Core competencies assessment in public research university groups: a case study of three laboratories at University of São Paulo Engineering School

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Core competencies assessment in public research university groups: a case study of three laboratories at University of São Paulo Engineering School

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Abstract: Strong public research university is emerging as a key asset in today's knowledge-based society. As knowledge producers, its groups and laboratories contribute with fundamental and applied research to enhance society at large, particularly to increase innovation in the productive sector. However, despite its importance, the relationship between industry and academic research groups is still a challenge, especially in middle-economic countries that have a strong tradition of state controlled economy, such as Brazil. This paper aims at identifying and assessing the portfolio of core competencies of public research university groups. The paper begins by reviewing some of the relevant theoretical basis related to the key concepts of strategy, organizational competencies, innovation and scientific networks. Secondly, it explores three academic groups's environment and research path at University of Sao Paulo Polytechnic School. The assessment leans heavily on each group's activity, comparing current conditions to desired ones.

Key words: core competencies assessment; research groups; scientific networks.

1 Introduction

In today's knowledge-based society, a strong public research university is a key asset. As knowledge producers, its groups and laboratories contribute with fundamental and applied research to enhance society at large, particularly to increase innovation in the productive sector. However, despite its importance, the relationship between industry and academic research groups is still a challenge, especially in middle-economic countries that have a strong tradition of state controlled economy, such as Brazil.

This paper aims at identifying and assessing the portfolio of competencies of public research university groups, focusing on a given set of knowledge, abilities and values. Besides, there are some issues about these groups that should be investigated: connections between different levels, conflicts of interests, problems in integrating the different systems, the absence of strategic vision, etc. We also discusse the public research university groups' situation: the gaps, problems and opportunities, both in current reality and future scenario. Management bottlenecks, organization learning and inter-institutional relationships are some of the issues dealt with.

The paper begins by a brief discussion about the Brazilian Research scenario. Secondly, it reviews some of the relevant theoretical basis related to the key concepts of strategy, organizational resources, competencies, innovation, and scientific networks. Thirdly, it explores each group's environment and research path of three laboratories at University of Sao Paulo Engineering School. The assessment leans heavily on each group's activity, evaluating specific programs, projects, and portfolios of competencies, and comparing current conditions to desired ones, according to a strategic vision.

2 The brief panorama of Brazilian Research

In the last fifteen years, government, universities, and research institutes have been engaged in a fight to achieve resources to fundamental research. Evidences reported in recent studies, supported by CNPq (National Council of Technological and Scientific Development), point out important regarding scientific research performance in Brazil: scientific production growths 60% above the world average, and there are almost 60 thousand researchers, that produce 1.55 % of all articles published in world. Thus, government sector funds have been created to stimulate knowledge chains and strategic alliances. In fact, Brazil is the unique country in Latin America that destines near of 1 % of the PIB (Gross Domestic Product) to science and technology. Particularly in Sao Paulo State, FAPESP (Fundacao de Amparo a Pesquisa do Estado de Sao Paulo) is going to coordinate the studies for the implantation of four technology parks in the state of Sao Paulo. On the same subject, the businessmen will be presenting their business plans to the Financier of Studies and Projects (FINEP), which, in Sao Paulo, will support 40 projects with funds from the Research in Companies Support Program. The technology parks will be distributed in four municipalities and will follow "regional vocations", as the governor explained. The first one, in Greater Sao Paulo, will be implanted in partnership with the University of Sao Paulo (USP), the Institute for Technology Research (IPT) and the Institute of Nuclear Energy and Research (IPEN), and will have as its focus nanobiotechnology.

The debate on policies for stimulating innovation in the country converged towards a consensus: that companies have a central role in the generation of new technologies. Up until the end of the 1990s, the policies for science and technology regarded the university and the research institutes are centers generating the innovation to be transferred to companies. The change in the focus of innovation – from the university to the company – began in 1999, gained force in 2001, at the first National Science and Technology Conference, and was materialized with the Law on Innovation. Recently approved by the Federal Congress, Brazilian Innovation Law was created in order to stimulate cooperation among universities, research institutes and firms. The law is a part of a broader strategy: to promote industrial policy, scientific and technological development in productive sector, stimulating innovation. In a practical way, it creates facilities for hiring researchers, makes the licensing of products nimbler, and makes the Law on Tenders more flexible, to allow the State to take on the role of a strategic for companies, with the commissioning of technologies. Those initiatives are positive, but they are not sufficient to change the national innovation scenario, because of structural economic and cultural problems. Particularly, the interaction between academia and industry has been difficult.

First because it is not possible to consider that the university research centers have the capacity to survive without government supplies, only supported by firms (fewer than 29,000 Brazilian scientists were working in companies in 2001). The indicators for intellectual property reflect the absence of researchers from the companies and the low investment in R&D: 120 patents deposited by Brazilian companies, against 3,500 by Korean companies, for example. Research institutions budget analysis shows that government is still their major client.

Second, the difficulty rests on the convergence between two different visions: the academic groups' vision and the industry's vision. University has an inherent bureaucracy and complexity. There isn't an efficient and systematic institutional information system and communication policy. Because of these, the academy has an endogenous perception of reality, its groups tend to be self-centralized, based on academic freedom standpoint. On the other side, industry and firm vision tends to be based on short term, productivity and strategic perception of the reality, emphasizing applied science and innovation.

The challenge around the university-firms knowledge and technology transfer has been discussed by academy and firms by many scientists and professionals. The virtuous dialogue can be possible only if both of them assume a common standpoint and possibilities of communication. According to FAPESP, more than to produce robust technological and scientific systems, it is necessary to create mechanisms of stimulating society development upon built in knowledge and scientific networks, and cooperative activities. The approach to networks is more efficient in scientific and technological activities because of their potentiality to design more consistent strategies of sustainable development in long terms, and to ensure innovation processes. The network approach is based on two major points: 1) the connection between enterprises, universities, research institutes, and public (the four helix), set on knowledge and competencies exchanges, and 2) the potential that the mechanisms of interaction have to minimize development cost and innovation risks.

A positive notice is that the number of science and technical articles credited to Latin American institutional authors almost quadruplicated between 1988 and 2001 (Table 1).

TABLE 1. Science Citation Index article output and share of selected Latin American countries: 1988 and 2001

		SCI article counts		Percent of Latin America SCI article output		USP article in SCI	
Rank	Country	1988	2001	1988	2001	1988	2001
	Latin America	9.332	28.393	100,00	100,00	--	--
1	Brazil	3.189	12.804	34,17	45,09	874	3.154
2	Mexico	1.704	5.639	18,26	19,87	--	--
3	Argentina	2.099	5.179	22,49	18,24	--	--
4	Chile	1.371	2.333	14,69	8,22	--	--
5	Venezuela	533	1.170	5,71	4,12	--	--
6	Colombia	149	746	1.60	2,63	--	--
7	Costa Rica	150	243	1.61	0,85	--	--
8	Peru	137	279	1.47	0,98	--	--

NOTES: Countries ranked by their 2005 share. Latin America total excludes countries classified by the World Bank as high income, which are the Bahamas and Barbados. Paraguai and Uruguai result zero.
USP=The main university in Brazil - University of Sao Paulo - 1988=9,36% ; USP 2001=11,11%
SOURCE: Institute for Scientific Information, Science Science Citation Index. CU=country.

Evidences reported in recent studies conducted by CNPq show that there is a broadly movement around the interaction among the four helix. Brazilian Science and Technology Ministry (MCT) has been evolved in programs that aim at to promote: 1) the considerable growth of competencies in science and technological areas, thereby wide and effective local, national and international participation; 2) the creation of favorable innovation environment, foreseeing knowledge transfer mechanisms for the public sector, aiming at to contribute to the big national problems in one side, and, in other side, aiming at to enlarge Brazilian enterprises competitiveness; 3) the development of inter and multidisciplinary research projects, built upon scientific and technological networks articulation, partnerships and local capabilities, in different geographical areas of the country (Table 2); 4) scientists and specialized professionals' formation and competencies development; 5) and diffusion for the society of scientific and technological knowledge and research results.

TABLE 2. International coauthorship on S&E articles of four selected Latin American countries: 2001

(Number of international articles in parentheses)

	Argentina (1,587)		Brazil (3,369)		Chile (954)		Mexico (2,066)	
Rank	Country	Percent	Country	Percent	Country	Percent	Country	Percent
1	United States	34,9	United States	39,0	United States	39,2	United States	42,2
2	Spain	18,8	France	13,8	Spain	16,1	Spain	11,7
3	Brazil	12,6	United Kingdom	12,8	France	15,7	France	11,4
4	France	10,9	Germany	10,7	Germany	15,4	United Kingdom	10,6
5	United Kingdom	10,6	Italy	7,0	United Kingdom	10,3	Germany	7,4
6	Germany	10,3	Spain	6,9	Argentina	7,4	Canada	6,4
7	Italy	6,0	Argentina	5,9	Italy	6,8	Russia	6,1
8	Canada	4,6	Canada	4,8	Brazil	6,1	Brazil	5,3
9	Chile	4,5	Russia	4,0	Canada	5,5	Italy	4,7
10	Mexico	4,3	Japan	3,5	Mexico	4,1	Cuba	4,5

NOTE: The percents are the share of the country's coauthorships on internationally co-authored articles. The sum of the collaborating countries exceed 100 percent because the number of coauthorships exceed the total number of internationally coauthored papers. This is because countries are each credited one whole count for their participation on internationally coauthored papers.

SOURCES: Institute for Scientific Information, Science Citation and Social Citation Indexes; CHI Research, Inc., Science Indicators database; and National Science Foundation, Division of Science Resources Statistics.

As we can see, there is a large effort to include Brazilian society in scientific and technological movement. In fact, nowadays political context in Brazil claims to the incorporation of a new voice in the triple helix dialogue: the voice of the society. The focus is the social technology, an instrument of social inclusion and life quality improvement, contributing to establish a new paradigm to the sustainable development of the Country. The general objective is to create a close connection among government, university and society.

This is the third academic revolution based upon the creation of entrepreneurial universities focusing societal transformation (Viale and Etzkowitz, 2005).

In particular, because of their historical path, public research university laboratories have directed part of their research to the solution of society problems. They have diverse portfolios of interdependent core competencies, some of them linked to innovation processes and products that involve government, industry and society in general. Some others have been linked to basic or fundamental research that do not product innovation but knowledge and science theoretical advance. In today's scenario, portfolio of resources, capabilities and competencies is a powerful instrument of visibility for the academic research groups and diffusion of science and technology.

2 Conceptual Issues

Strategy

In recent years, organizations have been experienced endogenous and exogenous changes. Globalization trends to market competition and a key issue has emerged: the strategic thinking. Nowadays, organizations are conceived as a sociological and technological systems, with focus on relationships, interactions, learning, innovation and dialogic processes. (technology is view as a human-centered instrument). They should be self-organized, autonomous and self-sustainable, according to a recursive circle of learning, and they should be more reactive to environment to pay attention to forces acting on the environment. In other side, it's necessary to pay attention to internal resources and competencies.

Outside-in process

The organizational reaction to market demand and forces, understanding strategy as an action and decision set consistent to external environment. In that traditional standpoint, organizations strategically respond to competitive environment based on their capability improvement front competitiveness patterns. The work of Porter (1985) was focused on the market needs and opportunities, and on portfolio and strategic management around SWOT (organizational strengths, weakness, opportunities and threats) analysis. Threats and opportunities are external, regarding the conditions of the environment. Strengths and weaknesses focuses your organization to look internally at what it can do.

Inside-out process

While the traditional approach is an outside-in process, it is also necessary to consider an inside-out process that starts with internal analysis and then examines the exterior. More recent strategic research is embodied in the so-called “Resource-Based View” (RBV) of the organization (Wernerfelt, 1984; Barney, 1991, 2001; Mills, Platts and Bourne, 2003). The action undertook by the organization upon its resources, capabilities and competencies generate an expansionist movement capable to create new market and society demands and innovation. In a Resource-Based View, the central proposition is that organizations have tangible and intangible assets (Prahalah and Hamel, 1990). According to this theory, an meticulous analysis of the organizational resources, capabilities and competencies will result in a better understood of areas of strengths and search of opportunities. The focus of strategy formulation and implementation is the sustainable competitive advantage.

In fact, the process of globalization has affected University: resources that in the past represented a source of competitive advantage, today are not so representative. Nowadays, universities have to operate in national and international domains. International higher education consortia is an example of collaborative arrangement that has been adopted by Polytechnic School with another schools around the world[i]. The increasing of international orientation has built a necessity of a new institutional strategy. The contemporary university makes the assumption of optimizing its resources and capabilities, and diversify competences in order to gain competitive sustainability. University’s resource–based view is not about the creation of a corporate university. Instead, it is a rational perspective on organizational behavior, according to a neo-institutional view.

Resources

Resources are the inputs into the organization’s (Barney, 1991) that can be categorized into three groups: physical resources (such plant, equipment, location and assets); human resources (management team, experience, learning and training); and organizational resources (such as culture and reputation). Some resources are tangible while some of others are intangible. Particularly, University resources include ICT infrastructure and virtual learning environments, teaching and research facilities, laboratories, geographical location. Human capital refers to experience, knowledge, scientific and professional networks of academics and non-academics. The organizational capital resources include university’s operating systems, administrative systems, reputation and relationship with industries, government and others (Beerkens, 2004).

Capabilities

Each organization has a bundle of resources but not so ever exploits them. The ability to put its into best use refers to organizational *capabilities*, the second level, that are functionally based and resident in a particular function (Javidan, 1998), i.e. marketing capabilities, management capabilities, research capabilities, etc. The existent resources are directed to research activity, embracing IT infrastructure and “infostructure”, processes, data basis, among others.

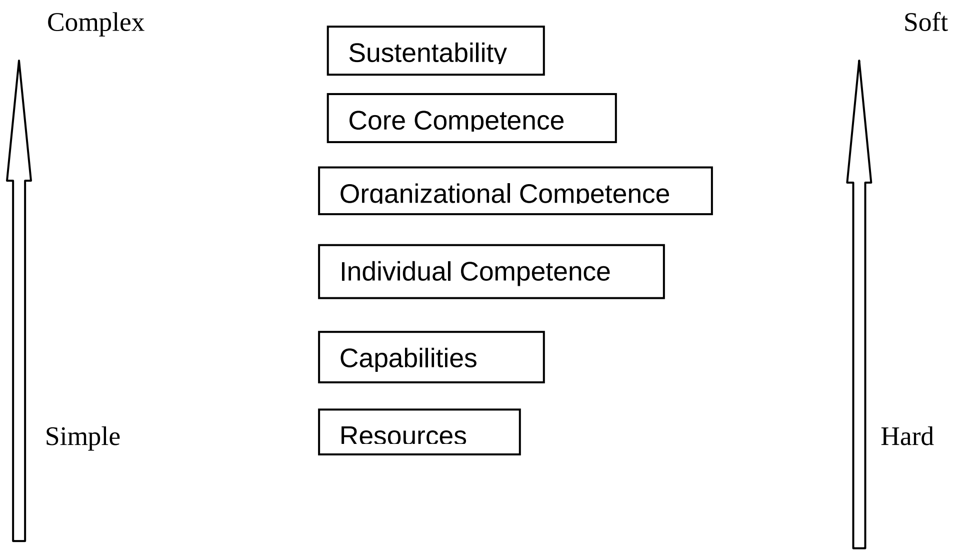

Fig 1. The competencies hierarchy. (Adapted from Javidan. 1998)

Competencies

Competence is the third level in the hierarchy, based on a cross-functional integration and co-ordination of capabilities: a set of skills, knowledge and attitudes. Individual competence is related to the mobilize technical processes and workflow knowledge, social abilities and attitudes (Zarifian, 1999). In research groups, *individual competencies* are related to research competence (including information search, organization, critical thinking, problem-solving, writing and communication skills), social and scientific networks competence. *Organizational competencies* are related to business strategy, the portfolio management and knowledge of market opportunities, according to specific key-activities and individual competencies of the group. Organizations that build coherent organizational competence are able to take advantage in market, and they will be able to control their internal and external environment, reducing uncertainties. It is necessary to translate learning into core competencies.

Dynamic Core Competencies

The highest level in the hierarchy is the *dynamic core competencies* that result from the integration between the organizational competencies, and are built upon meta-learning process. Under the concept of Resource-Based View, the concept of core competencies are developed from organizational learning and implies in a mobilization, i.e., continually evolving and change process of acquisition of insights of problem-solving and project creation.

> "Dynamic core competences, thus, represent more than sophisticated technologies or manufacturing skills necessary for competing rapidly changing markets. Indeed, dynamic core competences provide the basis for continually realigning the firm's social framework, dynamic routines and knowledge base through meta-learning, to build and sustain competitive advantage." (Lei, Hitt and Bettis, 1996, p. 566)

In a research group, the core competencies are manifested basically in processes of knowledge generation and innovation, linked to the specialization foci. Innovation-related activities are intrinsecally built upon tacit and explicit knowledge generation and diffusion by the team, and are dependable to organization path. "Learning by doing" and "learning by using" results in a differentiaded level of group maturity, specialization and a distinctive competence, that clients recognize as a differenciation factor from the other groups (the mark of the group, built upon your particular portfolio of competencies).

In a Electrical Engineering Laboratory, the engineer researcher combines basic and applied electrical and electronic theory with laboratory practice. Typical fields may include electronic communications, digital systems, automation technology, process control, electronic instrumentation, and electric power generation and distribution. The activities of the group include research and development of products and processes, based on project management and problem-solving processes. Most of the results are not properly innovation, because they do basic research too. But, basic or a fundamental research competence is essential for making effective decision making about to conduct research of an applied or developmental nature. Internal research competencies play an important role in innovation process.

Innovation

According to Nieto (2004), “the innovation process includes a set of activities that contribute to increase the capacity to produce new goods and services (product innovations) or to implement new forms of production (process innovations). Therefore, the concept of technological innovation is associated with the idea of a flow - generation, application, dissemination - of technologies”. The processes of innovation is based on organizational learning. Technological innovation is the learning process through which the organizations generates a flow of new technological knowledge, competencies and capabilities based on inputs that are also knowledge-intensive. It is path dependent, partial irreversible and non-linear process, intrinsically linked to *dynamic core competencies*. Therefore, it not easy for competitors quickly imitate the advantage of the group (Javidan, 1998).

In order to achieve a sustainable competitive advantage, organizations must to develop an *learning and innovation competencies*. Innovation competence is related to the ability to transfer research findings to the economy and to society. All of research groups have a potential to innovate. Organization uses of collaborative interorganizational relationships as an important source of innovation and new business creation. Re-arrangements, inter-organizational collaborative activities (e.g., joint ventures, consortia, strategic alliances), with others, firms, and government: these collections of diverse organizations create *innovation networks*, that are able to combine new technological and scientific capabilities and recombine old ones in a dynamic way.

In the university, innovation potentials are set free in regional alliances made up of members from the industrial, scientific, academic and administrative community, and it is the key to successful economic and social development. Innovation is a complex construct that is built upon social, market and scientific networks.

Social and Scientific Networks

Social and scientific networks are based on relationships in terms of nodes and ties. Nodes are researchers within the networks, and ties are the relationships between the researchers and others researchers, firms, organizations and government.. There are many kinds of ties between the nodes. The social network generate a map of the relationships between individuals, that are connected through various ways. The analysis of social and scientific networks allows to know the intelectual capital of individual agents. The shape of network determines your strenght. More open networks are more likely to introduce new ideas and, despite the waek ties, this networks have more possibility of survive and self-renew (Larson and Starr, 1993).

An example of social and scientific network is the Triple Helix systems, because they are based on a close co-operation between universities, private firms and (local, regional and national) authorities (Svensson, 2002). In research groups, social and scientific networks are interrelated, and are manifested by collaboration with pairs, students and professionals. This networks create "*communities of practice*", an invisible college (Bozeman and Corley, 2004). Communication plays a central role in the collective production of knowledge within scientific groups. Researchers collaborate with others in research projects and publishing of papers and articles. According to Rizzo (2001), "the development of cooperative research networks requires the collaboration among partners with different visions about the timing and goals of a research project. In some cases, even competitors are invited to take part in the same initiative, making ground to lack of communication and/or loss of interest in the outcome of the research"(p.21).

Assessment

In nowadays, organizations are increasingly dependent upon their innovation capability and competence. Governments view industry-driven science and technology as economic engines. Assessing the research organization performance is a challenge because research activity is a risky activity and nor all research activities leads to expected results or still innovative results. The majority of the academic research is pure or fundamental. Only a part of the research is of applied nature. Sometimes the benefits from research take years to materialize. Furthermore, researchers frequently do not have a strategic vision of their activities and the groups do not have a strategic planning. The assessment of their activities tends to be made on the performance passed with focus in the processes, instead of the results. The challenge lies within the scope of current and future assessment. According to Neufeld *et al* (2001), some of the attributes of high-performance research organizations are:

1. Management knows what research and other talent is need to accomplish the mission, and recruits, develops and retains the right mix of people.
2. Employees are passionate about their own work, have confidence in management, and are proud of their organization.
3. Leaders serve as examples and sources of inspiration. Their behavior and actions shape the environment within the organization and its relations with collaborators.
4. Leadership functions include setting directions (the strategic vision), projecting a strong constituency (client/stakeholder) focus, aligning the systems, policies and resources with the mission and the vision, and empowering employees to be productive.

5. The participation of research staff in planning activities strengthens their understanting of members and promotes alignment of research activities with those needs.
6. The maintenance of a research portfolio. Portfolio of programs represents the right research, at right time and the right investment.

3 Methodology

The present research was conducted in 2004, according to a variety of integrated and complementary analyses involving both qualitative and quantitative analysis, focused on the activities of three laboratories at University of Sao Paulo Engineering School. The methodology required the steps described below:

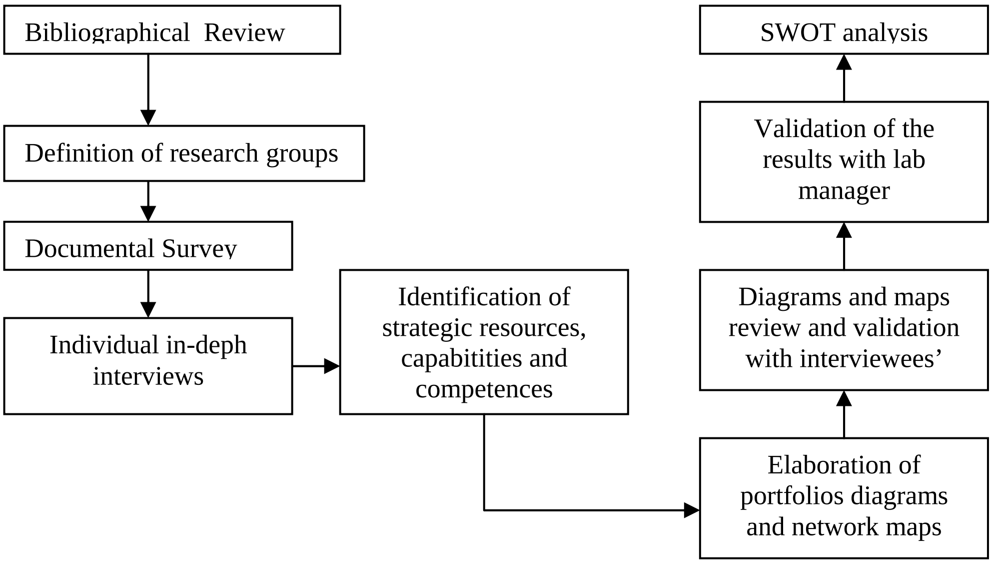

Fig.2. Main methodological steps

- Bibliographical Review of Theoretical Conceptual Basis;
- Documental survey about the activities of the three laboratories, in order to identify leading areas of research foci in groups and their underpin areas of core competence;
- Analysis of publication activity (quantitative and qualitative);
- Interview with the laboratory managers and senior researchers at the Electric Engineering Department, trying to identify leading research areas link to individual, organizational and core competencies, strategic vision and types of collaboration with partners: intra-community, inter-department, inter-faculties and inter-personal, both between the research groups and government/public institutions, and between the research groups and private

business; construction of social and scientific mapping of relationships, partnerships, and collaboration activities;

- Portfolio construction: core competencies based on research areas, technological platform, product or service applications, and potential users (society at large, with emphasis on private sector); Validation/feedback with intervieew';
- Identification of competitors/partners in the same research discipline-specific knowledge;
- Identification of opportunities, problems and options, barriers and gaps in private and public investments, based on a comparison between current reality and future scenarios; SWOT analysis;
- Recommendation of strategies and actions necessary to achieve a new position in academic research scenario.

4 The case study

University of Sao Paulo (USP), established in 1934, is the main institution of its kind in Brazil. It is responsible for ca. 25% the academic research undertaken in the whole country. Its Engineering School (Escola Politécnica) was established in 1893, according to the Eidgenössische Technische Hochschule Zürich (ETH) model, and incorporated to USP in 1934. Counts on 15 Teaching and Research Departments in 141,500 m2 premisses, 500 faculty members and 500 non-teaching staff work in cooperation. Polytechnic School interacts with industries by means of three basic mechanisms: the first aims long-term actions; the second, tactic actions for strengthening relationships; the third, day-to-day actions deriving from the agreements for research and development.

The present study focused on the activities of three laboratories of the Department of Telecommunication and Control Engineering at the Polytechnic School of the University of São Paulo:

- Control and Automation Laboratory,
- Signals and Communication Laboratory, and
- Biomedical Engineering Laboratory.

LAC – The Control and Automation Laboratory

The Control and Automation Laboratory was established in 1989, and currently has three senior researchers and nine associate lecturers. The main areas of research are:

- Control and Automation Systems (linear control, robust, adaptive, process control, intelligent control)
- Stochastics systems and probabilistic models (stochastic control, filtering, operational research, financial models)
- Dynamic Systems and Mathematical Models (non-linear systems, mathematical biology)

The portfolio of core competencies and its relation to technological platforms, products and services generated, and final users (markets and society) is presented in diagram 1.

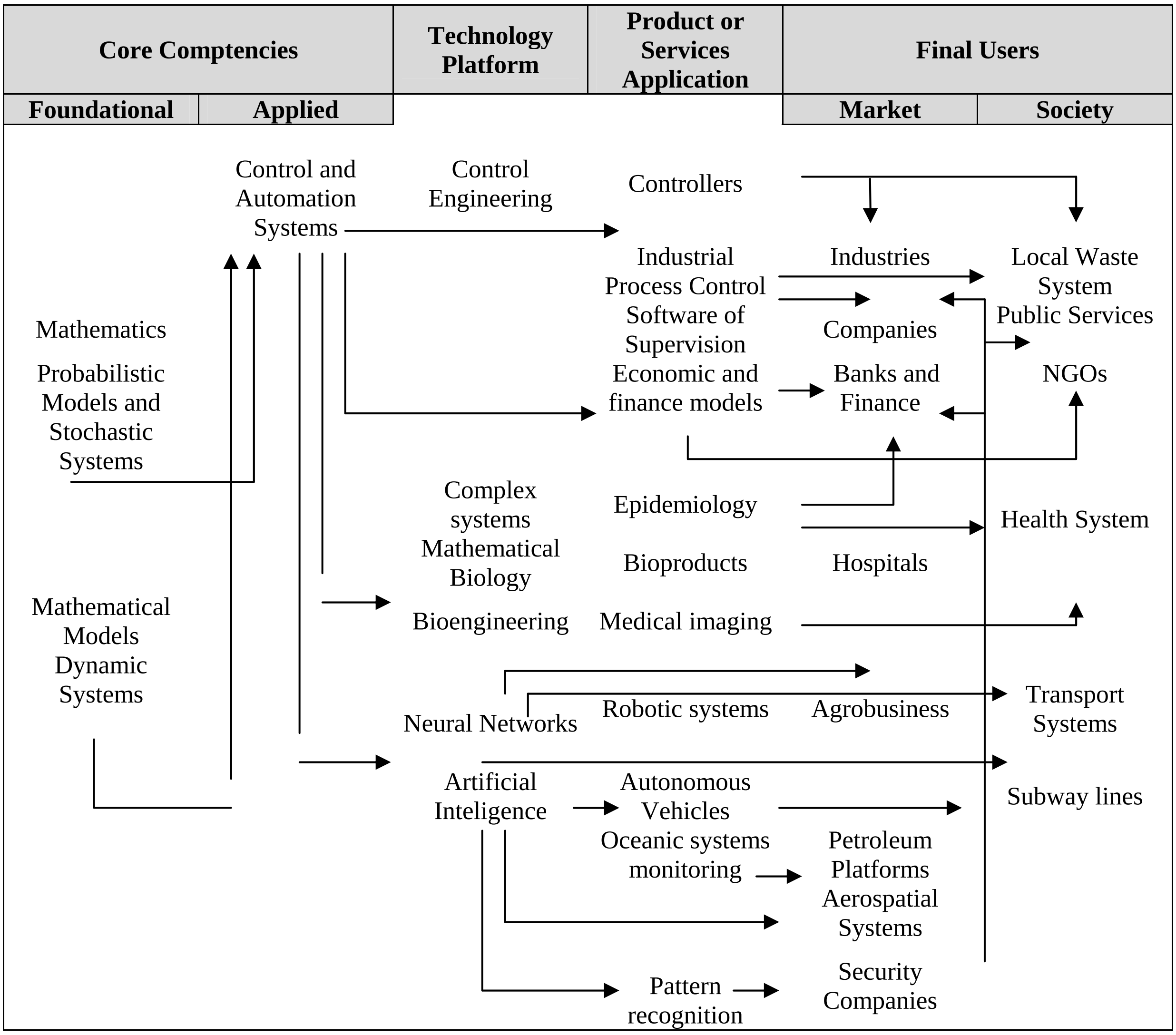

Diagram 1. LAC core competencies and its relation to market and society

LCS – The Signals and Communication Laboratory

The Signals and Communication Laboratory was established in 1984, and currently has six senior researchers and ten associated lecturers. The main areas of research are:

- Communication (spread spectrum communication, wireless distributed multimedia applications, wireless communication, digital telephony, mobile communication, CDMA)
- Signal Digital Processing (audio, voice and image signal processing, optical interfaces)
- Applied Electromagnetism (propagation and smart antennas)

The portfolio of core competencies and its relation to technological platforms, products and services generated, and final users (markets and society) is presented in diagram 2.

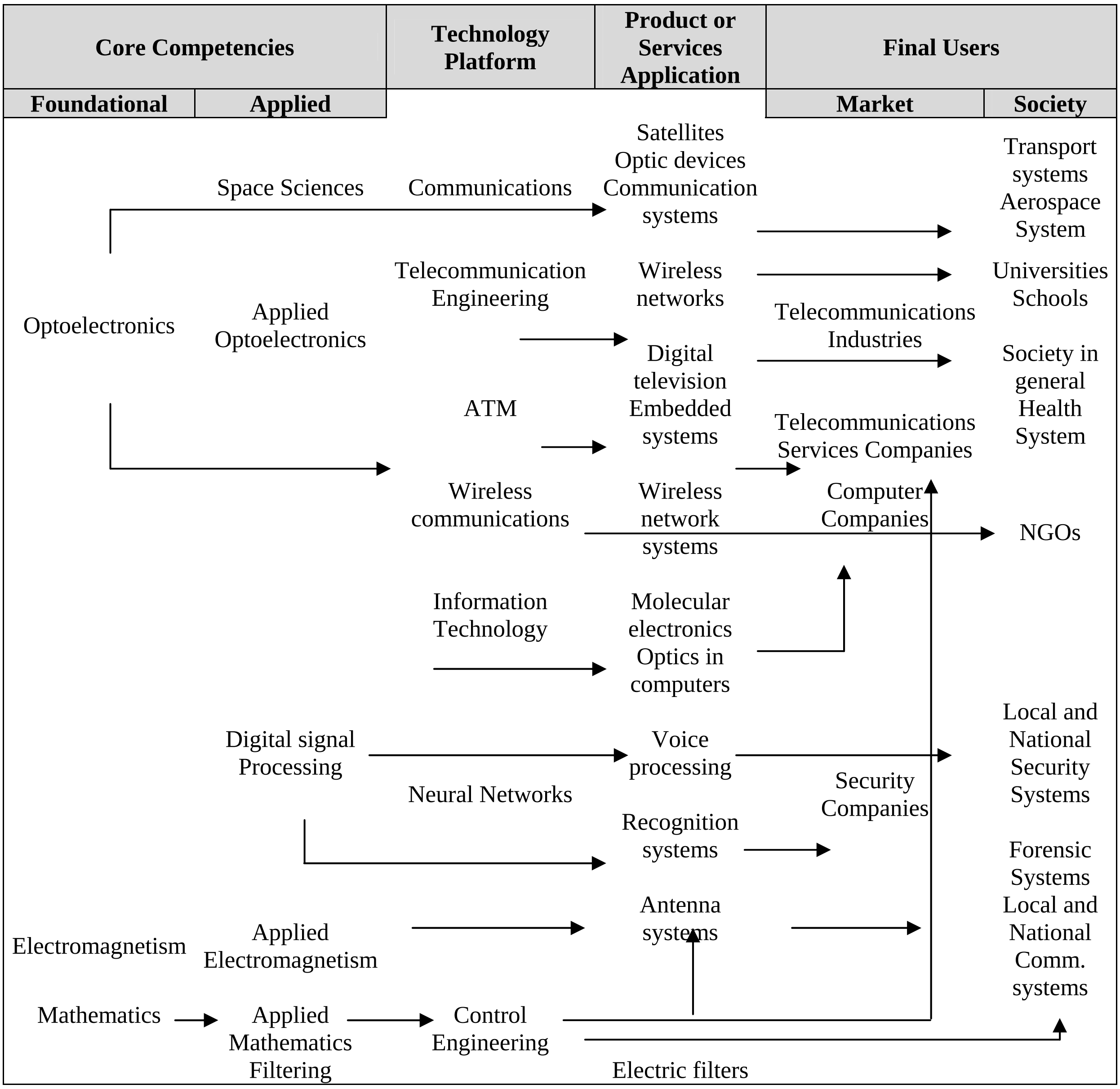

Diagram 2. LCS Core Competencies and its relation to market and society

LEB – The Biomedical Engineering Laboratory

The Biomedical Engineering Laboratory was established in 1981, with three senior researchers. The faculty associated to the Biomedical Engineering Laboratory is responsible for Biomedical Engineering courses taught at the Polytechnic School. The laboratory has had many projects in cooperation with biomedical science research groups and industries.

The main areas of research are:

- Rehabilitation Engineering and Biomechanics (prostheses, function neural stimulation, modeling, motion and gait analysis)
- Signal and Image Processing (electromyograms, evoked potentials, electrocardiograms and other biomedical signals
- Computational Neuroscience and Human Neurophysiology (mathematical models of single neurons, neuronal ensembles and resulting behavior)
- Medical Equipment Design, Testing and Certification (medical instrumentation, test of medical equipment)

The portfolio of core competencies and its relation to technological platforms, products and services generated, and final users (markets and society) is presented in diagram 3.

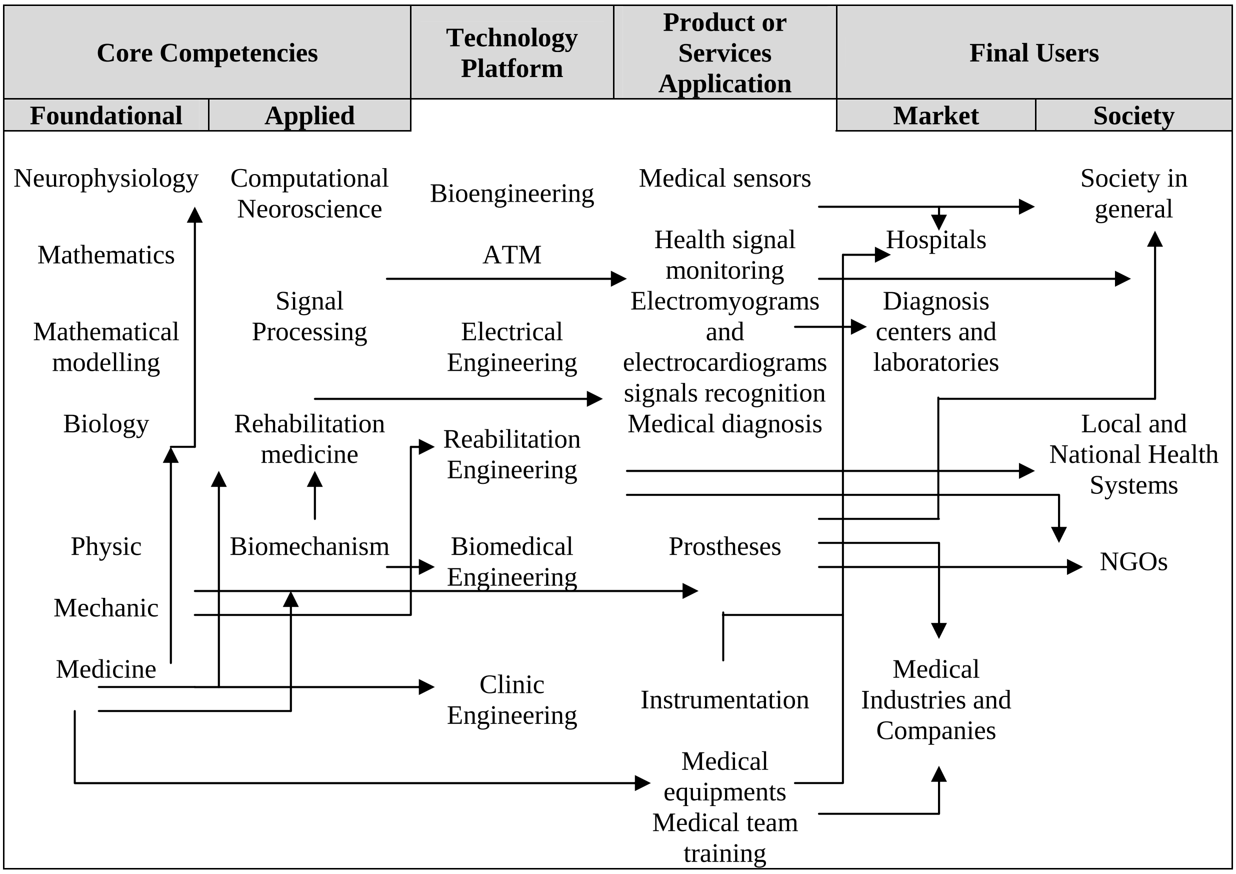

Diagram 3. LEB core competencies and relation to market and society

TABLE 3. Mapping synthesis of knowledge production and partnerships			
Laboratory	LAC	LCS	LEB
Date of Creation	1989	1984	1981
Number of Researchers	11	14	3
Number of Current Projects	11	Not informed	Not informed
Partnerships with Researchers of the other institutions/firms	1 Health Ministry	1 USP Medical School	4 USP Medical School
Partnerships within Polytechnic School	1 Dept. Naval Oceanic Eng	1 Lab Biomed. Eng.-LEB 1 Integrated Systems Lab	1 Integrated Systems Lab 1 Lab Sig. Comm. - LCS 1 Lab of Microelectronic
Inter-institutional partnerships	National Agency of Petroleum Marine Ministry Brazilian Automatic Society	Not informed	USP Medical School Federal Univ. of São Paulo Antonio Prudente Found. USP School of Sports USP Psychologist Inst.
University-Firms partnership	Petrobras	Not informed	R&D Mediq Equip. Viotti Assoc. Electr.
University-Government partnership	FAPESP CAPES CNPq	CNPq CAPES	FAPESP CNPq CAPES
Number of Publications until 2004	598	511	184
Publication/Researcher average	54,36	36,5	61,33

Table 4. Main competitors/potential collaborators		
Sao Paulo City	Sao Paulo State	National Territory
Technological Research Institute	UNICAMP - University of Campinas (Campinas City)	LNCC – National Laboratory of Scientific Computation (Rio de Janeiro)
	UNESP- Ilha Solteira	Federal University of Rio de Janeiro (Rio de Janeiro)
	USP- Sao Carlos Engineering School (Sao Carlos)	Federal University of Minas Gerais (Belo Horizonte)
		Federal University of Campina Grande (Campina Grande)
		CEFET – Federal Center of Technology Education of Parana (diverse campi in Parana)
		PUC-Rio (Rio de Janeiro)

5 Result Analysis

Strategic View Movement

None of the laboratories has a structured strategic planning, nor a declaration of mission. Possible obstacles detected are: incomplete understanting of strategic vision importance, incomplete knowledge of relevant factors, fore-shortened vision, structured vision based on past formulas.

It is necessary to develop a strategic planning of cooperative research networks. One potential reason for the lack of success in the interaction between the different actors in the scientific and companies networks may rests on the absence of diversification of researchers formation that integrate the groups. The groups should be built upon diversification, in order to increase networks and different standpoints about research.

Critical factors for competitiveness and sustaintability are: organizational structure and alignment between competencies and strategy.

Research Electrical Engineer Individual Competencies

According to the interviewed researchers, the researcher should have discipline-specific knowledge, mathematical abilities from calculus to differential equations and functions of several variables, as well as a thorough understanding of physics, include logic, digital and analog circuit analysis, analog and digital electronics, circuit analysis fundamentals, electromagnetic theory, control and communication system analysis. Advanced competencies include electronic circuit synthesis, microwave systems and applications, filter and electronic instrumentation design. All engineer should master all this individual competencies. Engineers are expected to have the ability to present the results of their work, and be able to communicate with other members of development teams and with customers. Problem solving skills lie at the heart of the system design process, and so these skills are a component of the discipline-specific competencies described above. These problem solving skills include the development of system designs, the use of analytical techniques to evaluate and compare different designs that meet the specifications, and the implementation of selected designs that will satisfy the project specifications.

Research Laboratories Organizational Competencies

As a result, the following organizational competencies of the groups were found: the engineering application processes, flexibility, diversity, equilibrium between action and reaction, search of projects opportunities, ethic vision and colleague respect.

SWOT Analysis

Strengths	**Opportunities**
Reputation of the groups, tradition and linkage with University of Sao Paulo Polytechnic School, strong core competencies in electrical engineering.	improving communication and competencies visibility of the research groups, knowledge management process based on an integrated information system, and using more the university technology transfer office (or establishing an autonomous branch at the Engineering School). Building research quality through students excellence, establishing international contacts, and creating a collaborative environment.
limited coordination and collaboration, faculty gaps, losing researchers because of retirement, deficiencies in commercialization and technology transfer, endogenous perspective, individualist culture, limited strategic alliances and partnerships with other research groups, need for central users facilities, bureaucracy, lack of regular material resources and infrastructure, insufficient lab space.	competitors with representation in government research agencies, losing opportunities because of the lost of funds, no university focus on building critical mass, differences between university and industry interests.
Weaknesses	**Threaths**

Recommended Actions

- It is necessary identify the groups' mission, goals and priorities.
- Strategy One: An outstanding research movement is required, looking for bringing de gaps between academy and industry. It is means incorporate a strategic vision of the "academic research business", in order to achieve visibility and sustaintability.
- Strategy Two: It is necessary to improve the networks inside the groups, across sectors and with industry. The laboratories networks need to be built from the ground up; they do not yet have a critical mass of electrical engineering and telecommunications companies sufficient networks.
- Strategy Three: Universities, polytechnic schools and research groups should produce portfolios making reference to their capabilities and competencies and largely disseminate them. They should organize open days of their departments and laboratories, and invite firms to know their activities. Ensuring that the research results are communicated and/or transfer to all partners.
- Strategy Four: The groups should develop a project management competence, on an active basis.

6 Conclusions

In this study we have focused our research effort on three objectives: academic research groups core competence description, social and scientific networks mapping, and SWOT analysis of the groups. The study has made a valuable contribution to both research and practice. For practitioners, our research findings can be very useful to management strategies. The following success parameters were key in the development of the innovation groups concepts: strategic orientation, or strategic planning and entrepreneurial action, organisation and networking and cooperation, framework conditions, based on alternative thinking.

The most innovative products and applications are almost exclusively the result of highly specialised and integrative knowledge from many sources, minds and organisations of widely varying origins and orientation. The success factor of group is the formation of an network based on specific abilities and technologies. It is of vital importance to strengthen their innovative ability through new forms of cooperation. Successful networks do not require the best infrastructure as a pre-condition, can be created on the basis of a specific competence. The goal must to be to develop self-supporting innovation networks.

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[i] Since 1998, Escola Politécnica sent abroad 118 students under the Engineering Integrated Studies (with Brazilian scholarships – CAPES Program) being 40 students to French schools, 54 to schools in Germany and 10 to schools in the United States. Polytechnic School signed Double Degree Agreements for undergraduate students with the four schools of the Intergroupe of Écoles Centrales and other French schools, signed agreements with Politecnico di Milano and Politecnico di Torino, Technische Universität Darmstadt, and Instituto Superior Tecnico, Lisbon. Since the year 2000 Polytechnic School - POLI hosted 65 students from the mentioned schools. In the same time 20 French, German and Spanish students did part of their engineering courses at POLI.