Some contributions to management, theory and research of innovation from a multiple case study.

Jaime de Souza Oliveira (prof.jaime@uol.com.br)
Fundação Getúlio Vargas

Luiz Di Serio
Fundação Getúlio Vargas

Celso Malachias
Fundação Getúlio Vargas

Abstract
Rothwell (1994) suggested an innovation model based on five generations. Hobday (2005) highlighted weaknesses of model: theoretical basis, empirical evidence and systemic view. Besides not recognize the diversity and unpredictability of innovation. Through multiple case study involving five global companies, we aim to deepen knowledge and contribute with empirical research.

Keywords: innovation research, innovation theory.

Introduction
In various business management areas a set of elements that make up an evolutionary process of maturation of the models, practices and concepts have been observed. This maturing, increasingly oriented towards a systemic approach (Senge, 2006), happened for example in the areas of "Strategic contribution of production" (Wheelwright and Hayes, 1985), "quality" (Garvin, 1992; Price and Chen, 1993), "Logistics" (Di Serio et al, 2007.), "Risk" (Schuch, Di Serio and Oliveira, 2011; global Risk Network Report, 2013) costs (Fama and Bruni, 2002), and others. In this sense, the literature recognizes and identifies patterns that determine the direction and pace of change, from an initially more diffuse-analytical conception to a more evolved complex-systemic approach.

Theoretical reference
In the innovation field, Rothwell (1994) and Hobday (2005) analyzed five different stages of the maturity evolution of its models, practices and concepts. They observed patterns that characterized the change process. Hobday (2005) defines the five stages as follows:

a) 1st generation or technology push (1950s to mid-60s). Simple linear sequential process, emphasis on R&D push. The market ‘receives’ the results of the R&D.

b) 2nd generation or market pull (mid-1960s–1970s). Market (or need) pull; again a simple, linear sequential process. Emphasis is on marketing. The market is the source of ideas and provides direction to R&D. R&D has a reactive role.

c) 3rd generation or coupling models (mid 1970s–1980s). Sequential model, but with feedback loops from later to earlier stages. Involves push or pull-push combinations. R&D and marketing more in balance. Emphasis is on integration at the R&D–marketing interface.

d) 4th generation or integrated model (early 1980s–1990). Parallel development with integrated development teams. Strong upstream supplier linkages and partnerships. Close coupling with leading edge customers. Emphasis on integration between R&D and manufacturing (e.g. design for manufacturability). Horizontal collaboration including joint ventures and strategic partnerships.

e) 5th generation or systems integration and networking model (post-1990). Fully integrated parallel development supported by advanced information technology. Use of expert systems and simulation modelling in R&D. Strong linkages with leading edge customers (customer focus at the forefront of strategy). Strategic integration with primary suppliers including co-development of new products and linked CAD systems. Horizontal linkages including: joint ventures, collaborative research groupings, collaborative marketing arrangements etc. Emphasis on corporate flexibility and speed of development (time-based strategy). Increased focus on quality and other non-price factors.

Method

In this article, we present the maturity evolution of innovation processes from a multiple case study, wherein business success examples are related to each of the five evolution cycles of innovation processes maturity, presented at the seminal research of Rothwell (1994). The multiple case study method was applied considering the research aim, i.e., to study in depth and breadth specific phenomena of organizations operating in different contexts. In this way, to achieve the objective, a comprehensive and exhaustive search was performed. Data for analysis were obtained from the sample definition of five major companies operating in the global market, in environments with high technological competitiveness (BASF, HARLEY DAVIDSON, TOYOTA, NISSAN and GOOGLE). Then, a structured literature review was performed for analysis of empirical research related to these companies and published in major management operations and competitiveness journals such as: Journal of Operation Management (JOM), International Journal of Operation & Production Management (IJOPM ), Production and Operations Management (POM), International Journal of Production Research (IJPR), Harvard Business Review (HBR). Information was also obtained directly in institutional relations in these companies’ websites and ISI Web of Knowledge and EBSCO, only peer-reviewed articles being used.
Results

As a result of the research, we developed a theoretical framework demonstrating a consistent relationship between the companies analyzed, the environment in which they operate and their innovation cycles. Second Rothwell (1994), nowadays all kinds of innovative processes (regardless of their maturity stage) continue to exist in several forms. To some extent, this diversity is the result of sectorial differences. Therefore, although the characteristics of the five generations of innovative processes undergo changes throughout time, their theoretical essences were preserved according the marketing characteristics of each sector, industry or firm. The research findings provide "important insights" for managers and researchers concerning the points of innovation management in different competitive environments, establishing a direct relationship with their contextual innovation cycle.

Decisions on investments in R & D and the consequences on the development of organizational absorptive capacity become essential for companies in formulating their strategies. Zahra and George (2002) stated that the company's ability to create, manage, and exploit knowledge can be considered a critical resource. Thus, the absorptive capacity may be a company competitive advantage source and, consequently, influence the company performance through product and process innovation. These should be adjusted to the environmental characteristics of each sector, industry or firm, in line with its innovation prevalent cycle.

Case study 1: BASF (technology push)

Historical - Second Freman (1995), the main industrial innovation of an internal R & D department was introduced in 1870 in Germany. The German dyes industry was the first to realize that it could be profitable to promote the new product research and development of new chemical processes on a "regular basis business" in a systematic and professional manner. In the 1950s and 1960s, we observed a rapid expansion in all industrial countries, including the Third World. Hoechst, Bayer and BASF continued and reinforced the German tradition to the present day, with its R & D laboratories employ thousands of scientists and engineers. The huge success of the German chemical industry led to the development of R & D activities in the chemical companies from other countries.

Organization - One of the most innovative companies worldwide, BASF plays a strategy focused on the innovation process management. It is a global and integrated chemical company that develops innovative and sustainable solutions. BASF continually presents sustainable solutions to the market, which contribute significantly to improving the life quality and resources' conservation such as water or energy. Its success is driven by research.

Market - Their competence in R & D is closely linked to its operational excellence, knowledge of markets and their relationships with customers. In this way BASF leverages sustainable products and solutions to promote the long-term success of your customers and create value for society. Examples of opportunities: agriculture, plant health and nutrient management, water management (supply and sanitation), organic electronics, batteries for mobility (high energy density, long life, improved safety, long-range, lightweight design and low cost) wind
energy, plant biotechnology (green genetic technology to increase productivity and quality of crops such as soybeans and rice), etc. In this sense, the development solutions requires the use of several cross technologies and interdisciplinary approach, which focus on three areas: alternative raw material, materials, systems and nanotechnology, and white biotechnology.

**Innovation** - BASF obtained the first place in the Patent Asset IndexTM. The innovative strength of a company is also measured by the number and quality of its patents. In 2012, BASF has registered about 1,070 patents worldwide. Getting once again, first in the Patent Asset IndexTM. This patent portfolios comparison method across the industry shows that BASF is the most innovative company in the global chemical industry. The index of patent assets is calculated by the size of the portfolio and the competitive impact factors. The competitive impact is determined by their technological relevance and market coverage.

**Case study 2: HARLEY DAVIDSON (market-pull)**

**Historical** - In 2003, Harley-Davidson celebrated its 100th anniversary. According Nolan and Kotha (2006), the company that nearly went bankrupt in 1970 became once again the leader in the motorcycle industry "heavyweight" of the U.S. Since 1990, the company achieved 50% of the U.S. market and 32% of the global market. Shares of Harley were among the top stocks with higher growth in the United States since its IPO in 1989 (annual average gain of 37%). However, their customer base has been weakened considerably in the last decade, due to the increase in the average age of Harley owners, which went from 35 to 47 years. Younger Americans have preferred the lightweight sports bikes from Suzuki, Honda, Yamaha and Kawasaki. In 2005, the company's stock price declined by 17% due to slumping sales estimates. The need to review or change the strategy has become urgent.

**Organization** - Harley Davidson executives sought to strengthen relationships with customers, seeking to develop more sensitive tools for their needs. To do this second Rimoli et al. (2013) a channel relationship with the customer community brand was created, the Harley Owners Group (HOG). Staff at Harley Davidson, from executives until the simplest positions, participate HOG events until today allowing directly meet the desires of your customers. Suggestions for improvement are collected from the customers, strengthening the ties between them, the employees and the company. As a result we found robust growth of the company's financial performance, significant appreciation of its shares and increase of the brand's prestige. Over the years the company became professionalized but the strategy remains very clearly directed to the market that guides decisions about the quality and incremental improvements.

**Market** - Second Moran (2005), sales of Harley Davidson motorcycles showed robust growth between 1996 and 2000 driven by the brand prestige, having an average of 8.6% per year since 1991. However, growth slowed considerably between 2002 and 2004. For 2005, Moran estimated a growth of only 3.4%. This deceleration suggested that the market for products from Harley-Davidson could be mature. Brand owners are mostly male (about 90%) according Rimoli et al. (2013) and are included in the age group called "mature", ranging from 40-59 years. This situation represents a risk if the brand fails to renew his identity and...
also cannot reach other age groups in the coming years. The drop in sales can be an indication of market loss.

**Innovation** - Harley-Davidson uses the innovative potential of their brand communities for new product development (Mc Alexander et al, 2002; Verona et al, 2006). In general, members of brand communities are considered desirable to add value throughout the whole the innovation process. They contribute to innovation through various activities to identify needs. They suggest ideas and concepts to modify the prototyping and the product testing, playing the role of inspectors and final co-creators (Nambisan, 2002). Their involvement reflects the perceived personal relevance for innovation activity (Zaichkowsky, 1985).

**Case study 3: TOYOTA - TQM (model coupling)**

**Historical** - Toyota Motors highlights on its institutional website (http://www.toyota-global.com, 11/20/2013) its pioneering introduction of a creative suggestions system to support the change and innovation process. Based on its philosophy of "customer first" and "total quality", introduced in 1951, the number of suggestions has grown. The system has supported flexible responses to change, making substantial contributions to the company development. As a result, the TQM concepts, the problem solving, the continuous improvement based on creative innovation were propagated throughout the enterprise. Cultural roots have been established contributing to a higher quality product and work at all levels and degrees of organization.

**Organization** - A disciplined, flexible and creative community led Toyota to important results. The tacit knowledge that underlies the Toyota Production System can be captured in four basic rules. These rules guide the design, operation and improvement of all activities, connections and path for each product and service: (1) all work shall be highly specified as to content, sequence, timing, and outcome, (2) each customer-supplier connection must be direct, and there must be a unique and unambiguous way to send requests and receive responses, (3) the way for every product and service must be simple and straightforward, and (4) any improvement must be made in accordance with the scientific method, under the technical guidance, at the lowest possible level in the organization. Every system has automatic identifiers to signal problems. The immediate and ongoing responses to problems makes the system (apparently hard) flexible and adaptable to changing circumstances. To see people doing their job and designing production processes, we understand that the system actually encourages employees and managers to engage in the kind of experimentation that is recognized as the cornerstone of a learning organization. This distinguishes Toyota from other companies. In the long term, the companies' organizational structure that follow the Toyota Production System goes on changing to adapt to the nature and frequency of problems they encounter. The nature of the problems is that determines who should solve them and how the organization must be structured (Spear, 1999).

**Market** - The Toyota Production System has been considered as an excellence source in Toyota performance. Practices as their distinctive Kanban cards system and quality circles, e.g., have been widely introduced in other organizations such as GM, Ford and Chrysler. Companies
that sought to adopt the system can be found in diverse fields such as aerospace, consumer products, metals processing, and industrial products.

**Innovation** - The Toyota Production System has long demonstrated the competitive advantage resulting from continuous process improvement (Spear, 1999). The unspoken rules of the model determine how people do their work, how they interact with each other, how the flow of products and services is and how people identify and solve problems. The rules rigidly specify how each activity should be performed. Variances are immediately identifiable allowing people respond immediately to problems in their own work. Activities, connections, and production flows in a Toyota factory are rigidly established, but their operations are extremely flexible and adaptable. Activities and processes are always reassessed and brought to a higher level of performance allowing the company to innovate and improve continuously.

**Case Study 4: NISSAN (integration model)**

**Historical** - Fundada em 1933, a Nissan Motors tornou-se a segunda maior montadora do Japão. (Johnson and Hunter, 2007) No entanto, a empresa enfrentou problemas no início dos anos 90, tais como: custos elevados, ineficiência no desenvolvimento de novos produtos e US $ 22 bilhões em dívidas. Renault took the opportunity and bought a shareholding of 36.8% of the company for $ 5.4 billion. Renault introduced the "Revival Plan", which included a series of goals to reduce costs. In one year, Nissan resumed its profitability and also recorded their highest profits in corporate history. After the "Revival Plan", Nissan introduced the "Nissan 180 Plan", which established the sustainable long-term growth levels for Nissan, based on four elements: increased revenue, reduced costs, improved quality and speed of production and management, and maximizing the synergy benefits with Renault.

**Organization** - Nissan introduced a new integration network with the client (ICON). The ICON Project was developed as part of the "Nissan 180" program to address three key imperatives: focus on the customer demands (pull model), alignment of practices and processes, and support the Nissan goals (increased revenue, lower costs, higher customer satisfaction, reduce delivery times, reduced inventories of finished products and maximizing of synergies with Renault). The ICON project was implemented in 18 months at a cost of $ 6.5 million.

**Market** - In 1999, the Nissan global market share was 4.6%. In 2010, Nissan reached a record 5.8%. Nissan's global sales reached 4.84 million units in 2011, up 15.7% on year. As a result, the global market share increased by 6.4%, a new record. In 2012, reported record global sales of 4.94 million units, an increase of 5.8% (data: http://reports.nissan-global.com/EN, 09/10/2013).

**Innovation** - The proposed construction of vehicles based on actual customer demand seemed feasible in view of the long-term suppliers and associated costs. However, the ICON process has changed dramatically as the sales organization, factories and dealerships interacted. The ordering process the vehicle came to be done by monthly, weekly and daily ordinances. The ICON concept allowed accurately capturing orders traded in the short term and aligning the
supply chain in line to have the right car, at the right place, at the right time. Dealers began to close sales faster and more efficiently (Johnson and Hunter, 2007).

Case study 5: GOOGLE (network integration model)

Historical - The need to search services grew with the expansion of the World Wide Web. In June 1999, Brin and Page announced funding for your start-up, Google (Edelman and Eisenmann, 2011). A year later, the index of a billion pages of Google surpassed all rivals. Back then Google was focused solely on algorithmic search. Until December 1999, revenues were exclusively from licensing its search technology. In December 1999, Google introduced its first paid advertisements. In mid-2001, Google has become the ninth largest site in the U.S. with 24.5 million monthly visitors. In May 2002, AOL moved to Google. In 2004, the market share of Google overtook Yahoo! have reached 58.4% in 2007 and 65.6% in 2009. At the beginning of the "era of the searches" at least half of user requests received no useful results. To improve performance, the engineers at Google perfected search algorithms. In January 2004, Google launched a custom search (basel on analysis of previous research and user's clicks). In addition, Google increased efforts to attract more advertisers. In late 2005, Google and its partners have achieved 60% of "paid advertising revenues" and 52% of "U.S. search queries."

Organization - Early in the history of Google, Page and Brin instilled corporate "strong and distinct" values in the organization: (1) "do not be evil", (2) technology issues, and (3) make our own rules. The central principle "do not be evil" represented the refusal of Google in compromising the integrity of the search results. In other words, Google refusal to manipulate the rankings and favor the partners in search results. Technology - Google did important investments in infrastructure in order to support speeds faster's returns on search queries. Besides the distinct structure and corporate governance values, Google adopted unconventional approaches to innovation management. Engineers are encouraged to spend 20% of their time working on projects of their own choosing (generated a lot of initiatives, including Google News and Orkut). To encourage rapid implementation, Google engineers work in small teams of three to five people. As a result, we developed a flexible organization with small teams working on hundreds of projects. In this context, priority setting was a challenge. The management used the 70/20/10 rule: 70% of engineering time was dedicated to the core business, 20% for projects that broadened the scope of the business (Gmail) and 10% in new business. Google also maintain policies for investment in long term projects and high risk.

Market - According to data from late 2013, Google leads the U.S. search market with 67.3% market share, followed by Microsoft with 18.2% and Yahoo 10.8%. Ask accounted for 2.5% of searches, followed by AOL with 1.3%. There were more than 200 billion searches in the USA in 2013.

Innovation - Google became successful for being better and faster than other search engines back then (Edelman and Eisenmann, 2011). However, the technology come a long way since then ... Nowadays, Google is still looking to the future, producing competitive innovations,
based on some fundamental principles that guide their actions: (1) focus on the user (to provide the best possible experience), (2) do one thing very well (to solve complex issues and provide continuous improvements), (3) fast is better than slow (time is valuable), (4) democracy on the web works (search depends on the millions of people posting links / development of open source software innovation takes place through the collective effort of many programmers), (5) access to information anywhere, whenever necessary (solutions mobility); (6) Making money without doing evil (Google is a business) - a) does not allow ads on results pages, b) adopts an effective advertising without being flashy, based on what is important to the user, c) does not manipulate rankings to benefit partners, (7) there is always more information out there (news, patents, academic journals, billions of images and millions of books ...), (8) the need for information crosses borders (over 110 languages); (9) the work should be challenging and the challenge should be fun, encouraging a creative environment, and (10) the good is not good enough (set goals that are not possible to achieve "yet" ...).

Google today is a global organization focused on the management of creativity and innovation. But this is not the only thing that matters to Google, also has the management of the day-to-day. To do this, invests in a bigger technological infrastructure, more complex and more demanding than anything that has been built. At Google, the operations are critical to the company success. Therefore, Google has made efforts and used creativity to develop this activity as operations in developing new products.

**Conclusion**

In conclusion, we present an intelligible and consistent framework with the elements of each maturity evolution cycle of the innovation processes, from the “technology push model” (1st generation) to the “network integration process” (5th generation) with the innovation processes' characteristics of the global business models. The research findings confirmed the perception of Rothwell (1994) that the current reality is far more complex, inasmuch as all kinds of "cycles of maturity" of innovation processes concurrently share different business environments. To some extent, this diversity is the result of sectorial differences. I.e., innovation in certain consumer products is related to Market Pull model. In assembly industries, the innovation process is integrated and occurs in parallel. In science-based industry (such as the pharmaceutical and chemical industry) the innovation leans more to Push Technology. Therefore, we observe that the model of Rothwell (1994) transcends a purely chronological understanding, to move forward on issues related to the different business models in different sectorial or industrial environments.

Another research's evidence refers to innovation as a know-how process accumulation, or learning process, involving elements learning internal and external. Therefore master the fifth generation process, should involve considerable learning, including organizational learning (Rothwell, 1994). In this sense, for Cohen and Levinthal (1990), organizational learning, over time, is becoming increasingly strategic and involving more complex environments, such as chains and business networks. Cohen and Levinthal (1990) emphasized this strategic character when they mention the risk of the "creative destruction process" (Schumpeter, 1942). They emphasized also the cumulativeness' characteristics of absorptive capacity and its effect on the formation of expectations. Zahra and George (2002) reported the same aspect by
claiming that the company's ability to create, manage, and exploit knowledge can be considered a critical resource and thus absorptive capacity may be a competitive advantage source of a company and therefore influence the company's performance through product and process innovation. Rothwell (1994) speculates that fifth generation process properly deployed perhaps will contribute more effectively to the products development (and the manufacturing process), considering speed and efficiency aspects. Whatever the trend seems likely to Rothwell (1994) that firms which invest in mastering the fifth generation process today will be the tomorrow's innovative tip.

For future research we suggest that a deeper analysis should be carried out with the aim to check if the five "maturity's generations" of innovation processes are effectively characterized chronologically, overlapping over time, or if each of these generations came at a given time, according to related temporal aspects. And stand firm, each one responding for specificities of their respective sectorial or industrial environments. If search will find evidence of the latter, the chronological character will lose importance over other aspects, such as industrial or sectorial environments. In this case, a model revision will be required.

From a similar logic, Cohen and Levinthal (1990) state that investments in R & D and absorptive capacity development are related to the different specificity's degrees of innovation processes and products and their respective industries or sectors. This thesis is in line with industrial or sectorial delimitations of each one the five "alleged generations" of the maturity's evolution of the innovation processes. Therefore, as indications for future research is interesting to analyze the quantitative aspects, but mostly the qualitative aspects of R & D aimed at the development of absorptive capacity in each of the five maturity's "alleged generations" of the innovation processes over time. We could thus begin to gather evidence for "analyze temporal and spatial aspects" of maturity's evolution cycles of innovation processes and perhaps extend the current theoretical delimitation.

References


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