in this dimension, especially along the commercial capability. As introduced before, the Wii is able to download various game titles from previous generations of game consoles through the Virtual Console, an online platform for downloading game content. Moreover, through other services such as the Wii Channel (e.g. internet channel, shopping channel and forecast channel) and a 24-hour sleepless connection, the Wii is able to continue communicating with customers after their purchase and delivers updates to customers 24 hours a day. Compared to the Wii's competitors and predecessors, these new services bring a different experience to existing customers and inspire the interests of new customers, which fit the characteristics of commercial discontinuity in Veryzer's framework.

The technological capability of online capability relies on the technological capability of connectivity, which refers to ports and peripheral capabilities. While the GameCube is only able to connect with the Internet via a Broadband Adapter and Modem Adaptor, the Wii has achieved a significant technological leap with the help of other technology providers, e.g. Wi-Fi USB connectors, developed by Ralink and Buffalo Technology; a LAN Adaptor, released by Datel; and Bluetooth, designed by Broadcom and manufactured in Taiwan (see Table 4.3). According to experienced gamers' judgments of the offering levels of connectivity, the differences between Nintendo Sony and Microsoft have been dramatically reduced (see Figure 4.16). From the Broadband Adaptor and Modem Adaptor to the USB connector, LAN adaptor and Bluetooth, the technological capability for connectivity improved discontinuously while the commercial function does not significantly change. Thus, we located connectivity in the quadrant representing continuously commercial capability and discontinuous technological capability. The technological capability of online capability is positioned the same as that of connectivity.

Backwards compatibility describes the ability of new game consoles to function the same as the previous generation consoles. In other words, it describes whether the game titles from the previous generations of consoles can be run on the new generation console (Schilling, 2003). The Wii is completely backwards compatible with all official GameCube titles, while GameCube is only compatible with some portable hardware. The improvements of both the technological and commercial capability are continuous, leading to the position of backwards compatibility being the same as that of primary performances.

Finally, our analysis comes to the dimension of the controller, the Wii Remote, which is regarded the most unique design for the Wii. Seen from Table 4.3, a lot of new technologies have been incorporated into the design of the Wii Remote, especially MEMS accelerometer technology. The Wii Remote's technological capability is completely discontinuous in the history of video game controller development. As for the commercial capability, the new experience created by the Wii Remote is the most attractive thing promoted by Nintendo in its advertising activities for the Wii. Unlike the common combination of buttons and joysticks, the Wii Remote can be held in one hand and operated in an intuitive and natural way. It can be also used simultaneously with another controller, the Nunchuk, which is held in the other hand. Figure 4.15 shows the typical experiences when different people play with the Wii. From these pictures, we easily find that the Wii is dedicated to providing new experiences to attract non-gamers, including seniors and females. In contrast to the traditional playing style, that is, the player sits alone on the sofa and holds the controller with two hands, the experience for gamers playing with the Wii is physically moving the body and having fun with other family members or friends. The messages delivered by these pictures strongly support Nintendo's basic strategy written in its annual report: "to expand gaming population regardless of their age, gender or cultural background". This is very distinct from Sony and Microsoft's strategies which aim to provide the experience of stunning graphics, crystal clear sound effects and astonishing processing power to hard-core gamers. Therefore, the Wii's controller is absolutely discontinuous both in its technological and commercial capability, and has been placed in the bottom-right quadrant of Figure 5.1.

Figure 5.1 Wii's technological and commercial capability



Based on the discussions above, we concluded that Nintendo, as an "inferior-technology" incumbent, successfully won over its "superior-technology" competitors, e.g. Sony, Microsoft, through discontinuous innovations on its product's secondary features. Based on the discussions from the previous literature, discontinuous innovations are normally adopted by new entrants. These innovations acquire fundamentally different skills, sacrifice offering levels on primary performances and target at impenetrable or less profitable markets that are usually overlooked by established incumbents (Tilton, 1971; Hannan and Freeman, 1977; Astley, 1985; Abernathy and Clark, 1985; Henderson and

Clark, 1990; Christensen, 1997). However, through our case study of Nintendo's Wii, we found that discontinuous innovations can be also adopted by "inferior-technology" incumbents, but with different characteristics. First, it can happen only along the product's secondary features, which result in the old knowledge infrastructure still being useful in terms of the technological development along primary performance. Second, incumbents can maintain the offering levels along primary performances by conducting continuous innovation, although the degree of improvement may be small compared to the "superior-technology" competitors. The continuous improvement on primary performances leads to the third characteristic of discontinuous innovation when initiated by incumbents, that, both the existing market and the new market can be taken care of. While the discontinuous innovation along secondary features may expand the industry boundary by attracting new customers, it also creates new experiences for the existing customers who may be bored with the existing experiences.

5.3 Discontinuous Innovation and Company Competencies

Based on the previous literature, we summarized the established incumbents' competencies that help them overcome difficulties and successfully respond to discontinuous innovations initiated by new entrants. These competencies fall into five categories: market competencies of shedding unique insights about customer needs or identifying a new market (Abernathy and Clark, 1985), inter-firm collaborative relationships with technology providers (Mitchell and Singh, 1996, and Rothaermel, 2001), incorporating internal complementary knowledge (Tripsas, 1997), learning from unique historical conditions and environment turbulence (Barney, 1991; Hill, 2003) and developing diversified technologies (Ahuja and Lampert, 2001). However, we are more curious about how established incumbents can initiatively create discontinuous innovations. After discovering that "inferior-technology" incumbents can win over "superior-technology" incumbents through discontinuous innovation along their product's secondary features, we try to unveil what kinds of competencies are needed for established incumbent to create discontinuous innovations when they are technologically inferior to their peers.

Based on our patent analysis, we concluded that Nintendo is weak in its technological competencies. Thus, we eliminated the competency of developing diversified technologies from our discussion. Our focus is then put on the other four competencies while examining the data collected at the company level and the product level. These competencies are regarded as companies' heterogeneous resources, accumulated through their idiosyncratic history and difficult for others to emulate (Collis, 1991; Peteraf, 1993; Hoopes, Madsen, and Walker, 2003).

Based on the findings in the previous section, we break down the discontinuous innovations along secondary features into four parts: the technological capability of the connectivity/online capability, the commercial capability of the online capability, the technological capability of the controller and the commercial capability of the controller. Table 5.1 shows the relationship between these four company competencies and the four parts after breaking down the discontinuous innovations along secondary features.

Table 5.1: Linkage between Nintendo's competencies and discontinuous innovation along secondary features

	Secondary Features			
	Connectivity/Online capability	Online capability	Controller	
	Technological capability	Commercial capability	Technological capability	Commercial capability
Market competencies		• Accessibility • Communicating with customer after purchase • A virtual letter box for family member • Price variety		• Accessibility • Controller, the nearest thing to the player (Ikeda) • The life style of customers (Takamoto)
Collaborative relations	• LAN Adaptor: Datel • LAN Module: Mitsumi Electric • Wi-Fi USB connectors: Ralink and Buffalo Technology • Bluetooth: Broadcom • Browser: Opera	• Partner with SEGA and Hudson • Game titles Sega Genesis • Game titles of TurboGrafx-16	• Table 4.3 • One-handed controllers have definitely been released by peripheral makers (Iwata)	
Incorporating internal complementary knowledge		• Game titles of Nintendo Entertainment System • Game titles of Super Nintendo Entertainment System • Game titles of Nintendo 64		• Simple and easy to understand gaming experience (Miyamoto) • Software titles asks for new type of gameplay (Ashida) • Nunchuk is a request from Metroid (Ashida)
Learning from unique historical conditions and environment turbulence		• NES: accessibility • Turning back to the history (Iwata)	• Specific teams coupling controller or peripheral with GameCube titles (Takeda) • GameCube: single large button • DS: stylus • Game Boy Color: accelerometer • Pocket Pikachu: pedometer	• Birth of controller due to constant belief in keeping entertainment fresh. (Takeda)

In contrast to new entrants, incumbents are stronger in their marketing competencies, shedding unique insights about customer needs and the application of technologies (Abernathy and Clark, 1985). With these competencies, Nintendo discovers that the "conventional path would eventually lead to a battle of sheer brute force with competitors and fewer and fewer consumers would able to keep up" (Iwata) and that "the sheer inefficiency of this path when we compared the hardships and costs of development against any new experiences that might be had by our customers" (Takeda). Therefore, Nintendo shifts its innovation path and searches for innovation opportunities along secondary features. Since it is inferior in terms of technological competencies, the opportunities to win through continuous innovation seem to be slim, leading to the decision to create discontinuous innovations.

To compensate for its weakness in technological competencies, Nintendo collaborates intensively with other technology providers. From Table 5.1 we see that the competency to collaborate with various component makers, peripheral makers and third-party developers realizes the technological discontinuities on the online capability, connectivity and controller, as well as the commercial discontinuity on the online capability. This not only helps Nintendo reduce costs, but also allows it to fully take advantage of cutting-edge technologies from others.

For a product that is located in a network and can only add value to customers when it is combined with a complementary product, incorporating internal complementary knowledge can help companies generate more new ideas during the hardware development process. Nintendo repeatedly mentions its "software-driven" mindset in its public annual reports. Nintendo's employees also have positive appraisals of the close relationship between the hardware and software developing teams. "Many requests and ideas are received from game creator during hardware developments.", says Ashida, "It's the teamwork between our hardware and software divisions. This cooperation gives Nintendo the power to come up with new ideas." Intensely incorporating knowledge from internal game developers helps Nintendo's game console development team understand the game developers' requirements. The "entire software team has been under constant pressure to come up with new ideas to attract the public.", says Miyamoto. According to Ashida, "software titles ask for new types of gameplay". Therefore, hardware development groups start to think about discontinuous innovations to make the game console more accessible and create new gaming experiences. This idea finally affects the design of the controller, which is regarded as "the nearest thing to gamers" (Ikeda).

Last but not least, learning from successful and failed experiences from the previous generation consoles is the most precious competency for Nintendo, who is the oldest player among the current video game console manufacturers. These experiences not only stimulated the commercial discontinuity on the controller and online capability, but also provided some insightful suggestions on the technological discontinuity of the Wii's controller. From the NES, Nintendo learnt that only a machine that can be easily operated by everyone is able to gain worldwide popularity. From the GambeCube, Nintendo learnt that it is impossible to improve the accessibility by simply adding something to the existing controller. From the DS, Nintendo learnt that a user-friendly interface can make the machine easily accepted by non-gamers. Especially from the DS's stylus, Nintendo identified the prototype of the one-hand operated controller. From the Game Boy Color, Nintendo began to think about integrating an accelerometer that could detect the movements of players. Finally, from the ups-and-downs in the past two decades of its history in the video game industry, Nintendo learnt that only by keeping a "software-driven" and constantly innovative mindset it can go back to the root of fundamental problems and create breakthrough innovations in a way that "hardware-driven" companies are unable to do.

Both the previous literature about how established incumbents respond to discontinuous innovations (Ahuja and Lampert, 2001; Methe, Swaminathan, Mitchell and Toyama, 1997; Tripsas, 1997; Rosenbloom and Christensen, 1998; Rothaermel, 2001) and this case study illustrating how "inferior-technology" incumbents create discontinuous innovations when competing with their "superior-technology" peers, effectively demonstrate the importance of these four competencies among incumbents' heterogeneous resources. According to the terminology coined by Tyler (2001), these four competencies can be grouped together as companies' "cooperative competencies". Through this case study, we found that cooperative competencies not only help established incumbents defend their dominance in the attack of discontinuous innovations created by new entrants, but also help established incumbents create discontinuous innovations along secondary features when they are technologically inferior to their peers. This finding significantly supplements the previous literature on how established incumbents handle discontinuous innovations.

5.4 Conclusion

This chapter summarized the most substantial findings from our single empirical case and answered the research questions we raised in the literature review chapter. We concluded that the "inferior-technology" incumbents can win over their "superior-technology" competitors through discontinuous innovations along secondary features and their cooperative competencies. Cooperative competencies include market competencies, inter-firm collaborative relations, incorporating internal complementary knowledge and learning from unique historical conditions and environment turbulence. During the creation of discontinuous innovations, cooperative competencies can compensate for weakness in technological competencies. We hope that these findings can help managers overcome the difficulties in technological competencies development and gain uniquely competitive advantages. We also look forward to developing new theories and supplementing the research in the domain of technological innovation management, especially the dynamic between established incumbents and discontinuous innovations.

Chapter 6 Conclusions and Implications

6.1 Introduction

In this chapter, we first summarize the research findings from our in-depth case study of Nintendo's Wii. Implications for scholars and managers as well as, the limitations of this study are then explicated. Finally, this chapter is ended by pointing out some directions for future studies.

6.2 Research Findings

We were motivated to do this research to help established incumbents handle discontinuous innovations and to open the black box of company competencies. Once we understood why established incumbents encounter greater difficulties in the face of discontinuous innovations and how established incumbents successfully respond to discontinuous innovations initiated by new entrants, we raised the research questions that our study aims to address:

- How do "inferior-technology" incumbents win over their "superior-technology" competitors through discontinuous innovation?
- What kinds of competencies are needed for established incumbent to create discontinuous innovation when they are technologically inferior to their peers?

After carefully investigating a living case in the video game industry, we successfully identified the ways that incumbents create discontinuous innovation and the needed competencies. The most important findings are presented below:

- "Inferior-technology" incumbents can win over their "superior-technology" competitors through discontinuous innovation along secondary features.
- Cooperative competencies, including market competencies, collaborative relations, incorporating internal complementary knowledge and learning from unique historical conditions and environment turbulence are needed for established incumbents to create discontinuous innovation when they are technologically inferior to their peers.

Relying on the Wii Remote's technological and commercial discontinuity and other discontinuities along this product's secondary features, Nintendo successfully won over Sony and Microsoft even though it remains technologically inferior to them. During the Wii's development process, Nintendo discovered the changes in customers' requirements and the development difficulties in the software market. Learning lessons from previous experiences, Nintendo came up with ideas to create discontinuous innovations along its controller and other secondary features. It built up tight collaborations with various component makers, peripheral makers and third-party developers while incorporating their new ideas and utilizing their new technologies. With the help of all these cooperative competencies, Nintendo successfully created the Wii, a discontinuous innovation.

6.3 Implications for Scholars

From an academic perspective, this study emphasizes the initiatives taken by established incumbents in launching discontinuous innovations rather than passive responses when they are attacked by new entrants' discontinuous innovations. Cooperative competencies are identified as the major drivers behind this competitive strategy. The previous literature on cooperative competencies relied on the underlying premise that the cooperative competencies provide a temporary competitive advantage if all else is equal (e.g. technological capabilities) (Tyler, 2001). For example, Tripsas's study (1997) in the typesetter industry that partially evidenced that above average cooperative competencies can buffer incumbents from technological limitations. In our study, the case of Nintendo's Wii provides a convincing example that cooperative competencies not only compensate for weaknesses in technological competencies, but also create an exceptional competitive advantage and help the "inferior-technology" incumbents retrieve their market dominance from their "superior-technology" peers.

This study also illustrated a new type of innovation in addition to the disruptive theory proposed by Christensen (1997). Disruptive technology initially underperformed along the dimension of primary performances which mainstream customers historically valued, but had better offering level along an alternative dimension: it can either "attack from below" or "open a new niche market". However, comparing with the typical innovations that result from disruptive technology, the discontinuous innovation created by Nintendo had some unique characteristics. It maintained the offerings along the dimension of primary performances which already exceeded existing customer needs, but augmented the continuous innovation along primary performances by adding discontinuity (e.g. disruptive attributes) along the secondary features. Disruptive attributes refer to the design of the Wii Remote which uses MEMS technology. This case study demonstrated a new derivative of Christensen's disruptive theory and opened a new door for established incumbents. Three strengths of this discontinuous innovation which are created by established incumbents along the product's secondary features are then identified and compared with the discontinuous innovations created by new entrants, e.g. disruptive technology. Firstly, since the discontinuity only happens along secondary features, it doesn't completely make the old knowledge infrastructure obsolete, especially in terms of the technological development along primary performance. Secondly, incumbents can maintain the offering level along primary performances by conducting continuous innovation, although the degree of improvement may be minor compared to "superior-technology" competitors. Finally, since the traditional performances are not sacrificed, incumbents can maintain their existing customers who may be bored with the existing experiences by providing new experiences that result from the discontinuous innovation on the secondary features.

6.4 Implications for Managers

From an industrial perspective, although companies are encouraged to trade technology and knowledge world-wide rather than keep their discoveries highly secret upon the arrival of open innovation (Chesbrough, 2003), the competencies to integrate and coordinate internal resources are still keys to incumbents' success, efficiently compensating for their weaknesses in technological competencies. The different ways to integrate and coordinate internal resources lead to different types and directions of innovation. In this particular case, the strengths of both Sony and Microsoft lie in the primary performances of their hardware. These companies boost their superior technological competencies in hardware development and attract numerous third-party developers by providing a supercomputer-like platform. However, their "hardware-driven" mindsets make them only focus on technology enthusiasts and ignore the nature of the video game industry which is to provide enjoyable experiences for all players. Thus, they continuously innovate along the traditional path. On the other hand, Nintendo, as a company specialized in creating unique "software-driven" entertainment, understands the nature of gaming more deeply than Sony and Microsoft. Nintendo's "software-driven" mindset is developed from its competencies to incorporate internal complementary knowledge and learn from unique historical conditions and environment turbulence. With the help of this mindset, Nintendo is able to explore what gamers are really interested in and adjust its flexible innovation strategy. Although all three of these companies intensively collaborate with component makers, the different ways that they integrate and coordinate their internal resources eventually cause them to pursue different innovation paths.

In contrast to technological competencies, cooperative competencies have two strengths. First, they are harder to imitate because they result from unique historical conditions, are socially complex and the causal linkage between cooperation and performance may be ambiguous (Barney, 1991). Second, it is easily to create flexibility through cooperative competency. Establishing inter-firm collaborations in various layers and areas brings in new opportunities and reduces the risk of core rigidity. Some support for this contention is found in Hagedoorn's work (1995) showing that most strategic technological alliances are not found in core businesses, but rather in businesses related to diversified interests developed in an effort to create flexibility.

Another suggestion for managers is that, as the innovation strategy shifts, the offering levels of primary performances and secondary features may change. This can result in the major functions of the product also changing and the boundary of the industry being reestablished. While established incumbents always heavily invest in innovations along primary performances, new opportunities lie in the dimensions of the secondary features. These are not always appreciated by existing customers, but are able to attract new customers whose preferences are different from those of existing customers. The strengths of cooperative competencies facilitate incumbents to create discontinuous innovations along secondary features despite their weaknesses in technological competencies. For companies who are aiming to create a breakthrough innovation but lack strong technological support, they can concentrate their efforts for discontinuous innovation on one or several components rather than every single dimension of the whole product. Furthermore, these components can be parts of the secondary features rather than aspects of the primary performance in traditional innovation strategies.

6.5 Limitations

The limitations of our work are listed in three aspects: the research methodology we adopted, the nature of the data we relied on and the scope of the whole project.

As we know, case study is a research methodology that has been criticized for its weakness in generalization for a long time (Kennedy, 1979). Although Nintendo is a multi-national company, it was born in Japan and has been greatly influenced by its Japanese culture. Additionally, the video game industry is a special industry belonging to the business of entertainment. We are not sure whether our findings can be generalized to other industries and companies in other nations.

Unlike other research strategies, such as survey, that rely on statistic generalizations, and experiments which can identify cause-and-effect relationships under strictly controlled conditions, the scientific rigor and reliability of conclusions drawn from case studies are always challenged (Kennedy, 1979). In our project, we hardly verify the causal relationship between Nintendo's competency set and the birth of the Wii, and we were unable to recreate all controlled conditions in order to test whether the same result will be achieved. During the investigation process only one full-time investigator was involved, resulting in subjective judgments of the descriptive information. Also, without the aid of multiple investigators, a cross-analysis was not conducted.

The second limitation results from the sources of our data. We mainly draw our conclusions from secondary data. Although the depth and width of this data sufficiently support our analysis, we still feel regretful that no first-hand data was available. We would be more confident about the findings if we could gain access to Nintendo and conduct some fieldwork, e.g. interviews and observations.

Much of the secondary data was collected from public sources and in a retrospective manner which subjects it to the political constraints, competing environments and the memory of past events. All of these factors negatively affect the accuracy of our data and weaken the reliability of our conclusions.

This study was conducted to fulfill the requirements for the degree of Master of Engineering within a two-year time period. Due to the time consideration, our focus lies on Nintendo and its product the Wii in the current home video game console generation with a limited coverage of Nintendo's competitors, Sony and Microsoft, as well as the Wii's predecessors, the GameCube, N64 and so on. By conducting a similar in-depth analysis for Sony and Microsoft, we could improve on the evidence that Sony and Microsoft have inferior cooperative competency sets compared to Nintendo.

6.6 Future Research

Capacious room is left for future research to break the limitations we mentioned above. Multi-case studies or a survey could be used as main research strategies to expand the applications of my findings into other fields, to generate testable propositions based on these findings and then to verify the significance of these propositions. Our work can also be supplemented and refined if researchers in this area are able to get access to the industry, the company and other players along the value chain in the future. We hope that followers of this project could further involve Sony and Microsoft with more exploratory studies.

In addition, this study opens the door for further research that discontinuous innovations can be created initiatively by established incumbents. Future studies may expand to broader areas, e.g. new product development, knowledge management and technology diffusion, and more analytical tools can be adopted, e.g. more sophisticated patent analysis tools, text-mining tools, etc.

As a potential area for future research, it would also be very interesting to discuss about Wii's unintended impacts on other industries, positioning Nintendo as a discontinuous entrant. For example, Wii has unexpectedly entered health care industry due to its contribution in helping people lose weight and improving elder people's health, as well as rehabilitation.

6.7 Conclusion

In summary, this study delivered an effective solution for "inferior-technology" incumbents to compete with their "superior-technology" peers. We demonstrated that it is possible for "inferior-technology" incumbents to overcome their weaknesses in technological competencies by pursuing a discontinuous path along a product's secondary features. In contrast, "superior-technology" incumbents are more likely to pursue the traditional path constantly innovating along primary performances, which is the dimension appreciated by existing customers. We observed that the competencies that effectively help established incumbents adapt to discontinuous innovation created by new entrants can also help established incumbents initiate discontinuous innovations when they are technologically inferior. These competencies are grouped together in the class named "cooperative competencies". We obtained these conclusions through an in-depth case study in the video game industry, but it may be limited in its ability to generalize to other companies and other industries. However, understanding one successful case may offer valuable lessons for managers who are struggling in technology-intensive competitions. They are encouraged to develop unique competency sets rather than restrict their emphasis to R&D and blindly pursue leadership in the most cutting-edge technologies.

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APPENDIX A: Definition of patent classes

Class	Sub-class	Definition
273		Amusement apparatus or means, e.g. games, sports
345		Computer graphics processing and selective visual display systems
	501	Computer graphics processing system
	584	Attributes wherein the information is processed that relates to the characteristics of visual viewing, e.g. texture
	161	Display peripheral interface input device, e.g. joystick
	582	Attributes wherein the information is processed that relates to the characteristics of visual viewing, e.g. texture
	609	Attributes wherein the information is processed that relates to the characteristics of visual viewing, e.g. Bi-linear
348		Generating, processing, transmitting or transiently displaying a sequence of images
	0E5.108	Details of television systems, e.g. reception of a digital modulated video signal
360	137	Apparatus and corresponding processes for the storage and retrieval of information based on relative movement between a magnetic record carrier and a transducer
361	703	Housing or mounting assemblies with diverse electrical components
375		Pulse or digital communication systems using electrical or electromagnetic signals
	240.001	Signal source is a sequence of images which normally vary with time and are intended to portray motion.
	0E7.128	Providing for systems for the transmission of television signals using pulse code modulation, e.g. digital video signal compression
382	286	Apparatus and corresponding methods for extraction of physical properties exhibited by imaged objects
386	131	Apparatus and corresponding processes having specific utility for treating a television signal for dynamic storage or retrieval of the signal, e.g. converting one television format to another.
463		Amusement, recreation, games, chance devices, puzzles, fortune telling, and others
	039	Means for processing electronic data, e.g. wireless signal
	042	Means for processing electronic data, e.g. network

Class	Sub-class	Definition
705	014	Automated electrical financial or business practice or management arrangement, e.g. distribution or redemption of coupon, or incentive or promotion program
709		An electrical computer or digital data processing system or corresponding data processing method for transferring data or instruction information between a plurality of computers
710		Electrical computers and digital data processing systems: input/output
	006	Means or steps for specifying the order in which the peripheral and digital data processing system or computer perform a function in order to transfer the user data between a peripheral and digital data processing system or computer
	073	Means or steps for making certain types of peripheral compatible with digital data processing system or computer, e.g. user input device other than a keyboard or a cursor controller.
712		Electrical computers and digital data processing systems: processing architectures and instruction processing, e.g. processors
	207	Locating and retrieval of instruction data for processing, e.g. fetching of a given instruction or variable before it is utilized
	039	An internal processor mode may be changed by an external means connected to the processor by an electrical contact
	042	Subject matter comprising a CPU on a single integrated circuit chip or on plural integrated chips or in plural discrete units which provide serial processing, e.g. specific functioning of the processor is recited
713	171	The transmission and reception entities exchange information during authentication which establishes an operational key.
715		Data processing: presentation processing of document, operator interface processing, and screen saver display processing
717	168	Means or steps for modifying an existing operating system, application program, or other executable program, in order to produce an upgraded or updated program.
725	080	Means or steps for controlling the communication with, or communication between, diverse elements within the structure.

APPENDIX B: Survey for secondary features

After collected the data from the respondents, we used a statistic tool Analysis of Variance (ANOVA) to verify whether the data from three different sources can be combined together as samples from a single population. ANOVA is specialized in testing for differences among at least three groups, since the two-group case can be covered by a T-test. In our study, the level of significance is set at 0.05. The results are summarized in Table 1.

Since neither N64 nor PS had connectivity, online capability and backwards compatibility, the comparison in this generation is only for the controller. Furthermore, all the respondents give 10 to PS2 in terms of backwards compatibility. And since Xbox is the first product of Microsoft, backwards compatibility is not applicable. Therefore, we eliminate the verification of backwards compatibility of PS2 and Xbox from this generation.

Based on Table 1, all the p-value for the F test are greater than 0.05, which indicates that from statistical point of view, the three samples from different sources are not significantly different. Therefore, we could regard them as samples from the single population.

We then calculated the average score for each item and re-scored them according to our rule. Finally, in order to be consistent with the labels of primary performances, we translated the new scores into percentages, see Table 2.

Table 1: Summary table of ANOVA

	Average (group1)	Average (group2)	Average (group3)	p-value	Average (general)
Controller: PS	9.6	10	9.75	0.585	9.778
Controller: N64	8.8	7.333	7.875	0.296	7.926
Connectivity: PS2	8.8	9.333	8.625	0.675	8.815
Connectivity: GameCube	2	2.333	3.5	0.529	2.963
Connectivity: Xbox	9.8	9.833	9.063	0.273	9.370
Online capability: PS2	8.6	8.5	8.063	0.774	8.259
Online capability: GameCube	0.8	1.167	3.563	0.064	2.519
Online capability: Xbox	10	10	9.625	0.406	9.778
Backwards compatibility: GameCube	6.8	7.333	6.188	0.588	6.556
Controller: PS2	9.6	10	9.375	0.450	9.556
Controller: GameCube	7.6	8.167	7.188	0.484	7.481
Controller: Xbox	8.6	9	8.5	0.750	8.62962963
Connectivity: PS3	8.8	9.167	9.313	0.600	9.185
Connectivity: Wii	8.8	9.167	8.438	0.489	8.667
Connectivity: Xbox360	9.2	9.167	8.5	0.517	8.778
Online capability: PS3	8.8	8.833	9.188	0.687	9.037
Online capability: Wii	9.4	8.667	7.938	0.089	8.370
Online capability: Xbox360	9.4	9.833	9.25	0.472	9.407
Backwards compatibility: PS3	8.4	9.333	7.438	0.278	8.037
Backwards compatibility: Wii	9.6	9.833	8.75	0.336	9.148
Backwards compatibility: Xbox360	7.4	8.667	7.063	0.165	7.481
Controller: PS3	8.4	8.833	8.063	0.453	8.296
Controller: Wii	9.2	9.667	9.313	0.748	9.370
Controller: Xbox360	8.6	9	8.938	0.811	8.889

Table 2: New scoring for the secondary features*

	PS		N64		PS 2		GameCube		Xbox		PS 3		Wii		Xbox360	
Connectivity	0	0	0	0	9	90%	3	30%	10	100%	10	100%	9	90%	10	100%
Online capability	0	0	0	0	8	80%	3	30%	10	100%	10	100%	9	90%	10	100%
Backwards capability	0	0	0	0	10	100%	70	70%	0	0	9	90%	10	100%	8	80%
Controller	10	100%	8	80%	10	100%	8	80%	9	90%	9	90%	10	100%	9	90%

* The new score is obtained from following method: for example, the average scores for the controllers of the PS and N64 are 9.78 and 7.93, thus, we re-score the controller of the PS at 10, and relatively, the new score for the controller of N64 is 8 (7.926*10/9.778).