

MANAGERIAL COGNITION AND INNOVATION MANAGEMENT
IN THE PHARMACEUTICAL INDUSTRY

THE SUCCESS OF GENENTECH

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MANAGERIAL COGNITION AND INNOVATION MANAGEMENT IN THE PHARMACEUTICAL INDUSTRY – THE SUCCESS OF GENENTECH

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Abstract

The purpose of this paper is to add further knowledge to the research on organizational evolution, concerning managerial cognition and organizational innovation activities. In our view, managerial cognitions are an essential link between organizational activities and developments in the business environment. Managerial cognitions, in combination with an organization's alignment with industry recipes, fundamentally influence on how an organization is able to balance between explorative and exploitative innovation activities. Pursuing this balance is essential for organizations in order for them to adapt to changes in their business environment and thus survive and succeed in the long-run. We construct a historical case study on Genentech, one of the first and largest biotechnology companies in the world, to depict how explorative and exploitative innovation activities evolve alongside senior management cognitions. Our descriptive approach presents a nuanced view of the dynamic, context-specific and sometimes conflicting issues behind the coevolution of organizations and the business environment. We expand on the key factors behind Genentech's extraordinary performance in bringing new health care solutions to market. Finally, we offer five propositions on how managerial cognitions might generally direct organizational innovation activities.

KEYWORDS: managerial cognition, innovation management, coevolution, exploration, exploitation, biotechnology

Introduction

Innovation activities are in the very core of the pharmaceutical business. Pharmaceutical companies have to be able to discover, develop and market new drugs in order to stay ahead of the strong competition. As drugs can usually be easily copied, it is very hard for a single company to protect its competitive position after its patents expire without creating new offerings. The development of biotechnologies, which can be seen as a continuous stream of interlinked innovations, has hugely impacted on the ways drugs are discovered in the pharmaceutical business, and ultimately on the whole industry recipes. Founded in 1976 in the United States, Genentech has continuously been on the forefront of this development, making it a fruitful target for case research.

In the strategic management literature, there has lately been interest in the evolution of organizations – how organizational adaptation, performance, and survival are intertwined with the developments in the business environment. It has been suggested that organizations need to adapt by balancing between explorative and exploitative innovation activities in order to survive and succeed in the long run (March, 1991). Another perspective that has recently gained prominence emphasizes the role of senior management, and managerial cognition in particular, in defining how organizations are able to adapt to their changing environment (Garud & Rappa, 1994; Kaplan, Murray, & Henderson, 2003; Tripsas & Gavetti, 2000). Managerial cognition can be seen as an intermediate element between organizations and “developments in the society and technology, and the structure, ideology, and the systemic properties of the firm” (Lamberg & Tikkanen, 2006).

However, there has been little research on the possible role of managerial cognition in the adaptation of organizations through balancing between different innovation activities. In this paper, we analyze how managerial cognitions are related to the success of balancing between explorative and exploitative innovation activities. We study how Genentech, its structure and processes, have co-evolved with the business environment, focusing on the cognitions of its top management and analyzing the key factors that have enabled Genentech to keep bringing innovative health care solutions to market. We conclude by offering five propositions on how managerial cognitions might generally direct organizational innovation activities.

This paper continues by providing a theoretical background for our research. First we outline a framework that is used to construct an account of the evolution of Genentech. Before the case analysis, we shortly go through some essential managerial issues related to the pharmaceutical industry. We then describe how Genentech’s managerial cognitions and innovation activities have evolved in tandem with the development of the business environment, concluding with a summary of the essential factors behind Genentech’s success. Finally, we propose how managerial cognitions influence on firms’ innovation management and offer guidance for future research.

Theoretical Background

Understanding innovation activities is a key strategic concern for everyone interested in firms’ survival and performance in the long run. Two different innovation activities, which involve different types of knowledge and capabilities, have been suggested: exploration and exploitation (March, 1991). In this paper, exploration refers to firm behavior characterized by search for, discovery of, and experimentation with new alternatives. Exploitation refers to firm behavior characterized by efficient use, refinement, and extension of current knowledge, resources, and capabilities.

It has been argued that the long-run success of a firm requires balancing between exploration and exploitation (March, 1991). Exploration enables firms to remain open for new alternatives, create new products and win over new customers. Exploitation, however, is needed for building efficiency and ensuring the short-run success of the firm. Successful organizational adaptation to changes in the business environment requires organizations to balance between these two types of innovation activities (Kyriakopoulos & Moorman, 2004; Levinthal & March, 1993; Lewin & Volberda, 1999). Two basic strategies for achieving the balance have been suggested: “ambidexterity” (Benner & Tushman, 2003), which refers to the synchronous pursuit of both exploration and exploitation through organizational differentiation, and “punctuated equilibrium” (Burgelman, 2002), which refers to the pursuit of balance through cyclical periods of exploration and exploitation.

The research on managerial cognition (for an overview, see (Walsh, 1995)) offers a potentially insightful perspective for understanding why and how firms engage in balancing their explorative and exploitative innovation activities in certain ways. It is suggested that it is the senior management team that mediates between external forces for innovation and change and internal inertial forces (He & Wong, 2004; Virany, Tushman, & Romanelli, 1992). The top management makes decisions regarding the organizational structure and processes that guide the innovation activities toward exploration and exploitation, either simultaneously or successively. While some studies have been conducted analyzing the role of managerial cognition in organizational adaptation and evolution (e.g. (Garud & Rappa, 1994; Kaplan et al., 2003; Tripsas & Gavetti, 2000)), there is little knowledge on the effects of managerial cognition on firms’ balance between different innovation activities. Smith and Tushman (2005) studied how the top management manages innovation streams by dealing with “strategic contradictions”. They argue that balancing contradiction in decision making, for example between exploration and exploitation, is rooted in senior team cognitions. However, while explicating on the roles of cognitive frames and processes in managing strategic contradictions, they remain silent about how the cognitions ultimately affect the choices that lead to differences in the innovation activities. This study contributes to understanding the role of managerial cognition in guiding the balance between organizational exploration and exploitation.

The roles of managerial cognition in organizational adaptation are highly complex. The managers’ mental models may lead managers to overlook important environmental changes (Barr, Stimpert, & Huff, 1992) and underestimate the importance of exploring new alternatives. The mental models may also be geared toward explorative learning, as can be observed for example in the scientific research communities whose members are starting their careers in the pharmaceutical business.

It is important to note that, in addition to the decision making process being social in nature, the decisions behind business operations are always made by individuals with ‘bounded rationality’ (Simon, 1955). Thus, firm’s actions and finally the conceptions of these actions’ outcomes are first filtered through managerial cognition. To better understand the workings of these cognitions, it is good to review some basic assumptions offered by Lindell et al. (1998):

- Thinking and acting are mutual and intertwined processes;
- Experienced top managers develop rather stable belief structures or strategic ways-of-thinking regarding how to develop, manage and lead an organization;
- Mental structures function in a holistic mode and are a mix of cognition, values and emotions, an assumption which means that this perspective might be labeled ‘socio-cognitive’.

In their discussion of organizational adaptation, Barr et al. (1992) use the concept of mental models to refer to the tools that managers use to interpret and make sense of the

information they receive. They argue that as these models are based on limited managerial cognitions, they will be incomplete and their inaccuracy will increase as their environment changes. As the basis of cognitive research, Barr et al. introduce three ways in which mental models cause a mismatch between the available data and the processing of information:

- Managers will tend to focus on the data that most supports their current views and may, therefore, miss vital new data.
- Data will be interpreted according to the manager's current mental model, leading to a failure to see the need for change.
- The manager will have a limited scope of alternatives as they are in part, blinded by the boundaries of their current mental model.

Organizations operate in an environment where there are certain legitimized industry recipes that are collectively shared among industry practitioners (Spender, 1989). These recipes are constructions of the institutionalized, collective rationales behind certain 'right' ways of conducting business in the given environment. On the one hand, following the industry recipes gives organizations legitimacy for their actions, and they become more easily accepted (DiMaggio & Powell, 1983). Innovation activities that closely follow the industry recipes can be characterized as exploitation of current knowledge and capabilities, usually aimed at improving existing offerings. On the other hand, breaking away from the standard solutions gives organizations the possibility to create disruptive innovations (Tushman & Anderson, 1986) that organizations try to pursue through explorative innovation activities.

Thus, in our framework of organizational adaptation (see *figure 1*), managerial cognition is an essential link and filter between developments in the business environment and the structure and processes of an organization. Managers are constantly making assessments of the status of the organization vis-à-vis the status of the business environment. These assessments, whether conscious or more subconscious, can either be aligned with or opposing to the existing industry recipes. Eventually the assessments lead to actions and outcomes, which determine the balance between explorative and exploitative innovation activities. In our view, this balance is essential for the long-run success and survival of organizations.

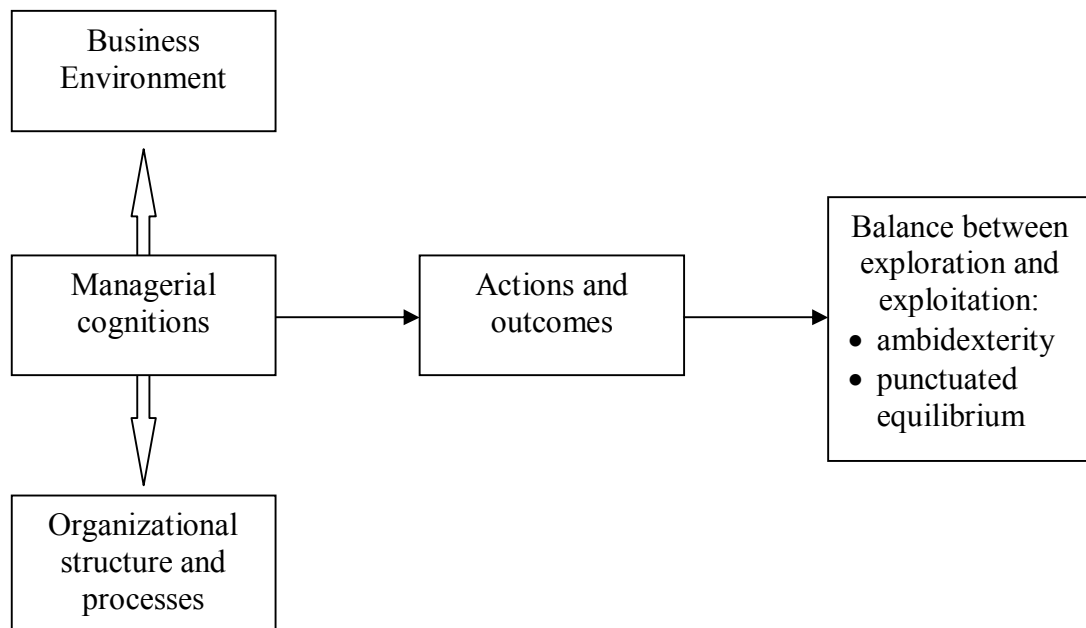


Figure 1. Framework of organizational adaptation through balancing between exploration and exploitation.

Methodology

We selected the case method (Stake, 1995) for our exploratory research because we wanted a deep understanding of the possible cognitive issues behind the evolution of a single organization. Although the influences of managerial cognition are limited only to this single case, we believe that this study allows other researchers to build on and validate our findings in different settings.

Using our framework of organizational adaptation, we conducted a historical case study of the organizational evolution of Genentech. Our primary data source for discovering the changes in the structure and processes of Genentech, and especially in the mental models of the firm's senior management, was the firm's annual reports. This methodology is supported by Barr et al. (1992), who studied the cognitive changes in two U.S. based railroad companies by using letters to stockholders to map the managers' mental models. Although not ideal, the annual reports provide a good view of the major actions that have taken place while also reflecting some of the prevailing thinking of the senior management. Genentech's annual reports were available to us for the years 1982-2005 although the company went public already in the year 1980. The missing information for the years 1980 and 1981 was largely covered up in the book 'From Alchemy to IPO' by Cynthia Robbins-Roth (2000). The book also provided information about Genentech's development for the years it was still privately owned and thus not obliged to official, regulated reporting practices. In addition, we selectively used press releases and material from the company's website to check factual issues such as dates and figures. To get more deeply into the analytical discussion surrounding the companies, we scanned through dozens of articles by such quality papers as the *Pharmaceutical Executive*; the articles that we quoted directly are listed in the references.

We constructed the top managers' cognitions from the source materials by analyzing, first, the actions undertaken by Genentech and, second, what was said about the intentions and strategies behind those actions. We then compared that data against our

understanding of the evolving business environment. By triangulating the collected data against interviews with several biotechnology specialists we aimed to validate our reasoning and then adjust the interpretations accordingly. To minimize the researchers' influence and biases, we first systematically registered the events and clues of cognitive changes from the annual reports in spreadsheets. From the collected data we built descriptions of the evolution of the firm. Based on the descriptions and the spreadsheets, we mapped a chronological path of the evolution, which proved helpful in discovering the top managers' cognitions. However, because of space limitations, in this paper we can only present an overview of the evolution.

Innovation Management in Biotechnology – Case Genentech

Biotechnology companies have developed solutions for many different fields since the advent of the industry in the 1970s. Our paper focuses on human health care, but biotechnology companies are involved also in other areas such as enhancing product processing in the pulp and paper industry. In the pharmaceutical sector, there have been huge changes in the operations of different actors in the last three decades, and much of that change is believed to be brought on by the development of the new biotechnologies. Schweizer (2002) identified three essential paradigm shifts: from random screening to focused screening; from hit-or-miss clinical trial programs to tailored products to a specific patient subsegment; and from mass-market –centric paradigm to consumer-centric paradigm.

Managing a biotechnology company successfully requires the acknowledgement of several issues characteristic to the industry. In his study of the key drivers and success factors for mergers and acquisitions in the biotechnology industry, Schweizer (2002) describes the organizational structures of typical biotech firms in the following way. Internally, they compose of overlapping interdisciplinary project teams with minimal hierarchy. The firms have merged academic practices, and often culture, with the requirements of a high-tech industry in order to create a lean and effective organization for drug discovery and commercial development. Costa et al. (2003) found that, historically, most of the new biotechnological innovations have been introduced by young science-based SMEs. Evidently, the start-ups have lacked the full range of relevant skills needed to develop therapeutic drugs in-house, so they have turned to numerous forms of collaboration such as joint ventures, research agreements or licensing agreements. Costa et al. also state that these smaller companies often do not possess, and find difficulties in accessing the necessary skills especially in the strategic management and marketing areas. Few companies are able to grow enough to manage the whole process of drug development and marketing, to become a fully integrated pharmaceutical company. Instead, they must choose to either operate in the supporting sectors or align themselves somewhere within the drug discovery continuum.

Genentech has been on the forefront of the biotechnology development. It has contributed to the changing ways of thinking and acting in the pharmaceutical industry. Next we will describe the environment and the factors that have enabled the company to effectively manage this continuous stream of innovation. The evolution of Genentech has been divided into four different periods: 1976-84: Scientific Exploration; 1985-90: Focusing on Commercialization; 1991-98: Regaining Explorative Innovation; and 1999-2005: Balanced Growth.

1976-84: SCIENTIFIC EXPLORATION

Genentech was founded in 1976 by venture capitalist Robert A. Swanson and biochemist Dr. Herbert W. Boyer. Swanson brought with him the entrepreneurial spirit generated in Silicon Valley, which enabled them to focus on productivity, not on establishing corporate guidelines or other secondary measures. At that time, most professionals in the pharmaceutical business worked in large companies which had their own habits and often rather bureaucratic routines. Few entirely new entrants had come to shake the industry recipes. Swanson's new approach was oblivious to the demands of the old professionals. Boyer, then, was one of the first to perfect the technology of recombinant DNA, a major milestone in the relatively short history of biotechnology. The new venture got initial funding of \$100,000 from the investment group Kleiner & Perkins (K&P), where Swanson was employed before his new position. Benchmarking firms from other Silicon Valley industries rather than other pharmaceutical companies, he started Genentech as a virtual company out of the K&P offices. As a group of academics and scientists, assisted by an intellectual property law specialist, they put together the first contract research deal that gave the new biotech company product rights. The initial experiments to generate proof-of-concept data for the technology, which were a classical example of truly explorative innovation activities, were conducted in the labs of Boyer at the University of California at San Francisco and Keichi Itakura and Art Riggs at City of Hope National Medical Center in Duarte, California.

When this first project showed that genetic engineering in fact could induce microbes to make foreign proteins, the founders and their financial backers moved the company into its own labs in a South San Francisco warehouse. The scientists, most employed right out of academia, worked in a very ascetic environment. They were all driven by science and were extremely motivated on achieving results that would make a profound difference to patients. The management had realized that in order to lure advanced scientists, the corporate culture must support their needs. Even though the work was intense, the employees got their own free time for doing off-project research or simply having fun. The atmosphere combined business instincts with cutting edge science but left no room for the big pharma mentality of enjoying the benefits of the past block-buster drugs.

Then, on October 14, 1980, Genentech Inc. was taken public. It was stated to be the first company to focus all of its attention on using the tools of the new biological knowledge to create products, and it was the first to successfully scale up protein manufacturing to support large quantities needed for clinical trials and marketing. At the time, the general press focused mainly on Genentech's interferon and its cancer-fighting properties, which naturally caused much investment interest and even hype. While cancer was a growing concern for the western nations, traditional pharmaceutical companies had not been able or even that enthusiastic to create new solutions for cancer care. Partly with the help of the cancer hype, the initial public offering raised \$35 million, an incredible amount for a company with no products on the horizon until 1984. By 1983, approximately a dozen companies had followed the same route until the IPO window closed for a few years.

Many of the early biotech firms were, in their excitement about the potential applications of the new technologies, unable to focus their development efforts. In other words, they were engaged in a continuous cycle of explorative innovation. The scientists' work was rewarded by new inventions, and they were reluctant to give up producing new solutions. Strategically it would probably have been better if at least some of the scientists would have focused on developing certain inventions further, to exploit the existing knowledge in order to create marketable products. Genentech's 1981 annual report shows

interest in three different product categories: industrial chemicals, animal health and human health care. It was not until after 1983 that the company focused exclusively on human health – pharmaceuticals clearly had the best potential for return on investment. In addition to creating new technologies, Genentech was innovative also in partnering. Back then, partnering was not as common as it is today. Pharmaceutical companies were not used to partnering with small knowledge intensive firms. Genentech sold its worldwide rights to recombinant human insulin to Eli Lilly & Co, a deal which spawned the very first biotech therapeutics to reach the marketplace in 1982, and rights to their human growth hormone to AB Kabi. Hoffmann-La Roche, which would complete a merger with Genentech in 1990, also bought the marketing rights to its interferons in 1980. These deals, among with several others, gave the young biotech firm cash to support its growth, and assurance to the investors that biotechnology indeed was real and valuable. They also enabled the firm to show net income already in 1979, and it has continued to do so ever since.

Finally, in 1985, it was time for Genentech to advance from an R&D boutique to a real pharma company – to sell drugs. This kind of rapid transformation to a fully integrated pharmaceutical company had been unforeseen at the time, and it has since been very rare. Genentech retrieved the U.S. marketing rights to human growth hormone in 1983 and obtained approval from the Food and Drug Administration in late 1985. That year it also hired its first 75 sales representatives.

In sum, the period of 1976-84 was a time of intense scientific exploration for Genentech. The founders realized that it is possible to develop new biotechnologies and finally discover drugs successfully using only small research groups. Traditionally it was believed that practically everything related to pharmaceutical research and development requires tremendous human and financial resources. By partnering with big pharma companies both in R&D and marketing, Genentech was rather quickly able to learn the whole process from drug discovery to selling drugs to customers. After Genentech's IPO in 1980, its market valuation remained relatively stable till 1985. At that time the investors were still patient enough to wait for future sales – they believed in Genentech's product pipeline.

1985-90: FOCUSING ON COMMERCIALIZATION

After seeing that it can successfully sell its own targeted therapies to small patient populations, Genentech continued building its sales force. The top management recognized that they had come to a situation where they could realize some of the built up potential in their research and development. The company even made a buy-out of two R&D partnerships that had shown large commercial potential. Genentech's research efforts were guided toward exploiting its earlier knowledge, developing products based on its earlier scientific achievements. The drugs would benefit relatively small patient populations that could be reached with a compact but well-equipped (utilizing portable computers already in the mid-1980s) sales force. CEO Bob Swanson outlined the marketing strategy in 1986 as follows: first, Genentech would bring products to market in the U.S. under its own label; second, it would market those same products overseas through agreements; third, other products that did not fit the core categories would be capitalized on by licensing them to key partners. Although ambitious, this strategy did not directly attack the long-established pharma corporations who were mostly after the so-called blockbusters that required huge marketing resources aimed to a great extent directly to consumers.

This period was the first time Genentech was really beginning to make profits from its own products. Before this time, a major effort was put on finding alternative ways of funding the drug development. However, while the sales were steadily growing, Genentech had lost focus in its R&D operations and stopped introducing new drugs in the late 1980s.

The management had gotten so excited over the sales expansion opportunities that their attention and emphasis was now clearly on exploiting the company's existing capabilities rather than developing new breakthrough ideas. The investors made their own conclusions about the hollow product pipeline, which sent the stock price down and finally made the company a takeover target. In 1990, a traditional Swiss pharmaceutical company Roche Holdings saw the opportunity and invested more than \$2 billion in Genentech. The two companies had already worked together in selected research projects in the early 1980s, so the managers at Roche acknowledged the potential Genentech held in its drug discovery resources.

1991-98: REGAINING EXPLORATIVE INNOVATION

Arguably the most influential partnership in Genentech's history, the deal with Roche gave Genentech, which was then being lead by a newly appointed CEO Kirk Raab, cushion to once again take on long-term R&D projects without constant fear of running out of funding. From the financial point of view, the deal gave Genentech tremendous security. The company has since spent record shares of its revenue in long-term R&D projects, which was in major part enabled by the Roche arrangement. As indicated by several specialists we interviewed for this study, the pharmaceutical business is essentially about taking and managing calculated risks. As an example, Genentech designed its oncology clinical trials to prove that its drugs could prolong life, which is considered a very high bar for an experimental cancer treatment to reach; most companies seek only to prove their drugs can shrink the size of a tumor. Although having been troubled for the last few years, the newly invigorated R&D departments were now pushing through multiple new innovations.

We believe it is fair to say that this time the signals for change came from external sources, outside Genentech. It is not unheard-of that new firms rely too much on their first innovations and then are unable to re-focus on explorative innovation activities after a period of strong commercialization and growth efforts. Genentech had already shown that not everyone needs to follow the industry recipes in the pharmaceutical business. The scientists, other developers, and the sales teams proved that drug development and sales could be conducted successfully with smaller resources. However, after the initial stir-up, the company was becoming too comfortable with its current operations. It had stopped exploring. Roche recognized that Genentech had skills and capabilities which were not fully utilized, and set a new track for the company which emphasized the need for explorative innovation.

In the 1992 annual report Raab admitted that they did not exactly know what the relationship with Roche would bring forth, but by that time they had developed "meaningful mutual respect and productive relationships." The arrangement was said to provide opportunities in "marketing of each other's products, international cooperation, product development and/or manufacturing support and significant research collaborations". Right before Arthur Levinson took over Kirk Raab as CEO in 1995, Roche negotiated a five-year extension on its option to purchase the balance of the company. This extension gave Levinson unusual freedom to invest in the company's pipeline, because the terms put a floor and a ceiling on where Genentech's stock could go in the next five years. This meant that Levinson could aggressively spend on explorative R&D without fear that it would depress the stock's price. Because pharmaceutical companies were and still are valued in the stock market largely based on their anticipated new products, this new turn set the stock price on a steady rising course.

1999-05: BALANCED GROWTH

Then in June 1999, Roche exercised its option that caused Genentech to redeem all of its outstanding stock not owned by Roche. In July, 44 million shares were offered under the new trading symbol “DNA” in the largest initial public offering of its kind in the U.S. healthcare industry history. These arrangements created Roche billions in profits, and today, Roche Holdings still owns 56 percent of Genentech. The partnership with Roche has given Genentech financial security and access to international product development and marketing resources. Probably the most crucial decision for the success of the partnership was that Genentech was left operationally independent. Roche did not interfere with the everyday management of Genentech. It has enjoyed full-scale resources without losing the innovation capabilities of a flexible organization.

This did not mean giving up on marketing. On the contrary: the business end was given more focus and effort. As PharmExec (2005, Oct 1) put it in a recent article: “If the first act of Genentech’s story was mostly about the science, act two will be focused on business.” While this comment refers more to the current issues, the seeds were planted in the beginning of Levinson’s CEO post. Levinson broadened the commercialization strategy: first, Genentech would grow current products by additional claims [for new indications] and by increasing customer base; second, they would maximize new product launches and reduce time to peak market share; third, they would expand product offerings and increase the depth of each of their therapeutic area; and fourth, they would further align discovery and development with evolving market needs. Genentech started to become a credible and skilled marketer in the U.S. As an evidence of this development, Roche had agreed to have its Roferon-A promoted by Genentech in the U.S. in 1996.

While not abandoning the targeted therapies strategy completely, Genentech’s new R&D innovations were now aimed at much broader patient populations than before. They were moving into the big players’ blockbuster arena with their newest oncology product, Avastin. It has been described as a platform drug (see PharmExec, 2005, Oct 1) because it uses a method [suppressing angiogenesis by directing an antibody at vascular-endothelial growth factor, slowing down tumor growth] that is not limited to just a certain type of a cancer. It was first approved in February 2004 to treat patients with first-line metastatic colon or rectum cancer, but studies have shown that it is efficient against other types of cancer as well. From a commercial point of view, these different tumor types may seem like new markets, but it allows a drug with several indications to be sold by the same representatives, potentially offering a major saving. In addition to the platform method, PharmExec (2003, Feb 1) raised a certain sense of urgency as Genentech’s top competitive advantage in launching new drugs, meaning that its medical/scientific excellence, aggressive commercial execution and seamless organizational alignment together enable the company to quickly focus on developing a product’s potential. Genentech’s commercialization capabilities are becoming comparable to those of traditional big pharma, but with a sales force of less than 1000 employees, the efficiency of their focused efforts is still remarkably better.

During this last period from 1999 to 2005, Genentech’s total product sales have rocketed from about \$1 billion to \$5.5 billion. Its share price, adjusted for splits, has tenfolded since 1998 till 2005. During those years, the only major setback in Genentech’s market capitalization growth was in 2001 and 2002 when the company’s most anticipated product Avastin got into unexpected troubles in the FDA approval process. The drug has since proved to be a huge success. In the end of 2005, the company also had multiple promising drugs in all the phases of its product pipeline. It seems that, during the last period, Genentech finally succeeded to effectively balance between exploring new alternative treatments and exploiting the commercial potential of its existing products.

SUMMARY OF THE EVOLUTION OF GENENTECH

Much has changed in the thinking of the pharmaceutical industry practitioners because of biotechnology, and Genentech has been at the leading edge of this change. Especially in the early days, Genentech's most notable cognitive innovations were related to the concept that small can be competitive also in the pharmaceutical industry. The company founders realized that they could develop new biotechnologies and then use those technologies to discover drugs in small research groups. They also believed in the commercial feasibility of targeted therapies to small patient populations and that these drugs could be marketed without a huge sales force. At the time, the industry was entirely dominated by big pharma companies that had enormous resources for R&D and sales. They were content with using the inefficient, traditional random-screening discovery processes and then marketing the resulting drugs to doctors and distributors with thousands of sales representatives and massive advertisement campaigns. To support the growth of the already large organizations, they were only interested in finding the next blockbuster drug or copying the success of others, ignoring potential new treatments with fewer users. Now that Genentech had reached to the list of the world's largest pharmaceutical companies, its top management answered to the stockholders' ever growing sales demands with a new solution: platform drugs such as Avastin. Avastin's research was focused on a very narrow target but, as it turned out, it has a much wider potential target base because it can be expanded into multiple indications. While big pharma was still aiming for single-indication blockbusters, Genentech's platform approach enabled it to keep clinical trial costs and sales forces smaller. With platform drugs it could continue serve patients that carried some other than the most common diseases, while creating sufficient profits.

We argue that much of Genentech's success and distinguished role in the pharmaceutical industry is attributable to the cognitions of its top managers and their impact on the innovation activities. The cognitions have enabled such a balance between explorative and exploitative innovation activities that has resulted in strong, growing sales and a continuous stream of truly innovative offerings. Genentech's senior management has largely avoided the common misperceptions and bounded views of the industry, which has enabled the company to constantly adapt and renew its strategy. Through different periods in the firm's evolution, the managers have learned to orchestrate the firm in a constantly developing business environment. In 1976-1984, the senior management guided Genentech strongly against the established industry recipes by emphasizing truly explorative innovation. This enabled the newcomer company to gain a position that was much more powerful than its economic size would have predicted. In 1985-1990, the managers focused on exploiting the innovations from the first period. While this enabled Genentech to grow its sales, the lack of exploration caused troubles for future sales and market valuation. In 1991-1998, with the help of Roche's financial backing and strong international presence, Genentech's research and development was again pointed heavily toward exploration. After that, in 1999-2005, the senior management of Genentech has been able to balance well between exploration and exploitation, without being bounded by the industry recipes. A summary of the evolution of Genentech is provided in the following table.

	1976-84 Scientific Exploration	1985-90 Focusing On Commercialization	1991-98 Regaining Explorative Innovation	1999-05 Balanced Growth
Managerial Cognitions	<ul style="list-style-type: none"> • It is possible to develop the new biotechnologies using small research groups • Late phase drug development requires additional resources from partners, commercialization without partnering is not possible yet 	<ul style="list-style-type: none"> • Most profits go for the companies that market and sell drugs • Genentech can market targeted therapies, not blockbusters, on its own to compete with big pharma 	<ul style="list-style-type: none"> • Pharmaceutical companies are largely valued for their product pipelines • Genentech needs to focus on its core capability, which is still drug development • The financial cushion from the Roche deal allows taking calculated risks in R&D • Cancer can be made a treatable disease in a decade 	<ul style="list-style-type: none"> • Investors' expectations for growth have increased because of the new public offering • Platform drugs are potential alternatives for competing with traditional blockbusters
Exploration / Exploitation Balance	<ul style="list-style-type: none"> • Heavy emphasis on exploring the new biotechnologies and developing new drug candidates • Lacking the skills and resources for exploiting the developments commercially 	<ul style="list-style-type: none"> • Emphasis on commercialization of the existing drug developments • Building the necessary resources for marketing the drugs 	<ul style="list-style-type: none"> • Re-emphasis on risk-taking explorative innovation without forgetting to enhance the commercialization capabilities, including efficient clinical testing 	<ul style="list-style-type: none"> • Continuing the strong R&D efforts, special focus on platform drugs • Developing the commercialization on skills further
Genentech vs. Pharma Industry	<ul style="list-style-type: none"> • Changes in the industry R&D and partnering practices: a small firm develops drugs through the early phases, larger firms develop them further and commercialize 	<ul style="list-style-type: none"> • One of the first new firms to enter the drug selling market. Before this there were practically no new entrants 	<ul style="list-style-type: none"> • Exceptional competitive advantages in biotechnology and drug development • The Roche deal allows high R&D expenditure 	<ul style="list-style-type: none"> • Genentech has developed a new kind of a platform drug and efficient marketing resources
Performance	<ul style="list-style-type: none"> • No own drugs on the market • Profits from licensing the technologies • Market capitalization stable 	<ul style="list-style-type: none"> • Sales starting to grow • Not enough new drugs in the drug development pipeline • Market capitalization rising at first, then going down because of the hollow pipeline 	<ul style="list-style-type: none"> • Sales continue to grow moderately • The drug development pipeline becomes more promising • Market capitalization on a rising course 	<ul style="list-style-type: none"> • Sales growing rapidly • The platform drug enables new products efficiently • Market capitalization rising rapidly

Table 1. Identified periods in the evolution of Genentech.

Conclusions and discussion

As suggested by our framework on organizational adaptation, and building on the insights of Smith and Tushman (2005), managerial cognition influences on how organizations balance between different innovation activities, namely exploration and exploitation. Managerial cognition works as a filter between business environment and organizational structure and processes, affecting managerial decision making and the following actions and outcomes. The case of Genentech reveals how managerial cognition might direct organizational innovation towards either exploration or exploitation or alternatively towards either ambidexterity or punctuated equilibrium (*table 2*). Next we discuss the discovered influences of managerial cognition on innovation activities and make five preliminary, generalized propositions. Naturally, our list of propositions is not meant to be all-inclusive. The propositions introduce simplified mechanisms by which decision making related to innovation activities is expected to be directed.

When the top management of Genentech perceived that the company's technologies for drug discovery were superior to those of their competitors, they quickly decided that they should out-license the technologies and sign agreements for further co-development with larger companies in order to move forward in the drug discovery continuum. It was only after they realized this superiority that they shifted the emphasis from exploratory innovation to finding ways to profit from their current technological capabilities. Because of the ambiguity of comparing different types of technologies or products with each other, and the lack of market mechanisms for more objective judgments, we argue that the timing of the innovation shift was highly dependent on managerial cognition. Thus, we offer the proposition that

P1. The managerial cognition that competitors are technologically behind and do or will have worse products on market directs decision making toward emphasis on exploitation.

It is common practice in the pharmaceutical industry that companies are valued largely based on their product pipelines – anticipated future drugs or other products. However, because the market capitalization is not a direct measure of the product pipeline and the information flow between analysts, investors, and managers is always incomplete, the top management has to interpret how the investors perceive the company's competitive situation. In the late 1980s, the senior managers of Genentech were slow to notice that the investors began to appreciate less the company's product pipeline. The value of the stock plummeted before the management took corrective action toward explorative innovation.

P2. The managerial cognition that investors perceive that competitors are technologically more advanced and they have or will have better products on market directs decision making toward emphasis on exploration.

Specifically in the pharmaceutical industry, but possibly in some other technology-intensive industries as well, it is commonly seen that only the established companies can truly move to exploit the technologies they have invented. In this paradigm, smaller firms can only function as research and development boutiques, focusing almost exclusively on explorative innovation, resulting in high-risk, future-oriented technologies. Often these firms set their strategies toward becoming targets for acquisitions. However, one can reasonably argue that the firms could also shift to exploit their technologies in one way or another: Genentech choose to license its technologies to larger companies, creating profits from early on.

P3. The managerial cognition that the current position in the product development network does not allow commercialization directs decision making toward emphasis on exploration.

Some of the managerial cognitions work toward finding balance between exploration and exploitation via either punctuated equilibrium or ambidexterity. Genentech's management started to emphasize ambidexterity, simultaneous pursuit of both exploration and exploitation, during the period from 1991 to 1998 when it perceived that the company had enough financial resources to engage in explorative research for finding novel solutions for cancer treatment while maintaining steady growth of sales of current products. Before this period the top management had concluded that in search for efficiency their limited resources had to be allocated, at least to some extent, to either explorative or exploitative innovation.

P4. The managerial cognition that the organization has enough resources and capabilities to both explore and exploit directs decision making toward finding balance via ambidexterity.

After Genentech's early strong focus on developing advanced technologies, the top management saw in the late 1980s that it had become imperative for the success of the company to put most effort to commercializing the existing technologies and products in development. The management became occupied with the pursuit of exploitation, when just years earlier they had believed in little else than breakthrough science in research and development.

P5. The managerial cognition that either exploration or exploitation is currently imperative directs decision making toward finding balance via punctuated equilibrium.

	Toward Exploration	Toward Exploitation
Managerial Cognitions	<ul style="list-style-type: none"> • Competitors are technologically equal or more advanced and they have or will have better products on market • Investors perceive that competitors are technologically more advanced and they have or will have better products on market • Current position in the product development network does not allow exploitation 	<ul style="list-style-type: none"> • Competitors are technologically behind and they do or will have worse products on market • Investors perceive that competitors are technologically behind and they do or will have worse products on market • Current position in the product development network allows exploitation
	Toward Punctuated Equilibrium	Toward Ambidexterity
Managerial Cognitions	<ul style="list-style-type: none"> • Not enough resources and capabilities to both explore and exploit • Either exploration or exploitation is currently imperative 	<ul style="list-style-type: none"> • Enough resources and capabilities to both explore and exploit • Both exploration and exploitation are simultaneously necessary
	<ul style="list-style-type: none"> • Toward exploration... 	<ul style="list-style-type: none"> • Toward exploitation...

Table 2. Managerial cognitions directing decision making related to innovation activities.

The main theoretical contribution of this study is to elaborate on the dynamics between managerial cognition and different innovation activities, namely exploration and exploitation. It is shown how the mental models of senior management are changing in accordance with the developments in the business environment. These mental models, in turn, influence on how an organization balances between explorative and exploitative

innovation activities. While these mechanisms can never be fully explored or explicated, researchers can discover and share insightful perspectives on them through descriptive case studies.

The literature on organizational adaptation has stayed relatively silent about how managerial cognition affects balancing between exploration and exploitation. Through a single case study, we have shown what kind of effects managerial cognition might have on managing innovation activities. Although our results are only preliminary and need more empirical analysis with other longitudinal material, we highlight that managerial cognition should not be ignored when studying how organizations evolve in changing business environments. As the human element is always strongly present, previous research has in many cases missed explanatory opportunities by ignoring the role of managerial cognition.

Considering practice, managers would be able to better avoid the common pitfalls in long-run innovation management if more research was conducted on the role of managerial cognition in balancing between exploration and exploitation. We believe that research can identify cognitive biases that commonly occur in the management of innovation activities. Our analysis already discovered potential ways of how managers place under or over emphasis on certain types of innovation activities under certain conditions. In addition, our study provides managers with naturalistic material that they can relate with and draw implications for their own managerial practice

While we are confident that this study provides a valid and insightful perspective on managerial cognition related to organizational evolution in the case of Genentech, it was certainly a limitation that we could not get closer to the management and the practical operations of the firm. Because of the difficulty of combining in-depth cognitive analysis with an evolutionary perspective over a long time period, we suggest two research approaches to be combined in the future. One should focus on the longitudinal evolution of an organization in its institutional and competitive landscape while the other should take a more cultural approach to interpret the social action of the members of an organization in its natural settings. This kind of pluralistic methodology would allow for a deeper understanding of the complex phenomena of managerial cognition in organizational evolution.

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