

## Innovation and Technology Management in Brazilian Subsidiaries in the Electro-Electronic Industry

Muriel de Oliveira Gavira<sup>1,2</sup>, Ruy Quadros<sup>1</sup>

<sup>1</sup>State University of Campinas, Scientific and Technological Politics Dept., Campinas, SP, Brazil

<sup>2</sup>Rutgers University, Business School, Newark, NJ USA

**Abstract**—In an increasingly competitive and challenging market, multinational corporations have evolved to allow or to actively encourage each subsidiaries to become more involved in the local generation of knowledge and innovation for the benefit of the global corporation. Subsidiaries, in turn, seek more responsibilities and opportunities in order to acquire more complex types of competences and to assure their survival and competitiveness. Thus, subsidiaries have been active contributors to the decisions and competitiveness of their wider corporate groups. In subsidiaries that acquire competence-creating mandates, the way in which technology and innovation are managed changes with their expanded responsibilities. This paper draws on an on-going case study of six subsidiaries installed in Brazil operating in the electro-electronics industries. The objective of the research is to compare these subsidiaries in order to better understand their actual technological innovation management practices (TIP), and to comprehend the connection between TIP and evolution towards more strategic roles on the subsidiaries. The preliminary research findings suggest significant TIP differences between the subsidiaries studied, and that the practices of innovation management are closer to the market (mostly product development related). Indeed, there is little presence of practices related to longer-term technology research.

### I. INTRODUCTION

Companies of all sectors have faced a growing number of challenges, like the high level of exigency and sophistication of customers, fast technological advances, expansion of the commercial, financial and information flows etc. Those changes imply in huge competitive challenges and drive enterprises to look for strategies capable to provide long-term competitiveness. Among such strategies, one of the most important is innovation.

In such a context, the multinational corporation (MNC) has evolved to increase its efforts to integrate their global units into research and development (R&D) and innovation activities. Such enterprises have increased the internationalization and decentralization of technological activities, in such a way each affiliate contributes to generate knowledge and innovation for the benefit of the global corporation [8, 11].

Consequently, MNCs headquarters (HQ) have evolved to allow or to actively encourage each of their subsidiaries to become more involved in the local generation of knowledge and innovation for the benefit of the global corporation. Thus, it is now common for MNC headquarters to have procedures in place to carefully analyze the capabilities of their various subsidiaries, in order to ascertain or confirm which

subsidiaries should acquire or retain product charters<sup>1</sup>, which are usually associated with more and with differently motivated R&D responsibilities.

Subsidiaries, in turn, seek more responsibilities and opportunities, mainly in higher value added activities, in order to acquire more complex types of competences and to assure their survival and competitiveness. Thus, subsidiaries have been active contributors to the decisions and competitiveness of their wider corporate groups.

In this manner, a strategic role of the subsidiary is fundamental to the development not only of its own environment, but also to the improvement of the local environment where it is inserted. It can bring to the affiliate more autonomy, visibility, local and corporate prestige, lower costs, etc.; and, for the local development, can provide increased investments, attraction and absorption of more qualified people, knowledge diffusion, etc. [2, 6, 20, 21, 22].

Thus, the development of subsidiaries' roles is as important to the MNC as to the affiliate itself and the local environment. For example, Feinberg [12] states that the affiliate development (by means of increased charters) led to a positive economic impact in subsidiaries installed in Canada with biggest salaries and R&D labs. In these enterprises, the level of employment and investments has increased. Frost et al. [16] reinforce this observation saying that units with important charters, besides receiving more investment from headquarter, had exported more. Such impacts are vital to the economic development of host countries, particularly the developing ones.

A point stressed in the literature is the fact that subsidiaries of multinational corporations change their roles as they develop along time [26]. Such evolution depends on three sets of factors: headquarter, subsidiary and local environment determinants [6]. Different configurations and significance of these three sets determine the roles of the subsidiary, and consequently, the different capacities and responsibilities of the subsidiaries. Thus, the subsidiary can continuously alter its role inside the multinational firm by acquiring or losing capacities and capabilities.

The way technology and innovation are managed evolves with the subsidiary role in the corporate innovation process. The complexity of practices evolves in line with the complexity of the technological mandate of the affiliate. Moreover, there are particularities in the environment of the host country that may require different management approaches. The most evident is the idiosyncratic nature of

<sup>1</sup> Charter is defined for Galunic and Eisenhardt [3] as the business or elements of the business in which the subsidiary participates and for which it is recognized to have responsibility within the multinational. It is the visible manifestation of the subsidiary's role (business activities) in the MNC. [4]

the Science and Technology country environment and institutions.

Thus, the objective of this paper is to draw the preliminary research findings of an on-going case study in six electro-electronic industry subsidiaries installed in Brazil. The objective of the research is to compare the subsidiaries in order to understand their actual technological innovation management practices (TIP) and comprehend the connection between TIP and more strategic roles.

The literature of the subsidiary management area is vast and complex. Several authors have studied the subsidiary role and the technological innovation management practices, among them Bartlett and Ghoshal [3], Birkinshaw and Hood [6], Fleury [15], etc. However, there have been few studies comparing the TIP between subsidiaries, particularly on developing countries. Such fact has motivated the study presented in this paper.

Therefore, research about subsidiary practices of innovation management (including the nature of the process, the determinant factors, and the implications) is a potentially important contribution to the national and international literature of this area. The paper intends to provide subsidies for policy-makers and managers to improve Brazilian subsidiaries in terms of strategy, value and innovative activities.

The paper is organized as follows. In the Section II, there is a brief description of key concepts required for the study and in Section III is the study methodology. We present the preliminary results in Section IV and in Section V the main conclusions.

## II. THEORETICAL FRAMEWORK

### A. Innovation and Technology Management

The term innovation include the marketing, organizational, technical, scientific, technological, supply, financial, and business activities leading to the market introduction of a new or improved product and/or process [10, 25, 29, 30].

In this study, we focus only in the technological product and process (TPP) innovations, which, according to the Oslo Manual [25], comprise implemented technologically new products and/or processes and significant technological improvements in products and/or processes.

In the Oslo Manual, the minimum requirement for the innovation concept is that the product and/or process must be new (or significantly improved) to the firm. In this way, innovation management is considered as the set of policies and practices searched, defined and implemented by an organization in order to implement innovations (in this paper, TPP innovations).

Recently, Tidd et al. [32] argued that although innovation have an uncertain and often random nature, it is possible to identify underlying change patterns. Successful innovation management largely depends on ensuring that there are routines to deal with new situations. To them, successful innovation management is primarily about building and improving effective routines.

Therefore, several authors have described routine in similar ways. To Tannenbaum [31] routines are the regular patterns of behavior associated with each specialized task and with efforts to coordinate the interaction of all organizational members. Particularly, Nelson and Winter [23] describe organizational routines as repetitive patterns of activity in an organization. They identify routines as the mechanism by which tacit knowledge becomes codified through a process of 'remembering by-doing'. In this way, an organizational routine is handled as the "organizational analogue of individual skill. When rich and relevant information is available to guide action, organizations often find routinized ways of exploiting it". [24]

From the above description, we can infer that routines are firm specific and must be learned. However, we need to be careful with the negative side of routines: they can be difficult to change when the organization is too committed to them. Therefore, in innovation management, the ability to build routines is as important as the ability of successfully change them whenever necessary.

This study focus in the subsidiaries innovation management process to which people build routines. To this purpose, we define innovating routines as the predictable and regular behavioral patterns within organizations coping with the management challenges of innovational activities.

According to Pavitt [27], although substantial effort has been spent to analyze the notion of innovating routines, there is still only an unclear idea of what innovating routines are in practice. In such context, this research is important since compares the innovation management routines of six subsidiaries of the electro-electronic industry installed in Brazil.

In order to study the innovation management process of the subsidiaries, we divided the process into eight dynamic and interactive groups of activities or dimensions related to the processes of innovation suggested by Cotec [9], Dodgson [10], Pavitt [27], and Tidd et al. [32]. We investigate which routines from those groups are used by each subsidiary. The eight groups are:

1. Provide innovative environment: context features that promote innovation, such as culture, organizational process and trajectory, organizational structure and strategy, etc.
2. Scan for signals: scan and search for routines aiming the identification of market and technological opportunities and risks. Track and search internal and external environments to pick up and process signals about potential innovation. These signals can be changes in market and technology, legislation or government pressures, behavior of competitors, etc.
3. Determine innovating strategy: a strategy is selected from potential signals, which must be compatible with the organizational resources available. The challenge lies in selecting the signals that offer the best chance of developing a competitive advantage.
4. Allocate resources: chosen an option, organizations need to allocate resources to exploit it. The technical resources can be either generated by R&D, or acquired through

technology transfer. It is not just about embodied knowledge, but also about the surrounding bundle of knowledge, often in tacit form, which is needed to make the technology work.

5. Manage external linkages: manage external sources of knowledge, management of alliances and collaborations, relationship with customers, suppliers, universities and other firms.
6. Develop and manage projects: new products/processes development, which includes efficiency and effectiveness factors. It embraces of the following subjects: business and organizational patterns, hardware specifications, management of R&D teams, etc.
7. Implement the innovation: routines and mechanisms to make possible to implement the product/process innovation. It includes subjects like launch and commission, market tests, after-sales support, intellectual propriety, licensing, change management, etc.

8. Evaluate and learn: evaluation of innovation results, review of successful and failed experiences in order to learn about how better manage the process, and to capture relevant knowledge from the experience.

The model suggests that there is an interactive cycle, rather than just stages. The emphasis on each group will vary according organization and situation. Several tools and techniques [9, 32] can support these eight groups and, for each one of the sets, we associated innovating routines (formal and informal) that people can carry out. Some of formal routines are in the Table 1.

*B. International Management*

The literature presents some different classifications and concepts to define global companies. In this study, there is not a distinct approach for each kind of organization with presence in foreign countries. The term multinational will be generically used to designate any firm with business activity out of its original country.

TABLE 1 – EXAMPLE OF ROUTINES OF THE INNOVATION MANAGEMENT (COMPILED FROM [9, 10, 27, 32])

Process/Dimension	Routine
<b>Provide innovative environment</b>	<ul style="list-style-type: none"> <li>- Create an open and innovative climate</li> <li>- Set clear goals and targets</li> <li>- Invest in training and developing</li> <li>- Define clear job functions and salaries</li> <li>- Commitment of resources to monitor and assimilate technologies developed outside the firm</li> </ul>
<b>Scan for signals</b>	<ul style="list-style-type: none"> <li>- Evaluation of market</li> <li>- Technological forecasting</li> <li>- Benchmarking</li> <li>- Accumulation of knowledge from market, production, supply chains etc.</li> <li>- Analysis of patents and technological standards</li> </ul>
<b>Determine innovating strategy</b>	<ul style="list-style-type: none"> <li>- Fit with business strategy</li> <li>- Developing and testing a strategic concept</li> <li>- Integrating different perspectives</li> <li>- Early involvement of key users and suppliers</li> <li>- Matching technologies with product divisions</li> <li>- Considering technology-based product diversification</li> </ul>
<b>Allocate resources</b>	<ul style="list-style-type: none"> <li>- Combining new and existing knowledge</li> <li>- Developing a business plan</li> <li>- Transferring technology</li> <li>- Acquiring technology by: mobilizing tacit knowledge, in-house formal R&amp;D, reverse engineering, contract R&amp;D, Licensing, etc.</li> <li>- Coordination and integration of internal knowledge sources and functions</li> </ul>
<b>Manage extern linkages</b>	<ul style="list-style-type: none"> <li>- Develop a good relationship with suppliers and consumers</li> <li>- Determine alternative sources of external knowledge</li> <li>- Establish more direct links in university research</li> <li>- Searching partners in universities and public research institutes</li> <li>- Developing projects in the supplier</li> </ul>
<b>Develop innovation projects</b>	<ul style="list-style-type: none"> <li>- Early involvement and concurrent working</li> <li>- Develop a marketing plan</li> <li>- Using support computational tools</li> <li>- Stage gate decision process</li> <li>- Set clear targets</li> <li>- Planning flows of information and personnel amongst functions</li> </ul>
<b>Implement the innovation</b>	<ul style="list-style-type: none"> <li>- Test marketing</li> <li>- Change management</li> <li>- Launch format</li> <li>- After-sales support</li> </ul>
<b>Evaluate and learn</b>	<ul style="list-style-type: none"> <li>- Post-project reviews</li> <li>- Performance in the market</li> <li>- Auditing</li> <li>- Learning from others</li> <li>- Learning by analyzing and by doing</li> <li>- Evaluate and improve the innovation management routines</li> </ul>

However, it is useful to present a definition to subsidiary: is any operational unit controlled by a MNC and situated outside the original country. The subsidiary is an entity that adds value abroad and can execute one or more activities. Therefore, two or more subsidiaries possessing different evolving patterns can be installed in a same country [5].

Boehe and Zawislak [7] present a more specific definition of subsidiary: half-autonomous unit capable to take its own decisions, which are restricted by conditions imposed by the corporative command (headquarter) and by the characteristics of the local environment. Each unit fulfills (and establishes) specific functions of the multinational net, which are expressed in the respective business areas. The activities of a branch office reflect, at least in part, its level of specialization, and a subsidiary is only capable to perform the activities that are under its responsibility because it possesses (or has developed) a certain level of resources and capabilities for those functions.

Several authors present classifications for subsidiaries or aspects regarding the subsidiaries, using diverse frameworks and criteria. Cantwell and Mudambi [8] made an interesting classification of subsidiaries; they divided the mandate of subsidiaries into competence-exploiting subsidiary mandate and competence-creating subsidiary mandate.

- **Competence-exploiting subsidiary mandate:** subsidiaries whose functional scope is limited to sales and service, assembly, or manufacturing.
- **Competence-creating subsidiary mandate:** subsidiaries whose scope include either product development or international market development.

Fleury [14, 15] proposes a classification of subsidiaries

installed in Brazil based in their role. The author has carried out a longitudinal study about the product development operations of eleven subsidiaries from different sectors and characterized their trajectories in the country. The studied sectors were chemical, automotive, equipment and computers. From that, the author inferred a classification with three roles for the subsidiary (Table 2):

- **Type I - subsidiaries as operational arms of the corporation:** few decisions on products and processes. They operate in a regime of dependent complementarities: they must follow the plans established by the highest hierarchical company levels and operate in accordance with criteria already established.
- **Type II - subsidiaries as relatively independent units:** units placed in an intermediate position; they have the same characteristics, autonomy and activities presented in type I.
- **Type III - subsidiaries as centers of competence:** their administrative autonomy is recognized and they assume new responsibilities in the region. As the subsidiary acquires technological competence, it can compete with other subsidiaries and assume the leadership in some types of products and services.

Birkinshaw [4], Ferdows [13], Gupta and Govindarajan [18, 19], Pearce and Papanastassiou [28], UNCTAD [33] propose other subsidiary typologies, etc.

According to [8], the factors that influence the process of subsidiary evolution are also those that regulate the subsidiary mandate and their subsequent R&D behavior. Some authors have studied the process of subsidiary evolution; [6] provides a valuable dynamic framework.

TABLE 2 – CLASSIFICATION OF TRANSNATIONAL COMPANIES WITH RESPECT TO THE SUBSIDIARY ROLE (ADAPTED WITH PERMISSION OF [14, P.6] [15, P.559])

		Type I – operational arm	Type II - relatively independent units	Type III - competence centers
<b>(Re)Configuration decisions (subsidiary role in the global strategy of the corporation)</b>		Decision process center-ed at HQ*; seeks for global radical rationalization of activities	Subsidiary is heard in the HQ and has relative autonomy to manage own financial resources	Subsidiary has autonomy to make decisions about local/regional business
<b>Coordination decisions</b>	<b>Manufacturing strategy</b>	Defined in regional or global terms; subsidiary follows the specifications.	Defined in accordance with local characteristics, incorporating criteria of inter and intra firms transactions.	Defined locally; in some cases, there is competition between subsidiaries.
	<b>Product project</b>	Standardization in global terms; little local adaptation.	If the corporation is leader, breakthroughs and platform are developed at the HQ; derivative projects are developed locally with or without outsourcing. If the corporation is follower, the subsidiary seeks 'customer intimacy'.	Global leadership of the subsidiary in the development of certain products.
	<b>Organizational framework</b>	Rationalized in the global plan; intelligent functions assigned to central countries branches; the main local functions are production, logistic and technical assistance.	Subsidiary keeps different functions, but there is a high degree of complementarity with the HQ.	Subsidiary keeps all the functions; there is redundancy with the headquarters; seek for information integration systems.
	<b>Managerial Control Systems</b>	Developed in the headquarters.	Relative autonomy for local development.	Relative autonomy for local development.

\* Abbreviation to headquarter

Birkinshaw and Hood [6] argue that the subsidiary evolution is the result of the intensification or atrophy of the subsidiary capabilities along time and the gain or loss of responsibilities. The term "capacity", in turn, is stated by Amit and Schoemaker [1] as the subsidiary ability to organize resources using organizational processes to achieve its objectives.

Consequently, a visible manifestation of the role of the subsidiary in the MNC is its responsibilities (charter, mandate), defined as the business or business elements in which the subsidiary participates and has recognized responsibility [17]. Birkinshaw and Hood [6] define responsibility in terms of served markets, manufactured products, dominated technologies, covered functional areas, or any combination of those. That is why the responsibilities have impacts in the mission, strategy, visibility, and legitimacy of the subsidiary.

Birkinshaw and Hood [6] are among the most prominent and active authors of the subsidiary development stream. They provide a debate on the evolution of the subsidiary, emphasizing three perspectives: attribution of the central command, choice of the subsidiary, and determinism of the local environment. Those perspectives and respective factors have been extracted from a bibliographical research carried out by the authors. According to [4], the mandates can be assigned by the headquarters or conquered by the subsidiary.

In their studies, Birkinshaw and Hood [6], having as theoretical base the vision of the firm based on resources, consider such three perspectives in the following form: the subsidiary is a semi-autonomous entity able to make its own decisions, but limited in its action by the headquarters demands and by the opportunities of the local environment.

Therefore, the change to more strategic roles is directly related with the three dynamic factor groups stated before: local environment, headquarters, and subsidiary and influences. The detailed factors can be summarized in the following three groups:

- **Local environment influences** - local environment threats and opportunities: authorities and government influences, cultural environment, economic and marketing conditions, science base, infrastructure, strength of local demand and supply, centers of technological excellence, competence of local universities and research institutes, skilled workforce, etc.
- **Multinational corporation decision** - Factors out of the central command sphere: global environment changes, availability of resources, global market changes, etc. Factors under headquarters direct control: changes in the subsidiaries responsibilities, subsidiaries capabilities perception, degree of product or business diversification, technological development and centralization of the decisions, resources and investment distribution, etc.
- **Subsidiary decision** - subsidiary choice, capacity of independent decision: initiative of subsidiary managers, relationship of the foreign subsidiary to the parent firm,

intra-organizational power, strategic independence, organizational culture, credibility and reputation, strong capabilities and expertise, strategic practices, learning and knowledge transfer, autonomy degree, relations with the National Innovation System (NIS), etc.

It is important to recognize that these factors are not in any sense deterministic or static; they have different importance and can change in time. Besides, these groups of factors have dynamic feedback effects and can influence each other. For example, a subsidiary decision has direct impact in the decisions made by the HQ and by others subsidiaries, as well as in the local environment.

The core of the present paper deals with those factors related to the subsidiaries decisions.

### III. METHODOLOGY

This paper presents some results of an exploratory study that used the following data-collection procedures: documental and bibliographical researches and case study. An exploratory study is justified by the need for a better understanding about the complex and under-explored phenomenon of the subsidiary evolution. The objects of this study are six MNC subsidiaries installed in six different sectors of Brazilian industry: control and automation (AControl<sup>2</sup> subsidiary), information and communication (ICom subsidiary), medical solutions (MED subsidiary), power generation (GEN subsidiary), power transmission and distribution (TDE subsidiary), and transports (Transp subsidiary).

We conducted the bibliographical research to explore the scientific contributions on the concepts here employed and we used information from monographs and journals of those areas. In addition, the documental and case study research have carried out to gather information about the companies, their innovation, their management politics, etc. It is based in the analysis of internal reports, manual, cases, researches, publications etc.

The case study was chosen due to the necessity of a deeper investigation about the most significant characteristics of the Brazilian subsidiaries. The study was carried out with people that are directly related to the technological innovation management, with the R&D management, and with the innovation management tools and processes. The adopted data-collection methods were half-structured interviews and direct observation. The interviews were made with employees and directors of technological management and with managers of R&D and technological centers.

### IV. RESULTS

This section presents some initial results inferred from the research in the subsidiaries under study. The central

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<sup>2</sup> The names of the subsidiaries are fictitious.

objective of this stage of the study was to understand some key points of the subsidiaries' technological innovation management. The following section presents the main remarks. It is important to emphasize that the following observations came from initial studies, and that more data is necessary to consolidate the results and to structure a comprehensive theory. We will focus on the subsidiaries decision factors.

This section has two subsections: the first one refers to subsidiaries' characteristics and internal environment, and to the MNC influence, including the relationship subsidiary-HQ. The second section deals with the management of technology and innovation.

#### *A. Subsidiaries characteristics*

The subsidiaries are very different among them. Some are very large and others very small, reflecting the MNC strategy for the Brazilian subsidiary. It is important to note that all subsidiaries studied are consolidated, being in Brazil for at least 70 years.

The history of these subsidiaries confirms what many authors have argued about the evolution of the multinational corporation and their affiliates. Before the economic globalization and liberalization, there were several subsidiaries focusing in their own local environment and their activities. Their activities were, in small scale, similar to the HQ and to the other subsidiaries of the MNC. The MNC was, as named by Porter (1986), a multidomestic company.

In this period, there was an expansion of R&D Centers, especially Development Centers to adapt and develop products and services to local markets.

With the globalization and economic openness becoming reality in many countries, including Brazil, MNC changed their strategy to optimize and rationalize the activities and resources. As a result, many R&D Centers and factories were closed down, and the MNC became more centralized. All subsidiaries analyzed installed in Brazil before the economic opening.

With the knowledge economy and the pressure for innovations and reduced costs, the MNC Company became to spread factories, Centers of R&D and activities to their subsidiaries (Offshoring), starting a new decentralizing movement. However, now the subsidiaries must compete to gain responsibilities and regional and global mandates.

Despite this phenomenon, the diffusion of R&D Centers is mainly concentrated in developed countries, and great part of the research still is in the HQ.

At some moments, the HQ put together a multinational team for the development of a global product or process. The HQ generally settles these teams in its installations or using virtual networks. Each expert brings his knowledge into the team to develop products or processes to many different costumers. Sometimes the local subsidiary needs to adapt the product or process, but the concept is the same for any of the countries. The AControl, ICom and TDE subsidiaries have participated in this kind of multinational teams.

With exception of the ICom subsidiaries, the HQs of the other subsidiaries do not have strong internationalization strategies. In general, the role of those other subsidiaries is limited to the adaptation and development of products according to the characteristics of the local market.

It is observed that the development of software products is more easily decentralized than hardware ones. In addition, the more complex is the product, the more centralized are the R&D activities, due to the larger costs and risks involved.

#### **1. Control and Automation: named AControl Subsidiary**

The Control and Automation subsidiary supplies automation and control solutions for several industrial sectors, whose necessities range from planning to operation, protection and maintenance of installations. Its main clients are the automotive, electronic components, oil and gas, steel, and pulp and paper industries.

The subsidiary is divided into the following business units: Automation of Processes, Automation Systems, Automotive Industry, Building Security and Automation, Drives and Motors, Electrical Installation Technology, Logistics Systems, Low-Voltage Controls and Distribution, Sensors and Measuring Systems.

In the last years, the subsidiary has increased exports, new orders and revenues in the areas of integral plant maintenance contracts, soft starters, supply of machinery for assembling electronic components to cellular phone manufacturers, circuit breakers, and button lines. The units of electronic security, fire prevention, and building automation, with integrated security and comfort systems, have maintained their market leading position.

Innovation activities are very important in this area. In the year of 2004, for example, the area of products and systems solutions for processes and manufacturing industries registered an increase of almost 50% in the exports, thanks mainly to the projects of equipment nationalization.

The innovative activities of this subsidiary are concentrated in the adaptation of HQ products and services, and customization of some products, services and systems to the local market. AControl has carried on a few development projects, and there is no basic or applied research.

One of the most important challenges of this subsidiary is to deal with its vast variety of products, services and systems. Each business unit has its own market, features, particularities and degree of innovative activities. Some units act as sales office, others focus in the production and distribution of consolidated products, and few ones have active projects of adaptation and development. That is why using the same routines and tools in the entire subsidiary is very complicated. It is worth noting that the most innovative unit of the AControl is an enterprise recently acquired, which still keeps most of its original managers.

## **2. Information and Communication: named ICom Subsidiary**

The Information and Communication subsidiary has the goal to develop innovative products for current and future communications needs. Its portfolio includes solutions in telecommunications and information technology to small, medium and large companies. The ICom subsidiary has the following business units: Communication Services, Fixed and Mobile Networks, Information Technology, Telephone and Communication Systems, and Wireless Modules.

This subsidiary is distinguished for having one of the best performances of the MNC Corporation, exporting solutions to several countries. For example, in 2004 it exported over US\$ 100 millions to all Latin America.

In the Brazilian market, it is one of the leaders companies in infrastructure and services for telecommunications operating companies. In the segment of solutions and services for fixed telephone operating companies, revenues from service contracts (including out tasking) grew, with the business area providing solutions and services. Regarding the ICom technology niche for the corporate segment, its market share increased due to the innovativeness and quality of the solutions offered, especially in the case of Voice over Internet Protocol (VoIP) technology. The subsidiary is a worldwide export platform of communication centers, regional center for Next Generation Networks technology and optical systems, and Software Development Center for cellular phones.

The ICom is the most innovative of the analyzed subsidiaries. This unit has several development projects, some of them global, running at same time. There are also some projects of applied research. Using the same routines and tools in the entire subsidiary is complicated due to differences among units. As a result, the degree of R&D decentralization depends on the unit.

The Brazilian ICom sector has an important incentive, named "Informatics Law", which guarantees tax reduction to companies that invest in R&D. This law has driven the amount of R&D activities in several units of the ICom.

In this subsidiary, one unit deserves emphasis: ICom-A. The HQ knows the ICom-A competences very well. The unit is especially dedicated to develop projects to the HQ. Because of this, it has less autonomy than the others do. The responsibilities of this unit have increased because of its ability to deliver projects efficiently and in time. Well-managed projects have brought good reputation and new projects. The local projects are paid part by HQ and part by "Informatics Law".

This area formed, after hard negotiations with the HQ, a group of people exclusively dedicated to innovative activities. Compared with other subsidiaries of the ICom MNC, the size of the innovative team is small, but this number duplicates with the cooperation with universities and research institutes.

## **3. Medical equipments: named MED subsidiary**

MED offers solutions for health: image diagnosis equipments, medical care equipments, and solutions of information technology that optimize the workflow and increase effectiveness in hospitals and clinics. MED has the following business units: Hearing Solutions, Solutions in Medical Manufacturing, Oncology, Products and Solutions, Refurbished Systems, Services.

In 2004, Brazil's image diagnostics and therapy equipment market, after years of stagnation, began to grow again. The MED subsidiary outperformed the market, becoming the market leader in radiotherapy equipment. MED also increased its presence in the market of hospital information technology, with new platforms and conquering new key accounts.

Because Brazil is a developing country, its market cannot afford the most expensive and modern equipments. Thus according to the HQ strategy, there is no need to establish production and R&D of those equipments in Brazil.

In this context, the subsidiary began producing X-ray equipments using local components as substitutes for imported ones. Partnerships with the local suppliers made the equipment more competitive and adapted to local market.

About ten years ago, MED had a factory of image diagnosis equipments in Brazil. The factory closed due to a combination of small internal demand and costs increase. The market lacuna led the subsidiary to, first, import products from the HQ, and then to adapt products to the local market.

However, this time the products were adapted and developed in a strong cooperation with suppliers and with core technology or product concept imported from the HQ or others subsidiaries. In general, MED creates the product or system concept, contracts a third party to develop and produce the components, and then assembles the components and tests the final product. The goal of the subsidiary is to adapt products to the market of developing countries. In this way, MED can export to other developing countries besides Brazil.

## **4. Power Generation: GEN subsidiary**

GEN projects and supplies equipments and systems for generation of energy, and provides services of maintenance and after-sales. Its products and services include steam, oil and gas turbines, cogeneration, and industrial applications in various segments. The synergy between the operations of power generation units in the Mercosur has resulted in a growth for the unit.

GEN business units are Compressors, Energy Services, Solutions to Process Industries, Steam and Gas Equipments, Turbines, and Thermoelectric Industries Equipments.

A major part of GEN activities dedicate to sell products imported from the HQ or other subsidiaries, and/or to sell services of maintenance. However, with the acquisition of a national company, GEN was able in the last year to nationalize an HQ product. This was possible in part because

of the competence of the professionals that migrated from the acquired company.

The products of GEN have great complexity, and the risk of developing a product in Brazil is too high, particularly because of the lack of laboratorial infrastructure. Great part of its products is mature, and developing new technologies in this sector is very expensive. That is why GEN has very few innovating activities.

##### 5. *Power Transmission and Distribution: TDE subsidiary*

TDE projects and supplies equipments and systems for transmission and distribution of electric energy. It also provides maintenance and after-sales services. TDE business units are: Automation of Energy, Average Tension Products and Solutions, Energy Services, High Tension Products and Solutions, Power Network Communication, Power Quality, Power Transmission Systems, Protection and Substation Control, Telecontrol Systems, and Transformers.

In the transmission segment, the TDE has acquired some companies to strength its worldwide high-voltage portfolio. The transformer division posted one of the best performances in its history by almost doubling its sales in comparison with the year of 2004. The results consolidated the position of the subsidiary as an export platform for transformers and substation automation.

There have been some efforts to develop products and processes in the subsidiary. However, these efforts came from few units, and regard to low risk and complexity projects. There is no professionals dedicated exclusively to innovation projects, but TDE professionals have participated in several global teams to develop technology and innovation. Here, as in GEN, the technological changes are lower than in the ICom, for example.

##### 6. *Transportation: Transp Subsidiary*

Transp builds public transportation systems and develops components that make transportation safer and more environmentally friendly. The subsidiary also offers solutions for integration of transport networks and turnkey projects.

The Business Units of Transp are Integrated Services for Rail, Rail Electrification and Automation, Rolling Stock for Rail, Telematic Systems, and Turnkey Systems for Rail. In the subway-railway segment, Transp has supplied patio electrification and auxiliary systems. This subsidiary also has important synergy among operations in the Mercosur Region.

This is the smallest subsidiary studied. There are no experts dedicated exclusively to innovation projects and the managers are the most reluctant in supporting innovating activities. As for TDE and GEN, in this sector product development is expensive and risky. Incremental changes are more feasible. The exception is the automotive unit, which is very innovative, having several innovation projects running at same time.

##### 7. *Comparing subsidiary innovation activities*

This section presents a comparison between the subsidiaries. Fig. 1 shows the R&D investments (in R\$ Millions). These are important indicators to the electro-electronic industry, since it is strongly dependent on technological innovations. It is clear that ICom is the subsidiary with the most intense R&D activity.

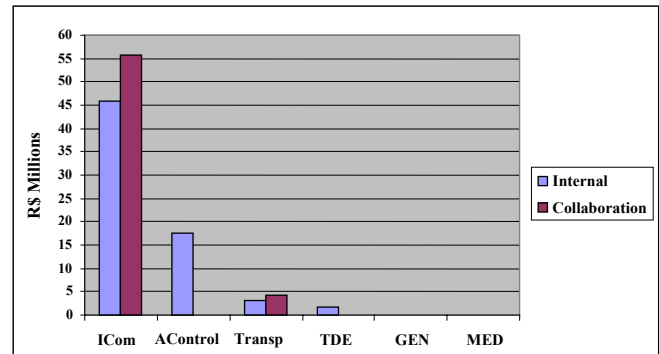


Fig. 1 - Investments in R&D (in R\$ Millions)

The ICom also has an important part of the R&D work developed together with external people, especially by collaboration with universities and R&D Institutes. The number of people involved in R&D projects doubles when those partnerships are considered.

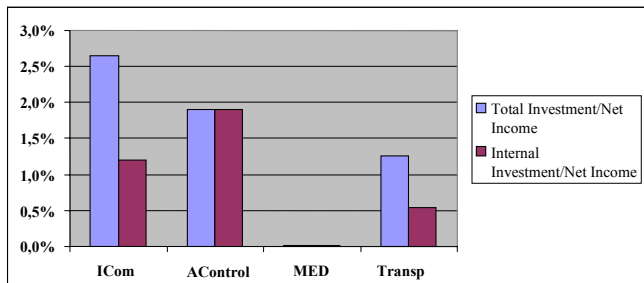
AControl, although in second place in investments, does not have significant collaborative R&D. As can be seen, GEN, TDE, MED and Transp do not have expressive R&D activities.

The relationship of some subsidiaries (ICom, Transp and MED) with the National Innovation System is very important and has been used. It is interesting to note that MED has a more intense relationship with suppliers than with universities and R&D institutes.

The differences between subsidiaries seem to lie especially in the openness of the subsidiary and its managers to trust in their counterparts and to share knowledge, in the degree of technological change of the industry, and in the demand pressure for innovation.

The innovative efforts of each subsidiary can be better evaluated if we take the ratio between R&D investments and the net income. This indicator shows a smaller difference between ICom and the other units. In fact, AControl leads in terms of internal investments on R&D with almost 2% of the net income. Transp also improves its performance when the ratio is considered. It indicates that the R&D also is important for others subsidiaries than ICom and AControl. Besides, the collaborative work is essential to ICom's innovation.

We observed that acquired companies answer for a large part of the resources invested in R&D in almost all subsidiaries. In the case of ICom, there is no recent acquisition, so its numbers are more uniform across the subsidiary (although the difference in TIP among its units). MED has the smallest net income what can explain the almost inexpensive place in Fig. 2.



**Fig. 2 – Investments on R&D in relation to the net income**  
Note: GEN and PTE did not provide data for net income

An important remark to be highlighted is that the differences among the subsidiaries with respect to the valorization and realization of R&D activities seem to be related to the factors like: products and process complexity; amount of investments; products, services and solutions portfolio; culture of the subsidiary; leadership; and degree of activities centralization for the headquarters.

The domestic market size or potential is the most important factor for aggregated value activities. If there is a great and sophisticated domestic market, there is a greater probability of new products development in the subsidiary. Factors like human resources ability and competences, negotiation power, subsidiary reputation etc., also seem to be decisive for innovative activities, but only when the domestic market is prosper.

### 8. Relationship with the Head office

Another important remark regards to the relationship between subsidiary and headquarters. We observed that the last one still directs or hinders many technological activities that could be carried out in the subsidiaries. Some projects come from the headquarters strategy to decentralize its activities, and not from a subsidiary initiative. In those cases, the subsidiaries compete for projects. Generally, such subsidiaries have the same capacity and competences. The difference relies in factors like negotiation, costs, reputation, past results etc. This happens in some ICom and AControl units. Sometimes the HQ allows development due to a change in the local demand or competition.

In general, the HQs centralize the activities in areas for which: the domestic market is small, the R&D investment/risk per project is very high, the command center ignores the subsidiary abilities, the product complexity is high, etc. In this context, the most centralized HQs are those of MED, GEN and Transp, and the ICom and AControl headquarters are the less centralized.

Nevertheless, even in ICom and AControl the most decentralized projects are of low risk and demand low investments in comparison with HQ projects. Software projects in general are less centralized than the hardware ones.

Behaviors that are important reasons to responsibilities gain: abroad divulgation of the subsidiaries capacities and competences, and existence of skills on projects sale and negotiation. Those two activities have particular importance

in gaining global and regional projects. However, as mentioned previously, the negotiation power is narrowly attached to the importance of the domestic market.

### B. Innovation management process

There is a large difference in technological innovation activities between the subsidiaries. It seems to be highly related with the domestic market importance (demand-pull). Up to now, technology/science push activities rarely come out during the research. Generally, the market is the departure point for product development in the affiliate.

We also observed that there is some confusion about the technology management nature, objective and process. Some managers confuse innovation management with projects management (which is only part of the management). Those managers generally have few experience with innovative projects, or are very focused only in the process of develop products.

Regarding the resources, ICom complains about difficulties in finding people with skills to manage projects. Such difficulty restricts the projects migration from the head-office to the affiliate. Thus, it is necessary to invest in the development human resources to manage projects.

Still speaking about human resources, all subsidiaries mentioned that the leaders' role is fundamental to the innovation success. The leader main function is to communicate, motivate, coordinate, organize, direct and control the people and projects under their responsibility. The ability of the leader in such activities is fundamental to the success of the unit under his command.

The high administration role, regarding the technological activities, is decisive for the subsidiary evolution. The motivation, valorization and resources allocation determine which and how the tasks are executed. If the administration has a long-term vision, it will direct the business for innovative and technological activities.

Some affiliates mentioned the lack of motivation and support from the high administration of the subsidiary to innovate; the administration was more interested in financial and sales results. It is possible that the managers lack on skills to negotiate with the headquarters. Because of this, many innovation projects came from initiative of mid and low managers, or even operational workers.

The cultural question is also marked; in all subsidiaries, the organizational culture favors sale activities and short-term results. Such culture makes it difficult to develop technological activities, whose results often take a long time to show up and are very difficult to measure. There is also a lack of enterpreunering culture, which is important to foment more R&D initiatives and autonomous activities.

### 1. Innovation management process and its routines

It was asked to the interviewed which routines of Management of Technology were carried out in the subsidiary and which is the importance of this routine for the Technology Management. Table 3 present the most cited routines (formal or informal):

TABLE 3 - INNOVATION MANAGEMENT ROUTINES

More used routines	More important routines
Analysis of market	Analysis of market
Analysis of risks	Analysis of value
Evaluation of the technological opportunities	Evaluation of the technological opportunities
Determination of technological strategies	Project management
Technological planning	Evaluation of projects
Project management	Projects selection
Evaluation of projects	Portfolio management
Accompaniment of the projects	Results evaluation
	Continuous improvement

We found few routines (as defined above) in the subsidiaries, with exception of ICom and some units of AControl. Moreover, where routines were found, they were directly linked to the market and the project management. These routines seem to be characteristics of developing subsidiaries because focus in demand and management of projects of local products. The subsidiaries state few efforts to seek for technological and global market opportunities.

Few routines were found because many subsidiaries innovative activities are so sporadic that the constitution of routines is not possible. This is due to the several barriers

imposed to the innovation management. We present the most important barriers cited by the managers in Table 4.

The most cited barrier is the restriction of resources like financial resources, human resources, infrastructure etc. About the financial resources, it is cited the fact that there is no division between operational resources and resources for innovation. If each subsidiary had fixed financial resources exclusively for innovation, it would ease the technological and strategically activities and would be better to project management.

TABLE 4 - BARRIERS AGAINST THE USE OF MORE INNOVATIVE ROUTINES

AControl	ICom	MED	GEN	TDE	TS
<ul style="list-style-type: none"> <li>▪ Lack of resources</li> <li>▪ Cultural</li> <li>▪ Results pressure</li> <li>▪ Lack of development skills</li> </ul>	<ul style="list-style-type: none"> <li>▪ HQ decisions</li> <li>▪ Cultural</li> <li>▪ Macroeconomics</li> <li>▪ Internal Infrastructure</li> <li>▪ Focus in the routine activities</li> </ul>	<ul style="list-style-type: none"> <li>▪ Lack of resources</li> <li>▪ HQ decisions</li> </ul>	<ul style="list-style-type: none"> <li>▪ Lack of resources</li> <li>▪ Macroeconomic</li> <li>▪ Internal Infrastructure</li> <li>▪ Technology maturity</li> </ul>	<ul style="list-style-type: none"> <li>▪ Lack of resources</li> <li>▪ HQ decisions</li> <li>▪ Results pressure</li> <li>▪ Technology maturity</li> </ul>	<ul style="list-style-type: none"> <li>▪ Lack of resources</li> <li>▪ Local Demand</li> </ul>

In the same way, they cited that short-term investments prevail. This fact seems to be the result of the financial and marketing annual goals. These goals make it difficult to accomplish long-term projects. Since these projects take more time to generate positive results, they are more risky. This fact is common to almost all Brazilian companies, especially subsidiaries, since the market competitiveness stimulates the companies to have faster answers with low costs.

The financial issue is very important to stimulate innovation activities, especially to MED, GEN, TDE and Transp. The subsidiaries can overcome this problem using governmental incentives and financing, but for it, the subsidiary must provide human resources, and an effort from employees and managers is also necessary.

The second most cited barrier is the HQ decisions, linked directly to the subsidiary autonomy. We observed that the HQ first defines (without the aid of the subsidiary) the subsidiaries portfolio, and only after that, the subsidiary is acknowledged. In GEN, MED, TDE, Transp and part of AControl, there is not a feeling of urgency in making R&D, since the HQ supply almost all products that the Brazilian unit needs. Moreover, there are the goals of financial results that the HQ establishes for the subsidiary, and the subsidiary must gain the HQ trust in order to guarantee the continuity of innovative activities and even gain others.

A problem frequently cited by the managers is the cooperative gap between the units inside the subsidiary and other companies in complementary sectors. As a result,

potential cooperative projects and sharing of resources are lost. Other problem mentioned is the cultural barrier: most people devote all their time and efforts to daily activities; innovative efforts and ideas are rare.

Some managers have tried to overcome this barrier, but those problems seem to come from intrinsic features and strategies of the modern multinational: the pressure for short-term results (especially financial results) and the lack of high administration incentives and motivations to innovative projects.

## V. CONCLUSION

This section presents some preliminary conclusions inferred from an initial exploratory research in the subsidiary under study. The study is an on-going research that has as main goal to understand and compare the process of technological innovation management of six subsidiaries of the electro-electronic sector.

The first results suggest that practices of innovation management, mostly focused on the market and related to the product development, have developed considerably in recent years, as the subsidiary has increased its mandates for the development of regional and global products and services. However, there is little presence of practices related to long-term technology research and related to global markets.

The partial findings suggest significant TIP differences between the subsidiaries studied, and that the practices are

closer to the market (mostly product development related).

ICom and AControl are the most innovative subsidiaries; however, the others subsidiaries have made efforts to increase their innovating activities. Nevertheless, these efforts must increase quickly in order to take advantage of the opportunities of the global market.

A suggestion that already looks like appropriated is to place people in constant contact with innovating activities. This kind of activity must be in the cargo description, in training programs, in change functions, etc. People that already have contact with innovating activities seem to be more likely to join this activities more times and be supportive to this kind of activities.

The managers must start to think in global and not only local terms, must became more supportive and be capable of expose the subsidiary competences and negotiate projects and resources with the HQ. At the same time, they must have competence to request governmental incentives and a better local environment to innovation; as well as, establish links with the NIS.

The Brazilian govern, in its turn, must provide an innovation environment with incentives, infrastructure, skilled workers, economic stability, etc. for all companies (subsidiary and local). In this way the NIS can grow and became sophisticated attracting more MNC companies and making the national companies more efficient and innovative.

Future research will focus in collecting more data to confirm and consolidate the remarks presented in this paper and to infer a plausible theory to the subsidiary innovation management in developing countries.

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