



## Management Research: Journal of the Iberoamerican Academy of Management

Management of technological innovation: Case studies in biotechnology companies in Brazil  
Daniel Chu Tales Andreassi

### Article information:

To cite this document:

Daniel Chu Tales Andreassi, (2011), "Management of technological innovation", Management Research: Journal of the Iberoamerican Academy of Management, Vol. 9 Iss 1 pp. 7 - 31

Permanent link to this document:

<http://dx.doi.org/10.1108/1536-541111131647>

Downloaded on: 08 March 2016, At: 13:48 (PT)

References: this document contains references to 64 other documents.

To copy this document: [permissions@emeraldinsight.com](mailto:permissions@emeraldinsight.com)

The fulltext of this document has been downloaded 930 times since 2011\*

### Users who downloaded this article also downloaded:

R. Phaal, C.J.P. Farrukh, D.R. Probert, (2001), "Technology management process assessment: a case study", International Journal of Operations & Production Management, Vol. 21 Iss 8 pp. 1116-1132 <http://dx.doi.org/10.1108/EUM0000000005588>

Fábio Lotti Oliva, Maria Cecília Sobral, Silvio Aparecido dos Santos, Martinho Isnard Ribeiro de Almeida, Celso Cláudio de Hildebrand e Grisi, (2011), "Measuring the probability of innovation in technology-based companies", Journal of Manufacturing Technology Management, Vol. 22 Iss 3 pp. 365-383 <http://dx.doi.org/10.1108/17410381111112729>

Voon-Hsien Lee, Lai-Ying Leong, Teck-Soon Hew, Keng-Boon Ooi, (2013), "Knowledge management: a key determinant in advancing technological innovation?", Journal of Knowledge Management, Vol. 17 Iss 6 pp. 848-872 <http://dx.doi.org/10.1108/JKM-08-2013-0315>

Access to this document was granted through an Emerald subscription provided by emerald-srm:478443 []

### For Authors

If you would like to write for this, or any other Emerald publication, then please use our Emerald for Authors service information about how to choose which publication to write for and submission guidelines are available for all. Please visit [www.emeraldinsight.com/authors](http://www.emeraldinsight.com/authors) for more information.

### About Emerald [www.emeraldinsight.com](http://www.emeraldinsight.com)

Emerald is a global publisher linking research and practice to the benefit of society. The company manages a portfolio of more than 290 journals and over 2,350 books and book series volumes, as well as providing an extensive range of online products and additional customer resources and services.

Emerald is both COUNTER 4 and TRANSFER compliant. The organization is a partner of the Committee on Publication Ethics (COPE) and also works with Portico and the LOCKSS initiative for digital archive preservation.

\*Related content and download information correct at time of download.



# Management of technological innovation

Management  
of technological  
innovation

## Case studies in biotechnology companies in Brazil

7

Daniel Chu and Tales Andreassi  
*FGV-EAESP, São Paulo, Brazil*

### Abstract

**Purpose** – The aim of this paper is to contribute to understanding of the process of innovation in the biotechnology companies operating in Brazil. The paper identifies the most critical factors in the innovation process of the enterprises in this sector; the paper then analyses the dynamics of the sector and the contribution of the universities and incubators to the innovation process and also evaluates how these elements affect the management process of the technological innovation within and outside the organization.

**Design/methodology/approach** – The research was of the qualitative exploratory type and involved seven case studies of biotechnology companies of different sizes, acting in various sectors, having undergone or not an incubation process. For interpretation of the results, content analysis was utilized.

**Findings** – The study indicated that, among the many obstacles to innovation, access to finance is the most critical. Partnerships have been adversely affected due to institutional and regulatory factors, namely a lack of clear laws and rules regarding intellectual property. The companies have sought to compensate by making their internal processes agile, creating flexible organizational structures and an organizational environment favourable to innovation, which is internalized, as a practice, in a tacit manner.

**Research limitations/implications** – Limitations are associated with the case study methodology: the results presented pertain to the companies studied, and, therefore, cannot be generalized or extended to other companies or areas.

**Practical implications** – The management process of innovation occurs in an informal and less than systematic manner. The innovation process in Brazilian biotechnology companies benefits from a pro-active posture adopted by them to manage and learn from adversity.

**Originality/value** – The paper increases understanding of the innovation process in Brazilian biotechnology companies.

**Keywords** Process management, Innovation, Biotechnology, Intellectual property, Universities, Brazil

**Tipo de artigo** Artigo de investigação

### 1. Introduction

Throughout the last century, science performed a critical role in a series of industries – for example, software, semi-conductors, and advanced materials – however, in all these, its role was to be more of a tool or an input in the creation of products and services, than a business venture in itself. After the conception of biotechnology, this role has been altered: science has begun to be viewed as a business. This became reality in 1976, when Genentech, the first biotechnology company was founded, and it remains in business until today (Pisano, 2006a; Silveira and Fonseca, 2005).



Before the emergence of biotechnology, science and entrepreneurial activity used to occur, to a large extent, in different spheres. The attempt to unite them, contemplating the needs of both, gave rise to significant challenges that have steered the biotechnology sector, whose main activity is the development of innovations, to seek new organisational and institutional arrangements necessary for the creation of an environment that is propitious for their development, such as: public policies to promote growth, government finance of research and development (R&D), stimulation of private investment, strengthening of the relations between universities and companies, availability of risk capital, strengthening of policies of support and training of human resources (Silveira *et al.*, 2004).

There exists consensus, however, that the current level of development of biotechnology, in the international ambit, albeit falling well short of the forecasts of its potential for industrial rupture and restructuring in the 1970s and 1980s (MCT, 1993). This fact, allied to the dynamism of the contemporary business economic context, which imposes increases in the pressure exerted by the market forces regarding the generation of results in the face of the scarcity of resources, of uncertainty, of the pace and costs of technological progress, and the frequency of application of science to the productive process of goods and services, induces the biotechnology companies to avoid the indiscriminate adoption of practices, models and arrangements that have worked well in other industries, including the high-tech segment, such as software, and have become structured in distinct ways (Pisano, 2006b).

At present, biotechnology forms an integral part of the productive base of diverse sectors of the Brazilian economy, with a market for biotechnological products that has reached approximately 3 per cent of the gross domestic product. A study conducted in 2007 by Fundação Biominas, identified the existence of 181 bioscience companies, of which 71 constituted the set of biotechnology companies (Biominas, 2007).

For the recent progress of biotechnology in Brazil public sector initiative has been crucial, indeed highlighted as the main agent of its promotion. Besides, the investments in training human resources, through the public universities and researches produced in institutions like Embrapa and Fiocruz, the state has been outstanding in the last few years for its growth stimulation policies with the creation of finance programmes, funds and specific laws, such as those related to biosecurity, and rights over intellectual property (Assad, 2001).

Nevertheless, biotechnology, as much abroad as in Brazil, has not yet fulfilled its promise, due to the economic impacts of its products being localized and the critical bottlenecks of a techno-scientific and marketing nature hindering effective transformation of the potentialities into commercializable industrial products (MCT, 1993). For the companies, the internal challenges faced are great, as the management of an emerging technology requires a set of skills, structures and strategies that are different from those necessary for management of the existing technologies.

Mapping performed in 2001 and 2007 by Fundação Biominas in the Brazilian biotechnology industry indicated that 75 per cent of the national businesses in this field fitted into the category, micro and small firms (Biominas, 2007), only 28 per cent were engaged in exportation, and only a small percentage of the companies (6 per cent) were capitalized by venture investors, with a total of eight private institutional investors (Biominas, 2001).

From the dichotomy present between the perception of competitive advantage inherent in the Brazilian biotechnology sector and the challenges imposed by its

---

unfavourable socio-economic condition, the general objective of the study is to contribute to understanding of how the innovation process is developed in the Brazilian biotechnology companies.

This also entails the following specific objectives: identification of the factors most critical for the innovation process of companies in the sector; analysis of the dynamics of the sector and the contribution of the universities and incubators to the innovation process; and evaluation of how these elements affect the management process of the technological innovation within and outside the organization. The analysis of these questions aims to deepen knowledge about the operationalization of the processes of innovation in the companies of the sector, from the perspective of the company's top management, thereby contributing to the advance of knowledge in the field.

## 2. Theoretical reference

In keeping with the objective of this work, which is deliberately broad in the sense of seeking to understand the technological innovation process in the biotechnology sector, this reference will deal with some topics that are important for understanding such a process. Thus, after an analysis of the evolutionary history of the innovation, the following items will be considered in order to achieve the objective of the work: competitive strategies in turbulent environments, technological strategies of innovation, incubators of companies with a technological base and university-company co-operation.

### 2.1. Historical evolution of innovation

The notion of innovation and its importance for the economic development of countries were initially recognized by the Austrian economist, Joseph Schumpeter, during the 1930s, who identified five types of innovation: new products or substantial changes in existing products (technological innovation of the product); new processes or production methods (technological innovation of the process); new markets; new sources of resources; and new organizations (Schumpeter, 1982). Viewed in this manner, innovation goes beyond technological questions, including as well the role of the company and the entrepreneurs in the process.

The recent theories of innovation are based on two principal ideas. The first is that innovation is developed as an evolutionary process, interactive among actors, and it presents different phases in the development of an idea. The evolutionary economic theory focuses on the need for experimentation as a technique for various solutions and mechanisms of selection of the most viable technologies. Nelson and Winter (1982), and Dosi (1982), outstanding evolutionaries, sought to explain the bases of the evolutionary theory, presenting routines, skills and learning as driving forces of innovation. The second principal idea is that there is a cycle among knowledge, learning and growth, and interaction among these components performs a crucial role for the developed economies (Arundel *et al.*, 1998).

For Schumpeter (1982), revolutionary change is the object of study of economic development, denominated "creative destruction". He affirms that the entrepreneur is considered the fundamental phenomenon of economic development, as the process of creation lies in his/her hands, by means of new combinations of productive factors. From the studies of this author, science and technology, which, in neo-classical theory

had been presented as variables that were exogenous to the economic system are endogenized as primordial elements in the process of capitalist accumulation.

In this Schumpeterian line, the works of Dosi (1982, 1988), and Nelson and Winter (1982) were developed. Dosi, based on the development of the concept of “technological paradigm” – which means a technological research programme based on models or patterns of solutions of certain problems, derived from principles and techno-scientific procedures – concluded that innovation is the result of an interaction between technical and economic elements, which refeed themselves in order to orient what vector (or technological trajectory) will be adopted in an environment marked by risks and uncertainties.

Another important point highlighted by Nelson and Winter (1982) is that the firms are heterogeneous because no agent is perfectly rational and they present different skills, learning and routines. For them, a given skill will make a firm apt to perform an activity, and, if not, it must acquire new knowledge by means of a learning process. Being in possession of the capacities to perform the activity, the firm will be able to execute it, according to a prescribed sequence of actions and reactions, which, in time, will be transformed into a routine.

Moreover, for Dosi (1988), technological innovation originated from the need for a solution to a technological problem, for which the knowledge available at the time is simply not sufficient to solve it. Besides, this, the author makes the proviso that this solution must consider cost and commercialization criteria. Therefore, a technological problem gives rise to the need or generates an opportunity for technological innovation to place.

Freeman (1995), observing technological innovation in a systemic manner, affirmed that this phenomenon does not occur in isolation, as a discrete event, but rather by means of sets of similar, technically and economically inter-related events.

Synthesizing the concepts presented, it is perceived that technological innovation may be regarded as a phenomenon arising from the fulfilment of a technological need and/or from a stock of scientific knowledge, which, after passing through some steps, is commercialized. Besides, this, it does not constitute an event that is discrete and independent of other occurrences, in view of the fact it is influenced by the interaction among various agents of society, causing a direct impact on the economy of countries and the performance of companies.

### *2.2. Competitive strategies in turbulent environments*

The characteristic dynamic of the sectors of the economy has been an increasingly studied theme (Bajari *et al.*, 2004; Lenox *et al.*, 2007), and it configures a special focus of attention, not only of the economy, but also for the research and practice in the strategy area. From this latter angle, the focus does not lie on the detailed study of the reasons that lead to conditions of turbulence, change and uncertainty in the sectors, but on aspects related to the strategy adopted by companies in the sectors marked by different types of turbulence (Bourgeois and Eisenhardt, 1988; Eisenhardt, 1989b; Brown and Eisenhardt, 1997; Christensen *et al.*, 1998).

Bourgeois and Eisenhardt (1988, p. 816) denominated the turbulent contexts “high-velocity environments”. Their definition of these environments is broad:

By high-velocity environments, we mean those in which there are rapid, discontinuous changes in demand, competitors, technology and/or regulation, so the information in these contexts is generally imprecise, unavailable or obsolete.

The definition above does not discriminate among distinct types of turbulence in the sectors – those of technology, demand, competitors, etc. all being placed in the same classification. One of the possible reasons for this is perhaps the fact that, in real situations, it is difficult to make an effective dissociation of factors of different types, causers of turbulence and change, given that they can arise in an integrated form. Furthermore, as a phenomenon, the existence of turbulences may be for different reasons, but it establishes similar challenges in relation to the process of decision-making or formulation of strategies. In the case of biotechnology, the greatest example of turbulence is that involving stem cell research, currently at the centre of one of the greatest debates, dividing the scientific and religious communities throughout the world.

The study of the competitive strategies in this type of context has been justified by the specific characteristics they bear if compared to the strategies adopted in fields that are more stable or have low turbulence. In these studies, some premises of analytical approaches to the area of strategy are questioned, like those of Porter (1986, 1992) or Barney (2002), who assumed, to a large extent, that the formulation of strategies depends on time and ample resources for the gathering and analytical processing of information. Given that, in turbulent environments information is not always available; and when available, it may be of questionable quality or obsolete; and the time for analytical processing may be noticeably restricted.

As a consequence of the high degree of change in turbulent environments, there exists a great risk that inadequate, poor and equivocal judgments will be made on the part of decision makers, given that “it is difficult to foresee the importance of a change at the moment it is occurring” (Bourgeois and Eisenhardt, 1988, p. 817).

The complexity of strategic choice is established as much by the potential scope of the consequences in turbulent environments as by the difficulty in making judgments, and privileging one alternative to the detriment of others.

All this turbulence caused by the increase in the pace of change and in the degree of competitiveness, in the ease of imitation by the competition and in the challenge in managing the knowledge that is generated on an exponential scale, makes the traditional form of creation of strategy, by means of a periodic, formal process of centralized planning, insufficient to deal with this situation (Mariotto, 2003; Whittington and Melin, 2003). In this context, the strategies must be elaborated and re-elaborated continually, and those considered “emerging” may have a crucial role.

By “emerging strategy”, the term proposed by Mintzberg (1978), essentially, one understands an unplanned strategy, such that a course of action that is developed and only perceived by the members of the organization as it advances or when it is concretized. The “emerging strategy” is opposed to the “deliberate strategy”, a pattern of action pursued according to a prior plan and formally established by the top management, and only made possible when the configuration of the organization and its culture favour the action of autonomous teams, as opposed to control by the upper echelons of the management hierarchy. For Mintzberg (1979), “emerging strategies” are characteristic of innovative organizations.

### *2.3 Technological strategies of innovation*

Freeman and Soete (1982) identified six types of strategies adopted in relation to technological innovation: offensive, defensive, imitative, dependent, opportunist and traditional. In analyses already conducted by Coutinho *et al.* (2003) taking

the biotechnology sector into consideration, the authors observed that three strategic postures prevail in the sector:

- (1) *Offensive strategy*. Aimed at innovation, the company “assumes a commitment” to the evolution of technology, that is, commits to continually modifying and improving processes, products and services. It recognizes, in the technology, and, in particular, in the innovation, the chance of improving its competitive performance and seeking technological and market leadership.
- (2) *Defensive strategy*. Partially aimed at innovation, the company accompanies the technological changes, but it has no objective of becoming the leader; the innovations can be through the aggregation of more technology, adapting the product to the clients’ needs, learning from the experience of the offensive leader, without repeating his/her eventual faults, and thus obtaining its differentiation (Porter, 1992).
- (3) *Dependent strategy*. Assumes a “less innovative” posture, without betting on technological change as a factor of competitiveness; it values aspects related to prices and productive efficiency. Normally, it does not invest significantly in R&D, seeking in the market, by means of licensing or partnerships, the technologies they need. It is a typical strategy of companies that are institutionally or economically subject to others, such as the subsidiaries of multinationals or other firms’ suppliers. In these cases, the innovations are specifically demanded by the head offices or the companies that purchase the products from the suppliers.

Of these, the patent as a form of intellectual property performs an important role only for the offensive and defensive strategies. For the former, it is because it protects and maintains the position of leadership, whereas, for the latter, it works as a guarantee of non-exclusion from a new technological area. It is considered a “necessary evil” by the companies that adopt this type of strategy (Barbieri and Álvares, 2005).

Irrespective of the strategic posture adopted, for definition of a strategy based on the model of open innovation, new questions must be included. Besides, defining the objectives and vision of the innovation, the company must be capable of mapping the internal technologies and competences, the external technological trends, and of comparing them to the long-term strategic planning, in order to decide what will be developed internally and what will be sought outside its frontiers (Moreira *et al.*, 2008).

Dealing specifically with the Brazilian industry, Cerantola (1992) in his study about the technological strategies of the biotechnology companies in Brazil corroborates the idea that the competitive strategies adopted by the companies needs to be associated with the technological strategies as elements of anticipation, a response to technological changes arising from the dynamic of the environment with its growing risks, uncertainties and market demands. As strategic determinants and fundamental factors for the survival of these companies, the author mentions the following:

- the constant contribution and greater period of resources applied to R&D, and consistent planning for renovation of products and processes, besides strategic management of technology as a pro-active posture for innovation and maximization of results;
- solid strategies of commercialization and marketing for expansion of its sales, and business planning, *vis-à-vis* the allocation of scarce resources; and

- strategic orientation aimed at the formation of alliances with different public and private agents, with the objective of optimizing resources and potentializing results.

#### *2.4 Incubators of companies with a technological base*

Incubators constitute environments specially planned to foster nascent companies, as well as deal with those that seek modernization of their activities, so as to transform ideas into products, processes and/or services. The incubation process confers on the companies conditions favourable to the detection of trends, incorporation of novelties and accompaniment of market changes, acting principally as an interface between the academic and productive sectors (Anprotec and Sebrae, 2002). The incubators offer complementary training of the entrepreneur in his technical and managerial aspects. Besides this, they facilitate and speed up the process of technological innovation in micro and small companies.

According to Hackett and Dilts (2004), who performed an extensive review of the literature about incubators and the incubation process, the work of Smilor (1987) is perhaps the most comprehensible effort to identify and explain the various components of an incubation system. He categorized the benefits offered to the incubated companies into four dimensions: creation and development of credibility, shortening of the entrepreneur's learning curve, solutions to problems, and facilitation of access to network relations.

In the economic context, they are configured as an efficient instrument for decreasing the mortality indexes of the micro and small firms. According to Sebrae (2004), 93 per cent of the companies, whose embryo passed through an incubator, survive in the market. In the other cases, around 60 per cent of the micro and small companies, Brazil do not survive beyond four years of life.

Baêta (1997) affirmed that the activities of the incubators can aid the small companies with a technological base in the process of entrepreneurial capacitation, as, besides formal partnerships, there is a series of exchanges with other entities, for the use of laboratories, information exchange and use of spaces that occur in an informal manner. The businessmen, in also being professors and researchers at the university or research centre, or former actors in these institutions have ease of access to these spaces, besides their relationships with ex-colleagues. This makes interactive capacitation to develop in the incubation environment. For Lemos (1998), the permanence of the company in a space that facilitates its owners' learning may contribute to the success of the enterprise. In this sense, the incubators can facilitate the learning process, thereby creating conditions in which the company may compete in the market.

Some empirical studies observed the impact of an enterprise located in an incubator. The studies are, however, inconclusive regarding the effectiveness of the tools used in the incubation process to support innovative ventures. There are studies that point out the difference in performance, demonstrating that companies located in incubators have a greater survival rate (Ferguson and Olofsson, 2004) and greater growth rates in terms of the number of employees and sales (Colombo and Delmastro, 2002) than companies conceived outside the incubation process. Besides this, incubated companies display a high degree of co-operation with research institutions in the innovation process (Colombo and Delmastro, 2002; Fukugawa, 2006).

On the other hand, other studies have not found significant differences between incubated companies and those that have not undergone this process. In the UK, Westhead (1997) did not find any significant difference when using innovation indicators (for example, expenditure on R&D, patents and trademarks). Another example is the study by Lindelof and Lofsten (2004), whose results indicated that Swedish companies located outside incubators launched more products than incubated ones.

According to Barbieri (1995), there is consensus among those who study incubators in Brazil that the absence of risk capital constitutes an important limiting factor for the expansion and growth of this type of company. In Brazil, the risk capital available to companies at this stage of development is limited to the still very incipient public risk capital. Despite the vertiginous growth in the number of incubators – according to data from Anprotec, the number in Brazil grew between 1998 and 2006, from two to 377; in 2005, the number of incubators with a technological base representing 40 per cent of this total (Anprotec, 2005, 2006), while this restriction lasts, the Brazilian incubators will hardly become consolidated as an instrument to stimulate development of new businesses within the current competitive patterns (Barbieri, 1995).

### *2.5 University-company co-operation*

The process of university-company co-operation has already been studied for a long time by researchers all over the world. In Brazil, these include Plonski and Vedovello (1990), Moraes and Stal (1994), Plonski (1995, 1999), Marcovitch (1999), Segatto-Mendes and Sbragia (2002) among others, which demonstrates the technological research by means of partnerships between companies and universities, research institutes are a world trend. Thus, there are various discussions regarding issues, such as barriers, facilitators, motivation, knowledge transfer processes and others crucial for the development of the process (Segatto-Mendes and Sbragia, 2002).

In Brazil, where the companies' level of investment in R&D, including expenditure related to training of human resources, is still very timid, the capacity of the Brazilian universities and research centres in developing technologies with high innovative potential represents a great opportunity and indicates the importance of the university-company relation as a fundamental condition for advances in the economic development of the country (Sbragia *et al.*, 2006).

The Brazilian companies, however, are still reticent regarding the capacity of the universities and research institutes to support their innovation process, given the difficulty different institutions face in their interrelations. There is a conflict, caused by the difficulty in matching the needs of the companies with the supply of services that the university could render, due to the restrictions imposed by the academia itself, still essentially very concerned with the advance of knowledge, not with its application.

However, from this co-operation a great advance is expected in the innovation process in Brazilian companies, as it is understood as crucial for the survival and efficiency of both institutions, as well as for the technological development of the country (Bicalho-Moreira and Ferreira, 2000). In almost all countries, the process of developing close liaison between universities and companies is already a reality, which has intensified over the last 30 years, due to the growing incorporation of scientific knowledge into the generation of products and services, especially in new industrial sectors, such as microelectronics and biotechnology (Moreira and Queiroz, 2007).

---

In research conducted by Segatto-Mendes and Sbragia (2002) with Brazilian universities and companies, the authors observed some important points of this co-operation process, including the following:

- main motivators for the co-operation with the universities for the companies are: access to highly qualified human resources and solution of the technical problems that generated the need for such research; and
- main barriers to the co-operation: university bureaucracy, very long project duration and differences in level of knowledge among the persons of the two institutions. Another barrier is raised when the results of the researches need to be protected by means of patents: the question of tension generated among the parties due to the lack of transparent understanding in relation to the premises for interaction among them.

Finally, a summary table was elaborated with the aim of explaining the main authors used in the literature review. This will serve as a basis for empirical analysis (Table I).

### 3. Research methodology

The fundamental approach of the research in this work was to carry out studies of multiple cases that were particularly adequate for answering questions of the “how” type and for exploring new areas of knowledge – study of exploratory cases, the objective of this work. The main advantage in considering various cases is that the results and the study itself are often regarded as more significant (Yin, 2005).

For Eisenhardt and Graebner (2007, p. 25):

[...] study of multiple cases are like a series of laboratory experiments that serve to replicate, contrast and understand the emerging theories, but as laboratory experiments isolate the phenomenon of their context, the case studies emphasize the rich context of the real world where the phenomenon occurs.

From the strategies put forward by Marshal and Rossman (1999) for the selection of cases in qualitative researches, this study used the strategy of seeking a variety of visions with the aim of documenting the diverse variations on the theme, and, from this point, identifying common patterns.

In the total, there were 16 interviews, whose duration varied from one to two-and-a-half hours. In order to have a clearer notion of the sector before starting the interviews of the companies, four interviews were conducted with professionals acting in the sector, representing development agencies, universities, incubators and suppliers of products to biotechnology companies. The second stage involved interviewing 12 management level employees from 11 companies of the biotechnology sector.

From these interviews, seven companies were considered for participation in the work, selected according to wealth and interest in their trajectories for the study in question. This intentional selection makes sense, in so far as it confronts classes of distinct companies. The literature that treats the case studies as the basis for the construction of theories supports this form of selection, in indicating that “the cases may be selected to fill theoretical categories or provide examples of extreme types” (Eisenhardt, 1989a, p. 537). In this study, it was opted to select cases in which “extreme types” would represent diversity of companies within the biotechnology sector in Brazil – this diversity being represented by different sectors of activity, size and

category of incubation. This form of selection of cases is very different from the selection process of samples that aim at randomness, typical of experimental studies, and is oriented to valorize the generation of elements relevant to the theory, based on the case studies. Besides, the interviews, secondary sources were also consulted about the companies considered, such as documents, sites, material published in the media, among others, which contributed to a more complete description of the companies.

### 3.1 Companies selected for analysis

Considering the scope of this work and the methodology of research adopted, it was sought to collect representative cases of the phenomenon of study. Thus, seven case studies were selected for analysis. The sample selected sought to contemplate:

- companies belonging to the Associação das Companhias Brasileiras de Biotecnologia – Association of Brazilian Biotech Companies, or allied enterprises;
- companies acting in different sectors, such as agriculture, human health, animal health, bioenergy;
- companies of different sizes, ranging from microfirms to companies belonging to multinational conglomerates; and
- companies at different stages of incubation (resident, non-resident and graduated) and companies that have not undergone the incubation process.

Table II presents the relation of the companies included in the research, characterized according to the criteria mentioned above.

In the choice of the companies, they covered the range from those belonging to a multinational conglomerate – the case of Alellyx/Canavialis, recently acquired by the Monsanto group, to microfirms. Regarding the question of the incubation process, it was also sought to contemplate companies from different incubators, so as to broaden the diversity of the sample. Thus, of the graduated/non-resident companies, one originated from the Centro Incubador de Companhias Tecnológicas – Incubation Centre for Technological Companies (CIETEC), one of the most important incubator centres in the country located in São Paulo; the other is from the Incubador de Companhias de Base Tecnológica – Incubator of Technology Based Companies, located in Ribeirão Preto.

Items of theoretical reference	Main authors
Competitive strategies in turbulent environments	Bourgeois and Eisenhardt (1988), Eisenhardt (1989b), Brown and Eisenhardt (1997), Christensen <i>et al.</i> (1998), Bourgeois and Eisenhardt (1988), Mariotto (2003), Whittington and Melin (2003), Mintzberg (1979)
Technological strategies of innovation	Freeman and Soete (1982), Coutinho <i>et al.</i> (2003), Cerantola (1992)
Incubators of companies with a technological base	Smilor (1987), Baêta (1997), Ferguson and Olofsson (2004), Colombo and Delmastro (2002), Fukugawa (2006), Westhead (1997), Lindelof and Lofsten (2004), Barbieri (1995)
University-company co-operation	Segatto-Mendes and Sbragia (2002), Bicalho-Moreira and Ferreira (2000), Plonski and Vedovello (1990), Moraes and Stal (1994), Plonski (1995, 1999)

**Table I.**  
Main authors used

---

Of the incubated companies, one is in CIETEC and the other in the Incubador de Companhias de Base Tecnológica – Incubator of Technology Based Companies at Campinas University – UNICAMP.

### 3.2 Analysis of the data

To analyze the data obtained in the interviews, content analysis was used:

Content analysis is a set of techniques for analysis of the communications, aimed at obtaining, by systematic procedures and objectives of description of the message content, indicators (quantitative or not) that permit inference of knowledge regarding the conditions of production/reception (inferred variables) of these messages (Bardin, 1977, p. 42).

Bardin (1977) reports a series of techniques of content analysis, such as categorial, evaluation, enunciation, expression, relations and discourse. For this study, the categorial analysis technique will be applied. In this manner, the texts of all the interviews were divided into themes – each theme identified constituted a unit of isolated meaning – which, by means of analogical regrouping, were classified into thematic categories. Among the different possibilities of categorization, the investigation of the themes, or thematic analysis, is rapid and efficacious in order to be applied to direct, simple discourses such as interviews. The three categories used here are related directly to the research questions posed: main determinants of the specific innovations of the sector; contribution of the relationship among companies of the sector, universities and incubators for the innovation production process; management of the technological innovation process in the companies of the sector. From the transcriptions of the interviews, passages that could be fitted into the defined categories of analysis were grouped and analyzed.

## 4. Analysis and discussion of the results

According to the basic literature on strategy in turbulent environments (Bourgeois and Eisenhardt, 1988; Eisenhardt, 1989a; Brown and Eisenhardt, 1997), the factors that comprise the turbulence of a competitive environment are typically outside the companies, such as, demand, competition, technology and regulation. The objective proposed here is centred on identifying which of these factors, according to the perspective of the companies studied, most impact the innovation process of the companies in the sector, in order to understand, based on the evidence of the cases studied, how the direct participants of the sector (companies, universities, incubators, investors, etc.) relate with the institutional schemes that connect them (markets of capital, knowledge and products) and the norms that rule and influence the functioning of these (regulation, corporate governance, intellectual property rights, etc.). The results generated add important elements to the understanding of the dynamics of the sector and of the management practices of the technological innovation adopted by the companies and help to respond to the problem of research, which is to understand how the innovation process in the Brazilian biotechnology companies occurs.

### 4.1 Principal determinants of the specific innovation in the biotechnology sector

The key determining factors for the innovation process concern the failures or gaps linked to: the pattern of finance; the laws that guarantee intellectual property rights; the regulatory laws related to the risks to health and the environment, and the action of the regulatory agencies; as well as the partnerships (in particular, those formed with the

**Table II.**  
Relation and  
characterization of the  
companies participating  
in the research

ID	Name of company	Size of company	Areas in which the biotechnology companies act				
			Human health	Animal health	Agriculture	Bioenergy	Inputs/ others
<i>Non-incubated</i>							
E1	Allelyx/ CanaVialis	Large (international)			X	X	
E2	Genoa	Small	X	X			
E3	Vallée	Large (national)		X			
<i>Graduated</i>							
E4	Exon	Small		X			X
E5	Nanocore	Small	X	X			X
<i>Incubated – non-resident</i>							
E6	Engene	Micro		X			
<i>Incubated – resident</i>							
E7	Bioactive	Micro	X				

universities). Other important factors commented were: the quality of the human capital and the external dependence on machinery, equipment and inputs.

For whatever the enterprise, access to finance is possibly the most critical determinant. The challenges to obtain it, however, are greater for the biotechnology companies, whose product development cycles generally involve long periods of maturation and technological validation.

There exists another aggravating factor, more related to the economic and cultural context of the country than exactly to market risks. In Brazil, the high-technology enterprises embody an excessive degree of risk, due to some factors, such as: the lack of incentive given to this type of initiative, the economic-cultural problem of low valorization of the investments in the areas of science, technology and innovation and the high-opportunity cost. These factors are viewed as important restraints on the development of risk capital in Brazil (Andreassi and Siqueira, 2006), whose scarcity is one of the main gaps in the development of biotechnology in the country, which adversely affects even the large companies in the sector. The only studied companies that counted on venture capital, Allelyx/CanaVialis are also the first major cases of success with this type of investment.

What one observes is a strong dependence on public resources. The cases reveal that one of the main initiatives of public risk capital investment is that provided by the Banco Nacional de Development Social (BNDES), through BNDESPAR, which operates in support programmes for the companies with a technological base.

In general, the companies use public finance in the form of resources directly invested in innovation or indirect activities, incentives and subsidies that favour innovation. This massive participation of public institutions in the promotion of biotechnology is, in fact, a strong point and a limiting factor at the same time. If, on the one hand, it renders viable many researches and products of high cost and risk – which would be unviable if exclusively financed by the private sector, on the other, it creates two problems related to dependence:

- (1) a major part of the researches and investments in the training of human resources makes it dependent on public resources; and

---

(2) it ends up generating a state of inertia in the organization itself.

Two studied cases offer alternatives that reduce dependence on public finance:

- the case of exon shows that with a strategy of focusing on a market niche with a product/service of relatively simple, cheap development, aiming at slower, more gradual growth, it is possible to even avoid this type of finance; and
- the case of nanocore – much in line with the Porter's (1992) precepts of obtaining a competitive advantage by means of adding value to the product – shows that it is possible to generate one's own revenue and immediately, creating a professional structure for the provision of services perceived by the clients as benefits generating differentials in relation to the competitors. This strategy for, on the one hand, avoiding dependence, in principle, increases costs and generates a negative impact on profitability, and, on the other, contributes to the perpetuation of the company.

If the finance factor is viewed as the greatest obstacle to innovation, the quality of the human capital, pointed out as the great motivation for companies to establish partnerships with universities (Segatto-Mendes and Sbragia, 2002), is considered as a key factor for companies to gain competitiveness and as a great facilitator of innovation. The reflection of this is the marked presence of high-level professionals performing as much activities of R&D as of administration in the companies studied.

Owing to its multidisciplinary character, the task of training professionals to work with biotechnology is made more difficult than in other knowledge areas. The fact that all the interviewees considered the quality good and the availability of human capital satisfactory does not reflect the reality of the country, and it is only explained by the demographic location of the sample. All the companies studied operate on the São Paulo – Minas Gerais axis, which also concentrates the country's best teaching institutions. It is no surprise that it is also where the great majority (71.9 per cent) of the companies in the sector are located (Biominas, 2007). Brazil, despite the efforts made by various teaching and research institutions over the last few years, faces the imminent problem of overcoming bottlenecks in the training of qualified professionals to develop diverse activities in biotechnology, such as the engineering of bioprocesses, genetic sequencing, legal advice in the environmental and industrial property areas, valuation of biodiversity, and administrative and financial management (Silveira *et al.*, 2004) and in the concentration of professionals in the South and Southeast, which is detrimental to the synergies and exploitation of regional vocations in other parts of the country.

With regard to the other institutional conditions highlighted as determinants for the occurrence of the innovation process, the cases studied illustrate how the orchestration of a more agile, transparent and predictable regulatory framework is a critical element for definition of an institutional environment appropriate for the development of biotechnology.

In the absence of more transparent, agile and easily understood legislation, the company encounters enormous difficulties in performing its R&D activities, using all sorts of resources in a sustainable manner, prospecting for new businesses, combating biopiracy and working on collaborative projects with universities and research centres.

The case of Alellyx/CanaVialis suggests that, in the ambit of biotechnology aimed at the agricultural area, the legislation is less restrictive when compared with the other areas of the application of biotechnology. The comments in this regard were:

E1 – We have legislation that is quite clear and not impeditive, but only regulatory. Having a clear law that protects intellectual property and has clearly defined parameters of approval was a decisive factor to begin to invest, in this line of products as of 2002.

E1 – There is no special facility in this area [agriculture], but what does exist is the fact there are not so many obstacles in the way of the research.

The intellectual property system also provides evidence of an ambiguous position, in which it is sought to simultaneously combine instruments present in the Acordo de Direitos de Propriedade Intelectual relacionados ao Comércio – Agreement regarding Intellectual Property Rights related to Trade and in the Convenção de Diversidade Biológica – Biological Diversity Convention. However, it is observed that there may be conflicts between these related to what is or is not susceptible to patent, to whom belongs the patent right and the level of detail of the object to be patented (Dal Poz *et al.*, 2004). This impasse gives rise to the need to intensify the debate about such rights, in accordance with the evolution of the technical base of the knowledge. Besides, this, the slowness in the analysis and granting of the patent title is also a cause of risk and uncertainty for the company, which may incur losses in the negotiation process for technology transfer.

If for some companies, the risks and uncertainties linked to intellectual property render investment in R&D activities unviable by not guaranteeing ownership rights, for others, they impose a pace of innovation so intense that they exhaust the company's resources, as noted by the interviewee from bioactive:

E7 – The risk of launching the product before holding the patent is great, but this cannot wait [...] It is a serious problem. It obliges you to innovate with other things, make another and another and another [...]. There are companies that can't cope with it and go bankrupt.

Another determining and limiting factor pointed out is the great external dependence on machinery, equipment and inputs for product R&D. This difficulty is related to the lack of resources and importation difficulties, given that the national production is insufficient or non-existent. When there is availability of resources, two more difficulties arise: the bureaucracy entailed in importation and the constant oscillations in the exchange rate, which, at some moments, reduce the company's purchasing power. For many researchers, the development of an equipment and inputs industry is essential for Brazil to sustain the biotechnology development process without losing sight of the cutting edge technology (Silveira *et al.*, 2004).

#### *4.2 Contribution of the relations among companies of the sector, universities and incubators to the innovation production process*

As much the literature on the theme as the observations made in the companies that participated in this study showed that, due to the environment of uncertainties, risks and the natural characteristic of the biotechnological developments – which generally demand an extensive knowledge base, the interlocution with universities and public and private research centres, and support institutions is fundamental for development of technological innovations, and, as a consequence, for the economic development of the country.

With the information gathered in the course of the empirical research throughout the 16 interviews, in conjunction with the theoretical reference used, it was possible to delineate the “anatomy” of the sector and characterize the environment in which the interactions with universities and incubators occur. Figure 1 shows a vision of the anatomy of the biotechnology sector in Brazil: the players are represented by squares; the institutional schemes, by lines; and the norms, by ellipses. In no way, does this scheme have the intention of representing all the complexity of the sector, but it is just to illustrate at macro level, the main players, connections and norms taking part in the system. Many details of the “anatomy” of the sector have already been covered by other authors (Segatto-Mendes and Sbragia, 2002; Moraes and Stal, 1994; Stal and Fujino, 2005; Smilor, 1987; Barbieri, 1995; Andreassi and Siqueira, 2006), and the present discussion does not intend to focus on the interaction among companies, universities and incubators.

The strongly scientific character of the biotechnology companies ensures the existence of close relations with the whole network of specialists in the academic sphere. In all the cases studied, the first relationships for the development of R&D in partnership with universities emerged from the informal personal relationships of friendship with people at the universities. This type of relationship was pointed out by Segatto-Mendes and Sbragia (2002) as the main instrument used for making the co-operation effective, which suggests the importance of this common background (six of the seven companies studied were created by persons from the academic field) in this process, and also reveals signs of prejudice and suspicion from both sides to establish a professional relationship. Part of this dissonance is the legacy of decades of a substitution policy for importations that distanced these two worlds, besides constituting really different worlds. Some of the interviewees’ comments in this regard were:

E7 – Each has his function in society [...] It is [necessary] to recognize the differences, know what are different things and recognize the importance of each one.

The information collected in the empirical research displayed the existence of diverse conflicting aspects, which make it a remarkable feature of the relationship between these two actors. Some of these strongly verified aspects were:

- The conflict of primordial focus of activity, which, in the university, is generation of knowledge for society, and, in the company, generation of profit:

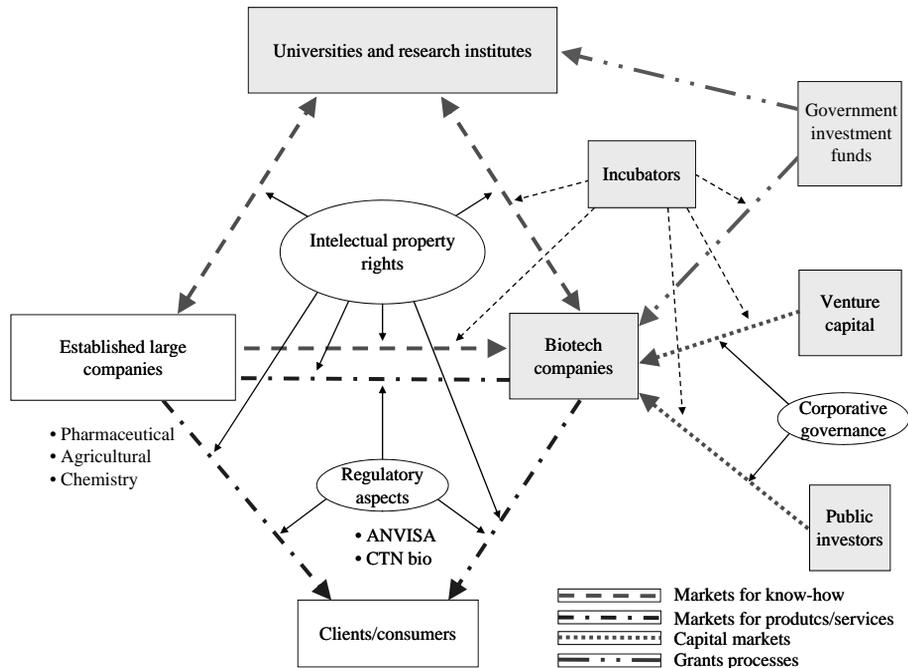
E2 – When you say that such and such is going to bring wealth to the country, he/she [the researcher from the university] says “No”, that it is going to bring you money! He/she forgets that we are going to generate employment for several post-doctorates, we are going to bring various opportunities, we are really going to bring wealth to the country.

- The conflict of periods:

E4 – The great challenge to talk over is the timing. The time of the researcher is different, very long.

E3 – The research institutions have another vision of periods in relation to the projects. This is changing, but, at times, we still face this problem.

- The conflict due to the difference in research focus and objective. The researcher strives for quality and excellence in the name of science, whereas the company seeks economic performance:



**Figure 1.**  
Anatomy of the  
biotechnology sector  
in Brazil

E6 – The researcher is not accustomed [...] to make a thing, not because he/she finds it interesting for science, but because it is simpler, because it is going to be innovative [...] that, even not being the best that could be made, it is the best cost-benefit.

- The conflict regarding the form of reward for the effort invested in the development of the project:

E3 – There are still researchers who think it is sufficient to make a legal study for publication, but we want a product.

E5 – The currency that is charged is the publication, either you publish or you patent [...] If you publish, you lose the innovation.

- Finally, perhaps the main conflict, is that of purpose between the two institutions, expressed by the emphasis of research of the university on the basic research and that of the company on the applied research:

E1 – The main barrier is the position that Brazil adopts: the position of the universities and research centres, which are much more aimed at the research base.

With regard to the areas related to biotechnology, the research results suggest that, although the conflicts remain the same, as pointed out by Moraes and Stal (1994), 15 years ago, they do not constitute insuperable barriers. The companies recognize the advantages of the interaction and what really makes the formation of long-term partnerships impeditive, but, for more complex, more expensive development, it is

the risk associated to the lack of a clear policy in relation to the management of the intellectual property. Of the seven companies studied, four currently do not engage in partnerships with universities, and for three of them, the impasse about patents is the reason for not doing so. Among these were included two incubated companies, precisely those that partnership would lead to greater leverage.

The result of this research corroborates the Stal and Fujino (2005) hypothesis that the Brazilian triple helix remains incipient. On the other hand, it differs from the result of the Segatto-Mendes and Sbragia (2002) research, conducted in the engineering departments of three Brazilian universities considered prestigious in the academic milieu, which attributes to the ownership of patents a degree of importance as a barrier to university-company co-operation inferior to that attributed to the university bureaucracy, to the long duration of the projects and to the difference in level of knowledge among the university personnel and the company involved in the co-operation. Such a difference suggests that, in a comparison between these two areas, either:

- (1) the intellectual property has a greater weight of importance for the biotechnology area; or
- (2) the intellectual property policies of the universities are clearer in relation to the engineering area.

Synthesizing, from the results presented, it is concluded that the institutional and regulatory factors are critical, and the intellectual property is only the “touchstone” of all this institutional construction. The regulatory aspects are as important, although they appear less times because the processes are interrupted before. The example cited, that of partnership for the development of a medication for malaria illustrates this point. The regulatory blockages will only be revealed once the blockages to intellectual property are overcome.

Regarding the contribution of the incubator in the innovation process of the incubated companies, of the four dimensions identified by Smilor (1987), effects were observed in only two of them: shortening of the learning curve of the entrepreneur and facilitator in the access to the network of relationships. The research conducted in the companies that underwent the incubation process did not offer indications that the incubator favoured the creation or development of credibility of these companies, nor did it favour effective action as a problem solver.

The incubators that allocate the two companies studied are located on university campuses and have an active role in developing their closer relationship with the respective universities. However, with the other interlocutors (the incubated companies themselves, the other companies of the sector, the development promotion agencies, the public investors and the private), this role is still not performed in a satisfactory manner from these companies’ perspective.

The action of the incubators was remarkable with regard to the shortening of the learning curve. The interviewees from the incubated companies were emphatic in recognizing the importance of the capacitation services and consulting rendered by the incubators, ranging from the structuring of the business plan to the management training provided by support entities for the small and micro firms, such as Sebrae. Reservations arose in relation to the specialized consulting services (the examples cited were consulting about patents and regularization of installations). Besides, this, it was also stressed that there was a lack of success on the part of the incubators in establishing

business viabilization with risk investors (even those companies that had guidance from the incubator to devise their business plans) – a situation that is shown to be practically unaltered since the evaluation carried out 13 years ago by Barbieri (1995).

*4.3 Management of the technological innovation process in these companies of the sector*  
Treating the cases studied as experiments that seek to understand a phenomenon, great differences are perceived in the way each company generates its innovation process, especially as each area in which biotechnology is applied presents distinct characteristics, although comparative analysis reveals agreement concerning the motivation behind the innovations. In all the cases, the precepts of Christensen (2001) were verified: the companies are driven by a perception of market opportunity to seek differentiation of the product and/or service as a means of growing and keeping themselves in the competitive scenario of the sector. It can be inferred that the need to find little exploited, or even unexplored, business niches in which it is possible to generate greater gains, is the driving force in the quest for innovation. The reflection of this could be observed in the technological strategies adopted in order to achieve matching of products, processes or services to the market. Such an observation is in line with the logic of the evolutionary line of Nelson and Winter (1982).

Of all the companies studied, only Vallée uses a formal model of the innovation process (in this case, the funnel model), which may be attributed to the hypotheses of lack of knowledge, or, more probably, in the case of the small and micro firms, organizational immaturity. In the majority of the cases, innovation became a competence of the persons of the company, internalized as a practice in the routine and in the management in a tacit manner. In the same way, the management of innovation is recognized by companies, albeit not formally, that is, the management of the innovation process is made according to the momentary needs and the intuition and experience of the incumbents.

From analysis of the individual cases, some other elements relevant to the internal organizational environment of the companies are outstanding, which are added to the understanding of the management of the technological innovation process. Some are related to the aspects of market competition, while others are related as much to the structure as to the organizational culture.

The case of exon shows that it is possible to establish a relation between the management of persons and the results achieved by their innovations. Few hierarchical levels, rapid, effective communication between the marketing and technological areas, with all talking the “same language”, orientation for the client seeking to collect information about needs disarticulated from new clients and markets through observation and research of pioneer users seem to compose its offensive strategy, which enables the company to develop and introduce innovations into the market.

In turn, the case of Genoa shows how the organizational structure can evolve in a pragmatic manner throughout the life cycle of the enterprise, matching the scope and limitations of each stage of the cycle. Moreover, this case highlights the importance of considering the role of the entrepreneur inside the organization at each stage. As the requirements to which the organization is subject vary over time, it is supposed that there will be a need to evaluate the competences and skills of the entrepreneur to deal with them, and, eventually, some adjustment in the configuration of the organizational structure will be necessary, for example, contracting a professional executive officer. The case also shows how the adoption of a methodology of measurement of intangible

---

assets aids evaluation of the management processes, which also reduces the difficulty in co-ordinating and controlling that inevitably arises when, during expansion, separate business units are created.

The successful case of Alellyx/CanaVialis is evidence of an environment that promotes and encourages constant learning, besides boosting and rewarding (via some system of incentives, such as metrics of performance and variable remuneration) the generation of new ideas, permitting all the collaborators to become potential sources of innovation.

On the other hand, a marked cultural feature pointed out by the majority of the interviewees was the general lack of preparation of the companies to work in collaboration with competitors or companies that act in complementary areas. Only four of the seven companies studied form or formed partnerships of this nature; one of them, Alellyx/CanaVialis, only formed one partnership: with Monsanto, for the development of genetically modified sugar cane, tolerant of herbicides and resistant to insects and diseases – precisely the partnership that culminated in the acquisition of the company. Despite this, cases such as that of Genoa and Nanocore suggest that the partnerships, whether they be with companies or universities, national or international, increase the credibility of the companies *vis-à-vis* the financial entities (in these cases, with BNDESPAR).

Finally, the element common to all the cases is the adversity, as much techno-scientific as conjunctural, that forms part of the routine of these companies. One underlying result of the research was that the companies have faced this reality without entering a spiral of complaint and commiseration. They have succeeded in envisaging opportunities in adversities and managed them, instead of simply avoiding them. Also, they made an active effort in terms of learning from them, suggesting that there exists one more practical form of learning and capacitation adopted by the companies: learning from adversity.

## 5. Final considerations

This work had the aim of contributing to understanding of how the innovation process in Brazilian biotechnology companies is developed, and for such the study was limited to analysis of three aspects: main specific determinants of the innovation of the biotechnology sector; contribution of the relationship between companies of the sector, universities and incubators to the innovation production process; and management of the technological innovation process in the companies of the sector.

With respect to the main determinants of innovation in biotechnology, the study showed that access to finance is still the main barrier to be overcome by the companies of the sector, whole cycle of development of products generally involves long periods of technological maturation and validation, besides the high risks involved and the strong dependence on public resources. As an alternative to this barrier, the companies end up concentrating on niche markets with lower development costs, or on high-added value products. As other determining factors for the innovation process, the study also identified the importance of qualifying the human resources, and a more agile, transparent and predictable legislation, contemplating the intellectual property system and ease in importing highly specific machinery and equipment.

Regarding the relationship among the companies of the sector, universities and incubators for the innovation production process, as much the literature on the theme as the observations made in the participating companies showed that the

relation with universities, public and private research centres, and support institutions is fundamental for the development of technological innovations. One result of this study of managerial utility is the idea that partnerships, as much with universities or companies, are intangibles assets that present an additional advantage: they strengthen the credibility of the companies *vis-à-vis* the financial community and eventual allies, thereby being one more motivator for the establishment of the same.

Finally, concerning the management of the technological innovation process, the study showed that, as the biotechnological products/services are intensive in knowledge and subject to economies of scale, a key factor for the success of innovation is the orientation to the market, but not necessarily “by the market”, given that often the innovations create new markets and cater for needs not yet articulated. In order to make up for shortcomings and obstacles observed at macro level, the companies can compensate at the micro level, conferring agility and flexibility upon their internal processes by means of efficient management of personnel and knowledge, of the creation of an organizational environment that favours innovation and organisational structures that support it and adapt to the needs of the different phases of the enterprise. However, it is observed that, in general, these internal processes occur with little formality: the innovation is internalized, in practice, in a tacit manner, and the management of the innovation process does not occur in a systematized manner, but dictated by momentary needs and guided by intuition.

However, the results of the study suggest that the innovation process in the Brazilian biotechnology companies is benefited by the pro-active posture adopted by them. In the effort to accompany the advances and changes that occur in the national and international contexts, the companies have sought to manage the adversities and learn from them.

The results presented pertain to the companies studied, and, therefore, cannot be generalized or extended to other companies or areas. However, it is expected that these results may serve as a starting point for other studies in the areas analyzed. Studies of a quantitative nature are recommended, contemplating larger, more significant samples in order to better evaluate the results arising from this qualitative research.

## References

- Andreassi, T. and Siqueira, E.M.R. (2006), “The funding of new technology-based firms in Brazil”, *International Journal of Entrepreneurship & Innovation Management (Online)*, Vol. 1, pp. 369-82.
- Anprotec (2005), “Panorama 2005 Anprotec”, available at: [www.anprotec.org.br/publicacaopanorama.php?idpublicacao=54](http://www.anprotec.org.br/publicacaopanorama.php?idpublicacao=54) (accessed 15 February 2009).
- Anprotec (2006), “Panorama 2006 Anprotec”, available at: [www.anprotec.org.br/publicacaopanorama.php?idpublicacao=54](http://www.anprotec.org.br/publicacaopanorama.php?idpublicacao=54) (accessed 15 February 2009).
- Anprotec and Sebrae (2002), “Planejamento e implantação de incubadoras de empresas”, working paper, Anprotec, Brasília.
- Arundel, A., Patel, P., Sirilli, G. and Smith, K. (1998), “The future of innovation measurement in Europe: concepts, problems and practical directions”, IDEA Report No. 3, STEP Group, Oslo, available at: [www.scribd.com/doc/239713/The-future-of-innovation-measurement-in-Europe](http://www.scribd.com/doc/239713/The-future-of-innovation-measurement-in-Europe) (accessed 20 May 2008).

- Assad, A. (2001), "Programa Nacional de Biotecnologia e Recursos Genéticos", working paper, Ministério da Ciência e Tecnologia, Secretaria de Políticas e Programas de Ciência e Tecnologia – Departamento de Programas Temáticos, Brasília.
- Baêta, M. (1997), "As Incubadoras de Empresas de Base Tecnológica: uma nova prática organizacional para inovação", PhD Thesis, Universidade Federal do Rio de Janeiro, Rio de Janeiro.
- Bajari, P., Benkard, C.L. and Levin, J. (2004), "Estimating dynamic models of imperfect competition", NBER Working Paper Series 10450, National Bureau of Economic Research, Cambridge, MA.
- Barbieri, J.C. (1995), "Parques e Incubadoras de Base Tecnológica: A Experiência Brasileira", working paper, Série Relatórios de Pesquisa FGV-EAESP No. 4, Fundação Getulio Vargas, São Paulo.
- Barbieri, J.C. and Álvares, A.C.T. (2005), "Estratégias de Patenteamento e Licenciamento de Tecnologia: Conceitos e Estudo de Caso", *Revista Brasileira de Gestão de Negócios – FECAP*, Vol. 7 No. 17, pp. 58-68.
- Bardin, L. (1977), *Análise de conteúdo*, Edições 70, Lisboa.
- Barney, J. (2002), *Gaining and Sustaining Competitive Advantages*, Prentice-Hall, Upper Sadle River, NJ.
- Bicalho-Moreira, L.M. and Ferreira, M.A. (2000), "Inovação tecnológica na universidade: representação nos indicadores de ciência e tecnologia", *Proceedings of the XXI Conference on Simposio de Gestão da Inovação Tecnológica, São Paulo*.
- Biominas (2001), "Parque Nacional de Empresas de Biotecnologia", available at: [www.anbio.org.br/pdf/2/mct\\_parque\\_nacional\\_empresas.pdf](http://www.anbio.org.br/pdf/2/mct_parque_nacional_empresas.pdf) (accessed 11 January 2007).
- Biominas (2007), "Estudo de Empresas de Biotecnologia do Brasil", available at: <http://win.biominas.org.br/estudobio/estudo/> (accessed 10 November 2007).
- Bourgeois III, L.J. and Eisenhardt, K.M. (1988), "Strategic decision process in high velocity environment: four cases in the microcomputer industry", *Management Science*, Vol. 34 No. 7, pp. 816-36.
- Brown, S.L. and Eisenhardt, K.M. (1997), "The art of continuous change: linking complexity theory and time-paced evolution in relentlessly shifting organizations", *Administrative Science Quarterly*, Vol. 42 No. 1, pp. 1-34.
- Cerantola, W.A. (1992), "Estratégias Tecnológicas das Empresas de Biotecnologia no Brasil", *Revista de Administração*, Vol. 27 No. 2, pp. 5-14.
- Christensen, C.M. (2001), *O Dilema da Inovação*, Makron Books, São Paulo.
- Christensen, C.M., Suárez, F.F. and Utterback, J.M. (1998), "Strategies for survival in fast-changing industries", *Management Science*, Vol. 44 No. 12, pp. 207-20 (Providence).
- Colombo, M. and Delmastro, M. (2002), "How effective are technology incubators? Evidence from Italy", *Research Policy*, Vol. 31, pp. 1103-22.
- Coutinho, P., Bomtempo, J.V. and Weinberg, G. (2003), "New typology for the strategic/technological positioning of firms in developing countries", *Proceedings of the 12th International Conference on Management of Technology (IAMOT), Nancy, France, 13-15 May*.
- Dal Poz, M.E., Silveira, J.M.F.J. and Fonseca, M.G. (2004), "Direitos de Propriedade Intelectual em Biotecnologia: um processo de construção", in Silveira, J.M.F.J., Dal Poz, M.E. and Assad, A.L.D. (Eds), *Biotecnologia e Recursos Genéticos: Desafios e Oportunidades para o Brasil*, Instituto de Economia/FINEP, Campinas.

- Dosi, G. (1982), "Technological paradigms and technological trajectories: a suggested interpretation of the determinants and directions of technical change", *Research Policy*, Vol. 11 No. 3, pp. 78-101.
- Dosi, G. (1988), "The nature of the innovative process", in Dosi, G., Freeman, C., Nelson, R., Silverberg, G. and Soete, L. (Eds), *Technical Change and Economic Theory*, Pinter, London.
- Eisenhardt, K.M. (1989a), "Building theories from case study research", *Academy of Management Review*, Vol. 14 No. 4, pp. 532-50.
- Eisenhardt, K.M. (1989b), "Making fast strategic decisions in high-velocity environments", *Academy of Management Journal*, Vol. 32 No. 3, pp. 543-76.
- Eisenhardt, K.M. and Graebner, M.E. (2007), "Theory building from cases: opportunities and challenges", *Academy of Management Journal*, Vol. 50 No. 1, pp. 25-32.
- Ferguson, R. and Olofsson, C. (2004), "Science parks and the development of NTBFs: location, survival and growth", *Journal of Technology Transfer*, Vol. 29, pp. 5-17.
- Freeman, C. (1995), "Innovation in a new context", STI Review No. 15, OECD, Paris.
- Freeman, C. and Soete, L. (1982), *The Economics of Industrial Innovation*, Frances Pinter, London.
- Fukugawa, N. (2006), "Science parks in Japan and their value-added contributions to new technology-based firms", *International Journal of Industrial Organization*, Vol. 24, pp. 381-400.
- Hackett, S.M. and Dilts, D.M. (2004), "A systematic review of business incubation research", *Journal of Technological Transfer*, Vol. 29, pp. 55-82.
- Lemos, V. (1998), "O papel das incubadoras de empresas na superação das principais dificuldades das pequenas empresas de base tecnológica", MSc Thesis, Universidade Federal do Rio de Janeiro, Rio de Janeiro.
- Lenox, M.J., Rockart, S.F. and Lewin, A.Y. (2007), "Interdependency, competition, and industry dynamics", *Management Science*, Vol. 53 No. 4, pp. 559-615.
- Lindelof, P. and Lofsten, H. (2004), "Proximity as a resource base for competitive advantage: university-industry links for technology transfer", *Journal of Technology Transfer*, Vol. 29, pp. 311-26.
- Marcovitch, J. (1999), "A Cooperação da Universidade Moderna com o Setor Empresarial", *Revista de Administração da USP*, Vol. 34 No. 4, pp. 13-17.
- Mariotto, F.L. (2003), "Mobilizando Estratégias Emergentes", *RAE – Revista de Administração de Empresas*, Vol. 43 No. 2, pp. 72-80.
- Marshall, C. and Rossman, G.B. (1999), *Designing Qualitative Research*, Sage, Thousand Oaks, CA.
- MCT (1993), *Estudo da Competitividade da Indústria Brasileira: Competitividade em Biotecnologia*, MCT/Unicamp, Campinas.
- Mintzberg, H. (1978), "Patterns in strategy formation", *Management Science*, Vol. 29 No. 9, pp. 934-48.
- Mintzberg, H. (1979), *The Structuring of Organizations*, Prentice-Hall, Englewood Cliffs, NJ.
- Moraes, R. and Stal, E. (1994), "Interação Empresa-Universidade no Brasil", *RAE – Revista de Administração de Empresas*, Vol. 34 No. 4, pp. 98-112.
- Moreira, D. and Queiroz, A.C. (2007), *Inovação Organizacional e Tecnológica*, Thomson Learning, São Paulo.
- Moreira, B., Feldhaus, D., Saad, D., Pereira, G.L. and Mattioli, M. (2008), "As Oportunidades e Desafios do Open Innovation no Brasil", Instituto Inovação, Brasília, available at: [www.institutoinovacao.com.br/estudo.php?escolha=154](http://www.institutoinovacao.com.br/estudo.php?escolha=154) (accessed 13 June 2008).

- Nelson, R. and Winter, S. (1982), *An Evolutionary Theory of Economic Change*, Harvard University Press, Cambridge, MA.
- Pisano, G.P. (2006a), *Science Business: The Promise, the Reality, and the Future of Biotech*, Harvard Business School Press, Boston, MA.
- Pisano, G.P. (2006b), "Can science be a business?. Lessons from biotech", *Harvard Business Review*, Vol. 84 No. 10, pp. 114-25.
- Plonski, G.A. (1995), "Cooperação Empresa-Universidade na Ibero-América: Estágio Atual e Perspectivas", *Revista de Administração*, Vol. 30, pp. 65-74.
- Plonski, G.A. (1999), "Cooperação Universidade-Empresa: Um desafio gerencial complexo", *Revista de Administração*, Vol. 34, pp. 46-55.
- Plonski, G.A. and Vedovello, C. (1990), "Cooperação Universidade-Empresa no Campo da Física", *Revista de Administração*, Vol. 25 No. 1, pp. 151-6.
- Porter, M.E. (1986), *Estratégia competitiva: técnicas para a análise de indústrias e da concorrência*, Universidade Federal do Rio de Janeiro, Rio de Janeiro.
- Porter, M.E. (1992), *Vantagem Competitiva: Criando e Sustentando um Desempenho Superior*, Universidade Federal do Rio de Janeiro, Rio de Janeiro.
- Sbragia, R., Stal, E., Campanario, M. and Andreassi, T. (2006), *Inovação: Como Vencer esse Desafio Empresarial*, Clio Editora, São Paulo.
- Schumpeter, J.A. (1982), *A Teoria do Desenvolvimento Econômico*, Abril Cultural, São Paulo.
- Sebrae (2004), "Data from 2004", available at: <http://sebraesp.com.br> (accessed 10 November 2007).
- Segatto-Mendes, A.P. and Sbragia, R. (2002), "O Processo de Cooperação Universidade-Empresa em Universidades Brasileiras", *Revista de Administração*, Vol. 37 No. 4, pp. 58-71.
- Silveira, J.M. and Fonseca, M.G. (2005), "Biotecnologia na Agricultura e Inovação Tecnológica: Novas Questões, Novos Desafios", *Programa de Seminários Acadêmicos*, Seminário No. 19, Universidade de São Paulo, São Paulo.
- Silveira, J.M.F.J., Dal Poz, M.E. and Assad, A.L.D. (2004), *Biotecnologia e Recursos Genéticos: Desafios e Oportunidades para o Brasil*, Instituto de Economia/FINEP, Campinas.
- Smilor, R.W. (1987), "Commercializing technology through new business incubators", *Research Management*, Vol. 30 No. 5, pp. 36-41.
- Stal, E. and Fujino, A. (2005), "As Relações Universidade-Empresa no Brasil sob a ótica da Lei de Inovação", *Revista de Administração e Inovação – RAI*, Vol. 2 No. 1, pp. 5-19.
- Westhead, P. (1997), "R&D inputs and outputs of technology-based firms located on and off science parks", *R&D Management*, Vol. 27, pp. 45-62.
- Whittington, R. and Melin, L. (2003), "The challenge of organizing/strategizing", in Pettigrew, A.M., Whittington, R., Melin, L., Sanchez-Runde, C., van den Bosch, F., Ruigrok, W. and Numagami, T. (Eds), *Innovative Forms of Organizing*, Sage, London.
- Yin, R.K. (2005), *Estudo de Caso: Planejamento e Métodos*, Bookman, Porto Alegre.

#### About the authors

Daniel Chu got his Master's degree in Business Administration from Fundação Getulio Vargas, where he took part of an MBA exchange program at the University of Southern California (Marshall School of Business). He has a Bachelor of Science degree in Mechanical Engineering with specialization in Design and Manufacturing from the University of São Paulo. He currently works with Program Management at General Motors in Design Development. Recent past experiences include Business Consultant for Cluster Competitiveness Group, working in partnership with

---

MRJIAM

9,1

Government on projects of regional economic development and IT Project Manager at Accelera Technologies developing web-based integration systems. Daniel Chu also has more than ten years of experience in engineering and product development in companies such as General Motor, Ford Motor Company and MSX International, both in Brazil and in the USA. Daniel Chu is the corresponding author and can be contacted at: danielchu@gvmail.br

30

---

Tales Andreassi teaches Entrepreneurship and Innovation at Escola de Administração de Empresas de São Paulo, Fundação Getulio Vargas (FGV/EAESP) for undergraduate and graduate courses, as well MBA, Master and PhD courses. At FGV-EAESP, he also serves as Associate Dean for MPGI – Master’s in International Management, an FGV Program which is part of the CEMS Alliance. He is also the Director of GVCenn – Center of Entrepreneurship and New Business and Director of the 10,000 Women Project. He was the Chair of IntEnt Conference 2006, an international conference that aims to discuss the teaching of entrepreneurship. Tales Andreassi also participates as Team Advisor to several business plan competitions, including Latin America Mootcorp, Mootcorp and Intel Ventures. He also teaches Master’s courses at Universidad Central del Ecuador. Prior to his career in academia, he was Project Manager for ten years at Anpei – an association that groups Brazilian companies with R&D centers. As an educator, Tales Andreassi has researched, written and lectured on various aspects of entrepreneurship and innovation. His work has appeared in more than 20 academic journals, he has presented more than 30 papers in scientific conferences and is the author of four books. Tales Andreassi earned his PhD at São Paulo University, his MPhil at Science Policy Research Unit (SPRU), Sussex University and his BA at São Paulo University.

