STAGES OF DEVELOPMENT OF ENTERPRISE-UNIVERSITY COOPERATION IN BRAZILIAN MULTINATIONAL

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1. Introduction

Innovation is an essential factor for the success of a business in the 21st century. While many companies have become highly efficient in the last 25 years, the fact is that innovation will continue to create sustainable competitive advantages for the next 25 years. Brazil, China, India and Russia (BRIC) are leaders in the global economy and many of their companies compete effectively in global markets. Specifically, China has almost four times more engineers than the U.S. and receives more foreign direct investment. In 2007, national expenditures on research and development (R&D) in Japan and South Korea reached, respectively, 3.44 and 3.21 of Gross Domestic Product (GDP), surpassing the U.S., whose expenditure on R&D was 2, 68 of GDP in that period (MCT, 2010; OECD, 2009). Fourteen of the 25 most competitive companies in information technology are in Asia. Almost 50% of patent applications filed in the U.S. come from foreign companies and inventors born in other countries (HITT, 2008).

From these indicators, it is noted that the current challenge is not just the generation of product and process innovations, but the continuous search for innovative solutions both organizational as marketing. The analysis of the innovative process, before focusing only on the linear generation of new knowledge, now covers the development of open and dynamic shapes and to generate and share knowledge, skills and technologies (LUNDVALLl, 1992; BELL; PAVITT, 1993; TEECE; PISANO, 1994; FREEMAN, 1994 and 1995; GAVA, 2007). If in the past innovation was the privilege of a select group of large business groups located in developed countries, today it is notable the innovative performance of firms of different sizes and nationalities, especially for the sectors of

high technological intensity of the BRICs (CHESBROUGH, 2003, 2004 and 2008; CHESBROUGH; CROWTHER, 2006; VAN DER MEER, 2007).

Besides innovation, it is remarkable emergence of a competitive second theme, called internationalization. Initially the international operations of companies was restricted to productive activities, but nowadays innovation activities are also held abroad, and these in turn are held in subsidiaries or in partnership with universities and research institutes (DUNNING, 1980, 1988, 2002; BARTLETT; GHOSHAL, 2000; ARRUDA, et al., 1994; ASPELUND; MOEN, 2005). Recent studies emphasize that the internationalization of R&D is gradually evolving and currently constitutes a key factor for enhancement of the innovative potential of multinational enterprises, and some trends can already be drawn, such as the orientation of R&D processes for international markets; increased autonomy and authority of R&D centers abroad: the integration of decentralized R&D and the development of global networks of R&D, whose main focus is to improve the overall efficiency (PATEL; PAVITT, 1998; CHIESA, 1995, 2000; REDDY, 1997; GASSMANN; ZEDTWITZ, 1999; ZEDTWITZ; GASSMANN, 2002).

The third essential theme for business innovation performance refers to interactions signed between companies, universities and government to share, produce and disseminate knowledge, technologies and innovations (MORA-VALENTINE et al, 2004; DEBACKERE; VEUGELERS, 2005; HANEL; PIERRE, 2006; PORTO, 2006; BEKKERS; FREITAS, 2008; BERGH; GUILD, 2008; TETHER; TAJAR, 2008). In this context, the Triple Helix model predicts that the future economic growth is dependent not only of a new innovation cycle, but of a new innovation structure that links basic and applied research in an ever closer way. In Triple Helix 1, the first three levels (university, industry and government) are institutionally defined. The interaction among them occurs through industrial relations, technology transfer, and official contracts, widespread in developed and developing countries. In the Triple Helix two spheres are defined as different communication systems, consisting of market operations, technological innovation and interface control. The interfaces generating new forms of communication related to the transfer of technology and relying on a patent law. Finally, institutional spheres of university, industry and government, in addition to traditional roles, take on each other's role. The university now has an almost governmental performance, for example, organizing the local or regional technological innovation (ETZKOWITZ; LEYDESDORFF, 1996, 2000; LEYDESDORFF; ETZKOWITZ, 2001; LEYDESDORFF, 2003; LEYDESDORFF; MEYER, 2006; LEYDESDORFF et al., 2006).

Broader cooperative phenomena gained prominence in recent decades, such as the emergence of systems that converge globally and locally (GloCal) and the emergence of innovative networks and sectors which are driven by complex, nonlinear and dynamic processes of creation, dissemination and use of knowledge. Thus, the need to re-conceptualize, or even re-invent ways and means of producing, using and renewing the knowledge (BELL; CALLON, 1994; LORENZONI; LIPPARINI, 1999; COLES et al., 2003; RITTER; GEMÜNDEN, 2003). Carayannis and Campbell (2009) then proposed an "Ecosystem of Knowledge and Innovation", which allows and emphasizes the co-existence and co-evolution of different paradigms of knowledge and innovation. In this ecosystem, it is emphasized that competitiveness and superiority of a knowledge system are highly

determined by the adaptive capacity to combine and integrate different knowledge and forms of innovation through co-evolution, co-specialization and co-opetition of stock and dynamic flows of knowledge.

In order to promote the concepts of "Knowledge and Innovation Ecosystem ", Carayannis and Campbell (2009) proposed the extension of the model of "Triple Helix" of Etzkowitz and Leydesdorff (2000) and then suggested the Quadruple Helix. In this conceptual extension, the fourth helix involves culture and values, how public reality is being constructed and disseminated by the media and the influence of each national system of innovation. The authors also emphasize the emergence of key elements in this ecosystem, such as: (a) Innovation Systems and Multilevel Knowledge of Global and Local Convergence expressing a substantial degree of hybrid overlay, involving simultaneous processes of innovation and knowledge at different levels as the global, national and sub-national level, and also refer to stocks and flows of knowledge with local significance and global reach, (2) Knowledge Clusters that represent an additional evolutionary development of geographical and sectoral clusters, (3) Innovation Networks which drive and internally operate the knowledge clusters or permeate and connect different clusters, with the aim of improving the dynamics of innovation systems and knowledge, (4) Co-opetition that reflects a specific balance between cooperation and competition, where intra and inter relationships of a network are based on a mix of cooperation and competition, and (5) Fractal Knowledge stressing the continuity and progress of complexity, where each knowledge cluster or innovation network should be understood with a sub-component of clusters and larger networks (CANTNER; GRAF, 2006; NIETO, SANTAMARIA, 2007; HARRYSON et al., 2008; SIMARD, WEST, 2008; CARAYANNIS; CAMPBELL, 2009).

Due to the relevance of this theoretical and empirical background, this paper aims to **propose an evolutionary framework for Enterprise-university cooperation, with the aim to investigate the Brazilian multinationals**. Specifically, it was: a) categorize the evolutionary stages, the procedural steps and the dynamic factors of Enterprise-University cooperation, b) develop a general overview for each evolutionary stage, and finally, c) verify in which evolutionary stage the studied Brazilian multinationals are.

2. Methodology

The research was qualitative and took over a descriptive nature and the method used in this research was the study of multiple cases. The choice of the studied companies was defined according to four criteria: 1. perform industrial activities of extraction and processing, 2. have a national capital controlled or have a significant Brazilian history, 3. to develop productive activities abroad and 4. To own technology partnerships with external technology sources, such as universities and national and / or international research institutes.

Using these criteria, five attractive cases were selected - Embraco, Alpha (fictitious name), Beta (fictitious name), Tigre and WEG - which were targeted in-depth interviews. It is noteworthy that from the five selected companies, only the Embraco is not really Brazilian, because in 1997 the American Whirpool took up its controlling shares. However, this company was kept in the study

because of its impressive history in Brazil, since the beginning and development of its technology partnerships (started in the 80s) and its internationalization process (begun in 1990) occurred before its acquisition. We should also mention that the company continues to operate structurally independent because of the uniqueness of your business (EMBRACO, 2006).

Primary and secondary data and to interpret them were used in this research; we used document and content analysis. The primary data were collected through semi-structured interviews and questionnaires and secondary ones were obtained from reports and organizational documents and also from secondary sources of evidence, such as newspapers, periodicals, conference proceedings and on the websites of the studied organizations.

Data collection was carried out by two sequential steps. The first stage involved a preliminary collection of primary and secondary data, ie the multinationals received questionnaires with open questions in order to obtain information about the Enterprise-University cooperation, management of R&D and productive internationalization. In this first stage, files of multinationals from secondary data obtained from newspapers, journals, conference proceedings and on their sites were also prepared. After these activities are completed, the second stage began and primary and secondary data were collected, respectively, in the interviews, documents and reports provided by enterprises.

5. Proposition for an evolutionary framework for Enterprise-University cooperation

5.1 Background

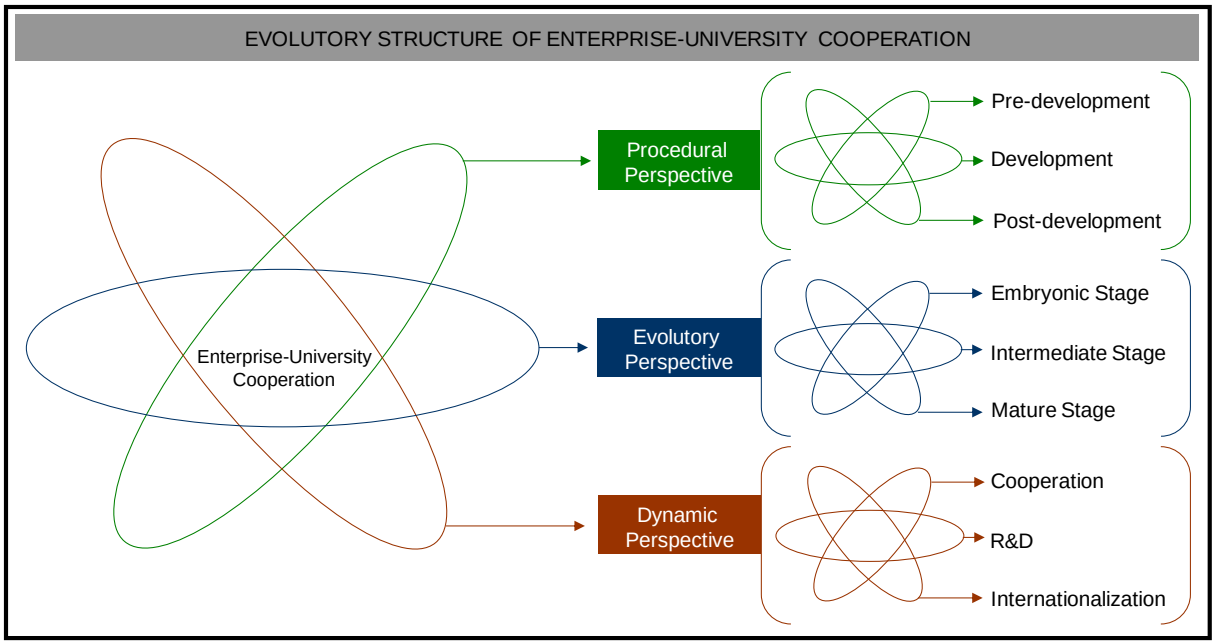
According to Torres (2006), a model is a simplified representation of reality. Cooper and Schindler (2003) state that a model is a representation of a system built to study some specific aspect or the system as a whole. The role of a model is a representation, unlike the role of theory, which is the explanation.

The models can have three main functions: description, explanation and simulation. The descriptive models are those that describe the elements' behavior of a system in which the theory is inadequate or nonexistent. In the explanatory models, we seek to extend the application of well-developed theories or improving understanding of key concepts. Meanwhile, the simulation models account for the structural relationships of concepts and attempt to reveal the relationship among them (COOPER; SCHINDLER, 2003).

Theories on Enterprise-University cooperation are recent and simultaneous analysis of the evolutionary, procedural and dynamic perspectives sets up a gap at the academic area, the main contribution of this paper is to propose a descriptive model, called **Evolutionary structure for Enterprise-University cooperation**.

This is an unprecedented contribution within the thematic Enterprise-University cooperation, since the procedural steps and the dynamic factors of cooperation are addressed in the evolutionary model. In practical terms, the Evolutionary Structure will offer the Brazilian multinationals a general description of evolutionary stages (mature) within each stage of the cooperative process, highlighting the factors that may dynamically affect cooperation (Figure 1).

Figure 1: Representation of the evolutionary framework for Enterprise-University cooperation.



Source: Elaborated by the author, 2009.

5.2 Model Description and Categorization

The interaction initiatives between Brazilian multinationals and national and international Scientific and Technological Institutions should be analyzed using three perspectives: evolutionary, procedural, and dynamic.

The evolutionary perspective implies how far or how close is a Brazilian multinational given the evolutionary stages of company-universities cooperation, among them the *embryonic*, the *intermediate* and *mature*. The first stage represents the highest level of incipient development in terms of management (adopted management practices), science (science results) and technology (knowledge and generated technological innovations) and is classified as an embryonic stage, the second was classified as intermediate, represents a level median and the third and final stage, represents the highest level of development were classified as mature.

In the mature stage, the cooperative projects have great in scientific and technological relevance and a formal governance model is adopted to balance the company's technological needs and university's scientific interests. In the intermediate stage, the cooperative projects continually enhance the internal R&D and although they are present in some formal management practices, there is a formally structured management model. In the embryonic stage, the cooperative projects increment the internal R&D and informal administrative practices are predominantly adopted, which makes it impossible to structure a management model for the formal Enterprise-University cooperation.

The procedural perspective shows that cooperation initiatives are processed into three independent stages, namely: *pre-development stage*, *development stage*, and *stage of post-development of cooperation*. These phases are not necessarily sequential and involve, respectively,

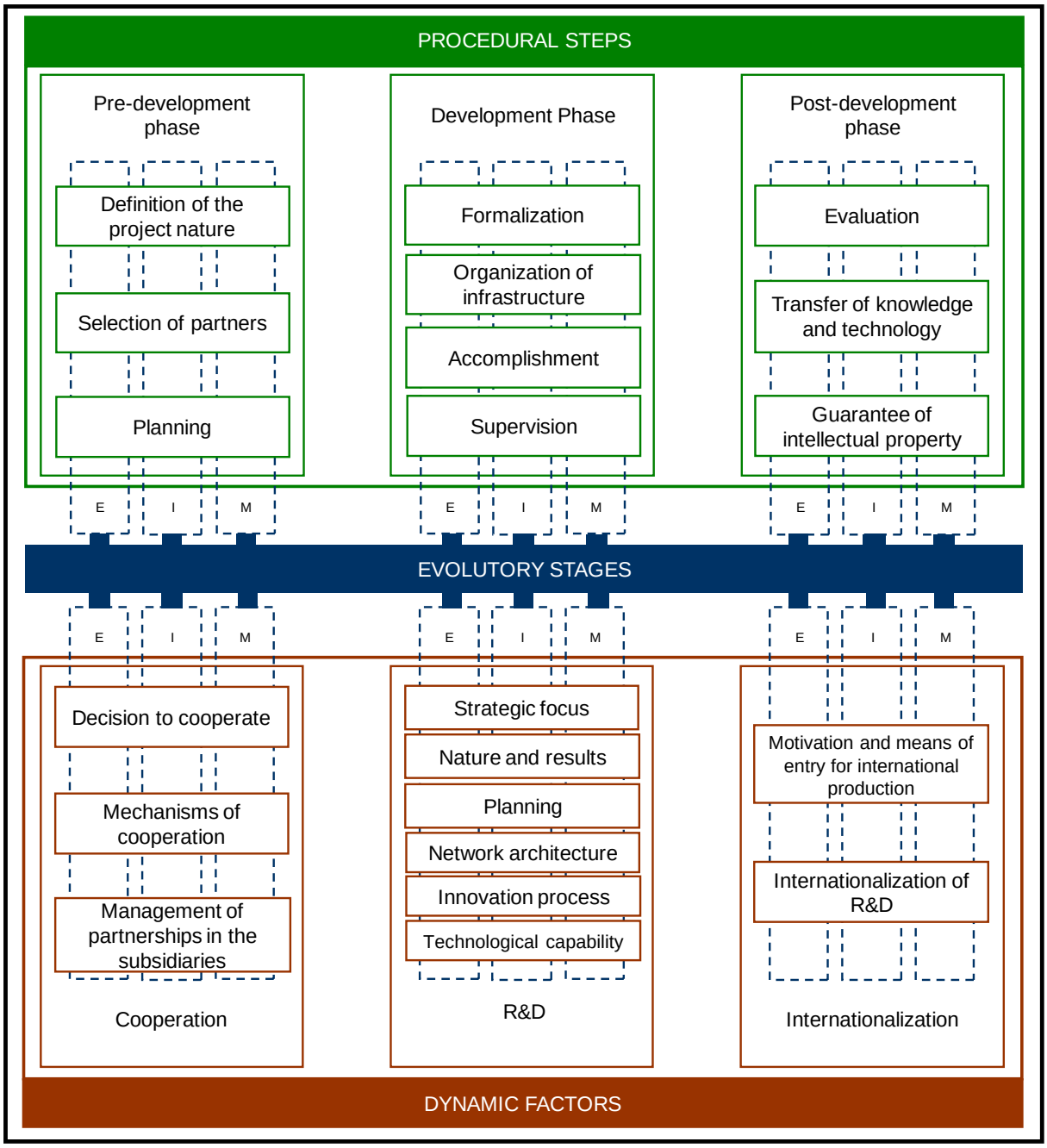
the following routines: (i) defining the nature of projects, selection of partners and planning, (ii) formalization, infrastructure organization, implementation and monitoring, and (iii) evaluation, knowledge transfer and technology and intellectual property assurance.

Some factors dynamically affect the evolving structure of cooperation, since the progression from one phase to another is not a sequential, stable and free of problems process, in fact, happening in the context of open and mutant system, it is subject to conflicting interests, variables managerial structures, and different types of interference. Given this uncertain environment, the **dynamic perspective** include dynamic accessory factors of internationalization, R&D and cooperation itself, but which nevertheless can affect the interactions Company-Universities, namely: (i) *the dynamic factors of internationalization*, involving the motivations and forms of entry for international production and the internationalization of R &D; (ii) *the dynamic factors of R&D*, which address the strategic focus of R&D, the internal nature of R&D and its results, the existence of a technological planning, the composition of the portfolio of projects, the network architecture of knowledge, the innovation process, and the strategies of technological capability, and (iii) *the dynamic cooperation factors*, which include the decision to cooperate, cooperation mechanisms and global monitoring of partnerships.

A cross-analysis of these three perspectives integrates the evolving structure of the Enterprise-University cooperation and the passage from an incipient stage to a more mature stage throughout the phases of cooperation development and its dynamic factors mean a leap not only scientific and technological but also managerial that will promote a number of positive implications, as examples: (1) the adoption of more efficient management practices that will make the cooperation process more flexible for both parties, (2) the conduct of more robust cooperative activities that generate more meaningful results in terms of science and technology, such as the collaborative research programs, (3) the implementation of strategies for productive internationalization and R&D which will promote the strengthening and expansion of national and international cooperation and (4) the view that Enterprise-University cooperation is not only a source of knowledge and skilled human resources, but also an effective possibility of promoting competitiveness and generate technological innovations.

Below, details of the evolutionary, procedural and dynamic perspectives are shown (Figure 2 and Tables 2 and 3).

Figure 2: Illustration for evolutionary, procedural, and dynamic perspectives.



Source: Elaborated by the author, 2009.

Legend: E = embryonic stage; I = intermediate stage; M = mature stage.

Table 2: Evolutionary stages and procedural steps in Enterprise-University cooperation.

Stage	Routines	Embryonic Stage	Intermediate Stage	Mature Stage
Cooperation predevelopment	Defining the nature of projects	Projects are not formally structured and cooperative activities involve technical services, consulting, academic and / or technological monitoring.	Punctual Projects of R&D that require not internally available expertise and enhance the internal R&D.	Strategic projects that require knowledge and skills which are not internally available and are tied to the company's core technological competencies.
	Partner Selection	There is no formal selection process and no established criteria.	Formally processed without pre-established criteria, usually refers to the network of partners and internal recommendations.	Formally processed and established criteria are used, such as evaluation of partnerships's history and scientific skills, and management of potential partners.
	Planning	Informal and non participative planning.	Formal, but not participative.	Formal and participative.
Cooperation development	Formalization	There are no agreements, only informal activities for cooperation and there is no formal model for cooperation management.	Contracts are signed only for long-term activities with hardly flexible clauses and there is no formal model for cooperation management.	Signed contracts are short, medium and long term ones with flexible clauses, and there is a formal model for cooperation management.
	Infrastructure Organization (financial, physical and human)	Only the company's internal resources are used: only the partner and universities' facilities are used, teams are not formally structured to run partnerships.	Use of sources of national funding, facilities of both parts are used, teams are formed by researchers from the University and company's employees of R&D.	Use of sources of national and international financing, facilities from both sides are used, the physical structures are built, teams are formed by researchers at the University, by employees of the company's R&D, and administrative staff are hired.
	Acting	Seeks to meet only the needs of the company and there is little flexibility in implementing the goals.	The goals are executed in a linear way, there is enough flexibility and, if necessary, changes are made.	The goals are executed dynamically; there is flexibility for change, and continuous interaction between the parties.
	Follow up	There is no formal monitoring.	Performed by employees of the company's R&D through reports and spreadsheets.	Continuously performed through reports, meetings and by direct contact with the partner. A R&D manager is the formal responsible.
Cooperation post-development	Evaluation	Informally held only at the end of projects and the company solely checks if its needs were met.	Informal and continuous; check only deadlines and if the goals were reached.	Systematic and continuous and at the end more detailed criteria are adopted, in which the process of cooperation and its results are valued and recorded.
	Knowledge and Technology Transfer (KTT)	Occurs only at the end of the project, through reports and, if necessary, providing technical support.	Occurs formally in specific situations such as meetings and technical and academic support.	Systemic and continuous, occurring by direct contact between the parties, during formal and informal meetings, by recruiting students and in training.
	Guarantee of intellectual property in cooperation.	The partnerships usually do not generate innovative, patentable results.	All the innovations generated in a cooperative manner are patented and solely owned by the company.	Innovations generated in a cooperative manner are patented and the ownership is for the company and the partner institution, licensing is not allowed for the company's competitors.

Source: Elaborated by the author, 2009.

Table 3: Evolutionary stages and dynamic factors of Enterprise-University cooperation.

Dynamic Factors	Routines	Embryonic stage	Intermediate stage	Mature stage
Internationalization	Motivations and forms of entry for international production	Marketing and logistical factors motivate the productive internationalization. Joint-Venture as a means of entry for international production.	Technological factors incipiently motivate productive internationalization. Acquisition of companies as a means of entry for international production.	Technological factors motivate the productive internationalization. Construction of own plants as a means of entry for international production.
	Internationalization of R&D activities	Centralization of R&D activities and decisions.	Partial decentralization of R&D activities and decisions without global coordination.	Decentralization of activities and decisions of R&D with global coordination.
R&D	Strategic Focus of R&D	Conducting technological benchmarking and monitoring of market trends.	Valuing R&D and search for technological differentiation.	Technological leadership and innovative product development.
	Nature and results of internal R&D.	Development of processes that result in ad hoc incremental innovations processes.	Development of products and processes that result in continuous incremental innovations in products and processes.	Research and development of products and processes that result in radical and continuous innovations of products and processes.
	Technological planning	There is no exclusive technological planning.	There is formal technology planning and R&D is continually influenced by market.	There are formal technology planning, and R&D are continuously influenced by market and science.
	Architecture of knowledge network	Knowledge is created only in headquarter and transferred to subsidiaries in a linear way, there's an only national technological partnership.	Knowledge is created predominantly in headquarter and continuously and linearly transferred to the subsidiaries, there are national and international technology partnerships.	Knowledge is continuously and interactively created and disseminated in global networks, there are national and international technology partnerships.
	Innovation Process	Linear (linear sequence of stages in which new knowledge arising from scientific research lead to invention processes that are followed by activities of applied research and technological development).	Mixed (logical sequence, but not necessarily continuous, whose innovation inducing ideas are generated from a constant contact between the business areas involved in the innovation process).	Interactive (combination of several interactions within companies, between individual enterprises and the science and technology system, and the constant market information and numerous feedbacks promote interactive linking of the phases).
	Strategies for Technological capacitating	Duplicate imitations, technological adaptations and development, both focused in the process.	Duplicate and creative imitations development and technological adaptations, both focused on product and process.	Duplicate and creative imitations, technological adaptations, development, search, technology purchase and sale, search and maintain technology leadership, focused on product and process.
Cooperation	Decision to cooperate	Decision is centralized.	Decentralized, but no monitoring of this decision process by headquarter.	Decentralized and this decision process is monitored by headquarter.
	Cooperation Mechanisms	Punctual agreements of cooperation	Covenants, ad hoc arrangements and contractual services.	Research programs, consortia, contracted services, ad hoc arrangements and interlaboratory partnerships.
	Management of partnerships ans subsidiaries	Subsidiaries do not settle technological partnerships	Subsidiaries have the autonomy to manage partnerships and there is no monitoring by headquarter.	Subsidiaries have the autonomy to manage partnerships and there is ongoing monitoring by headquarter.

Source: Elaborated by the author, 2009.

6. Evolutionary Stages of Cooperation in the Studied Brazilian Multinationals

To assess the evolutionary stages of cooperation in the studied multinationals, the routines of procedural steps and routines of dynamic factors will be analyzed.

6.1 Routine of procedural steps

R&D projects considered strategic by Embraco and WEG, which require knowledge and skills not internally available are developed with external sources of technology, such as universities and research institutes. Therefore, the cooperative projects are tied to the core technological competencies of these companies. In the case of Alpha, Beta and Tigre, only specific projects of R&D, which require knowledge and skills not internally available, are made with universities and research institutes. Thus, the cooperative projects only enhance the internal R&D; not direct influencing on their core technological competencies.

Regarding the selection of technology partners, Embraco, Tigre and WEG seek to develop cooperative projects with institutions that are already partners; new partnerships are sought only when the current ones do not offer the skills and competencies necessary to implement a particular project. In this case, nominations on new technology partners are required from the partner institutions and, in addition to this, a mapping of national and international reservoirs of knowledge and technology is done. Later these companies list the potential partner institutions and have a first contact to assess their interest in establishing technology cooperation agreements. Should the initial contact be satisfactory, these companies continue the work, if unsatisfactory, resort to other types of partnership. Alpha and Beta use their relationship networks and internal statements to select their respective technology partners, and potential partner institutions are then listed, a first contact is established to evaluate the initial interest in establishing cooperation agreements. If the initial contact is unsatisfactory, Alpha and Beta use other types of partnership.

In order to plan partnerships, Embraco and WEG along with their technology partners, formally plan aspects structural, managerial, legal and cooperative projects. Tigre also formally plans structural and legal aspects of partnerships, however, this does not occur in a participatory manner, ie, planning established by the said company is simply passed to the partner institution and there is no debate among the involved parties. In the cases of Alpha and Beta, partnerships are not formally planned.

The legal formalization of partnerships usually occurs by the establishment of exclusive contracts at Embraco and Tigre, with the exception of the consortia and agreements involving other companies. At Alpha, Beta and WEG only exclusive contracts to formalize its technology partnerships are established.

To facilitate cooperative activities, all studied Multinational use national sources of financing such as the MCT, FINEP, CAPES, and CNPq and all companies use the physical infrastructure of partner institutions. Only Beta refers only to its own resources to facilitate partnerships.

The teams involved in cooperative projects at Embraco, Tigre and WEG are, in most cases, comprised by students, professors, technicians, administrative staff and project managers of companies. At Alpha and Beta, these teams are basically formed by students, professors, and some staff from R&D.

Cooperative projects are dynamically executed in cases of Embraco, Tigre and WEG. There is flexibility to make changes in scope and deadlines and there is a continuous interaction between the involved parties. Regarding to Alpha and Beta, the implementation of these projects is exclusively linked to meeting the goals contained in the contract and there is little flexibility, since the partnerships linked to these companies take on the characteristics of a technical service supplier.

Regarding the monitoring of cooperative activities, Embraco and WEG use various tools such as evaluation reports which reflect the evolution of projects, meetings and direct and continuous contact with the technology partner. In such cases the project managers are responsible for monitoring partnerships. Alpha, Beta and Tigre use tools for monitoring such as periodic assessment of reports and spreadsheets that reflect the evolution of cooperative projects, while certain employees in R&D are shown to follow the projects.

Partnership evaluation at Embraco is systematically and continuously done and more specific evaluation criteria are adopted during the completion of projects such as the University's knowledge base, the interaction quality, the institution's ability in understanding the company, its ability to generate knowledge and run the project and the results obtained with the partnership. Alfa, Tigre and WEG informally and continuously assess its partnerships and collaborators in the R&D basically observe if the goals and deadlines defined in contracts are being met. For Beta, the evaluation is informally done with the completion of projects, and to affect it, a developer of R&D in the company evaluates whether the goals and deadlines specified in the contract were met.

To transfer knowledge and technology from the University for the business environment, Embraco, Tigre and WEG use some procedures, such as direct and continuous contact with the technological partner to hire students and targeted training to employees from the R&D to internalize the knowledge generated in partnerships. For Alpha, the technology transfer occurs through continuous meetings with partners and by technical support provided by the University. For Beta, technology transfer occurs only through reports and technical support provided by the University.

With respect to intellectual property, it is noted that in cases such as Embraco, Tigre and WEG, all cooperatively generated innovations are patented, and the ownership is divided between these companies and their technology partners, and there can be no licensing for competitors. For Alpha and Beta, all cooperatively generated innovations are also patented; however, ownership belongs to the company.

6.2 Routines of dynamic factors of internationalization

The entry form for international production was predominantly the acquisition, with the exception of Beta which has opened branches abroad. Another relevant point is that Tigre and Embraco used more than one strategy for the internationalization of production, while the Alpha, Beta and WEG have adopted a single type of strategy.

Logistics, marketing, customs and location factors were the central motivators of productive internationalization for studied multinational. The technological and scientific question is still virtually ignored by these companies in relation to decisions of production internationalization, except for Alpha

which considered the technological factor when acquiring recently a specialty steel Spanish company that had a central R&D strategic to their business.

Regarding the internationalization of R&D, it was found that the factors of "demand", including the need for reaching markets, providing technical support to the subsidiaries, formulating quick responses facing the needs of international markets and loyalty relationships with foreign customers, influenced the decision of these firms to internationalize R&D. "Technology" factors as the access to technology and international expertise, selection of foreign talent and technological partnerships with foreign universities and research institutes, are not highly regarded by the studied companies in relation to the decision to internationalize R&D.

Only Tigre focuses entirely on the headquarter its activities and decisions related to R&D, on the other hand, Beta totally decentralized activities and decisions related to R&D to its units. Between these two extremes are the other companies. While maintaining development activities at its plant in Portugal to meet the technical requirements of a particular product line, WEG adopts a posture predominantly centralized, as their R&D are carried out in the headquarter and only engineering and customization activities are performed in the subsidiaries. Embraco, on its turn, assumes an intermediate position, centering on the search array of mastered and non-mastered technologies and the development of non-mastered technologies, decentralizing among subsidiaries the developing of mastered technologies. In the case of Alpha, there is a more decentralized position, because while its R&D product is performed in two units, one located in Brazil and the other located in Spain, its development activities of processes are spread by their numerous production units. All the studied companies made process development abroad to modernize and even production methods of its subsidiaries.

The dispersion of non-existent or nascent globally R&D in cases of Embraco and WEG may be partly justified by the still recent internationalization of these companies. Companies such as Alpha and Beta, which accumulate on average 27 years of direct intervention in the market, have adopted more decentralized approach with respect to R&D. Tigre is the only company that does not suit in this line of reasoning, because in spite of accumulating nearly 30 years of direct action abroad still centralizes all its R&D in the headquarter.

6.3 Routines of dynamic factors of R&D

Embraco and WEG have a bold strategic direction regarding to R&D, there is great concern by those companies with respect to technology leadership and continuous development of innovative products. While valuing the R&D and seek technological differentiation of its products, Beta has a more considered strategic direction. As for the R&D from Alfa and Tigre have a narrower strategic focus, being linked primarily to the implementation of technological benchmarking and the observation of market trends.

Embraco, Beta and WEG held internally robust R&D activities such as research, development, engineering and customization, resulting in radical and incremental innovations in both products and process. Alfa internally performs R&D product development activities and intensive customization of processes as well as managerial improvements that result in incremental innovations in product, process and management. Tigre conducts internal development, engineering, customization, prototyping and

tooling activities, resulting in technological adaptations and incremental innovations in products and processes.

Another finding is that Embraco, Tigre and WEG do a formal technology planning and its R&D activities are continually influenced by the market and current state of science. Although also performing a formal technology planning, Alfa guide their R&D by the current state of the market, and scientific developments end up in the background. Beta now directs its R&D through general development plans that are developed from the guidelines of management, in the absence of na exclusively technological planning.

In the studied companies, knowledge is predominantly created by R&D centers and through technology partnerships, then is reversed in product and processes Technologies, and finally, is sprinkled throughout the production units. It is noteworthy that the knowledge related to the process development are created and disseminated by the productive units of multinationals in a more sprayed form, while the knowledge related to product development are concentrated in the headquarter or in some other specific of R&D centers.

With respect to the innovation process, it is noted that in Embraco and WEG innovation occurs in a dynamic way, continually influenced by marketing, technological and scientific developments. In this case one has an interactive innovation process, where internal and external activities of R&D confirm the dynamic execution of research, development, engineering, customization, production and marketing stages. Beta has a mixed innovation process, where there is a logical sequence, but not necessarily continuous for R&D, whose innovation inducing ideas are generated from constant contact with science and market. Alpha's and Tigre's innovation process are predominantly linear, suffering intense influence from market and consists of sequential stages that involve research and development, resulting in marketable products and processes.

The technological capability of the studied multinational companies followed an evolutionary process and it is now possible to identify different technological levels among such companies. The processes of technological capability of Embraco and WEG chronologically resulted in duplicate imitation, creative imitation, incremental and radical innovations, and development of technologically competitive product, technological leadership and sale of own technology. Imitation duplicated, radical and incremental innovations and the development of competitive products are the results of the chronological process of technological capability of Beta. The technological efforts of Alpha and Tigre chronologically resulted in duplicate imitations, technological adaptations, incremental innovations and development of merchandising differentiated product.

6.4 Routines of dynamic factors of cooperation

The decision to cooperate is not centered for Alpha and Beta, there are initiatives in these companies scattered over all production plants; however, there is no formal monitoring of the partnerships that are globally dispersed. Embraco, Tigre and WEG, decision to establish partnerships is centralized at headquarters. It should also be noted that partnerships at Embraco and WEG involve research, development, technology monitoring, professional qualification and technical services which result in knowledge and new concepts of products and processes. Tigre's partnerships are related to technical

services, testing, prototyping and ad hoc research projects that result in knowledge and information for innovation. The partnership of Alfa and Beta involve technological adaptations and technical services that result in new knowledge.

To cooperate, Embraco and WEG adopt formal mechanisms, such as programs of research consortia, contracted services, arrangements and Inter-laboratory partnerships. Tigre uses covenants, ad hoc agreements and contracted services as cooperation mechanisms. Alpha and Beta rely solely on a mechanism for cooperation, punctual projects. It is also important to note that headquarter and subsidiaries of Embraco, Alpha, Beta and WEG have autonomy to manage the partnerships and in the case of Embraco and WEG, partnerships that are globally dispersed are monitored, which does not occur for Alpha and Beta. It is noteworthy that the subsidiaries of Embraco, Alpha, Beta and WEG, perform only specific projects of cooperation and, in most cases, the most significant cooperative activities are linked to the headquarter.

Finally, we point out that studied multinationals are embedded in global networks of knowledge basically compound of productive units (headquarters and subsidiaries) and by national and international technology partners. In knowledge networks of Embraco, Tigre and WEG, the knowledge created in the internal and external activities of R&D are allocated to headquarter which subsequently disseminates as product and process technologies to the subsidiaries. Reverse flow is weak. On Alpha and Beta, it is not possible to map knowledge flows between production units and technology partners, since there is no formal of global exchange management of knowledge and there is no formal monitoring of international technological partnerships. Importantly, considering the studied multinationals, Tigre is the only which has purely national technology partners: all other companies have international technological partnerships.

Below on Table 4 figures 3 and 4 that illustrate the stages of development of multinationals studied from the evolutionary structure of the proposed Enterprise-University cooperation.

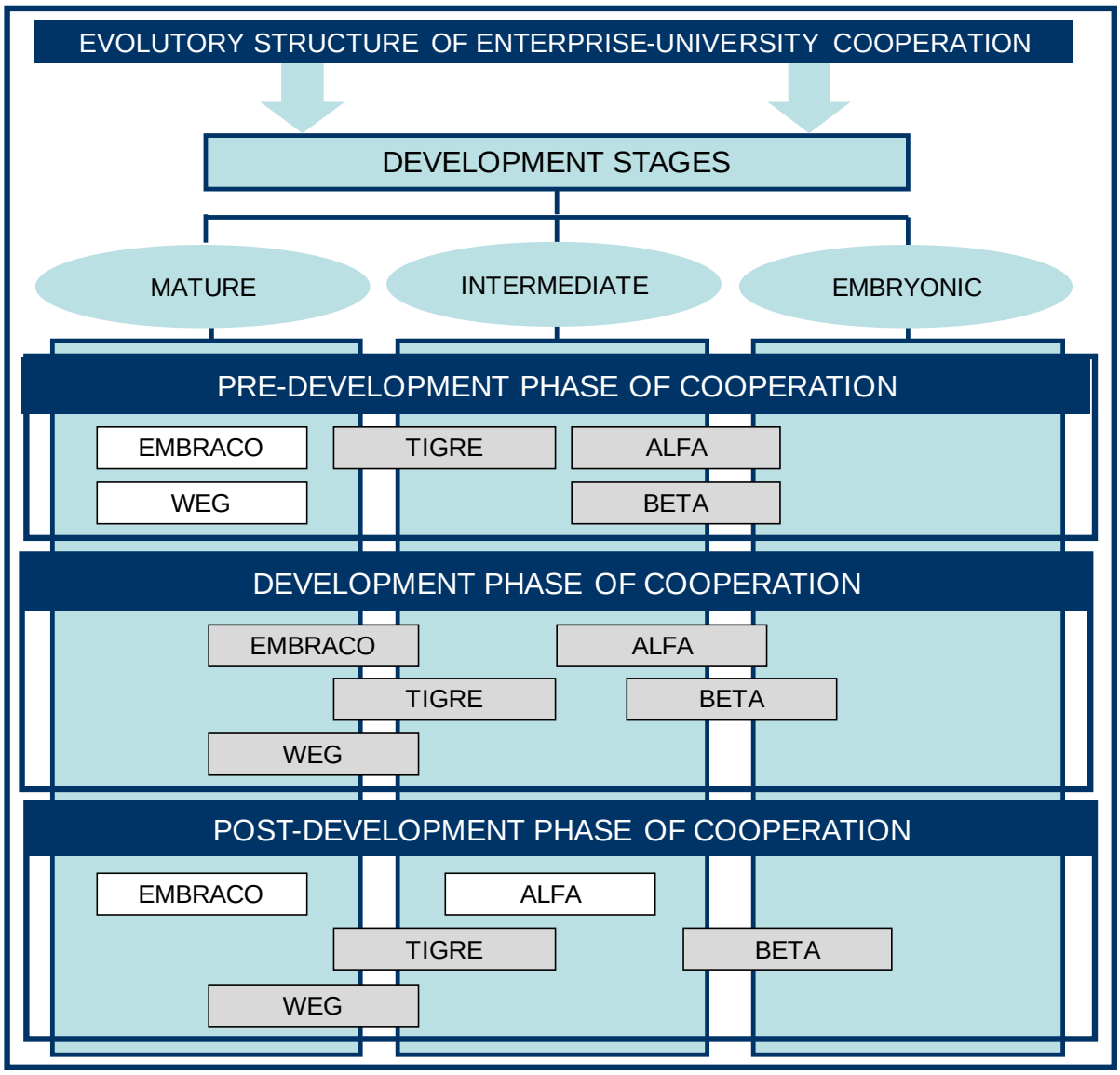
Table 4: Evolutionary stages for cooperation in studied multinationals.

Evolutionary Structure of Cooperation		Routines	Studied multinationals / Classification of development stages				
			Embraco	Alfa	Beta	Tigre	WEG
Phases	Predevelopment	Definition of the nature of the projects	M	I	I	I	M
		Selection of partners	M	I	I	M	M
		Planning	M	E	E	I	M
	Development	Formalization	M	I	I	M	I
		Organization of Infrastructure	I	I	E	I	I
		Accomplishment	M	E	E	I	M
		Follow up	M	I	I	I	M
	Post-development	Evaluation	M	I	E	I	I
		Knowledge and technology transfer	M	I	E	I	M
		Guarantee of intellectual property	M	I	I	M	M
Dynamic Factors	Internationalization	Motivations and entry means for international production	I	E	I	I	I
		Internationalization of R&D	I	I	M	E	I
	R&D	Strategic focus of R&D	M	E	I	E	M
		Nature and results of internal R&D	M	I	M	E	M
		Technological planning	M	I	E	M	M
		Architecture of knowledge network	I	I	I	I	I
		Innovation process	M	E	I	E	M
		Strategies for technological capability	M	E	I	E	M
	Cooperation	Decision to cooperate	E	I	I	E	E
		Mechanisms of cooperation	M	E	E	I	M
		Management of partnership in subsidiaries	I	I	I	E	I

Source: Elaborated by the author, 2009.

Legend: M = Mature Stage; I = Intermediate Stage; E = Embryonic Stage.

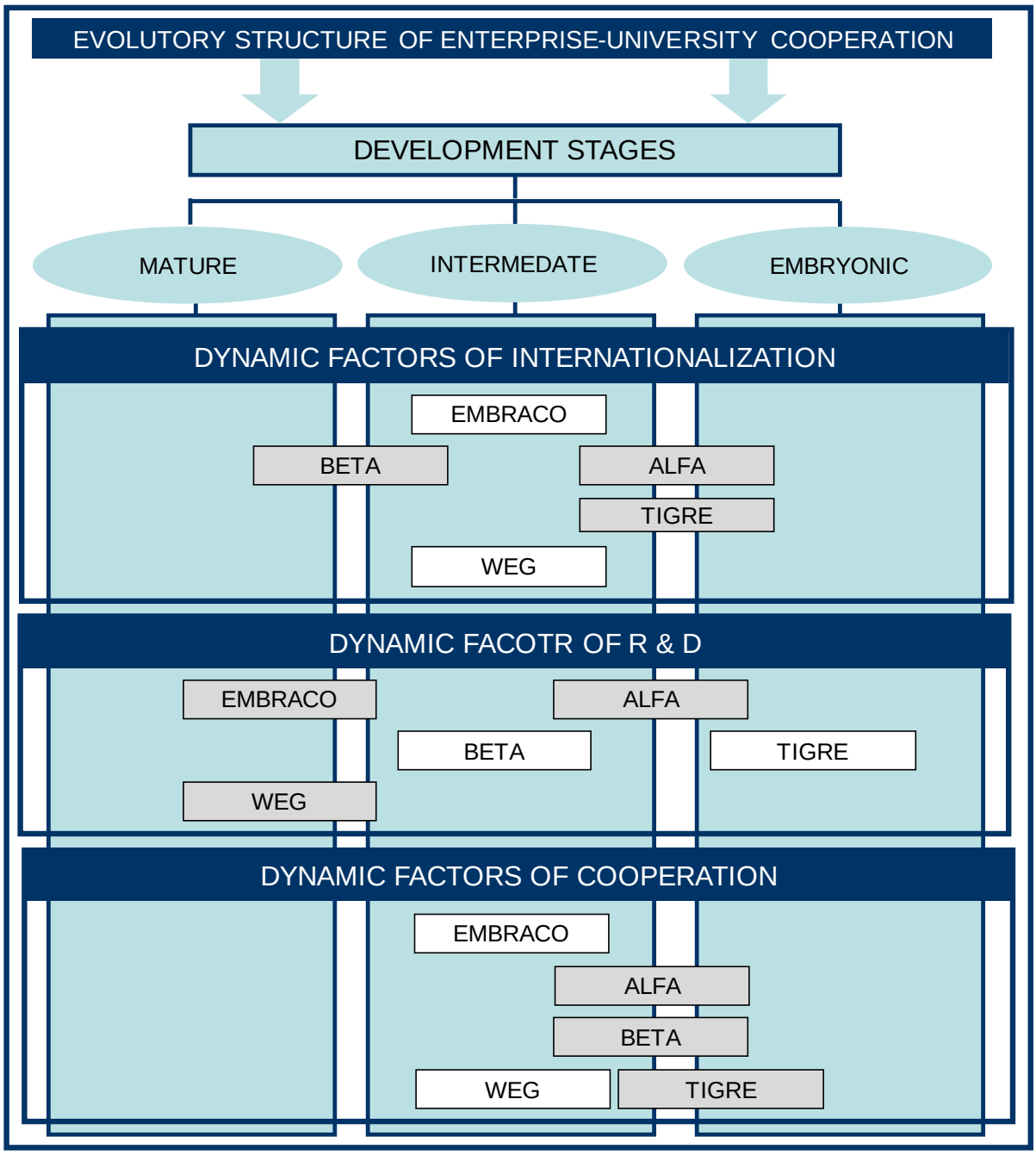
Figure 3: Evolution stages of Brazilian multinationals and procedural steps.



Source: Elaborated by the author, 2009.

From figure 3 it is concluded that Embraco and WEG have structures for Enterprise-university cooperation close to the mature stage, since the routines of predevelopment, development and post-development stages of cooperation were predominantly classified as mature in these companies. Alfa has a structure that approaches the intermediate level once it showed mostly intermediate routines along these steps. Beta despite having come closer to the intermediate classification also showed a considerable number of embryonic routines in procedural stages when compared to other studied companies. As for Tigre, the routines were classified as heterogeneous, but it was observed that the cooperation structure is closer to intermediate stage.

Figure 4: Evolution Stages of Brazilian Multinationals and the dynamic factors.



Source: Elaborated by the author, 2009.

The dynamic factors of R&D were predominantly classified as mature, in Embraco and WEG, while Alfa traverses between the intermediate and embryo stages. Despite having mixed structures for R&D, with mature, intermediate and embryonic characteristics, note that Beta is predominantly closer to the intermediate stage, while Tigre is closer to the embryonic stage. As for the dynamic factors of cooperation, there is a mixed classification for Embraco and WEG (oscillating in three stages), Alpha and Beta pass through the intermediate and embryonic stage and Tiger came up to more embryonic stage.

7. Final considerations

The results of the study indicated that the initiatives of interaction between Brazilian multinationals and universities / research institutes, both national and international should be analyzed through three perspectives: *evolutionary*, *procedural*, and *dynamic*. The evolutionary perspective implies how far or how close a Brazilian multinational is from the evolutionary stages of Enterprise-University cooperation, among them the *embryonic*, the *intermediate* and *mature* stages. The procedural perspective shows that cooperation initiatives occur through a process, not necessarily sequential, formed by the steps of *pre-development*, *development* and *post-development* cooperation. Regarding the dynamic perspective, it is observed that there are some factors that may dynamically affect the Enterprise-University interactions and these are classified as dynamic factors in the *internationalization, R&D* and *cooperation*.

A cross-analysis of these three perspectives integrates the evolving structure of the Enterprise-University cooperation and the passage of an incipient stage to a more mature stage throughout the phases of cooperation development and its dynamic factors will mean a leap not only in science and technology but also management that will promote a number of positive implications that could strengthen and expand the national and international activities of cooperation

Specifically, it was concluded that in the studied Brazilian multinationals the routines of the of predevelopment, development and post-development stages transited, predominantly, between the mature and the intermediary stages. Considering the dynamic factors of internationalization, R&D, and cooperation, there was an oscillation between the intermediary and the embryonic stages.

With regard to the limitations of this research, we can mention the fact that studied multinationals have been selected for convenience and because the study was conducted with five companies, impeding the realization of generalizations about the findings obtained in this study. It is intended to conduct future research with a representative sample of Brazilian multinationals to assess the adherence of these companies to the descriptive proposed model, and then produce more general conclusions about the Enterprise-University cooperation in the evolutionary, procedural and dynamic perspective.

Finally, three findings will be presented to instigate future discussions on Enterprise-University cooperation. The first is that there is no hard consensus or standard for the use of certain arrangements and mechanisms for technology cooperation in Brazilian multinationals, and their choices will depend on the position and goals of each participant face the cooperative process and should consider flexibility and adjustments necessary to the kind of relationship to be developed. The second one is that the academic and business interests can and must be compatible and in the present context, the University may not refuse to actively participate in the process of economic and technological development, as a provider of knowledge and prepared professionals to face the new reality and on the other hand, the corporate sector must also participate in update techno scientific discussions, to promote organizational learning and support with the economic and technological development of the country. The third and final proposition is that the Enterprise-University cooperation is a driving a strategy of technological competitiveness and, consequently, should be the focus of attention not only of companies but also universities and government.

Thus, cooperate to innovate should become the strategy of the present and the future for companies that prioritize technological development. But to make that a reality in enterprises of those countries seeking for development like Brazil, some challenges must be overcome, such as:

1. Overcome cultural, managerial, structural, financial and political barriers, i.e cultural mutual respect should be a consensus among the scientific, productive, and governmental sphere.
2. Formal models for the management of technological cooperation must be implemented and efficient and flexible administrative practices should be adopted during the implementation of cooperative projects.
3. Technology partnerships should be structured at national and international levels, in order to have knowledge global networks created continuously.
4. Funding lines should meet the needs of technological cooperation of small, medium and large size companies, in addition, international funding lines should also be the attention focus of national companies;
5. And finally, more effective public policies for the Enterprise-University cooperation should be developed and implemented.

Therefore, we conclude that in addition to "cooperate to innovate," it will also be necessary to "innovate to cooperate'!

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