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PATTERNS AND CHARACTERISTICS OF UNIVERSITY-INDUSTRY RELATIONSHIPS: EVIDENCES FROM A COLLEGE OF ENGINEERING IN BRAZIL

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ABSTRACT

The university-industry interactions have been perceived by academics and governments as one of the key drivers for social and economic development of nations. In Brazil, these interactions are still a recent phenomenon, with no conclusive results on its effectiveness and with no clear guidelines on how to tackle the main problems faced by the professionals, researchers and institutions involved on such interactions. In order to provide an accurate diagnosis of the characteristics, challenges and peculiarities of these phenomena, the present study investigates the university-industry relations in the School of Engineering of Universidade Federal Fluminense (UFF), located in the municipality of Niterói/RJ. In order to contribute to the analysis of the problem, interviews were conducted with professors and researchers affiliated with the School. The results shows, from the perspective of the respondents, the main motivations of the parties involved in these relationships, as well as the main limitations and difficulties in its establishment.

Keywords: University-Industry Relations; Innovation Policy; University Extension; School of Engineering of Universidade Federal Fluminense.

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1. INTRODUCTION

According to Mazzoleni and Nelson (2007), the innovativeness of an economy is determined by its scientific infrastructure`s degree of development and its integration to the market, which turns makes the science-industry relations of fundamental importance for the emerging countries, in order for them to catch-up to the global leader's socioeconomic development.

Although the interaction between academia and industry is considered one of the most effective ways to generate innovations, such relationships are recent in the Brazilian economy, having been developed from individual initiatives not integrated with each other. As reported by Etzkowitz, Mello and Almeida (2005), with the publication of the Innovation Law in 2004, the Brazilian government initiated a public policy to increase innovation capacity at the national level, aiming to improve the country`s scientific infrastructure and giving incentives to its integration with the productive sector.

To Etzkowitz (2001), the U-E interaction approach to innovation enhances the academic community`s appreciation of the economic potential of research beyond its natural scientific valor. This fact, in turn, allows the market to influence, in some degree, the choice of subjects researched, leading to the growth of regional innovation capacity. However, the literature (BENNER; SANDSTROM, 2000; PLONSKI, 2005; RAPINI *et al.*, 2009; ETZKOWITZ, 2011) indicates that the dynamics of innovation occurs through the interaction of various actors within industry, academia and the government – the three together forming a Triple Helix. Under this view, the government plays the role of creating incentives or barriers to the development of relations between academia and industry, which are responsible, respectively, for the generation of knowledge and the marketing of products and services.

With the Innovation Law (Law No. 10.973), enacted on December 2, 2004, the Brazilian government included in its agenda a national policy oriented to boosting its socio-economic development by increasing the innovation capacity, focusing mainly in improving the scientific infrastructure and its integration into the productive sector. The Innovation Law is an important catalyst for significant changes in federal universities, which make up most of the Science & Technology system in Brazil.

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However, due to institutional changes occurring gradually, there is little conclusive research on the functioning and effectiveness of the transformations already taking place.

This paper aims to identify the result of the transformations brought about by the Law of Innovation by diagnosing the university-industry interactions observed in the School of Engineering of Universidade Federal Fluminense (UFF), in order to meet the following objectives:

- To portray the recent experiences with the productive sector, and examining its characteristics;
- To analyze the factors that drive the emergence of and sustain university-industry interactions; and
- To evaluate the degree of institutionalization of the cooperation with the productive sector, considering the different views and levels of importance attributed to the phenomenon by the academic community.

This study presents relevant empirical data from one of the largest federal public universities in Brazil, located in the State of Rio de Janeiro, to the international community. Additionally, it serves as a methodological model for performing diagnostics of the university-enterprise interactions from other universities and academic institutions.

This paper is organized into five sections. The first section offers an overview of the Brazilian institutional environment regarding the public policy of innovation in addition to stating the study`s goals. The second section provides a review of scientific literature on issues related to the importance of the academy and its integration to the industry for innovation, as well as the development of the Brazilian science, technology and innovation system. The third section describes the method used for the empirical research, conducted at the School of Engineering of Universidade Federal Fluminense. In the fourth, the data collected is analyzed and briefly discussed, providing the main findings of the study, while the fifth and last section presents its conclusions and contributions.

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2. LITERATURE REVIEW

2.1. The contribution of academia for innovation and the role of the Triple Helix

In the current economic perspective, based on knowledge and characterized by the accelerating pace of change, the learning process is getting increasingly more important for a good economic performance, since it has direct influence on the innovation dynamics (LUNDVALL *et al*., 2002). Thus, the university, as a producer and disseminator of knowledge, plays a leading role in the process of industrial innovation (ETZKOWITZ *et al*., 2000).

However, due to the growing gap between the demands imposed by society and the responsiveness of universities, these organizations have been adapting to their new roles through a set of structural transformations, which can be summarized in five elements, as identified by Clark (1998 *apud* SANTOS, 2010):

- Creating a core body capable of coordinating the necessary changes;
- Creating peripheral structures to meet the new demands that are not satisfactorily met by pre-existing structures;
- Diversifying the sources of funding;
- Developing an entrepreneurial culture within the university, in an institutional perspective;
- Appearance of a few academic departments, more enterprising than the others.

With the emergence of the entrepreneurial university, which aims to capitalize on the knowledge it generates by approaching to the productive sector, the science-industry relationship is developed, becoming an important tool in national science, technology and innovation (STI) policies of industrialized countries. Standing out among them, the United States, Japan and South Korea are studied extensively because of the results observed in the economic and technological development area (MAZZOLENI; NELSON, 2007; GUSMÃO, 2002).

At the same time as it reveals itself an important mechanism for fostering innovation, the science-industry relationship`s emergence arouses discussions about the conflicts between economic interests and academic values (PETERS;

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ETZKOWITZ, 1990), such as the goals of academic research (pure science vs. applied) and the rights to commercially explore intellectual property arising from university research, much desired both by the companies that fund it and the researchers who execute it. However, despite being conflicting at first glance, the similar interests fostered the growth of research oriented towards both academic and economic goals, and as a consequence, a greater technological and economic development (ETZKOWITZ, 2001, 2011; DAGNINO, 2003; LIMA; TEIXEIRA, 2001).

These changes are reinforced in the literature by two lines of thought developed in the 80s and 90s: the evolution of innovation models from a linear to a systemic approach, and the Second Academic Revolution, which universities are now actively participate in economic development and social in addition to the traditional functions of teaching and research (ETZKOWITZ *et al*, 2000; DAGNINO, 2003; ETZKOWITZ, 2003a). Due to these currents, Etzkowitz proposes the theory of Triple Helix, in which the university abandons the secondary role occupied in previous models of innovation, rising to primary position equivalent industry and government alike. According to the author:

> "[…] the Triple Helix thesis postulates that the interaction in university-industry-government is the key to improving the conditions for innovation in a knowledge-based society. Industry operates in the Triple Helix as the locus of production; government as the source of contractual relations that guarantee stable interactions and exchanges; the university as a source of new knowledge and technology, the generative principle of knowledge-based economies (ETZKOWITZ, 2003b: p. 295)."

The helix representing each institution may vary its settings according to the degree of evolution of the innovation system and to the level of development of the university-industry interactions. In the configuration I (Figure 1), also known as Sábato Triangle, the national state encompasses academia and industry, directing their relationships. Examples of this model include the former Soviet Union and several Latin American countries. In configuration II (Figure 2), the institutional spheres are separated, with well-defined borders and highly circumstantial relations. This model would include examples such as Sweden and the United States at the end of the 90s decade (ETZKOWITZ; LEYDESDORFF, 2000).

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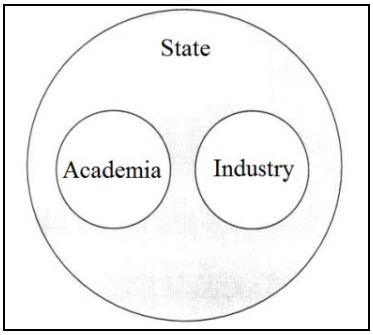

Figure 1: Static model of university-industry-government relations.
Source: Etzkowitz and Leydesdorff (2000)

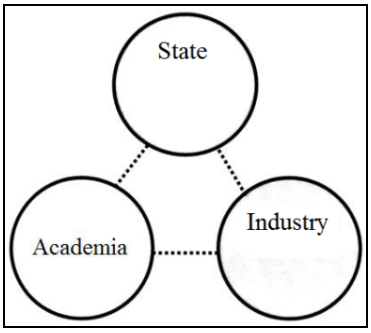

Figure 2: "Laissez-faire" model of university-industry-government relations.
Source: Etzkowitz and Leydesdorff (2000)

While configuration I was considered an inappropriate model of development, with little focus on bottom-up initiatives, where innovation would actually be discouraged, configuration II reflects a policy of economic liberalism ("laissez-faire"), being a radical attempt to reduce the prominent role of the state.

To Etzkowitz and Leydesdorff (2000: p. 112), "one way or another, most countries and regions are currently trying to achieve the configuration of the Triple Helix III" (Figure 3), where the institutional spheres overlap, giving rise to hybrid organizations.

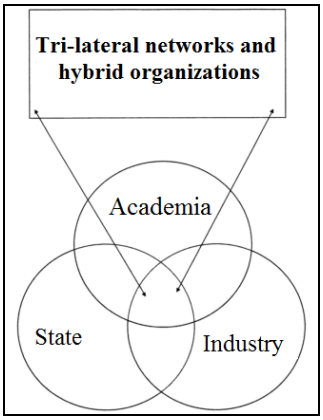

Figure 3: Triple Helix model of university-industry-government relations.
Source: Etzkowitz and Leydesdorff (2000)

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2.2. The development of the Brazilian science, technology and innovation systems

According to Longo (2000) and Silva (2008), the development of higher education in Brazil was late, starting in 1920 with the installation of the first university (Universidade of Brazil, current Universidade Federal do Rio de Janeiro), while in other American countries it had been created since the sixteenth century.

The Brazilian system of science and technology (S&T), which, as discussed earlier, plays an important role in the phenomenon of innovation, originated in the 1950s, with the creation of the agencies that coordinate the scientific and technological development (CNPq and CAPES) and the incentives to the massive opening of multinational companies in the country.

It is noticed, then, that since its creation, the Brazilian system of S&T gets an extensive involvement of the Federal Government, which would continue on the next decade with the creation of public research institutes and the integration of scientific research activities at universities, by operation of law.

However, the model of imports substitution, adopted in the Brazilian economy at the time, delayed the increase of competitiveness of domestic firms, despite the advances in industrialization and the development of the national system of S&T (SILVA, 2008; MACULAN; MELLO, 2009). In this context, Silva Junior and Spears (2012) argue that, as the federal universities did not interact with the modern economy and commodity exports were priority for economic growth, the university sustained a position of detachment from market demands, remained public-funded and went through few changes between the 70s and 90s decades.

Nevertheless, it was during this period, as reported by Etzkowitz, Mello and Almeida (2005), that the incubator movement emerges, becoming the main drive for the development of the triple helix relations in Brazil - initially from local and decentralized initiatives and, subsequently, through national and coordinated networks. It is important to emphasize that the Brazilian incubator movement not adopted in its entirety the traditional concept of incubator, intended to technology-based companies, in order to cover low-tech companies and cooperatives, among other organizations, due to the poor economic situation of the time.

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Later, in the 1990s, in order to increase its domestic industry competitiveness, the Brazilian government adopted a series of measures to stimulate technological development, such as the reduction of tariff barriers and allowing the foreign capital to pour in the economy, and also structured the regulatory basis of intellectual property (CARNEIRO, 2005; PEREIRA, 2008).

The incubator movement itself earned the support of public policies, allowing for an orderly expansion and eventually giving birth to programs of knowledge and technology transfer through university-industry interactions, in addition to public funds for the financing of R&D projects, the improvement of scientific infrastructure and the encouraging of university-industry interactions.

However, the Brazilian science, technology and innovation policies did not achieved the expected level of technological development for the industry, since they did not includes both necessary aspects for political models of technological development, summarized by Dudziak (2007): to stimulate spending on R&D in the private sector and to strengthen its links with public sector research. Thus, the STI system showed several bottlenecks, such as barriers to researcher's mobility, difficulties in contract negotiations between public and private sector and low level of entrepreneurship (MACULAN; MELLO, 2009).

The necessary conditions for successful university-industry interactions include stable legislation and political environment, in which trust on the compliance of contracts between both parties exists and their relationships can flourish (ETZKOWITZ; MELLO; ALMEIDA, 2005). Thus, in 2004, the government created a new regulatory framework to delineate favorable circumstance for the scientific and technological development and to encourage innovation in Brazil, placing the university-business interaction as the main driver for industrial development. This regulation is known as the Innovation Law (BRAZIL, 2004), which is organized around three components:

- Establishing a positive environment to the formation of strategic partnerships between universities, technological institutes;
- Stimulating the participation of science and technology institutions in the innovation process;
- Encouraging innovation at the company level.

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2.3. University-enterprise interactions

According to Antunes (2008), the university-enterprise interaction, in a context of the dynamics of innovation, occurs as long as both parties have interests on gathering its benefits, such as increasing the business competitiveness and improving the university`s education, research and extension activities, through mechanisms of knowledge management. The reason for a party to approach the other depends on the context in which this approach occurs, with common causes, as described by Webster and Etzkowitz (1991 *apud* DAGNINO, 2003) and Dudziak (2007), being:

- Growing difficulty in obtaining public funding for university research activities;
- Academic community`s interest on legitimizing their work to society;
- Rising costs of R&D, which are needed to secure advantages in an increasingly competitive market;
- The need to share costs and risks of pre-competitive research with other institutions;
- Escalating pace of innovation in the productive sector and reducing time between research execution and application;
- Globalization of the economy and the struggle among firms, sharpening competitiveness;
- Changes in the rules of intellectual property originated from public research;

On the other hand, there are also barriers to the occurrence of interactions university-enterprise, which may originate in the organizations themselves or in the economic, social and political environment in which they occur, as shown in Figure 4.

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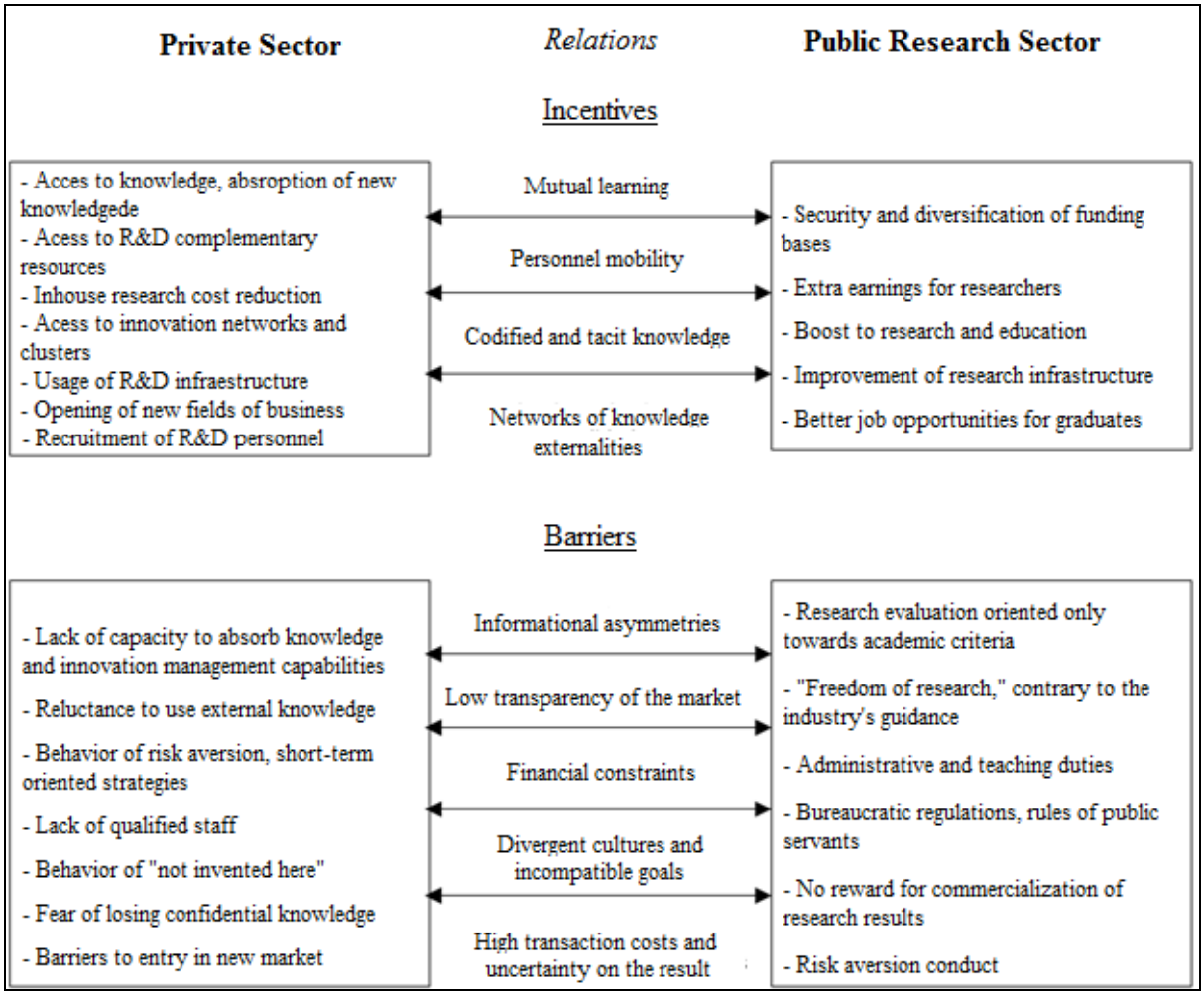

Figure 4: Incentives and barriers to science and industry interaction.
Source: Dudziak (2007)

Another relevant aspect of this phenomenon is the shape in which it occurs, ranging from the simple supply of technical services to research projects carried out jointly by both parties (DUDZIAK, 2007; MACULAN; MELLO, 2009). The modalities of university-industry (U-E) interactions observed in the literature are:

- Custom research, generally in the form of specific projects governed by financing agreements;
- Consulting projects developed in the teachers-researchers area of expertise;
- Programs of internships and training through work experience in industry;
- Research projects in collaboration with companies through public funding;
- Research consortia involving several research institutions and industrial companies;
- Creation of technology-based companies from research results (spin-offs);

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- Mobility of researchers from the university to the industry, and vice versa;

The changes in Brazilian universities, accelerated by the Innovation Law from 2004 onwards, have originated some of the commonly structures of today`s academies, such as technology transfer offices, support foundations, centers of excellence, technology parks and incubators. These are the structures responsible for managing the activities related to U-E interactions in order to overcome the barriers to their occurrence.

3. RESEARCH METHODOLOGY

Although the Oslo Manual (OECD, 2006: p. 133) recommends that "innovation surveys refer to those innovation activities in the business sector," this study`s goal is to identify the characteristics of the university-industry interactions phenomenon in the academic environment. Thus, its guidelines have been considered, but not strictly enforced.

After an extensive review of the scientific literature, a preliminary investigation was conducted in order to identify the forms, mechanisms and bodies involved in university-enterprise interactions in School of Engineering of Universidade Federal Fluminense (UFF) by interviewing two researchers who have been responsible for the bodies directly related to the university's innovation policy – namely UFF's Incubator and Innovation Agency. This stage generated the model of analysis and the survey form, which was evaluated in its consistency by conducting test-interviews with two professors at the same institution, and the necessary adjustments were made afterwards. The final questionnaire used in the interviews is in the Appendix.

The next step was the collection of data on the characteristics and the context of U-E interactions in the School of Engineering, through exploratory interviews with selected researchers. It is important to highlight that the data collected regarded the interactions occurred between the years 2011 and 2013, as the Oslo Manual recommends using data collected at a maximum period of 3 years before any research on innovation.

A total of 19 interviews were carried out, guaranteeing the anonymity to respondents in order to avoid any conflicts of interest and possible interferences on the data collected. The empirical research`s sample was delimited to a set of faculty

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members working for the Departments of Mechanical Engineering (TEM) and Production Engineering (TEP), since those are the only ones with full-graduate programs and also, because of the intrinsic proximity of these areas of knowledge with the industrial sector, with which School of Engineering of UFF has a historical relationship.

From the notes and audio recordings made during the interviews, the participants' responses to each question were analyzed and, through semantic analysis, the degree of similarity or divergence of the most frequent examples and statements were identified.

It is important to highlight that due to the limited availability of teachers, the interviews were restricted to volunteers from the previously mentioned departments. Thus, the results found in this study are limited to the perceptions of a representative segment of faculty members, but these do not necessarily reflect the university in general. Additionally, the information collected in the interviews is self-reported, not necessarily reflecting the opinion of a group of people or having previously been proven by researches.

4. CHARACTERISTICS OF UNIVERSITY-INDUSTRY (U-E) RELATIONS

Based on the analysis of the interviews, it was possible to observe different patterns in the U-E interactions investigated, such as to what degree the researchers involve in these relations, the profile of the organizations that work with the university, the primary type of relationship, in addition to the main mechanisms by which the parties approach each other and formalize their relationships. Each of these aspects is analyzed and discussed below.

4.1. Researcher’s involvement

Thirteen of the nineteen respondents were directly involved in at least one formalized partnership with the productive sector in the last three years. Among the others, two did not maintain any kind of relationship at all, while four sustained

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indirect or informal relationships[1] through the supervision of their student`s researches.

Despite the fact that most of the respondents have had some kind of partnership with the industrial sector, the degree of involvement on U-E relations varies significantly among them, as shown in Chart 1.

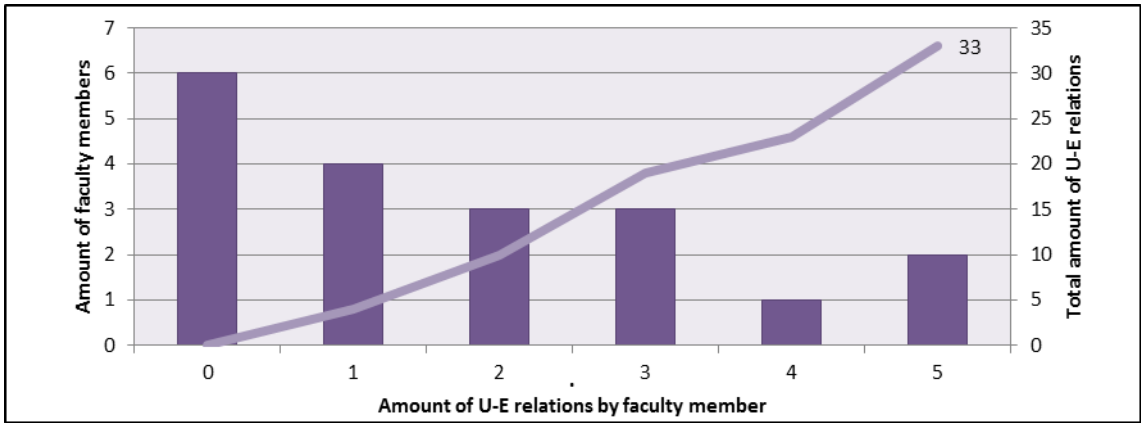

Chart 1: Distribution of the amount of U-E relations by faculty member.

Another key consideration is the concentration of university-industry interactions among researchers. As evidenced in the interviews, just a few faculty members explain most of the interactions: 3 researchers account for 14 of the recorded evidence, which represents 42.42% of the interactions. This fact is evidence to the premise of the prominence of entrepreneurial culture in a particular set of researchers, those who stand out for their extensive relationships with the productive sector, as discussed in the literature review. In addition, significant difficulties were reported in complying with the internal process for approval of U-E interactions, which discourage the participation of the faculty.

4.2. Profile of organizations that maintain relationship with School of Engineering

The organizations that maintain relationships with School of Engineering of UFF are mostly large companies[2] in the shipbuilding and oil & gas industrial sectors, as evident in Charts 2 and 3, with one company (Petrobras - largest company in

[1] In such cases, the contact with the productive sector was strictly academic, with purposes other than to transfer knowledge between the university and the companies, which, as discussed earlier, would configure the science-industry relationship`s goal.

[2] Annual gross operating revenue higher than R$ 300.000.000,00, according to BNDES (2011).

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Brazilian oil & gas industry) representing almost half (14 of the 33 cooperation projects) of UFF's partnerships with the productive sector in.

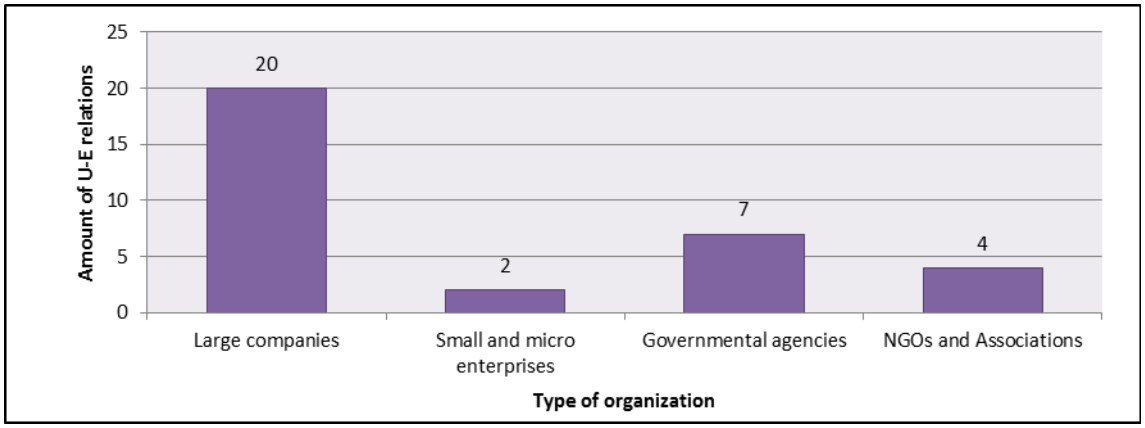

Chart 2: Distribution of the U-E relations by type of organization.

On the other hand, small and micro enterprises[3] were cited in only 2 relations, with a less expressive representation than the interactions with government agencies and nonprofit organizations. This finding suggests that there is a gap on the fulfillment of the university`s third mission, since its knowledge is becoming available to a limited group of organizations instead of to society as a whole. Also, this fact could be explained by the high costs and large bureaucracy involved on projects with the university, which only the biggest companies could afford.

Also, some industrial sectors had been responsible for only one of the U-E interactions identified, and thus were classified as "Other" in Chart 3. These include the electrical power, mining, steel and information technology.

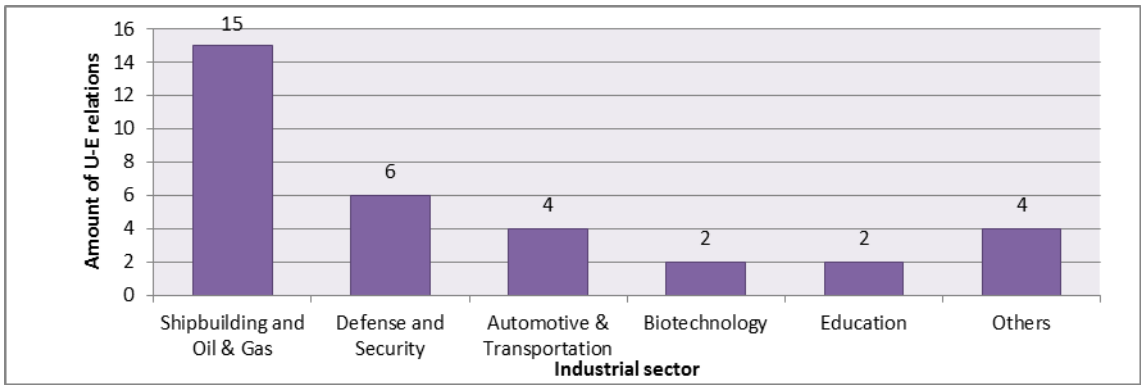

Chart 3: Distribution of the U-E relations by industrial sector.

[3] Annual gross operating revenue equal to or lesser than R$ 16.000.000,00, according to BNDES (2011).

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The sectors with only one U-E relationship (those classified as "other" in Chart 3) include the electrical power, mining, steel and information technology sectors.

4.3. The arrangements of U-E interaction employed

The arrangements of U-E interaction through which the demands and interests of each party are better considered have varied shapes and characteristics. However, a closed list composed of six modalities[4] was adopted, for standardization purposes, as follows:

- Courses and training: conducting courses with a focus on transfer of knowledge through teaching;
- Mobility of researchers and professionals: the professor acts as a company employee, or the employee as a researcher, for a short period of time;
- Consulting and specialized technical guidance: technical services for solving a specific demand with the application of knowledge already mastered;
- Rental infrastructure and supply of equipment: temporary or permanent transfer of equipment, laboratory infrastructure or software;
- Research on demand: technical services for solving a specific demand with scientific research and the development and application of new knowledge;
- Thematic researches: technical services for exploration of an overarching theme relevant to a company with a scientific research approach, aiming for the development and application of new knowledge;

As shown in Chart 4, the most cited modalities were research on demand, consulting and specialized technical guidance and thematic researches, which represent the primary means of using the academy's accumulated knowledge, by allowing the exploitation of its intellectual capacity with the goal of presenting solutions for the productive sector`s demands. For one of the respondents, these are the mechanisms that add more value to faculty members and companies alike: "the

[4] Based on the literature review and the preliminary investigation conducted by the author.

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more understanding the project requires, the more interesting it will be for those involved. Therefore, thematic research-type of interactions presents a greater value for both the company and the university. The exception occurs when a company has a specific problem that needs quick solution. In that case, it would perceive a greater value in the consulting- or research on demand-types of interaction, depending on which is most appropriate to the problem at hand".

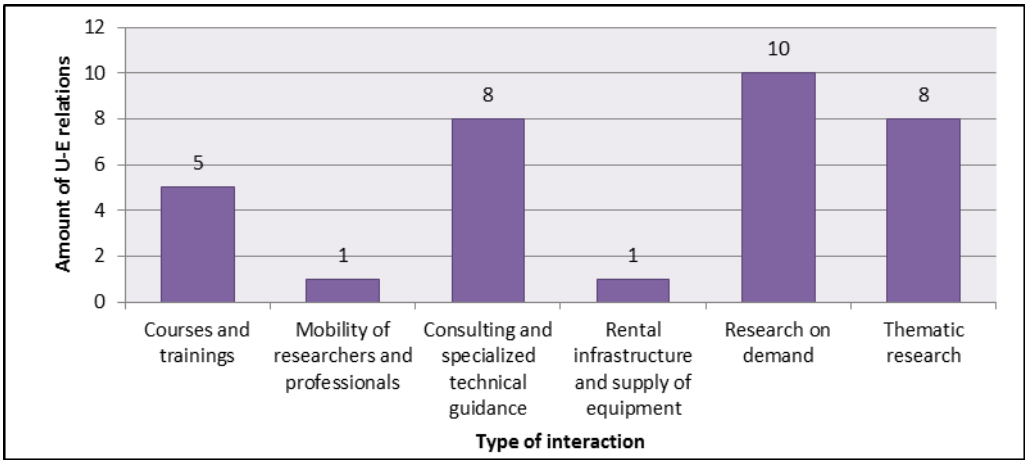

Chart 4: Distribution of the amount U-E relations by type of interaction.

The main features that differentiate modalities are related to the means by which an interaction is formalized. Consultancies, for example, tend to inhibit the development and publication of scientific papers, due to the large workload required and the restrictions on trade secrets. On the other hand, both thematic and on demand researches are less restrictive, allowing faculty members to allocate the funds received from agencies to other academic activities. However, such projects "occur slowly and feel like they will show no results," as described by one of the respondents.

The courses and training were cited in only 5 cases of interactions reported. However, those professors who have cited them highlighted the high frequency of courses and training and its importance as a form of U-E interaction by itself. It is noted, therefore, a discrepancy between these statements and the absence of citations from other respondents about their participation in courses and training for any companies. This evidences a diffused opinion on the courses and training modality as a type of interaction with the productive sector, since few faculties engage more deeply with the courses and most of them limit themselves to teaching some of the classes.

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The mechanisms of academic mobility and rental of infrastructure were the least cited, with only one case of each type. Such mechanisms are difficult to use because, according to the interviewees, the university does not have adequate infrastructure, which most large companies possess, or does not allow the faculty to become temporarily absent from their obligations to their departments. In addition, Brazilian law is restrictive in regard to the renting or lending of public facilities and equipment for private use, which is a particular institutional feature within the framework of federal universities.

4.4. Methods of approaching of U-E interaction

For the great part of respondents (31 of 33 reports), the initiative for the formation of the relationship came from the productive sector, which constantly searches for solutions to its specific problems through the intellectual capacity of the faculty. However, this initial approach don't usually happens via institutional channels, but through the faculty themselves, who are sought after across their network of relationships (students or alumni), or even contacted directly by companies due to its academic reputation in areas of knowledge relevant to their businesses.

Another important finding was that a large portion of the U-E relations reported by respondents were the result of previous interactions with the same company. In the opinion of one interviewee, "the same company often resorts to the university several times, but the liaison within the company changes and so for every interaction there may be different area or department seeking us."

There were only two cases where the professor took the initiative to seek the relationship with a company. In one of them, the faculty used his network of contacts to seek specialized services, nonacademic in nature. In the other, what motivated the researcher to look out for the firm contacted was the funding necessary to execute a research in the firm's industrial sector, in a way similar to what had happened in the company`s headquarter at another country.

4.5. Formalization instruments

The formalization of U-E relations is directly related to the involvement of the financial funding of the cooperative projects. The legal instruments used by the

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university to formalize such projects are either contracts or cooperation agreements, described below[5]:

- Contract of Service: aims to deliver a product to meet a specific demand. In this type of relationship, the university gets evaluated according to the service delivered, like any commercial agreement, and may also be fined for any failures.
- Cooperation Agreement: aims to allow the exchange of knowledge in areas of common interest with the university and may be comprehensive or restricted to specific themes, being more often used to formalize partnerships with public entities.

To be executed, both instruments must undergo a process of analysis and approval on the university's collegiate bodies, which however are different for each kind: the approval of a contract involving fewer decision-makers and less complexity. Additionally, both can contain clauses relating to the confidentiality of the projects, if necessary.

Despite the differences mentioned above, it was identified that faculty has little knowledge of the approval process for projects of U-E interaction within the university. Of the 33 cases reported, only in 17 the interviewees managed to specify the instrument used - 14 through contracts and 3 through agreements. Due to being easier approving projects through contracts, use of this instrument is predominant.

It is worth mentioning that all (33) U-E interactions identified and analyzed in this study were formalized by the university. However, several other relations, not formalized, were also reported – mostly coming from the professional networking of the faculty involved or from the orientation of research projects of their own students –, which means that there was no financial relationship between the parties.

5. CONCLUSIONS

The growing importance of the university in the innovation process has been unleashing several changes in its structure. With the Innovation Law, enacted in 2004, mechanisms were created to accelerate the development of the science-industry relationships, in order to increase the innovation potential of the Brazilian

[5] Based on the preliminary investigation conducted by the author.

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industry. Such relationships are essential for the university secure more resources to finance its activities, in addition to fulfilling its function of contributing to the economic and social development (DAGNINO, 2003; DUDZIAK, 2007; ETZKOWITZ, 2001, 2011; LIMA; TEIXEIRA, 2001)

This study identified a number of manifestations of U-E relationships that occurred with the School of Engineering of Universidade Federal Fluminense, an institution with a long history of association with the productive sector. Some of these manifestations' characteristics were investigated, such as the size and industrial sector of the university's partners, the level of involvement of the faculty members with these partnerships, the different arrangements used in the U-E interactions, the institution responsible for starting the U-E relationships, and the types of legal instruments used to formalize such interactions.

First, it was found that UFF's School of Engineering relationships with the productive sector occurs mainly with large companies from the naval and oil & gas industries. It was also evident that the U-E interactions are still concentrated on a small group of professors, which is explained by the diversity of researchers background and academic interests and the large dependency of U-E relations to their individual profiles, since there is no institutional guidance about the benefits, industries, themes or types of interaction that should be pursued in their cooperation with the productive sector.

Additionally, the bureaucratic hurdles and the lack of an adequate infrastructure and administrative support discourage the participation of researchers in external projects. In the same way, the procedures for legally establishing the U-E relations are not appropriately disclosed to the professors: the conducted interviews showed that the faculty members do not fully understand the role of the university's departments that get involved in the approval and administration of cooperation projects, a fact that also discourages their collaboration with external partners.

On the other hand, those professors who lead the U-E interactions shows entrepreneurial behavior, becoming directly responsible for the relationships with external organizations, which in turn are generally not influenced by the university`s institutional acts. Thus, the U-E interactions are particularized by faculty members, not representing, in essence, an institutional relationship between both parties. Despite this, the existing U-E interactions show that they happen, unilaterally, because the industry demands knowledge from the academy. The reverse scenario,

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in which the faculty would seek closer ties with companies in order to pursue benefits for the university, was not identified.

In addition to the university`s reactive posture, the predominance of projects that focus on providing services for businesses are evidences of the lack of integration of the teaching role in their relationships with companies. It is worth saying that providing courses and training for businesses is not widely recognized by the faculty as a legitimate mode of interaction with the productive sector.

At last, it was identified that most of the existing U-E relations are formalized through contracts, rather than cooperation agreements. This fact indicates that the relationship with the industry has more of a commercial bent than signs of mutual partnership between parties. One possible reason is that, as indicated by the respondents, the procedure for approval of a cooperation agreement is more complex and time consuming than the approval of contracts. However, contracts hinder the researcher's ability to create knowledge due to their strict deadlines and rigorous constraints on the dissemination of research content. One of the consequences is the lower frequency of published scientific papers based on research carried out in the industrial environment, which in turn plays a big part on the low rate of innovation, as evidenced by the fact that only one patent had been registered by the 33 identified U-E relations.

In general, the various findings of this study give a deeper understanding on the context of the U-E interactions in an academic unit that already has some degree of relationship to the industry. To achieve its transformation into a truly entrepreneurial university, however, UFF’s School of Engineering must increase its efforts in the administrative structure, repeatedly characterized by faculty as one of the main factors of discouragement for the occurrence of U-E relations. In addition, all of UFF`s academic units, and the School of Engineering in particular, could benefit from an greater effort to raise awareness of faculty members about the importance of integrating the roles of teaching, research and extension in academic activities.

The information contained in this research will hopefully contribute to the adequate UFF`s institutional practices and policies, and possibly induce other universities to rethink its practices regarding innovation and U-E relations. Also, other studies should be performed to help universities achieve this goal, for example, performing similar exploratory researches on other academic units, and also

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analyzing the university's U-E relations based on quantitative data and documentary information, aiming to reinforce the findings described here. Additionally, a survey with entrepreneurs, executives and professionals could be conducted to identify the productive sector's perceptions of the U-E relation's benefits and difficulties, and this paper could be used as a guideline for the information to be collected, as well as a framework for analyzing the differences and similarities in the perceptions of both parties involved in U-E relations.

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APPENDIX: QUESTIONNAIRE INTERVIEWS WITH FACULTY MEMBERS

Purpose of the interview: to explore the opinion of faculty members on the context of the university-industry relations existing in the School of Engineering from 2011 to 2013, considering the institutional policies in place and the experience of the professor in such relationships.

To that end, the following questions are intended to identify the characteristics and peculiarities of U-E relations from the experiences of each faculty in these interactions. It also seeks to characterize such relationships holistically, considering the variety of existing interactions, and to identify barriers to their occurrence and the benefits they generate.

In the context of this paper, the term "business", "productive sector" and "customer" are used broadly, including, in addition to private companies, other types of organizations, such as NGOs, not-for-profit institutions and government agencies.

- *Involvement of teachers in the relationships U-E*

1) Have you recently participated (from 2011 to 2013) in any projects together with clients outside the university? What is the project`s purpose and its field of knowledge? What is the industry in which the client operates?
2) Among the following options, how would you classify the type of U-E interaction of each project? Among the types you have experience with, could you identify some feature, advantage or disadvantage that stands out from the others?
    - Courses and training
    - Mobility of researchers and professionals
    - Consulting and specialized technical assistance
    - Rental infrastructure and supply of equipment
    - Researches on demand

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- Thematic researches

3) How was the approach to or from the customer in these projects? Who sought whom? Was the demand spontaneous or induced by some kind of incentive?

4) Were these projects formalized by any sort of contract or covenant? How did this formalization occur? Did you have any legal and / or administrative support in the preparation of contracts and / or agreements?

5) The project's deliverable is a scientific article or a service? If it is a service, does it have a technical application and / or practice feature? Does it consist in the creation or improvement of products and / or processes?

6) Does the result of the project have any potential for patenting or marketing? If it does, would you want to market it through an enterprise yourself or would you pass the right to do it to another company? Why?

7) Are the relationships with the customer occasional or ongoing / recurring? What drives a customer to maintain and / or resume relations with School of Engineering of UFF?

- *Institutionalization of U-E relations*

8) In your opinion, in what ways does the approach to School of Engineering of UFF contribute to the productive sector?

9) In your opinion, what is the greatest motivation for the faculty to maintain relationships with the productive sector? What are the benefits generated for the professor and for the department?

10) What are the difficulties (internal and external) encountered in the establishment of U-E interactions within the School of Engineering of UFF?

11) Do you know the Law of Innovation (2004) and its consequences for federal universities (incentives for partnerships with business and administrative support to innovation)? Since its enactment, did School of Engineering of UFF activities of teaching, research and extension become closer to society? Why?