University-Industry Cooperation: Conduct of Research Projects and Construction to the Path of Innovation in the Brazilian Oil Industry

Polido, W. R.¹; Longo, O. C.²

Abstract—Each day increases the need of research that attends the fast process of technological innovation in the world. This situation brought together universities and companies. However, many are the universities that are still far from the market reality and far from successful partnership in research, largely because of the precarious or inadequate laboratory facilities. This article presents the relevance of cooperation between university and industry as an important arrangement as the industry’s innovation capacity, and analyzes the matter of knowledge management involved. It also presents a brief survey of the Brazilian scenario, where companies seek proximity to universities, which therefore has need to increase its professional staff trained to manage construction projects and technological research. A few years ago the scenario was not favorable, but with good expectation due to the legal obligation of investment that the oil industry has to perform in partnership with universities.

Index Term—Innovation management, Investment management, Research and development, Technological cooperation

I. INTRODUCTION

We observed often in developing countries, that small and medium-sized companies do not have internal research and development (R&D) structured. This scenario refers to the need to resort to external sources, highlighting around universities.

However, university and company can be analyzed as two different worlds, with different values and goals [10]. Such differences can lead to disagreements in defining the objectives to be achieved, which enhances conflicts between the parties and difficulties in conducting the work toward a common goal, in this case, technological innovation.

So, how is the development of the innovation process? The innovation process is an iterative process carried out with the contribution of various economic and social agents that have different types of information and knowledge. The arrangement of various sources of ideas should be considered as an important way for companies to build capacity to generate innovation and to face changes with a view to the solution of most technological problems involves the use of knowledge of various types [27].

The interaction between science and technology institutions (ICT), specifically the universities and the productive sector is an important strategic issue. This relationship enables a way to improve the R & D activities and, consequently, increases the technological competitiveness of enterprises and scientific advancement of research institutions. These sectors of the economy involved in innovation and national technology development process, present themselves in a complementary manner to achieve mutually beneficial goals and at the same time, different from each other [30].

Lastres [26] draws attention to the fact that power is no longer restricted to the material means field and political and institutional apparatuses, but, increasingly, is defined from the immaterial control and intangible - whether the information or knowledge. Within this context, it is necessary to develop new industrial policies, technology and innovation, they are able to deal with the new socio-economic reality, making it urgent government encouraging the creation of networks, in which the resources, knowledge and information circulate quickly and at low cost.

The policy at this stage of rapid changing, are extremely important to guide and adapt production and innovation systems. The policy formulation should involve the industrial, the education and research sectors and the government, in conjunction with other agents, can contribute to the learning of enterprises, the strengthening of its technological capacity and the consequent increase of its competitiveness. Consolidates thus knowledge as the main resource that should be the basis of new policies to promote industrial and technological development, and learning how central this development process [7].

In Brazil, technological innovation has been the subject of several publications, where the account of successful experiences demonstrates the need to strengthen the interaction between government, universities and companies.

II. PATHS OF R&D INNOVATION

From 1970 begins a series of studies aimed at overcoming technology gaps. In Brazil, Herrera [23] [24] studies the focused on causes and ways to reduce technology gaps between developed and developing countries, and this theme later spread by works such as Perez [31] and Mansfield [29].

The macro perspective of the technological gap reduction studies from the 1980’s was directed to the analysis of the

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differences between the countries' economic growth from its internal capabilities, especially those required for absorption of the technology / knowledge from other countries. It was basically the ability to complete satisfactorily, technology transfer processes [11].

The most important points of this discussion stands out the notion that gaps reductions depend on efforts of the receiving party. This should take an active role in the creation of skills able to play and advance the development, promoting the so-called catching-up [1] [32]. In the center of discussion, the key point is to build internal absorption capacities and, hence, to the development of hops.

Although the gap reduction approach has been applied in the literature on transfer between countries ("macro" level of approach), it can be also applicable to so-called "micro" level, with organizations or even between different units of the organization, which makes it useful in this discussion on the management of R&D companies in the Brazilian oil industry.

From the perspective that covers levels "macro" and "micro" technology transfer can be defined as the process by which a set of tacit and codified knowledge, know-how, methods, procedures and / or physical devices, all they apply to the production and marketing of goods and services are transferred from one organization or unit (provider) to another (recipient).

Amesse et al. [2] reported four situations which applies to technology transfer idea and gap reduction in the "micro" level. Two of them concern the transfer of R&D results generated internally to the company, either for use in production processes of the company, is for sale in the market. The other two cases involve the absorption of the results of R&D contracted out or technologies acquired from third parties, through adaptations necessary for its use in processes of the company or, in the case of the acquisition of R&D to commercialization in the market.

Also according Amesse et al. [2] to overcome these gaps goes through a set of actions involving the development of strategies for linking the R&D efforts in their corporate strategie, the involvement of potential users organizational units of the results in project development, management appropriate structure, resources and R&D skills, establishing relationships and adequate knowledge flows between the company and its partners, among others.

However, if on the one hand the solutions to overcome gaps undergo an appropriate management of R&D projects, respecting their objectives and different arrangements, on the other there are also important previous decisions, oriented to the best choice of developing a given internally technology, develop in partnership or buy it - known in the literature as a make or buy decision.

According to Teece [37], the application of the approach of transaction costs to the world of management, based on the weighting of risks associated with contractual arrangements, hybrid or internal hierarchical organization, is extremely appropriate to determine whether a particular investment should be conducted internally or be outsourced. For the studied scenario, it is set if the best arrangement undergoes a R&D in house, for implementation in partnership or direct acquisition of the technology.

In these two points, the literature of innovation management and open innovation also has a lot to contribute. There is a large body of work that discusses and presents tools for portfolio management and R&D projects, technology and innovation in its various aspects [13] [38] [33] [18], works that are directed to the discussion of the selection and management of partnerships and arrangements for the implementation of R&D and the development of knowledge absorption capacities [12] or directed to licensing analysis technologies developed within the organization [12] [28].

However, despite the contribution of this literature, we found no evidences of methods and tools that support an integrated way, for a given considered as a priority technology, make or buy decision and the adoption of decision, appropriation and dissemination of technology, understood as fundamental to the problem of management of R&D and innovation in the Brazilian oil sector.

As seen above, the R&D has not occupied a strategic role in companies in this sector and addressing this situation goes beyond promoting a better relationship management with partners and reach guarantee the expected results. It includes necessarily an expansion of the model based on outsourcing to a model of mixed arrangements where the outsourcing of R&D is one of the possible routes. At this point the level of maturity and other features of the technology of interest, as well as the availability of skills to develop them are key points.

This change also involves broadening the perspective on the results of R&D, today aimed at generating technologies for the marketing perspective and especially adoption of these technologies. At this point, the internal management aspects related to organizational processes in which these technologies can be applied in addition to the commercial perspective related to the existence of market and stakeholders in production and marketing are fundamental and should be taken into account, even though on the results of appropriation limits when dealing with the R & D regulated and compulsory.

III. RELEVANCE OF UNIVERSITY-INDUSTRY COOPERATION IN THE MANAGEMENT OF TECHNOLOGICAL KNOWLEDGE

According to Barton [5], sources of technology to address deficiencies in strategic technological skills are universities, research centers and other companies.

To the extent that business competitiveness in the globalized world depends on innovation of products and processes and R&D effort, its leaders are faced with a big challenge because they must expose their companies to a bombardment of new ideas from outside the to combat the strategic constraints and encourage employees to collect and disseminate information internally [5]. In addition, the company needs to develop a knowledge network, forming a technological innovation-friendly environment. Potential allies technology ranging from research institutes, universities and laboratories, through consortia competing businesses or not, to customers.

In developed countries, the interaction between the research sector and the business sector is part of the strategy of the companies in managing their technological knowledge, where external sources of knowledge are an important part of
this strategy. Barton [5] emphasizes the importance of creating porous borders to knowledge.

III. TYPES OF INTERACTION
Cassiolato [9] states that the university - business interaction involves different groups of actors in different conditions to generate knowledge, and cites four basic conditions to be considered in the cooperation process:

- peculiarities of the innovative process in its different stages, affecting the chances of university-business interaction;
- specific activities carried out in the academic and business spheres, as well as certain socio-economic and cultural values that prevail in these environments, which act as conditioning the possibilities of interaction;
- structuring of different institutional arrangements in response to environmental stimuli, which include qualitative changes in the interaction between universities and business, including through the consolidation of a new division of labor between these bodies;
- sectoral specificities that strongly influence the university-industry interaction possibilities.

This institutional diversity allows we draw different possibilities of arrangements between academia and the productive sector, as observed in the typology proposed by Bonaccorsi et al. [6], detailed in Table I, which distinguishes six forms of cooperation, based on the degree of commitment of organizational resources (personnel, financial resources and equipment) between the parties; the length of the array; and the degree of formalization of the established arrangement.

Thus, various instruments can be used for the implementation of cooperation, and your choice depends on the position and objectives of each participant against the process, considering the flexibility and suitability necessary for the kind of relationship to be developed [35].

Cunha et al. [16] reported that relationships start from Personal contacts and informal Teachers with such companies, such as Specialized Services Delivery (Conferences, consultancies, publications, etc.) and realization of courses and training programs/expertise. And evolve into formal agreements between the university and the company, which may involve a third agent mediating the interaction process and ultimately to more advanced levels, as permanent structures research between universities and industry.

<table>
<thead>
<tr>
<th>Relationship Types</th>
<th>Description</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 PERSONAL RELATIONSHIPS INFORMAL (The university is not involved)</td>
<td>They occur when a company and a person of university exchanges perform without any formal agreement, involving the university is prepared.</td>
<td>Individual consulting by academics, publication of research results, academic spin-offs, informal workshops.</td>
</tr>
<tr>
<td>2 PERSONAL RELATIONS FORMAL (Agreements between the university and the company)</td>
<td>They are as informal personal relationships, but with the existence of formal agreements between the university and the company.</td>
<td>Scholarships and support for post-graduate students training, staff exchanges, courses sandwich.</td>
</tr>
<tr>
<td>3 INVOLVEMENT OF AN INSTITUTION OF OPERATIONS</td>
<td>Comes an intermediate group. The associations that intermediate relations can be within the university, be completely external, or even be in an intermediate position.</td>
<td>Industry associations, research institutes applied, general assistance units, institutional consulting.</td>
</tr>
<tr>
<td>4 FORMAL AGREEMENTS WITH OBJECTIVE DEFINED</td>
<td>Relations that occur from the beginning, both the formalization of the agreement as the definition of the specific objectives of cooperation.</td>
<td>Research contracted, employee training, cooperative research projects and joint research programs.</td>
</tr>
<tr>
<td>5 COVENANTS WITHOUT FORMAL OBJECTIVE DEFINED</td>
<td>Formalized agreements as in the previous case, but relations have greater breadth, with strategic objectives and long-term.</td>
<td>Research sponsors and industrial development in university departments, donations and grants for research, generic or specific departments.</td>
</tr>
<tr>
<td>6 CREATION OF STRUCTURES SUITABLE FOR INTERACTION</td>
<td>Are the research initiatives conducted jointly by industry and university in permanent and specific structures created for this purpose, among others.</td>
<td>Technology parks, institutes, laboratories, business incubators, research consortium.</td>
</tr>
</tbody>
</table>

Thus, various instruments can be used for the implementation of cooperation, and your choice depends on the position and objectives of each participant against the process, considering the flexibility and suitability necessary for the kind of relationship to be developed [35].

III.II. SUCCESS FACTORS VERSUS BARRIERS IN THE INTERACTION UNIVERSITY/COMPANY
To effectively manage the cooperation between universities, research centers and industries, several points need to be clarified and analyzed, points these ranging from the definition of what is a successful cooperation of the criteria that can be used to assess efficiency a research cooperation, the most common causes of failures and frustrations, including, mainly, how is the process of learning in companies. Some authors have studied the difficulties and also on conditions that facilitate this interaction. Ferreira [20] pointed out several factors that should be the object of attention of the managers of this process, including:
it is necessary that the magazine is project of equal importance to the partners, taking into account the motivations rarely coincide;

it is also necessary that each partner (university, industry) has its identity and respected own goals. It is important, for example, find compromises between different times;

the communication between the partners, which is essential, should not refer only to the results achieved, but also to the work process. The probability of success increases with the frequency and the personalized nature of this communication (reference to the sharing of tacit knowledge, not just of the information generated by the projects);

supports the interaction, such as process-book, shared equipment and the models are very important as they provide a common basis for discussion, exchange and mediation, also teaching partners to work that look can be achieved with differences of temporality, rhythm that distinguish them fully. These brackets allow also integrate early the restrictions imposed by production;

the industrial partner must be able to learn the technology developed. Therefore, the qualifications, training and experience of those involved should be partly similar between academic staff and industrial;

it is also interesting that the interaction be given the same level of technological knowledge spectrum, for example, from research to research in order to reduce differences in language, culture and technical expertise;

the transfer, even if temporary, part of the project team, allows the exchange of tacit knowledge (know-how, savoir-faire), allowing also the research body to develop specific expertise in transfer and a greater understanding of the specificities of production and marketing, as the industry knowledge is not reducible to technical knowledge form of knowledge;

the preliminary information on the costs and market potential should be included in the interaction;

as the ability to motivate teams by their leaders, it should be supported by building stable networks of interaction between industrial and university teams;

finally, it is necessary to take into account the differences between the representations of academic and industry with regard to the learning (passage of a conceptual approach to another, procedural), value (value of estimated versus exchange value) and emotions (rupture of elation between the creator and the creature, representation of his mental universe, as opposed to the pleasure of risk and win in the market). Investing in the development of common success of the interaction representation is important for its good progress.

These aspects should be considered when evaluating interactions in research between universities and companies, as they are related to the success of these interactions with regard to the establishment of stable cooperation networks and technological learning.

However, one can synthesize some of the obstacles that are in front to the implementation of cooperation [25]:

difficulty of information: it is not known what is the local production of reality, and the availability of knowledge goods and which area can give the country a real advantage in international markets;

cultural barrier: universities and development institutions behave based on academicism. Also lack the entrepreneurial tradition in the use of proprietary technology;

there is a low degree of commitment of the productive sector with technological development;

the occurrence of cooperation is based on personal relationships;

political and financial difficulties: lack specific resources to each of the stages of the projects;

lack of political and financial conditions to ensure the independence and stability of the institutions. There is a lack of scientific and technological industrial development policies;

institutional barriers: lack laboratories in companies, universities and research centers;

lack continuity in the cooperation;

project management inability to R&D in universities, research centers and the productive sector;

lower promotion of interaction between knowledge centers and production;

there is a view that should be the state the sole financial agent of university research activities.

IV. COOPERATION UNIVERSITY/COMPANY: BRAZILIAN SCENARIO

IV.1. COMPANY’S VISION

The scientific and technological development efforts in Brazil departed, historically, the Government’s initiatives, quite timid private sector. As a result of this policy, the scientific and technological development was disengaged from the industry, in charge of universities and research centers, which gave priority to basic research, and state, which began to strongly act from the 70’s [36].

As a result, the debate on the importance of scientific and technological research activities was, for a long time restricted to the academic world, leaving aside that which is the component capable of transforming science and technology into wealth, which is the sector business [15]. There is therefore urgent to strengthen technological cooperation between universities, research centers and industry and the need to create networks in which the resources, knowledge and information circulate quickly and at low cost.

The removal of the private sector in R&D activities in Brazil contrasts with the behavior of developed countries that for decades have chosen innovation as a central instrument of competitive strategy of companies. As a result, the Brazilian industry has lost the opportunity to invest in the development of innovative capacity and creative processes set learning.

Among the macro-guidelines highlighted by Coutinho et al. [14] as key points to overcome the technological fragility and lack of cooperation in the Brazilian innovation system, are included:
the need to stimulate the private sector to strengthen its activities related to education, science and technology;

- increase connectivity between the various agents of the science system and technology (S&T) and induce cooperation as a way to expand and accelerate the whole learning process... should be encouraged cooperation between companies and research entities, ...that can positively contribute in boosting technological effort of the industrial sector;

- to support the assembly and the strengthening of programs to ensure: the rapid dissemination of scientific and technological information, the effective dissemination of knowledge and technologies of interest to the productive sector.

IV.II. UNIVERSITY’S VISION

Nowadays we can say that Brazilian public universities are the main institutional support for research and the academic education of researchers. The research development and growing presence of masters and doctors on academic board was associated, in most cases, to a high quality of education.

Today one can say with certainty that the Brazilian public universities are the main institutional support for research and the training of researchers. The development of research and the growing presence of masters and doctors in the faculty was associated, in most cases, to a high quality of education [19].

According to the author, however, these institutions are show precarious physical facilities (laboratories, classrooms and technical rooms), making it the major limiting factor for the research development of its own initiative or with companies partnership.

On major universities there are internal design offices that develop building projects and manage physical expansion. These offices teams can act since the design of a project to drill down to execution and monitoring construction. This group also can develop the architectural design or part of it, and externally hire other projects. Therefore, it is common for contractors to be hired to develop part of the projects, without an effective control of the contracted product. And some problems are often found along the way, such as: lack of clear scope of design, inadequate control of documents or information, lack of communication between the agents involved in the process, compliance errors, lack of critical analysis of the process and project.

Daigneau et al. [17] presents four trends related to society, economy, technology, governability and environment, that influences planning, construction, maintenance and management of the physical space of universities: (i) students genesis, such as nationality, economic class, age, market performance; (ii) studies accessibility; (iii) responsibility of educational institutions; (iv) environmental concerns such as reuse, recycling and reduction.

The same author also lists some myths that influence decision-making in the university:

- buildings that will be used for a long period of time: space constructed today based on the existing demand may not meet needs and expectations of the university in the future;

- development of flexible projects: construction of flexible buildings demand a great knowledge of its use in the future to be able to plan it in projects. Without these information many of these investments may become worthless;

- projects where form follows function: the needs program require changes, unlike buildings, whose forms end up influencing the function. During periods of change, design patterns based on past practice, should be challenged;

- the lack of regular maintenance for some buildings as an option: some facilities do not generate return on initial investment, and should involve a minimum of additional investment. But the general maintenance should be done, since they have been planned;

- facilities can attract new students: physical facilities are not the primary motivation on choosing a university, but its reputation is, as well as courses it offers, cost, location. Therefore money unnecessarily spent to support good education or research, in this aspect, is waste.

Daigneau et al. [17] conclude that responsibilities for the planning, management and coordination of projects inside universities live in a critical situation, but some factors can help them achieve their goals: understand the impact of decisions in the context of today and tomorrow; treat the buildings as an investment, maximizing investments globally, not individually; strive to develop strategies to improve institution positioning towards the paradigm shifts and economic situation; be aware that they are only agents, and must understand the other factors that influence the functioning of the institution, as its economy, processes and purposes.

As to Brazilian law, a law that has a great impact on university management is the 8.666 of June 21, 1993 [7], laying down general rules on procurement and administrative contracts of Public Administration, related to construction, services, purchase, disposals and leases. A problem brought by this Law is the contracting of services and works by the "lowest price", that ends up being used as justification for low quality of contracted products and addition of time and cost. The limitations on public institutions regarding on purchase reflects in difficulties to meet the demands of the market in quality processes [22].

V. PERSPECTIVE CHANGE OF SCENERY: OIL INDUSTRY INVESTMENTS

According to Moraes et al. [31], the Petrochemical Industry is essentially considered a "science-based" industry, and strongly intensive in R&D, since technology has a strong impact on sales. Thus, the major leading companies usually have strong investment in R&D long-term, through important research programs in their own laboratories and in association with universities and research institutes. On the other hand, other companies can only acquire this know-how through technology licensing.

From the 80’s, search technology sources were broadened, as well its capacity, making the Brazilian petrochemical companies to use services of alternative suppliers from the original licensors holders, as well as increase pressure for a deepening on the training received. Thus, a learning trajectory
began, leading promotion and institutionalization of technological activities, with creation of specialized centers of R&D in own companies. These centers, in turn, were promoted by the regulatory apparatus of technology policy in the industry, by combining the leadership and support of setorial agencies, Petrobras and Petroquisa, encouragement and levy of INPI and BNDES and financial support from the Financier of Studies and Projects (FINEP) [31].

According to Santana et al. [35] the amount of spending on R&D between 1985 and 1989, in terms of value, increased 289% (from US$ 13.63 million in 1985 to US $ 53.07 in 1989), while the its percentage on sales increased by 2.7 times over the same period (from 0.32% to 0.86%).

Despite the significant growth of investments in R&D, the absolute value of expenditures (US$ 53 million) were insignificant compared to international standards, as well as its percentage on sales of 0.86%, and there were scarce companies that directed more than 1% of their spending for technological activities. The number of people employed in R&D laboratories was also modest: in 22 brazilian companies analysed, there were no more than 32 top-level technicians in any company, totaling only 281.

Thereby, it is observed that although achieving a certain level of innovative capacity in the 80s, Brazilian petrochemical companies had spent paltry compared to international standards. This was the result of its tripartite implementation process, with a restricted production (only a few products), small capacity and in which foreign private companies were intermediate on technological support for a long period.

From the 90’s the investment scenario in R&D in Brazil suffer a real turn. The Investment Section Research and steady development of the Concession Agreement for Exploration, Development and Production of Oil and/or Natural Gas, signed between Petrobras and the National Petroleum Agency - ANP, since 1998, establishes the obligation of the concessionaire to invest amount equal to 1% of gross revenue from a particular farm field, in qualifying expenditures on research and development when so focus Field Special Participation.

According to ANP Resolution No. 33, of 24/11/2005 - D.O.U. 25.11.2005,

[...] Dealers must invest in Brazil , the amount corresponding to 1% of gross income from production in a given field, in conducting qualified research and development expenses when the Special Participation is appropriate for this field in any quarter calendar year; Whereas at least 50% of this amount must be expenses incurred in contracting projects/programs at universities and research and development institutes previously accredited by the ANP for this purpose, herein after referred to as accredited institutions, as defined in Regulation.

This means oil companies exploiting oil and gas in Brazil - most notably Petrobras - must necessarily invest 0.5% of their gross income from production in a given field programs, R&D projects and laboratory infrastructure in partnership Accredited Institutions with the ANP (Universities and Research Institutes). The other half of this amount may be allocated in the Concessionaire's own installations.

Accreditation granted by ANP enables the institution to conduct research and development projects. It is the formal recognition that the institution works in research and development activities and/or educational activities in areas of major interest to the sector [3].

Other significant changes were introduced by the ANP to relax the requirement that resources were only employed in R&D activities: admit that they were used in construction (laboratory infrastructure) in universities and research centers involved, since it was observed precarious physical facilities suitable for conducting technological researches. According to Turchi et al. [39] the PNA hopes that these projects will produce the following results for those involved:

- for ICTs - deploy structured centers of excellence to promote technological development of the sector;
- for the oil and gas sector - to help supply the energy needs of the country; increase and improve national production; reduce operating costs, production , transportation, refining and distribution, with safety and environmental protection;
- for the supply chain - to increase the participation of national companies in the sector and provide highly qualified professionals;
- to the domestic industry - to promote the technological development of domestic industry.

Table II reports the investments made by dealers which have been authorized by the ANP, from 2006 to the 3rd quarter 2015.

**TABLE II**

<table>
<thead>
<tr>
<th>Company</th>
<th>Number of projects</th>
<th>Investment (R$)</th>
<th>% Investment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Petrobras</td>
<td>1,214</td>
<td>4,300,671,318</td>
<td>92.89%</td>
</tr>
<tr>
<td>BG</td>
<td>40</td>
<td>196,406,961</td>
<td>4.24%</td>
</tr>
<tr>
<td>Statoil</td>
<td>19</td>
<td>36,857,048</td>
<td>0.80%</td>
</tr>
<tr>
<td>Shell</td>
<td>5</td>
<td>23,510,770</td>
<td>0.51%</td>
</tr>
<tr>
<td>Petrogal</td>
<td>12</td>
<td>20,235,050</td>
<td>0.44%</td>
</tr>
<tr>
<td>Sinochem</td>
<td>12</td>
<td>16,964,173</td>
<td>0.37%</td>
</tr>
<tr>
<td>Repsol</td>
<td>10</td>
<td>10,363,982</td>
<td>0.22%</td>
</tr>
<tr>
<td>Chevron</td>
<td>9</td>
<td>6,365,974</td>
<td>0.14%</td>
</tr>
<tr>
<td>Queiroz Galvão</td>
<td>4</td>
<td>5,843,510</td>
<td>0.13%</td>
</tr>
<tr>
<td>Paranaiba Gás Natural</td>
<td>2</td>
<td>5,566,581</td>
<td>0.12%</td>
</tr>
<tr>
<td>Frade Japan</td>
<td>1</td>
<td>3,157,523</td>
<td>0.07%</td>
</tr>
<tr>
<td>BP</td>
<td>2</td>
<td>2,321,858</td>
<td>0.05%</td>
</tr>
<tr>
<td>GeoPark</td>
<td>3</td>
<td>672,903</td>
<td>0.01%</td>
</tr>
<tr>
<td>ONGC</td>
<td>2</td>
<td>503,790</td>
<td>0.01%</td>
</tr>
<tr>
<td>Brasoil</td>
<td>2</td>
<td>236,250</td>
<td>0.01%</td>
</tr>
<tr>
<td>QPI Petróleo</td>
<td>2</td>
<td>192,289</td>
<td>0.00%</td>
</tr>
<tr>
<td>Rio das Contas</td>
<td>1</td>
<td>111,101</td>
<td>0.00%</td>
</tr>
<tr>
<td>Total Brasil</td>
<td>1</td>
<td>92,198</td>
<td>0.00%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1,341</strong></td>
<td><strong>4,630,073,279</strong></td>
<td><strong>100.00%</strong></td>
</tr>
</tbody>
</table>

During this period numerous universities and research institutes - operating in the development of research projects in areas of interest to the oil industry and have technical/operational conditions - sought its accreditation with the ANP aiming to carry out research projects and
construction. Table III illustrates the amount of R&D projects/construction and the resources invested in each of these institutions.

### TABLE III
RESOURCES AUTHORIZED BY INSTITUTION
(Bulletin ANP Oil and R&D - issue No.26/Oct 2015)

<table>
<thead>
<tr>
<th>Institution</th>
<th>Number of projects</th>
<th>Investment (RS)</th>
<th>% Investment</th>
</tr>
</thead>
<tbody>
<tr>
<td>UFRJ</td>
<td>256</td>
<td>516,210,047</td>
<td>11.15%</td>
</tr>
<tr>
<td>UFPE</td>
<td>37</td>
<td>161,227,650</td>
<td>3.48%</td>
</tr>
<tr>
<td>UFRGS</td>
<td>56</td>
<td>156,865,291</td>
<td>3.39%</td>
</tr>
<tr>
<td>Unicamp</td>
<td>71</td>
<td>122,353,908</td>
<td>2.64%</td>
</tr>
<tr>
<td>UFSC</td>
<td>41</td>
<td>120,670,584</td>
<td>2.61%</td>
</tr>
<tr>
<td>UFRN</td>
<td>71</td>
<td>114,042,859</td>
<td>2.46%</td>
</tr>
<tr>
<td>UPRGS</td>
<td>71</td>
<td>102,443,499</td>
<td>2.1%</td>
</tr>
<tr>
<td>UFP</td>
<td>66</td>
<td>96,092,702</td>
<td>2.08%</td>
</tr>
<tr>
<td>UPP</td>
<td>26</td>
<td>78,008,458</td>
<td>1.68%</td>
</tr>
<tr>
<td>IEAPM</td>
<td>2</td>
<td>73,877,740</td>
<td>1.00%</td>
</tr>
<tr>
<td>UERJ</td>
<td>28</td>
<td>58,331,675</td>
<td>1.26%</td>
</tr>
<tr>
<td>UFPA</td>
<td>20</td>
<td>57,779,629</td>
<td>1.25%</td>
</tr>
<tr>
<td>UFES</td>
<td>21</td>
<td>57,591,876</td>
<td>1.24%</td>
</tr>
<tr>
<td>UFSCar</td>
<td>38</td>
<td>53,379,966</td>
<td>1.15%</td>
</tr>
<tr>
<td>IFT-SP</td>
<td>21</td>
<td>52,527,819</td>
<td>1.13%</td>
</tr>
<tr>
<td>Ciaba</td>
<td>1</td>
<td>47,881,369</td>
<td>1.03%</td>
</tr>
<tr>
<td>CIAPA</td>
<td>14</td>
<td>42,252,639</td>
<td>0.91%</td>
</tr>
<tr>
<td>UFMG</td>
<td>23</td>
<td>38,950,690</td>
<td>0.83%</td>
</tr>
<tr>
<td>Ciapa</td>
<td>2</td>
<td>36,275,211</td>
<td>0.78%</td>
</tr>
<tr>
<td>Istituições</td>
<td>457</td>
<td>2,245,554,603</td>
<td>48.50%</td>
</tr>
<tr>
<td>PNQP/Prominp</td>
<td>3</td>
<td>348,722,783</td>
<td>7.53%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1,341</strong></td>
<td><strong>4,630,073,279</strong></td>
<td><strong>100.00%</strong></td>
</tr>
</tbody>
</table>

Table IV illustrates the amount of R&D projects and resources invested in each Brazil’s Federative Unit.

### TABLE IV
RESOURCES AUTHORIZED BY FEDERATIONAL UNIT - 2006-2015
(Bulletin ANP Oil and R&D - issue No.26/Oct 2015)

<table>
<thead>
<tr>
<th>Federative Unit</th>
<th>Number of projects</th>
<th>Investment (RS)</th>
<th>% Investment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rio de Janeiro</td>
<td>474</td>
<td>1,355,724,001</td>
<td>29.28%</td>
</tr>
<tr>
<td>São Paulo</td>
<td>232</td>
<td>517,277,589</td>
<td>11.17%</td>
</tr>
<tr>
<td>Rio Grande do Sul</td>
<td>40</td>
<td>211,510,286</td>
<td>4.57%</td>
</tr>
<tr>
<td>Pernambuco</td>
<td>122</td>
<td>201,059,983</td>
<td>4.34%</td>
</tr>
<tr>
<td>Rio Grande do Norte</td>
<td>80</td>
<td>175,674,672</td>
<td>3.79%</td>
</tr>
<tr>
<td>Santa Catarina</td>
<td>53</td>
<td>138,129,297</td>
<td>2.98%</td>
</tr>
<tr>
<td>Bahia</td>
<td>44</td>
<td>127,300,432</td>
<td>2.75%</td>
</tr>
<tr>
<td>Minas Gerais</td>
<td>69</td>
<td>116,439,669</td>
<td>2.51%</td>
</tr>
<tr>
<td>Sergipe</td>
<td>28</td>
<td>86,750,361</td>
<td>1.87%</td>
</tr>
<tr>
<td>Pará</td>
<td>22</td>
<td>78,371,119</td>
<td>1.69%</td>
</tr>
<tr>
<td>Espírito Santo</td>
<td>11</td>
<td>66,150,887</td>
<td>1.43%</td>
</tr>
<tr>
<td>Ceará</td>
<td>36</td>
<td>56,150,762</td>
<td>1.39%</td>
</tr>
<tr>
<td>Distrito Federal</td>
<td>30</td>
<td>56,392,513</td>
<td>1.22%</td>
</tr>
<tr>
<td>Pará</td>
<td>25</td>
<td>45,088,780</td>
<td>0.97%</td>
</tr>
<tr>
<td>Maranhão</td>
<td>8</td>
<td>28,914,543</td>
<td>0.62%</td>
</tr>
<tr>
<td>Alagoas</td>
<td>6</td>
<td>19,508,135</td>
<td>0.42%</td>
</tr>
<tr>
<td>Paraíba</td>
<td>8</td>
<td>16,919,867</td>
<td>0.37%</td>
</tr>
<tr>
<td>Amazonas</td>
<td>21</td>
<td>15,046,917</td>
<td>0.32%</td>
</tr>
<tr>
<td>Goiás</td>
<td>6</td>
<td>8,606,857</td>
<td>0.19%</td>
</tr>
<tr>
<td>Mato Grosso do Sul</td>
<td>2</td>
<td>7,694,684</td>
<td>0.17%</td>
</tr>
<tr>
<td>Piaui</td>
<td>1</td>
<td>3,630,090</td>
<td>0.08%</td>
</tr>
<tr>
<td>Tocantins</td>
<td>1</td>
<td>973,944</td>
<td>0.03%</td>
</tr>
<tr>
<td>Mato Grosso</td>
<td>1</td>
<td>367,500</td>
<td>0.02%</td>
</tr>
<tr>
<td>Roraima</td>
<td>1</td>
<td>144,630</td>
<td>0.01%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1,341</strong></td>
<td><strong>4,630,073,279</strong></td>
<td><strong>100.00%</strong></td>
</tr>
</tbody>
</table>

Only with Petrobras the partnership resulted in the construction of 165 research laboratories, and renovation and expansion of other 268 laboratories, the evaluation of researchers have contributed to the development of other technological projects, maintaining the already established relationship with the company and increased the possibility of further partnerships. The projects developed by PETROBRAS generated in the period 2019-2013, 332 new products, 253 new cases and 531 new technologies [39].

In contrast, it is observed that despite all the success of this partnership has demonstrated in recent years can also, according to Turchi et al. [39], be identified major difficulties in the implementation and management of projects. The authors note:

- project approval time by the ANP (when necessary has extended the deadline for the start of activities in partnership);
- use of administrative procedures for management and monitoring of cooperative agreements;
- short experience of the management staff of the university to conduct construction projects;
- company Return to the research group of the partner institution regarding the results of cooperative research;
- research manager profile in the company influences the design of the driving process.

### VI. MANAGEMENT STRUCTURE – PETROBRAS MODEL
Given this scenario of investment in cooperative research and construction of laboratory infrastructure, on a scale hitherto unheard of in the country, Petrobras, more representative sponsor among the companies, was faced with the challenge of managing a large number of projects. In the first half of 2006, Petrobras, through its Research Center (Cenpes) has created two programs to manage these compulsory investments, and named the "Thematic Networks" and "Regional Centers". These are programs responsible for managing the resources that are invested in Brazilian universities and research institutes in the form of projects.

As centers of excellence, both cores as networks have in their mission the role of promoting research in Brazil, from investments in laboratory and R&D infrastructure, and developing regions that historically have limited access to resources for research. However, such "development institutes to research" fulfill different roles in the various regions of the country.

In this sense, one can understand the Networks and Centers as project portfolio management centers. These are programs that manage and are responsible for payment of the special participation of the company. Payment or accountability ANP starts from the selection of projects aligned with the company’s strategy, together with research institutes and universities public and private, throughout the country. Thus, Petrobras formalized a system of compliance with legislation, which passes in the form of investments in R&D and construction, the resources corresponding to its share of special interest to the foundations that manage these resources for universities and research departments.
Regarding networks, the projects are selected, in principle, the subject, because the networks are thematic. 49 were created, namely:

- Exploration: Micropaleontology Applied; Basin modeling; Studies Applied Geophysics; geochemistry; sedimentology; Stratigraphy and tectonic studies.
- Production: Monitoring, Control and Automation Wells (GEDIG) / Integrated Operations Management (GIOP); Computing and Scientific Visualization; Water Management Segment Oil Production; Materials Technology and Corrosion Control; Revitalization of Mature Fields; Heavy oils; Management and Reservoir Simulation; Modeling and observation Oceanographic; Subsea structures; Artificial lift; Technology in CO2 for oil recovery; Engineering Wells; Characterization and Modeling Geological Reservoirs; Modelling of Multiphase flow in pipes; Testing Laboratories integration with applications in the oil, gas and energy - Archimedes; Primary processing; Subsea Transmission and Power Distribution.
- Supply: Combustion and Gasification; petrochemicals; Asphalt Technology; Computational Fluid in Refining Processes; Concretes and refractories for the Oil Industry; Instrumentation, Automation, Control and Process Optimization; Development of Technologies for Clean Fuels; Product and Process Development Center for Refining; Development Catalysis; Vehicular development; Applied Materials Center to Petroleum Refining; Excellence in Oil Supply Chain; Metrology; Technology Center in Pipelines; Lubricants.
- Natural Gas, Energy and Sustainable Development: Nanocatalysis and Nanomaterials; Hydrogen: production, use and storage; Research Bioproducts; Natural Gas Technology Development Center; Climate changes; Planning, Management and Regulation in Oil, Natural Gas, Energy and Sustainable Development; Marine Environmental Monitoring; Conservation and Recovery of Ecosystems and Remediation of Impacted Areas; Reuse of Produced Water.
- Technology Management: Integration S&T-Industry in the National Productive Process; Converging Technologies.

Turchi et al. [39] states that, in relation to the Centers, the selected projects are preferably construction, must meet the region where is located the Center. Thus, the Centers originate in a more political context. The basic strategy of a Center is to develop the region where it is located, so to speak, apply the resources only in the Center region in view of the Organizational Units Petrobras (UO's) sites. Are they:

- Center of Bahia (UFBA);
- Center of Sergipe (UFS);
- Center of Espírito Santo (UFES);
- Center of Rio de Janeiro - Army Technology Center (CTEx);
- Center of Rio de Janeiro - Norte Fluminense (UENF);
- Center of Rio de Janeiro – Pontifícia Universidade Católica (PUC-Rio);
- Center of Rio Grande do Norte (UFRN).

Also according to Turchi et al. [39], Network works with various universities and research institutes to a central theme, and home to dozens of projects. In this sense, the distribution network through resources is fully decentralized serving R&D projects and investing in infrastructure throughout Brazil. A Center works with only one University and its projects are diverse as meet several UO's. The UO's have diversified interests, as they represent the Company's various businesses in a particular region. Networks also serve several UO's, but always with the focus on a single theme.

It is known that the volume of resources compulsorily applied in particular participation revolves around R$ 400 million annually [3], and 50% of the volume of resources are invested in projects in the Regional Centers and Thematic Networks. Currently, the Centers manage a resource volume close to R$ 500 million (loans contracted in civil constructions). On the other hand, the networks are left with the responsibility of managing approximately R$ 3.8 billion corresponding to the volume of resources allocated to research projects already contracted.

The number of residents in the projects in 2015 Centers is approximately 72 projects of which the networks reaches 1.150 projects. In this sense, one can say that networks and Centers manage a large volume of resources and care to manage other large volume projects. They are significant numbers, which, in another sense, move the regional economies, creating jobs in the areas of construction and R&D. Programs that handle this amount of resources (financial and human) deserve careful evaluation and suggestion of an agile business model that provides value both to Brazilian research institutions, as Petrobras (sponsor) it is necessary [39].

VII. CONCLUSIONS

The innovative industry needs a professional to be able to innovate. In other words, it states that the university can make this professional. This is the main product that the university can offer the industry [21].

As stated, the process of innovation is an interactive learning process that involves intense joints between different agents, requiring new industrial, technological and innovation policies and new organizational formats network. In this context, it is essential to invest in the training of human resources, responsible for the generation of knowledge. Attention is drawn to the training as one of the main structural axes of cooperation programs between universities, research centers and companies, where the results can be very broad, ranging from intensifying technological innovation in the industry, the largest share of the sector private financing of research, training of technical knowledge of networks to changes in public policy in the graduate sector.

This article shows that in the last decade in Brazil this scenario has shown promise in the areas of interest of the oil industry, to the extent that these companies have, by virtue of a decree issued by the ANP, have the obligation to invest in research projects and construction, scale hitherto unprecedented in country. This recent investment of considerable numbers, establishes therefore a huge challenge.
in transforming a small study of laboratory bench in technological innovation. The immaturity of Brazilian universities in conducting construction projects was also observed. Its design offices - to develop projects of buildings and manage the physical expansion of the university - have a reduced amount of trained professionals to conduct such projects, leading to outsourcing some parts of the project, without an effective control of the steps and consequently the building delivered.

It is expected that this new investment scenario can stimulate other sectors of industry to strengthen its activities related to education, science and technology, and encourage universities to enable its staff leading civil construction projects. An increase in connectivity between the various actors of the system, inducing cooperation as a way to expand and accelerate the whole learning process, in an effort to strengthen the management of technological knowledge in companies, is also expected.

REFERENCES


FOOTNOTES

The first author, Wellington da Rocha Polido, is a master’s degree student of the Post-Graduation Program in Civil Engineering of the Federal University Fluminense - UFF. He is graduated in Production Engineering from the Candido Mendes University – UCAM (2012) and Industrial Chemistry from the Federal University of Rio de Janeiro – UFRJ (2006). He is a Production Engineer from EPC Engineering Company. E-mail: wrpolido@gmail.com
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