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National Confederation of Industry
Brazil

CNI. THE STRENGTH OF THE BRAZILIAN INDUSTRY



INNOVATION IS ACTION.
22 INNOVATION BUSINESS CASES
OF SMALL, MEDIUM AND
LARGE COMPANIES

Brasília
2015



**INNOVATION IS ACTION.
22 INNOVATION BUSINESS CASES
OF SMALL, MEDIUM AND
LARGE COMPANIES**

CONFEDERAÇÃO NACIONAL DA INDÚSTRIA – CNI

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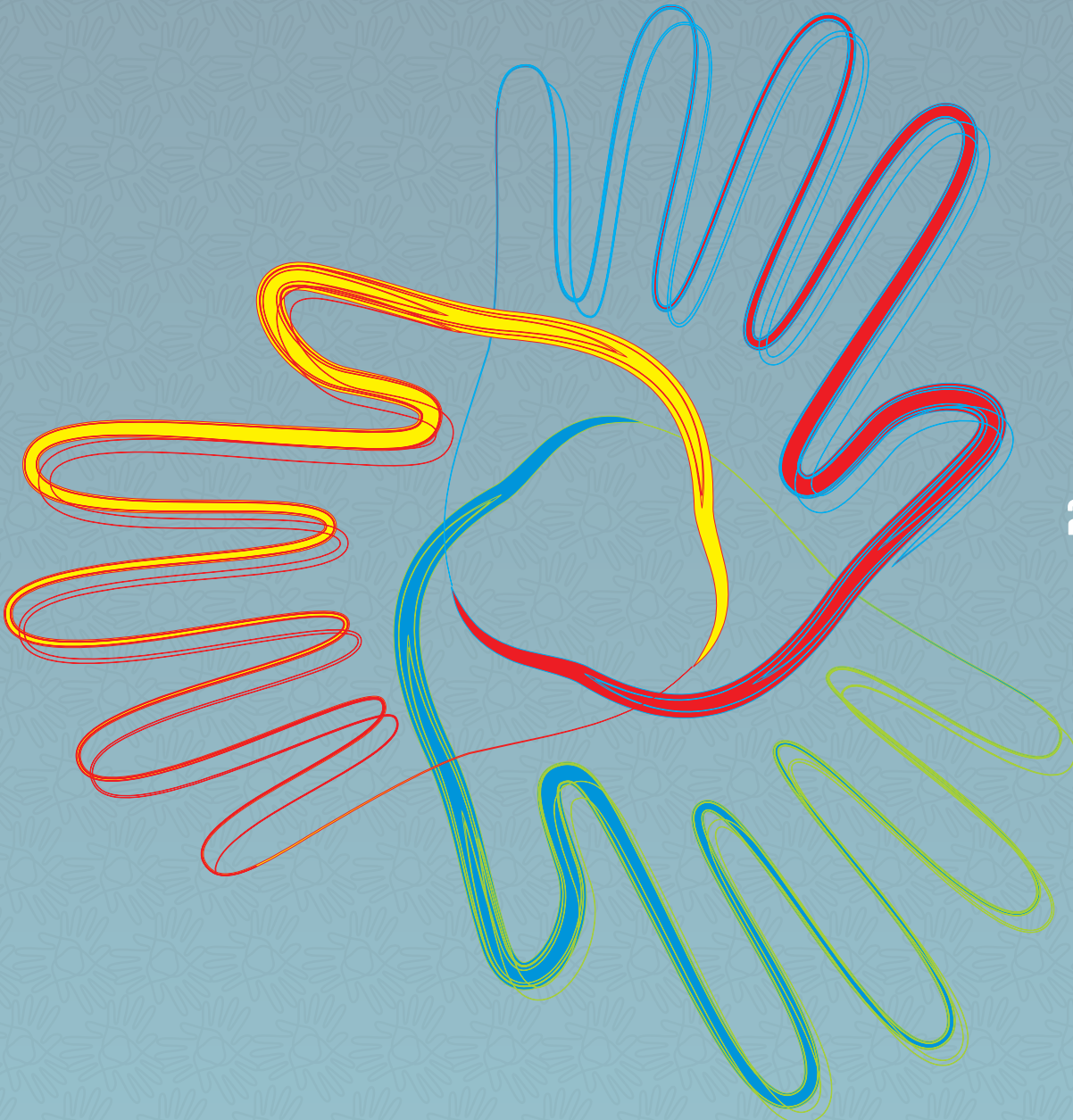
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PRESENTATION



The Brazilian industry has faced successive challenges since the first shock that occurred in the early 1980's, when instability, external debt crisis and uncontrolled inflation subjected the companies and the economy to strong turbulence. During the 1990's decade, with quick and intense opening, followed by a long period of exchange valuation, other challenges appeared.

The shocks represented by the structural limitations of the infrastructure, many times by blackouts, became an endemic element which is lead at high costs. In each one of those situations, the national industry presented answers that enabled it to continue with its history of growth, renewing the commitment towards the development of Brazil.

The advent of large scale manufacture of the new industrial countries of Asia resets the Brazilian industry's challenge into new thresholds, but with heightened intensity. The Business

Mobilization for Innovation (MEI – initials in Portuguese) is an instrument to leverage the Brazilian industry's transition to new pathways, of renewed tasks.

The strength of the national industry, proven in so many and so varied adverse scenarios, has to be redirected to construction of an agenda capable of matching diversity and fast pace of the domestic market with the opportunities of the global economy. Innovation is also the way to enable original solutions conquer amplitude and thereby enhance competitiveness.

Innovation fosters innovation. The results of a new product or process, such as management methods and business models stimulate the emergence of more ideas and projects. Once established this virtuous circle, the industry has more confidence to face the future.

Gradual adhesion of the companies to that path of renewing their opportunities and energies represents one of the most important purposes of the MEI. Leaders of small and medium companies work beside the large companies, leading the innovation environment to become richer and more diversified.

The MEI opens room for exchange of experiences and sharing of knowledge that allows building of adequate solutions. The shared difficulties give rise to answers, essays, trials, errors and hits. From the collective consideration, new tested methods arise to increase the business confidence in innovation. This process also helps to identify opportunities for enhancement of the public policies and the institutional environments.

The 22 cases gathered in this book depict the power of innovation in the Brazilian industrial companies. They also reveal the view of the entrepreneurs and their teams of executives and professionals. Whether being large, medium

or small, those business have reached, each one by its own way, eloquent results.

This is a small sample of what happens in the innovative universe of the Brazilian industry and it serves as stimulus to continue our our defense of a system propitious to innovation. The ecosystem we are thus building, with the help of so many people, companies and institutions, is the foundation for the future of the Brazilian industry and development.

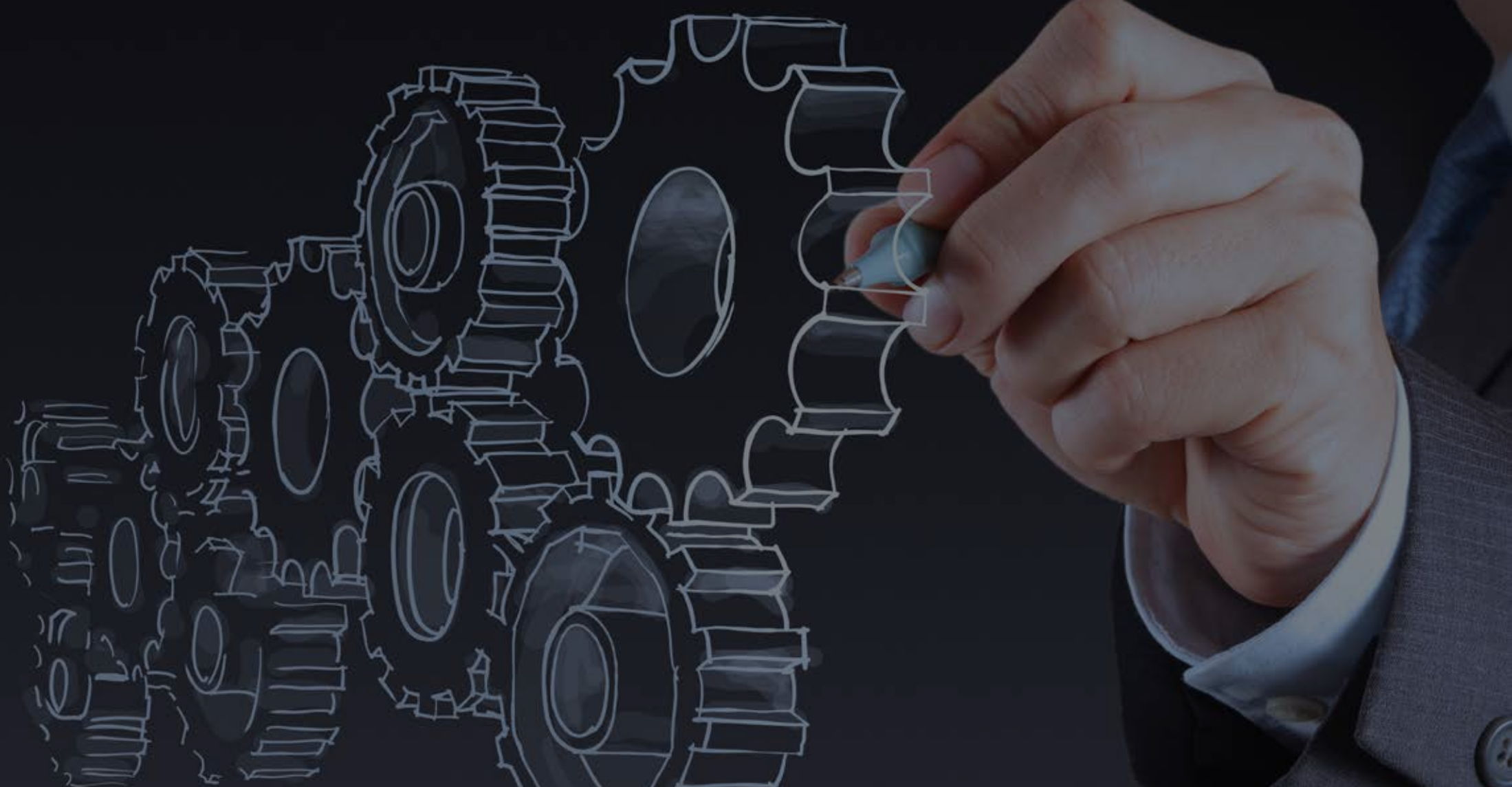
That reflection be fruitful. Enjoy the reading.

Robson Braga de Andrade

President of the National Confederation of Industry (CNI)

Luiz Barreto

President of SEBRAE



EXECUTIVE SUMMARY

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TO INNOVATE: TO ENTREPRENEUR, FACE RISKS AND ENHANCE MANAGEMENT

The set of case studies on business innovation listed in this book is a strong illustration of the potentialities and difficulties experienced by the Brazilian economy and by our companies. For those cases, it is possible to repeat the same saying that has already been stated in a prior collection edited by the Brazilian Industries Confederation – CNI (Initials in Portuguese) and by the Business Mobilization for Innovation– MEI: the innovation strategies are very different from one company to another, but what is shared is the fact that no one innovates alone. It is almost as a general rule to have partners, whether being suppliers, clients, research centers or universities.

However, this book provides understanding that goes far beyond this general lesson. Here, you will be shown that innovation essentially presupposes to entrepreneur and face risks. Risks of very different nature: **technological risks**, derived from the uncertainties inherent to the research, mainly in the technological item; **commercial risks** of the one introducing a new product, mainly in case of a small company still unknown to the market; **regulatory risks**, when developing a product that has to be certified by a governmental agency or meet a new

specific technical standard; **risks in finding proper and sustainable sources of financing and funding** for research and development activities.

To face risks, this book reveals that the essential point is the **capacity to entrepreneur**. The difficulties found by the companies, the time required for an idea to reach the market, the several stages necessary to obtain concrete results, demand this sort of determination, whether in small or large companies. Many of the cases discussed here reveal steps forward and backward in the history of enterprises, changes in the strategy, change in the focus, reengineering, shareholding rearrangements, entrance of new investors, etc. They reflect precisely that entrepreneurial characteristic of the owners, of the managers or of those responsible for the projects subsequently described.

A result of such entrepreneurial action is translated, as revealed by these cases, into the permanent search for internal capacity of **innovation management** in the companies. There is no single manner of managing innovation and it depends on the sector, specific conditions of each market, size of the company, the business model and complexity of the partnerships involved in the innovation. But the relevant point is that such innovation management cannot be limited to isolated or hand-made actions: they require tools, training and persistence. The teachings in this matter are clear: it is necessary to have





planning and method. Fortunately, as we shall see, there are increasingly more efforts towards professionalization of those actions and the search for help, through CNI-MEI, SEBRAE, FINEP, CNPq and Research Support Foundations from several States of the Federation.

The **innovation management** has a decisive dimension: how to handle and stimulate development of new ideas, how to organize the subsequent stages, how to select and know how to dispose of ideas and projects, how to manage partners, whether being universities, suppliers or clients, how to define and manage a policy for intellectual property protection, how to be ahead of eventual regulatory requisites and know how to change those standards into opportunities for new business.

It would be impossible to imagine – and this is one of the most important lessons from this collection – facing risks without the minimum external support, from policies and actions that support innovation. To innovate means to undertake risks. Therefore, in basically all the countries the innovation has **decisive support from public policies**, whether by the impact it has to increase productivity, or focused on increased competitiveness of the business layer, or yet by the purpose of generating more qualified jobs. In this book, there are several examples of business initiatives that would be unsustainable without some level of direct funding, support to the initial steps, for instance in a

business incubator, of support for personnel qualification and training, by some type of subvention or yet credit facilities at costs compatible with the level of the risk.

Beyond the risks and capacity to entrepreneur, the innovation management and decisive support from public policies, three other dimensions are very relevant in these case studies. First, the **partnerships** with other companies, with universities or with research centers. They are a source of knowledge, solutions and ideas, and, at some instances, they are a channel to create new markets, develop new clients. Second, the very relevant role that awards and recognition of success play for the company: **awards** hugely expand the business visibility, open doors, attract investors, create credibility in the external world and reinforce the confidence in the internal range to the companies.

The last dimension which becomes prominent from reading of these reports relates to the **difficulties** found by the companies. A lot can be learned from those and many times understand more than just by analyzing the reasons for the success. As an example, in the approach of a 'design by certification', to change a regulatory requirement into a pathway for internal learning that qualifies the companies to innovate beyond development of a specific product. Or yet in opening and conquering of any market, in the effort to create credibility, prove that the product has differential features towards the competitors or find the correct distribution channels.

Putting all of that in brief, we can state that to Innovate presupposes: **To Entrepreneur, Face Risks and Enhance Management.** Innovation is not a matter of chance and, besides persistence; it presupposes a systematic management effort.

ENTREPRENEUR ABILITY

A typical example thereof is provided by **Fumajet**, which developed an insecticides and pesticides spraying system to control urban and agricultural plagues, based on motorcycles. Fumajet is a small startup company, created in 2009, and which was incubated in Universidade Veiga de Almeida. Its solution is a more adequate and lower cost alternative for spraying in regions of unplanned urbanization, besides incorporating other functionalities, such as real time remote management.

Fumajet's case calls up the attention by several of the foregoing dimensions: the role of the partnerships, the capacity of entrepreneuring and the perseverance, the significance and visibility derived from the awards, the need to have clear commercial strategy and definition of a policy for intellectual property protection, certification of products by governmental agencies, the relevance

of counting with the support from public policies, mainly by SEBRAE, or yet business angels.

A lot can be learned from Fumajet's story, but what becomes more notorious in this story is the entrepreneurs' persistence. It is the summary of everything, as it was built-up to face the presented challenges: it was the outcome of the company's permanent learning. But, if it is the outcome of concrete learning history, it also has a dimension that should be very useful to all of us: management was attained through training, increasing professionalization and with method, by mobilization of external support, both public and private, such as from SEBRAE and ENDEAVOR, besides many other partners. This increasingly more professional approach was decisive to face the difficulties and also to understand the tools available in the market to foster innovation and to know how to present itself to the potential investors. It was not, in this sense, a work of fortune, and, besides the concrete learning, it was the result from numberless hours of consulting to support the company's internal management enhancement.

Another case of how the progressive professionalization of management makes the difference is the case of **Wise**, which develops equipment for tests, measurements, communication analyses and maintenance of data communication lines. Created in Brasília 26 years ago by ex-employees of a large manufacturer of modems which



was undergoing restructuring, Wise was, for some time, incubated in UnB (University of Brasilia).

The understanding that business management required methodic handling led Wise to first seek support of Empretec, by SEBRAE, to qualify entrepreneurs. In the sequence, the clearer the role of innovation became, Wise dedicated itself to structure those processes, designing its own innovation management system, the so called InovaWise, which counted with the support from the Innovation Nucleus of MEI - CNI. The InovaWise defines an innovation policy, with clear targets for the company, through systematization of the concepts, of management structure, of adequate methodologies and tools.

The results thereof can already be seen in the innovation indicators: by increase in the number of products in the portfolio, by new products' participation in the revenue, or yet by fund raising. The acknowledgment of such effort came with the numberless prizes that the company has been awarded with, such as the FINEP Innovation Award and the Brazilian Innovation Award from CNI, in Innovation Management.

PARTNERSHIPS WITH UNIVERSITIES AND RESEARCH CENTERS

Partnerships are a matter constantly verified in the histories described in this book. **NOVUS** is a good

example of that. The company is a great business success case that changed a small national company into a global player, with competitive products traded in more than 50 countries. It was created in 1982, in Porto Alegre/RS, by engineers graduated from the State of Rio Grande do Sul Federal University, focused on the development, manufacture and trade of automated electronic devices for measurement and control.

It was not an easy path, due to the radical change of the Brazilian computing policy in the early nineties. Until the decade of 1980, Novus was dedicated to market niches and on-demand products, using the strategy of replacement of imports. Upon opening of the Brazilian market, it became necessary to seek for another strategy. The way found for that was to diversify and expand its technological bases.

The company was the first of its segment to count with the Basic Manufacturing Process (BMP) and since 1997 it invests at least 8% of its revenue into R&D, within the range of the Computing Act. In the last eight years, Novus launched sixty new innovative products not only for the national market, but a large portion of those also for the global market. The Brazilian Innovation Award by CNI/MBC and the Rio Grande do Sul Export Awards are the recognition of that success.

That was the outcome of the implementation of specific management for the innovation process, with the creation

of transversal committee encompassing the commercial, marketing, R&D and financial areas, prioritizing ideas and suggestions of new products. The highlight was the capacity to combine strong internal R&D team with partnerships with Universities and Research Centers, in order to substantially expand the range of products traded. That gave origin to the NOVUS' products families: software technology to aggregate resources; international standards of quality and credibility; consumer assistance services in different languages.

The expenditures in R&D and the search for public funding, mainly by FINEP, leveraged that strategy of working in international markets, combining the internal effort with contributions from the academic world, through both reverse engineering and genuine scientific and technological efforts that reinforced its technical-productive capacity.

Another example of joining internal competencies with know-how generated in Universities is that of **TNS Nanotecnologia**, a startup from the Federal University of Santa Catarina, which was born in CELTA, the incubator of Fundação CERTI, supported by the CNPq and received contributions from a business angel. TNS develops nanotechnology for several other companies, mainly in segments of high economic potential, which incorporate those solutions to their products, adding value.

TNS' business model is founded on development of technologies that can be used for many products and for several clients, centering its attention in its basic competencies and outsourcing the industrial process. Those alliances and tailored solutions for several segments have been guaranteeing the company's success, as well as in other cases of this book, deserving several awards.

Since 2009, TNS has been performing and staggering researches already started in the University to find more active nanoparticles, determine the ideal concentrations of those particles and the encapsulating agents more appropriate for each use. Its technological competencies are crucial and it adds that to partnerships with its clients, who validate the product, provide feedback and suggestions for improvements.

TNS is a good example of that relation between companies and Universities, because it reveals how the knowledge can be appropriated in excellent business while also revealing the difficulties and costs inherent to staggering of those technologies until reaching the go-to-market stage.

PARTNERSHIPS WITH CLIENTS AND SUPPLIERS

Partnerships with clients and suppliers are another important component in the innovation strategies. A very



illustrative case is the story of **Pred Engenharia**. Pred is a company created in 1993, in Vitória, specialized in industrial Maintenance Planning and Control (MPC) and created from an internal activity of the then named Aracruz Celulose, currently Fibria.

Pred's core business is the predictive maintenance of equipment, monitoring variables (noises, vibrations, temperature and performance) capable of signaling problems before they actually occur and paralyze production. Pred started its activities using techniques of thermography, but gradually added competencies and technologies for planning, inspections, analyses, calculations, assessments and management for the most varied industrial uses.

Today, Pred incorporates to its predictive maintenance activities an operational system for process planning and control – the Industrial Intervention Intelligent System (S3i) — which integrates all the fault modules and mechanisms of the industrial equipment. And it also seeks new business models, with the support of SEBRAE, grounded on protection of its industrial property and constitution of franchises to expand its market.

The starting point of this business is a reflection of very common opportunities, derived from large companies' necessities: a full service agreement with the then named Aracruz Celulose, which required maintenance activities, but



understood that it would be better to perform them through a third-party. The acquired learning allowed a successful history, equally deserving awards, broadly expanding the initial scope and Pred's clients portfolio.

A very successful partnership with the client is also the case of **Croda do Brasil**. Croda do Brasil is the subsidiary of a well-known English multinational company, world leader in chemical specialties.

Croda has research centers in several countries and used to perform several developments in Brazil, aimed for customization of its products to the domestic market. But a large client's need led the company to seek new technological route to produce Hi Pur Sesame Oil for veterinary use. The success of that effort is reflected in the finding of a totally new, more economic and environment friendly route.

That success was only possible by the internal capacity of the R&D team of Croda do Brasil, showing the importance of scientific know-how and personal skills for innovation in the technological base industry. The accomplished result generated confidence and consolidates the R&D work philosophy, both in local terms and with the parent company as well.

But it is also worth highlighting the role performed by its client as well, who closely monitored the entire process, also due to its requirements for working in veterinary products

market. The client audited the laboratories, the product, the plant and validated large scale production, due to the strict parameters defined to validate the raw-material used by it. Beyond the technical challenges of reaching the desired purity level, the success of complying with the other clients' requisites granted more credibility to Croda do Brasil, and it allows considering new developments and more active role in the R&D international strategy of the group as a whole.

Another type of partnership, also very successful, with suppliers and clients, is reported by **Gerdau**, one of the world's main producers of steel, to whom efficiency of the value chain is essential for sustainability of its own business.

Gerdau is knowingly a company that develops innovative solutions for the markets served by it and which always directed the spotlight to the quality programs. Together with SEBRAE, Gerdau has been working with the micro and small supplier companies and clients, focusing on managerial and technical qualification of those companies, aiming to attain improved quality of the processes, products and services.

Therefore, Gerdau and SEBRAE have been investing in methodologies and tools under two major fronts: Gerdau's Suppliers Development Program, aimed at providing improvement of the managerial performance to the micro and small companies and also to their competitive dimensions (term, reliability, flexibility, innovation, cost,



quality and services); and the Locksmiths Project, aimed at increasing productivity, competitiveness and sustainability of small carbon steel locksmith units consumers of material from the company's value chain.

With courses for qualification and consulting by SEBRAE and SENAI, besides visits to trade shows and events, those projects are focused on changing the small businessmen's view and behavior. It includes actions and practical activities aimed for the areas of innovation, management, market prospecting and competitive intelligence, cooperation, productivity and competitiveness.

A critical element for that change is the definition of the KPIs, Key Performance Indicators, which enable viewing the points for enhancement in each case and also allow SEBRAE's monitoring of the action plans.

This is a relevant learning environment for the public policies aimed at the micro and small companies, as it enables action in scale and focus on sustainability of those businesses, opening room for other business innovation initiatives.

INTELLECTUAL PROPERTY MANAGEMENT

Another recurrent dimension in these case studies is the definition of proper policies for intellectual property

protection, by the companies. The case of **Fotosensores** is a good illustration of that point, as it both shows what has to be done and what should not be done.

Fotosensores is a company created in the State of Ceará, 21 years ago, manufacturer of intelligence devices and solutions for urban mobility, traffic engineering and public security, founded by a researcher from the State of Ceará Federal University, initially incubated in PADETEC (State of Ceará Federal University Technological Development Park), also receiving contributions from a business angel.

During its initial years of existence, Fotosensores dedicated itself to the production of equipment to control and monitor the urban traffic, with agents accredited in several locations. Despite its initial success, the lack of proper industrial property protection enabled several of its representatives to become, on the medium term, its own competitors.

The company's growth and initial learning changed its strategy, towards seeking not only to be a supplier of detection equipment and services, but also to work in the area of intelligence for public managers. That gave rise to a new product, the FotoSiga® Segurança Pública — which enables monitoring of vehicles by detection of passage through strategic points of the road network.



Today, the company has two subsidiaries, two manufacturing units and two R&D centers, one of them located in São José dos Campos Technological Park. And, more important, it has defined a much more active policy to protect its intellectual property, which is exemplified by the eight applications for patent registered with the Brazilian Intellectual Property Institute (INPI).

Another example of active policy on intellectual property protection is that of **VRP Premium**, a small company created in 2005 in Balneário Camburiu, which manufactures pressure reduction valves.

VRP developed a differentiated technology for valves, with easier installation, maintenance and safety of the equipment. This solution eliminates the need for manual adjustments, simplifies the number of components and allows granting of longer warranty period and even free of charge technical services, although the costs of the valve are higher, which is broadly offset by the longer useful life and lower costs with maintenance.

VRP's initial difficulties were those typical of a small company that needed to position itself within a market controlled by large supplier companies. During its beginning, besides having to be self-financed, VRP had to dedicate itself to rendering maintenance services in already installed building valves, to conquer clients.



To consolidate itself in the market, VRP differentiated products and services and centered itself in offering guarantee of its product's quality, reflected, for instance, in the traceability of its valves, which have unique code, allowing administration of the periodical maintenance and identification of which type of corrective maintenance is the one indicated for each part. It also invested, with the support of SEBRAE, into substitution of the raw-material, establishing a partnership with a new supplier. The results thereof did not take long to appear, with several improvements in the product and in the process and awards for the company.

A strategic aspect of this positioning was the following of the technical standards and guarantee of the intellectual property. Today, all VRP's products have patents of Model of Utility (MU) registered with the Brazilian Intellectual Property Institute– INPI. The company considers that in a highly competitive segment, the capital dedicated to this mechanism becomes an essential investment to maintain its differentiation strategy.

THE ROLE OF THE INCUBATORS

An expressive number of the cases that form this publication were supported by companies' incubators. **Biotron**, a small company from the South of the State of Minas Gerais,

manufacturer of medical electrical and dental equipment, is one of those cases.

Biotron developed a business model based on product differentiation, proximity with the user and innovation centered, with strong R&D internal team and well-established partnerships with universities and companies, as well as outsourcing of production as the strategy to save costs. Today, it is certified by ANVISA in Good Manufacturing Practices – GMP – and already holds several awards.

Its current products portfolio counts with 25 items, such as Negatoscopes (devices with special lighting to view negatives or radiographic plates); low noise air compressors, without emission of smoke or smells and oil free; abrasion and jetting chambers and dark chambers to reveal negatives; sealer, mini-incubator for biological tests, electrical triggers for faucets and spittoons of dentist clinics; or yet intraoral cameras.

Biotron was established, in 2007, in Santa Rita do Sapucaí Municipal Incubator. The inclusion into that environment contributed for its structuring and, among other advantages, opened the opportunity to receive financing from the State of Minas Gerais Research Support Foundation - FAPEMIG, through the Business Research Support Program - PAPPE. Likewise many other cases narrated in this collection, the incubators' innovation ecosystem opens doors for the

companies that are being created. In some cases, the support comes for improving the management, in others it helps with creation of suppliers networking, in many cases it is a way for fast learning of the existing mechanisms for incentive of innovation and facilitation to attain external support, derived from such knowledge.

Another case of incubation, which calls up the attention by its peculiarity, is that of **Emiatec Tecnologia Ambiental**. Founded in 2003 by professionals experienced in atmospheric monitoring services, Emiatec is a small company working in the area of atmospheric emissions and air quality, located in Curitiba.

Emiatec arose from a business opportunity derived from change in the law for monitoring of industrial emissions. It started as a services rendering company and evolved – based on technical know-how, qualification, partnerships with research institutes and local suppliers – to become a provider of technological solution grounded on development of new equipment (isokinetic collector) with patent duly registered with the Brazilian Industrial Property Institute (INPI).

Its initial difficulties illustrate what occurs to many small companies: self-financing and inexperience with management. What actually contributed to make the company viable was the possibility of being incubated in TECPAR, in Curitiba. A different incubation, as it was external,

but which enabled the access to consulting in management and trade of products, opening doors to new sources of financing, mainly the PRIME and PAPPE/SEBRAE-PR.

THE ROLE OF THE POLICIES ON SUPPORT OF INNOVATION

Examples of the relevance of policies on support of innovation can be found in several of the cases studied here. They range from subvention and direct support to the companies, through funding and credit, to indirect support such as tax incentive, reaching up to the incubation, training and consulting mechanisms.

One of the most illustrative cases proving that in lack of those incentives it would be impossible to entrepreneur is the case of **Recepta Biopharma**, a biotechnology company created in 2006 with scientific competencies in the areas of cellular and molecular biology and experience in research projects management.

Recepta is the result from the association between Brazilian investors and the Ludwig Institute, one of the most renowned world institutes of researches on cancer, aimed at creating competitive advantages through mutually beneficial partnerships with public and private institutions.



Recepta is dedicated to developing bio-molecules (monoclonal antibodies) capable of recognizing and bonding themselves to specific targets in tumoral cells. It is, therefore, an intensive science company – where risk is inherent to the research itself. It is an innovative case for the Brazilian reality, as it works on joining scientific and business competencies, by excellence in projects management, partnerships, intellectual property protection and attraction of private and public investors.

Recepta's business model is based on technological cooperation as a way to mitigate the risks inherent to the innovation process. The company aims to develop projects with potential to create new medication, working as an interface between the research developed in the academy and the industry. Therefore, the company has formed an extensive cooperation network with numberless institutions both in the country and abroad.

Its innovative character can be assessed by the fact that it was the first Brazilian company to perform Phase II clinical trials with monoclonal antibodies for cancer treatment, with ANVISA and FDA registration. Its portfolio currently encompasses bio-molecules at different research stages, going from immune-histochemical tests up to pre-clinical and clinical trials. Besides mobilization of private capital, this model would not be successful without strong component of public policies on the support of innovation.

Another example of how essential are the policies on support of innovation is that of **TOTH**, a technological startup company based on technical know-how and on partnerships with professionals from healthcare, researchers, university and research center for the development of technologies; and partnerships with large players of the sector who, besides being clients, guarantee market penetration.

Created in 2008 at the Tecnopuc, in Porto Alegre, Toth currently offers cardiac monitors, defibrillators and monitoring centers, besides other products. The location at the technological park facilitates, likewise with other incubated companies, access to funding and financing credit to research and innovation.

Toth develops medical equipment, prototypes, transfers technology and gives technical support, receiving royalties from sales of the ultimate product, which production is under the responsibility of the client. To bypass the difficulties of access to markets, Toth celebrated strategic partnership with a company already consolidated in the sector, Lifemed. Toth develops and Lifemed trades.

Toth's innovation and planning nucleus, named as INOVAR TOTH, is currently one of the most awarded Brazilian models on innovation management. It is aimed at prospecting technologies and partners, establishing relations with

Universities and Research Centers, managing the knowledge, measuring results, capturing opportunities, managing the projects portfolio and perpetrating the culture of innovation, always aligned with the business strategy.

Toth's business model is to be consolidated as a solutions research and development center, which solutions are subsequently licensed to third-parties for manufacture and trade. Innovation is the core of its business and therefore it mobilizes actions on funding and subvention, mainly by FINEP, FAPERGS, CNPq and SEBRAE, together with partnerships with companies. Without the support from policies on innovation, Toth would be another unfeasible business case.

TECHNOLOGICAL AND COMMERCIAL RISKS

It has already been stated here that innovation means to undertake risks and risks of several types. This is true for basically all the cases depicted in this collection. Some examples can illustrate that very well, such as the case of **FIT Networks**, developer of technical solutions for Internet optical fiber access providers.

FIT Networks is a startup company founded in 2012 by two engineering students from Inatel and incubated in the cluster of Santa Rita do Sapucaí, in Minas Gerais. Its

main product is a very innovative solution for optical fiber connection to the Internet, the so called PACPON (Point of Attendance to the Client — Passive Optical Network), which allows sharing optical fiber access between several houses, with advantages towards the solutions currently available in the market because it energizes the equipment through a source located in each subscriber's house. Hence, FIT resolves, at low costs, a well-known problem of high speed connections nicknamed as the challenge of the "last mile", as it connects the large fiber infrastructures already available, to each individual house.

FIT Networks concentrates its technological, commercial and management efforts in this product, for which it has applied for a patent with the INPI, in 2012. It is a product today already homologated by ANATEL and in process of approval of its Basic Manufacturing Process - BMP, counting with the advantages of having its purchase financed by the BNDES card and tax treatment favored in the State of Minas Gerais, largely due to the visibility generated by SEBRAE's support and the awards granted to it along its brief existence history.

But FIT Networks' technological risk is huge. This is a market where the products' lifecycle is very short and the need to innovate is inherent to the business of the manufacturer and of the innovative solutions provider. Renewal and arrival of new technologies occur very fast and there are alternative solutions already available in the market. It is quite possible



that technological advances may appear which shall enable implementation of optical fiber with affordable values directly in the house. For those reasons, the company invests on research and innovation approximately 40% of its revenue, aiming at maintaining its portfolio updated and well-managed to follow-up the market changes and renewals.

Another example of a company subject to high technological risk is provided by **FuturaGene**, a company resulting from the merger, in 2004, of CBD Technologies, created in Israel 20 years ago, with FuturaGene, spin-off of the Purdue University, and which was acquired, in 2010, by Suzano Papel e Celulose.

FuturaGene focuses its business model in the discovery and acquisition of technologies, prototyping in commercial plants, transfer of know-how and partnership with companies from the forestry sector, aiming to enhance Suzano's forestry equity. The company counts today with corporate and R&D structures in Brazil, China and in Israel, and performs field tests in the three countries and in the United States.

The purpose of the company is to develop technologies that shall improve productivity in the forestry plantations in a sustainable manner, with highlight to genomics of plants aimed for forestry, bioenergy and biofuel markets.

Its higher impact development – a genetically modified eucalyptus – can increase forestry productivity by 20% for uses such as cellulose, energy and biofuel. This new eucalyptus is being assessed in terms of performance and biosecurity since 2006 and, in April 2015, it was approved for trading by CTNBio (Brazilian Biosecurity Technical Commission), the Brazilian agency in charge of authorizing commercial use of Genetically Modified Organisms.

This technology puts FuturaGene in the leadership in the area of forestry biotechnology as the first one in the world to trade a genetically modified species of eucalyptus. It reveals an uncommon strategy for the Brazilian companies, of combining a high technology and next generation scientific basis company with a knowingly competitive cellulose company, enabling higher funds for research and high potential plant varieties base. It is an innovative model that might represent a valuable alternative for the public policies on promotion of industrial development. But, it is also a model inherently subject to the risks of any technology intensive activity, where uncertainty and risk are inherent to the activity itself.

A third example of the innovation risk, in this case of commercial risk, is the history of **Sigmarhoh**, manufacturer of parts and equipment for the oil and gas sector, founded in Aracaju, State of Sergipe, in 1994. The company was born out of the idea of nationalizing

equipment intended for drilling of oil fields, and offering them at more appealing prices.

Besides the logistic hindrances of the location far from the traditional centers of equipment manufacturing and therefore distant from the supply chain, the company also had to overcome the barriers of access to market and credibility with prospects.

In 2007, the company developed a new elastomer which increased productivity and practicality of the drilling operation – with longer useful life and at lower cost. That was possible with the support of the Cooperation Network of the Oil and Gas Productive Chain in Sergipe — Rede Petrogas-SE, a partnership established between Petrobras and SEBRAE/SE, in its Technological Development and Innovation — DTI line of action. That was the differential for its establishment in the market.

But, that has not been an easy path. First, in 2008, it was necessary to create the Sigmarhoh Well Testing aimed at tests services for oil reserves formation and market niche of the small and medium onshore marginal fields' operators.

After that, it has been necessary to improve management and seek quality certifications, which led, in 2011, to creation of new elastomer applicable to different drilling fluids, developed in partnership with the State of Sergipe Federal University.



The next step was to conquer markets, by distribution of free samples to the prospects, under the conditions that they should prepare an assessment and performance report.

In 2011, the report from the first client confirmed the longer useful life of Sigmarhoh solution. In 2012, the opportunity to offer the same solution to a foreign company that was starting exploration in Sergipe appears and after tests in three equipment units proved quality of the product. That was the decisive milestone for the company who, with that recognition and generated credibility was able to trade its products with Petrobras.

LEARNING FROM INTERNATIONALIZATION

A different case of learning, which impacts the company's global history and its potential for innovation is that of **TOTVS'** internationalization, provider of ERP — Enterprise Resource Planning software.

Created in 1983, then named as Microsiga, Totvs experienced organic growth, after acquisitions, until it became ERP leader in Brazil and in Latin America. The initial international expansion strategy was started yet in 1997, by opening of an agency in Argentina and distribution channels in Chile, Paraguay and Uruguay. After that, acquisitions in Mexico, Porto Rico, Colombia, Portugal and Angola came along.

The internationalization was aimed at assuring competitive position beyond the Brazilian territory. But, that first attempt of internationalization proved to be complicated, as it did not take into account the differences, compared to Brazil, of the external environments.

Totvs learned that even the close markets are not necessarily easy and that any international expansion demands well-anchored strategy. Differently from exporting, internationalization is a much more complex phenomenon as, in the case of Totvs, its systems have to run on specific platform, complemented by services layers that require customization, cloud solutions and consulting, requiring strong proximity with the clients. That required better planning, selection of personnel and preparation of a roadmap on the new products for the specialized activity segments.

The strategy of international expansion pursued three complementary goals. First, to follow-up the Brazilian clients in their natural expansion paths. Second, to open new learning sources. Finally, to expand the set of technologies and the business models to strengthen its competitiveness and open perspectives for the future. And, there is the main determinant element of the company's international expansion: the strengthening of its competitiveness.

CULTURE OF INNOVATION

Romi is a well-known manufacturer of machinery-tools, created still in 1930 in Santa Bárbara d'Oeste (SP), nowadays counting with eleven manufacturing plants, nine in Brazil and two in Germany, serving clients in all continents and from the most varied sectors of the industry. It is a very innovative company which holds large number of patents registered, investing about 4% of its annual net revenue in R&D, both in internal activities and by partnerships with the academic area.

Romi produces lathing centers, CNC lathes, conventional lathes, machining centers and milling machines, machinery and equipment to mold plastic by injection and by blow, and gray cast iron parts, nodular and vermicular, supplied either gross or machined.

But the challenges of being more competitive and the strengthening of competition at the international range after the 2008 crisis required the company to make the decision of looking for strong internal restructuring, in order to reinforce its market positioning. The adopted strategy was centered in reformulation of the manufacturing process and planning of the supply chain, seeking to make production flexible and offering the best solution for the client, implementing the SRP project —Romi Production System. The key issue in this process was a radical change of culture in all of the company's hierarchical levels.

The flexible manufacture strategy referred to streamlining the entire productive chain to the Lean Manufacturing concepts and of MTO (Make to Order) process. The outcome was the acquisition of Flexible Manufacturing System which selects and prepares the tools that will be used in the next production and that required huge joint effort with the supply chain and all of the company's departments, creating a Supply Chain management. Reduction of the total lead time – from six to three months – required combined actions in several areas of the company, such as projects, planning, production, logistics and manpower management, besides commitment of the suppliers, training and creation of purchases portal.

Vale's project for expansion of the iron ore mining and processing at the Carajás hub, in the city of Canaã dos Carajás, State of Pará, is a landmark for the company and for the entire mining sector, also being an example of change of paradigm and transformation of the corporate culture.

The S11D project is currently the largest of the global iron industry, involving investment approximate to US\$ 20 billion. With a new technology named as in-pit crushing and conveying, or truckless, Vale was able to sharply reduce the need for deforestation in the surrounding of the mine, use of water (93%), fuel consumption (77%) and emissions of carbon dioxide (CO₂ by 50%). Another relevant effort was the



use of more structured logistics, generating higher efficiency in its production outflow process.

The project is the result from five years of environmental and engineering studies, with the engagement of technical teams from Brazil, Canada and Australia which gathered Vale's entire learning in mining at Carajás and at its operations in other countries. The combination of competencies from different teams, located at different sites of the world and working in diversified physical and regulatory environments helped Vale to congregate the best of the actually existing possibilities and to create new business solutions with strong impact on the very corporate culture.

CERTIFICATION AND REGULATORY REQUISITES

Compliance with regulatory requisites is, sometimes, a decisive condition for the companies' innovation courses and many times source of learning for their future. That is the case of **Fras-le**, the largest global manufacturer of brake lining, which faced the need to cope with the change in the US standard for stop distance of trucks.

Fras-le is a global company with two manufacturing plants in Brazil, one in China and another one in the USA, holding products portfolio with more than 10 thousand items and

clients in approximately 100 countries. It is a much awarded company, which invests 2% of its revenue in R&D and holding strong partnership with the State of Rio do Sul Federal University, besides internal know-how in several areas related to innovation in friction material.

In 2004, the National Highway Traffic Safety Administration (NHTSA), responsible for regulation of traffic safety in the United States announced reduction of 30% for stop distance of tractor trucks, which would become valid as of 2011. Fras-le's clients in the United States started, then to request a solution that could comply with the standard, but within costs compatible with the traditional drum brake solutions, also compliant with additional environmental restriction of some US states.

Those requisites represented great challenge for the engineering teams, as they involved increased efficiency of braking that could not be reached by simple performance improvements or minor changes to the vehicles. The design of new brake systems configuration demanded re-dimensioning of their sizes and friction material.

The development of new high performance lining, by Fras-le, ended up serving new technical requisites and those products were registered in 2011. But, besides that, the result consolidated the company's positioning, also generating increase of its market share in the US market.

A second case of regulatory requisite that impacted a company's innovation history is that of **Protect**, a small company located in Sumaré, created in 1993, and which manufactures personal protective equipment (PPE) for the agricultural sector.

Protect supplies diversified products line, with more than 30 kits, each one specific for one rural activity, derived from its innovation efforts, which is based on partnerships with universities, research centers and contacts with agronomic engineers with in-field experience.

With SEBRAE's support, in a project that ended up receiving CNI's National Innovation Award, Protect systematized its entire innovation management process. More recently, the company has also been seeking to work with a new business model, by rental of PPEs and implementation of reverse logistics for hygienization and proper final disposal (incineration or reuse), thus better serving the rural producers' necessities.

Along its history to develop new technologies for the outfits, incorporating nanotechnology applications which allow forming of more uniform and longer lasting water-repelling pellicle, Protect ended up prospecting the international market and found the opportunity of supplying equipment for European countries. But, that demanded the company's

compliance with European PPEs' certification standards, much more restrictive than the Brazilian standards.

After a first frustrated attempt, the company adopted a development strategy totally aimed at compliance with the standard, in a design by certification model. Attainment of the certification demanded formalization and auditing of the entire manufacturing process, with a learning that might be very relevant for future certifications.





A similar case of design by certification is that of **Scoda Aeronáutica** (former Edra Aeronáutica), a medium company specialized in the manufacture and distribution of aircrafts and helicopter pilots qualification courses, created in 1997 in Ipeúna.

Scoda started, in 2001, assembling foreign aircrafts and then ended up developing its own project, the Super Petrel LS, an amphibious airplane responsible for 81% of its production, and which is traded in Brazil and in more than 16 countries. The Super Petrel LS is a Light Sport Aircraft - LSP, manufactured with composite material and which, at a first instance, did not have to meet specific standards of the regulatory agencies.

However, in 2005, the United States changed configuration of the certification process, defining requisites by the ASTM - American Society for Testing and Materials, and the FAA (US Federal Aviation Administration) became responsible only to check its compliance.

Adoption of the design by certification model was groundbreaking in the company's designing and manufacturing manner, showing that the international standard could be seen as a guide for performance of the project, because it required detailed study and long

compliance checklist, taking two years of work. Only after that, it was possible to proceed to the structural and aerodynamic project. The last instance of the project, in 2013, was the actual certification by the FAA and ANAC (Brazilian Civil Aviation Agency).

All the cases summarized here and which are subsequently detailed, provide relevant lessons for the Brazilian companies that want to innovate. In general, to exemplify diversity of the innovation agenda, a peculiar characteristic of each case was highlighted, but it is evident that in those paths they combine many things: management of several types of risks, innovation management, partnerships, external support, intellectual property policy, search for visibility and recognition.

As already stated, a summary of all this content is that to Innovate presupposes that: **To Entrepreneur, Face Risks and Enhance Management** Innovation is not a matter of chance and, besides persistence, it presupposes a systematic management effort. But it is an effort that pays-off to the companies, as it makes business more sustainable, creative and ambitious. That is the way to perpetrate and add value to your business and to the society as a whole.



BIOTRON

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BUSINESS MODEL BASED ON INNOVATION TO WORK IN THE MEDICAL EQUIPMENT MARKET

Biotron

Biotron is a small company from the south of the State of Minas Gerais, Brazil, working in the sector of medical electrical and dental equipment. Its business model is the key to the success of the company, an example of a well-structured strategy and vision focused on the actual needs of the final user are its fundamental qualities. Competitiveness by products differentiation and proximity with the user are the focus of the business strategy. Its model, centered on innovation, is based on a strong Research, Development and Innovation – RDI team, well-established partnerships with universities and industrial companies, and the outsourcing as production strategy to reduce cost per product. Its history, since the inclusion in the incubator up to revenue amounting to millions of Brazilian Reais, was the basis for the development and validation of its business model, being an example to prove that differentiation by technological innovation is possible, irrespective of the company's size.

1. THE COMPANY AND ITS SECTOR

The company was created as a technological basis enterprise developing solutions and manufacturing medical electrical and dental equipment. Established in 2007, in the city of Santa Rita do Sapucaí – State of Minas Gerais, the company started its history in the Sinhá Moreira Municipal Companies' Incubator, which is part of the city's Municipal Program for Advanced Incubation of Technological Basis Company - PROINTEC.

The company is embedded into the sector of medical, hospital and dental equipment and supplies – MHDE, prominent in the industrial health hub – IHC. This segment, which includes extensive and diversified set of equipment, material and inputs used in healthcare services, incorporates several technological platforms to the products. It is a market where more expressive shares are traditionally held by transnational companies, which leadership results from the high investments in Research and Development – R&D and from their integration into a healthcare system that counts with sophisticated solutions. In Brazil, the MHDE industry is mainly formed by small and medium companies, with standard of competition by product differentiation¹ being predominant.

1 PIERONI, J.P. *et al.* *A indústria de equipamentos e materiais médicos, hospitalares e odontológicos: uma proposta de atuação do BNDES*. BNDES Setorial³¹, p.185 -266 (2010). (BNDES Setorial 31)

In this sense, since its conception, its founders defined the practices of quality, technology and innovation ² as the company's pillars. The company's products portfolio currently counts with 25 items, with highlight to the following:

- Negatoscopes (devices with special lighting to view negatives or radiographic plates): the company's main product, highlighting the Ultra Slim LED line, being the slimmest in the market;
- Air compressors: low noise products, without emission of smoke or smells and oil free;
- Abrasion and jetting chambers and dark chambers to reveal negatives;
- Biosecurity: sealer, mini-incubator for biological tests, electrical triggers for faucets and spittoons for dentist clinics;
- Intraoral cameras.

Currently a company well-positioned in the sector, with revenue amounting to BRL 3.5 million, the small company had a peculiar beginning. Its remaining founder partner (the other partners elected alternative professional paths),



² Available at: <<http://www.biotron.com.br>>. Access on: November 4th, 2014.



graduated and holding Master degree in Administration, owned a projects development consulting firm. His proximity with the healthcare area occurred in 2006, when he suffered a car accident and, due to severe injuries in his left leg, had to be submitted to in-hospital treatment for seven months. During the hospitalization period, bothered by the inaccuracy of the medical prognosis regarding the time and evolution

of his recovery, he started, on his own, to survey and assess the possibility of projecting a piece of equipment that should offer more accurate solution for diagnosis of his condition. His idea was to develop something that would enable assessment of the clinical condition improvement, mainly the muscular recovery.

Based on that initial concept, the entrepreneur identified that the most adequate option for his project would be to use the technique of electromyography³ to make comparative analysis of the muscular response between the healthy leg and the injured leg and, thus, enhance the physiotherapy exercises aiming to accelerate the process of recovery. This type of equipment available at that time had simple technology and did not meet those requisites.

After leaving the hospital, he was really willing to make the project a reality. However, just with his know-how as an administrator he was not able to create, alone, the equipment, which he had already baptized as BioSense. He then joined two friends, a doctor and an electrical engineer and together they established, in July, 2007, the company that they had conceived.

3 Electromyography is a technique for monitoring the electrical activity of the excitable membranes of the muscular cells, representing the potentials of action triggered by reading of the electrical voltage (voltage in time). <http://pt.wikipedia.org/wiki/Eletromiografia>

Initially, the company was established in Santa Rita do Sapucaí's Municipal Incubator. The presence into that environment contributed for the company's structuring and, consequently, they had the opportunity to receive financing from the State of Minas Gerais Research Support Foundation - FAPEMIG, through the Program for Support of Research at Companies - PAPPE, which was important for the development of the BioSense. However, when the product was finished, the company found bureaucratic hindrances to register it, because BioSense could not be framed into any of the categories already existing in ANVISA. That condition impeded its manufacture and trade.

At that instance, the partners had already dedicated their personal financial reserves and the financing capital was finished. That was actually a critical moment for the newly created company and a plan was required to raise funds. The elected strategy was to develop products which the company referred to as "strategic" for its survival – products with low difficulty for development and which could be manufactured in large volumes, with the possibility of being easily accepted by the market. The purpose was to guarantee financial contribution, expose the brand and open the way for more technologically complex products. But that plan was not unanimously accepted by the partners in regard to the type of business that could be designed and, in 2008, the initial partnership came to an end. Once again,

the founding partner was the sole responsible for the company's direction.

That change in the strategy, combined with the wish to build a company that could be self-sufficient, resulted into definition of the company's positioning in the market and in the outlining of a business model that proved to be very successful. Today, the company continues to develop more complex products, with higher value added and higher risk regarding market acceptance, while maintaining the cash flow through trade of simpler and easily tradable products.

2. STRATEGY - THE PRODUCT ALIGNMENT WITH THE BUSINESS

The business model of the medical equipment manufacturer has the competitive advantage of applying differential technologies to medical equipment already consolidated in the market. The company proposes to develop modern products at low cost, positioning itself within a market niche that is not attractive to the giants of the sector. Today's flagship are the products initially referred to as strategic (for the company's financial maintenance), which count with not very complex technologies for development and which serve demands directly identified with the ultimate users. The spotlight constantly directed to the market necessities is also a notorious differential in the company's history and business model.

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The business model of the medical equipment manufacturer has the competitive advantage of applying differential technologies to medical equipment already consolidated in the market.”



The company has elected to outsource the production, as the technologies embedded into the company's products are simple. This kind of business is favored by the company's geographic positioning, included into the State of Minas Gerais Southern Technological Hub. The region, which includes Santa Rita do Sapucaí and Itajubá, 450 km distant from Belo Horizonte and 220 km distant from São Paulo, is proudly known as the "Brazilian Silicon Valley". It concentrates several technological basis companies, from which more than 25 work with the medical-electrical field. The main advantage of that location is the access to several nearby industries, which enabled outsourcing of all the manufacturing stages. Hence, Biotron's activities continue to be focused on research, development and innovation.



The creation of the medical electrical sector at the Vale da Eletrônica [Electronics Valley] in the South of the State of Minas Gerais started to be outlined in 2010, when the Group of Health Products and Services Companies (GEPSS), which favored creation of collective identity to a group of similar industries. The initiative is supported by the Union of Metallurgy, Mechanics and Electrical Supplies Industries of Itajubá (SIMMEI), by the Technology Basis Companies Incubator of Itajubá (INCIT), by the National Telecommunications Institute Incubator (Inatel), by the Municipal Incubator of Santa Rita do Sapucaí, by the Union of Electrical, Electronic and Similar Devices Industry of the Vale da Eletrônica (Sindvel) and by SEBRAE-MG. The businessmen of the sector are supported in several aspects, such as obtaining certificates, raising funds, participating in hospital fairs, management and administration processes and access to the market. Also, the Project for Development of the Medical Electrical Sector of the South of the State Minas Gerais was created as well, which will last until 2015, with the purpose of consolidating competitiveness and stimulating innovation. ⁴

⁴ SEBRAE-MG. O vale dos eletromédicos. Revista passo a passo. n. 143, Dec. 2012/Jan. 2013. p. 36-40.

The company has several competitive advantages. Among those advantages, it is possible to highlight the establishment of good image in the market, which identifies the company as a good provider of solutions for the market demands; arising out of spontaneous marketing network, derived from the clients' satisfaction with the offered products; and also the guarantee of producing higher quality equipment that accelerates and simplifies the daily activities of the professionals from the medical and dentistry areas.

3. THE PROJECT

The history of the innovative company from the south of the State of Minas Gerais, since the approximation of its founding partner with the area of health until launching of the first products in the market, served as the foundations for the structure currently assumed by its business. The critical moment when financial contributions were required and the enterprise became individualized, after two original partners decided to leave the company, led to the creation of a strategy based on products that would enable going to market and clients' attraction.

The business model started to be designed from the idea of launching those products, which were considered as "strategic". They were referred as such because they were aimed at, besides the input of capital, creating relationship

with the market. The purpose was, while the internal team was being structured, to give visibility for the company and attain know-how in a segment that was, until then, totally new to the entrepreneur.

In this sense, to identify which products could be developed, the company adopted a strategy that nowadays composes the relationship with the client, within its business model. A bank of ideas was created based on the actual necessities and demands,



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The history of the innovative company since the approximation of its founding partner with the area of health until launching of the first products in the market, served as the foundations for the structure currently assumed by its business.”



identified through consultation of doctors and dentists. The ideas are prioritized according to the following items:

- Easiness to go to market;
- Easiness for the development;
- Higher chance of acceptance in the short term, due to technological outdateding of the competitor products available in the market - in this case, the new product is based on an incremental enhancement.

Initially, just doctors and dentists that worked in the region wherein the company is located were consulted. To increase the range of those consultations, incrementing prospecting of ideas, the company started to participate in all the fairs and events of the sector. That practice became a habit and fundamental for the company's history, as it is a direct channel of communication with its target audience, enabling establishment of partnerships. The purpose is to present the products to the main players of the segment who, by identifying themselves with the company's portfolio and validating their technologies, generate what can be referred as spontaneous marketing, as they become spreaders of the brand/company. Today, within the business model, participation in events is one of the key activities, both in the area of relationship with clients and as channel of communication with the segment and the market.

The first product considered to be strategic, launched by the company from Santa Rita do Sapucaí in September, 2008, was the Inlux. It is a system that offers luminosity to the revelation dark chambers. Although being simple, the equipment was innovative and it was very well accepted by the market. From that point, new products were launched, all of them with simple technologies, but always meeting the real necessities of the doctors and dentists. In that manner, the company increased its portfolio and conquered clients and today the client themselves spontaneously present ideas for new products development.

The acceptance of the innovative company's equipment was decisive to consolidate its brand and for the company's credibility with the clients. Furthermore, as the business evolved, the difficulties and success in the sales helped to form a clear and broad view of the market and to define its positioning.

Basically, in the medical and dental equipment segment, Biotron found itself surrounded by large layers typical of that market. By one side, there were the large multinational companies with their high investments in research and development and complex and expensive technologies. At the other end, there were very small companies, developing very simple technology equipment, which worked for a single specific client. Observing that scenario, the company noticed that the market share more adequate to its reality and also





presenting itself as more promising was the one that would not be attractive for the large players and where the informal companies were not able to meet the demands, by lack of technology or capital to invest. After that, the company incorporated into its business model the strategy of focusing on the equipment aimed for the medical area, but which is not considered as equipment for healthcare and, therefore, does not require registration with ANVISA, where the process of registration might generate difficulties and delays to the company. All the products that currently compose its portfolio are included into this category.

Regarding the commercialization model, most of the medical equipment companies work with representatives in charge of the sales. Initially, that was the type of structure adopted by the company from the South of the State of Minas Gerais, but in the end it proved not to be advantageous, as it was a new brand, not attractive to the representatives that were better established and influent in the market. To bypass that problem, the company decided to supply its products trade to the ultimate consumers. Thus, in Biotron's business model the client is the distributor. When transferring to the distributors the responsibility for the direct sale to the ultimate user, the company's cash flow is less vulnerable. In addition, the option for the distributors is also essential for planning of the production, as it guarantees sale at larger volumes and production at larger scale, enabling reduction of the cost per product. However, the sales volume is not



yet as significant as to economically enable maintenance of proprietary plant. Hence, the entire production is outsourced, and the company is mainly responsible for the sales and development of the products.

Finally, as the core part of its business model, there is the company's value of the proposal: innovation in all products. In this sense, strength and competency of the strategy adopted for development of the products are essential. The research and development department, which was initially composed only by the businessman himself and a team of engineering trainees, evolved to a more structured and experienced team, establishing partnerships with universities and suppliers. That enabled simultaneous performance of several projects, as the period of products development varies a lot according to their nature, in a range that goes from six months to three years, approximately. That time is related not only to technology itself, but mainly to prioritization of resources, which takes into account evaluations of market maturity and sales opportunities.

As the entire manufacture is outsourced, the company's own team keeps focused on research, development and innovation. The projects are divided into three groups: internal development, partnership with universities and partnership with suppliers. The internal projects are those

that start with simple ideas, internally identified by the team itself or through contacts with the users, and which are assessed as having easy and quick development.

The partnerships with universities occur at two fronts: joint projects and segmented projects. The joint developments are those where the company-university interface is maintained along the entire project, from the conception up to its conclusion. In the segmented developments, the university is responsible for the substantiation and theoretical studies of the technology and the company is responsible for the project of the equipment adequate to it. More recently, the company has been studying also the possibility of patents licensing, for instance, of technologies developed during the Doctor degree studies projects which are promising, but which cannot reach the market. But, this approach is not consolidated yet.

Finally, the third group of projects in which Biotron engages itself is the one directed to partnership with other companies of development or suppliers. In this case, the company delivers a demand to the supplier and negotiates exclusivity in case the new product developed by it is successful – thus, it is possible to say that the relationship with the suppliers is no more of B2B (business-to-business) but it becomes a relation of commercial partnership.



Although launching of the so called strategic products has been performed focused on acquisition of know-how, qualification of the team and establishment of relationship with the market, its success ended up converted into more equipment units with the same characteristics and, thus, the products which the company had considered to be 'strategic' were then included into its definite portfolio. Those products represent today a significant percentage of the company's revenue, assuring its financial sustainability; and it simultaneously invests into development of new equipment units, also some of them that shall be launched in the near future, bearing more complex technology.

4. INTERNATIONAL SCENARIO

In global terms, the industry of healthcare products is one of the most dynamic sectors of the economy. The sales revenue has been experiencing annual average growth corresponding to 7%, going from USD 289 billion in 2009 to USD 487 billion expected for 2016. In the whole world, there are more than 25 thousand industrial companies working in the sector, employing more than one million people. The emerging countries such as Brazil, China and India are deemed to be the ones most promising to lead a new wave of growth, in this market.⁵

⁵ Available at: <<http://www.brazilianhealthdevices.com.br/market>>. Access on: November 4th, 2014.

Regarding revenue, in the block of the 67 countries that answer for 90% of the world sales of the sector, the USA holds the first world position, with 40% market share and more than USD 91 million in sales. After that, there are Japan and Germany, with 10% and 8% of the market, respectively. In the group of the emerging countries, Brazil is ranked second, with USD 2.6 million in sales and 12% of the market, behind China, which has annual revenue of USD 6.2 million and answers for 28% of the sales.

In the world range, the sector of healthcare products is segmented according to the functionality and application of each equipment unit. The segments and their respective market shares are ¹⁰:

- Dental products: 5%;
- Orthopedic products: 15.5%;
- Consumable supplies: 23%;
- Diagnosis and image: 23%;
- Other medical equipment: 33.5%.

In Brazil, the sector is segmented into Dentistry (equipment, consumable and instrumental supplies), Laboratory (equipment, reagents and consumable supplies), Radiology

(devices, accessories and consumable supplies), Medical-hospital equipment (Non-electrical furniture, medical-electrical, surgical instruments, physiotherapy equipment and hostelling), implants (orthopedic, neurologic, cardiac and others) and Consumable supplies (hypodermal, textile, adhesives and others).

The national revenue went from USD 2.5 billion in 2005 to USD 5.7 billion in 2013, a growth corresponding to more than 100% in 8 years. The micro and small companies answer for 18% of the sector's sales, which has the medium companies as predominant, holding more than 58% market share.⁶

5. RESULTS FOR THE COMPANY

Biotron's growth is a confirmation of the market's recognition and success of its business model. In 2010, the company received the award MPE Brasil – Award on Competitiveness for Micro and Small Companies, from SEBRAE, in the Industry category. That award has national range and "it acknowledges the micro and small companies that foster increase of quality, productiveness and competitiveness, by dissemination of

management concepts and practices"⁷. The award, which registered the fast growth of the company's portfolio and expansion of the business, was a landmark in the company's history, consolidating its credibility with the market.

Another important milestone in validation of the company's business model was the launching of the Negatoscopes UltraSlim line, in 2012. Negatoscopes are equipment units provided with special lighting to observe the negatives or radiographic plates⁸. The products of the company from the South of the State of Minas Gerais are differentiated from the others available in the market, with more sophisticated and efficient technology, besides being much slimmer. The market acknowledged that innovation, and today the equipment is the most successful in sales, being prominent among the other products of the portfolio, nowadays comprised by 25 products. In 2013, the company was certified by ANVISA in Good Manufacturing Practices – GMP of medical products, aiming at launching new products with more sophisticated technology.

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⁶ Available at: <<http://www.brazilianhealthdevices.com.br/market>>. Access on: November 4th, 2014.

⁷ Available at: <<http://www.mbc.org.br/mpe/index.php/apresentacao>>. Access on: November 4th, 2014.

⁸ Available at: <<http://www.dicio.com.br/negatoscopio/>>. Access on: November 4th, 2014.



the years. In 2014 there was an increase of 80% in sales, with revenues of R\$4 million. For 2015, the forecast is that sales increase in 50%, with revenues close to R\$ 6 million.

6. DEVELOPMENT AND PERSPECTIVES

Within the range of products development, Biotron's main future launchings will be the result from projects which are in progress, in partnerships with universities. An example of that is the bionic orthosis, created in partnership with the State of Minas Gerais Federal University – UFMG, which might allow recovery of members movement in patients with movement disability derived from stroke. Other products licensed from patents registered by researchers from other universities are in the final phase of preparation for going-to-market. The strategic planning for the next years forecasts that increasingly more the company's products shall come from those types of licensing, as they have already embedded a whole scientific knowledge that abbreviates its process of innovation.

Besides the products developed in partnership with universities, the BioSense, its first developed product, is also in the go-to-market process. After the bureaucratic problems faced for its registration with ANVISA, in the beginning of the company's history, the project remained in stand-by until 2013. Nowadays, the team has been working again with this

equipment, simplifying the product for a more commercially attractive version. Following the model of design by certification, adaptations and changes are being performed focused on the rules that must be observed to attain the registration. Other products that face the same difficulties are also in the phase of adaptation. Therefore, the design by certification may be added to the company's business as a practice of innovation management, mainly within the range of development of more technologically sophisticated products and with higher added value.

The company also plans to resolve the problem of production escalation, which it has been facing, as the number of requests today is higher than the production capacity. Two alternatives are being studied: construction of proprietary manufacturing plant, in a land that was granted by Santa Rita do Sapucaí City Hall or assembly of products in China – two very different paths, evidently, depending on miscellaneous future scenarios.

The company's planning and perspectives follow its value proposal focused on innovation. The company is an example of the statement that technological innovation is also possible in the small company when the market strategies and business model are well structured. Biotron's main trump cards today are the credibility and the good relationship established with the ultimate users and the partnerships for development of its products.



CRODA DO BRASIL 2

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HIGH REFINING OF PLANT OIL – RESEARCH AND INNOVATION IN THE BRAZILIAN CHEMICAL INDUSTRY

CRODA

Croda do Brasil has internally developed new technology to produce special oil for the veterinary health industry. That would not be something so extraordinary should the production route not be totally different from the one with patent already registered and well-established by its own parent company. The Brazilian final product has quality identical to the original one, and the process is more economic and more environmental friendly. The merit of the project lies mainly on the analytical capacity and knowledge of the Research and Development Team, and its bold behavior of not accommodating in the position of being mere receiver of technological packages.

1. THE COMPANY AND ITS SECTOR

Croda is an English multinational company, world leader in Chemical Specialties, mainly in the natural oils refining and processing segment. Its products are traded to a large variety of consumable industries across the whole world. In 2013, the company's global revenue exceeded £1 billion. The company has operations in 34 countries, encompassing Europe, Americas, Africa, India and Far East. Its structure is

comprised by 18 Research and Development Centers, 17 manufacturing units and 46 sales offices, counting with more than 3400 employees, and being listed, since 1964, within the chemical products sector of the London Stock Exchange.

The company was born in 1925 when George Crowe, then an owner of Merchant ships, bought a plant in Yorkshire to produce lanolin - a natural wax found in the wool that has to be extracted after the shearing, before its processing. The leader companies in the cosmetics market of that time started to use this product in the 50's, during which period Croda started its worldwide expansion. Today, the company serves skin and hair care markets, extracts of plants for personal and industrial use, excipients, solubilizers, proteins and biopolymers for nutritional, pharmaceutical, dermatological, veterinary uses and many others¹.

In Brazil, the English chemical company was originally established in São Paulo in 1974, but moved to Campinas in 1981, expanding its operations by implementing a lanolin manufacturing plant - a successful bet, considering that the country is the third largest world market in personal care and the largest industry in Latin America. In 2002, a new plant to produce high quality lanolin was launched, the only one of the kind in Latin America. In 2007, it opened a new plant

¹ Available at: <<http://croda.com>>. Access on: October 8th, 2014.



of “world technical level” esters, duplicating its capacity and starting its compliance with the Good Manufacturing Practices (GMP)².

Besides the lanolin products, its range of products also includes other specialties and oil-chemicals for personal care, veterinary, home care, polymers and lining, lubricants and additives for other industrial uses. The company uses various “traditional” chemical processes to convert renewable raw-material (mostly plant oils and fats such as canola oil, coconut oil and dende palm oil) and their byproducts, to then process them into a new range of functional specialties.

The products portfolio, however, is not limited to the “traditional” processes. The Research and Development has always been an important part of the company’s investments, globally, and remarked its establishment in the market. The Technology Investment Group (TIG) division is responsible for identifying and integrating new technologies into its global business structure. With technical centers spread across the world, the company’s scientists work close to one another, sharing ideas and information. That structure enabled creation of several exclusive and patent registered technologies.

² Available at: <<http://www.croda.com/home.aspx?s=1&r=73&p=99>>. Access on: October 8th, 2014.



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The company
invests in
human capital
and stimulates
production
of internal
researches and
development
of proprietary
technologies.”

The advanced Puremax™ purification and concentration technology, for instance, assists with creation of high quality pharmaceutical products and guarantees the company's position as one of the largest world suppliers of fish oil and Omega 3 concentrates. Crodarom, division that produces plant and botanic extracts, has developed its own microwaves technology to extract actives and it reaches the highest levels of purity. Another exclusive technology is the Super Refining™, which reaches the standards required by the healthcare and pharmaceutical markets.

The Research and Development department of Brazil's subsidiary launched in the market, in 2008, a technology which is alternative to the Super Refining™ that allows reaching equivalent quality requisites. The new process has reduced cost and it does not use organic solvents, making it more environmental friendly. It was entirely developed by the team of Brazilian scientists, after identification of a market necessity. The success of the project consolidated the Brazilian subsidiary towards the group as a provider of high quality solutions and technology, proving that scientific knowledge in the Brazilian industry can be leveled with the international industries.

2. THE STRATEGY – THE PROJECT ALIGNMENT WITH THE BUSINESS

The English chemical company's business model uses the strategy of distributing the series of technologies held by the company among the several plants across the whole world.

Each plant is specialized in some technologies and Brazil holds four of them: refining of oils and fats, production of esters, production of blends and production of amides.

Concerning Research and Development – R&D, most of the chemical multinational companies count with research centers in Europe or in the USA and they do not perform researches in Brazil, where, usually, they work just with transfer of technology. The Brazilian subsidiary also receives this type of demand from the parent company – ready technological packages for local adaptation and production. Clearly, the adaptation demands hard work – due to the differences in the local climatic conditions, equipment and raw-material that, although being alike or similar, are not identical to the original ones – but it is much less complex than development of a totally new process.

However, the Brazilian subsidiary decided not to accommodate in the position of receiver of ready technologies from the parent company. The company invests in human capital and stimulates production of internal researches and development of proprietary technologies. The R&D professionals – coming from the Chemical, Chemical Engineering, Biology, Pharmacy industries – are distributed between synthesis and application. There is also a team dedicated full time to research, to think and develop new things, working in projects aligned with the company's global strategic planning. The department maintains the view of developing products that have global application, not





being limited to the domestic marketplace. Thus, since the design of a product, requisites such as regulatory aspects in different areas of the world are analyzed, principles of Green Chemistry, global availability of raw-material and others.

The development of new technologies and solutions in the Brazilian company starts after two types of demands:

1. Internal identification of opportunities: the team of researchers keeps the look focused on use of by-products of the Brazilian agricultural industry (cane, corn, soy). Through readings, participations in events and their own experience, the researchers try to identify elements that are not being explored, but which have potential for being explored. The ideas generated are submitted to preliminary laboratorial tests and then become draft projects. Those are then shared with the group during cross-disciplinary meetings. In that event, experts from different areas, together with the marketing staff, identify the potential products that might be generated and their different applications. After that, the actual development is started.
2. External identification of opportunities: in this case, the demands are presented by the client, through sales team or the client itself directly contacts the company. In case a totally new product is requested, a market and cost analysis is internally prepared, before starting the development.

One of the eight main business pillars of Croda do Brasil is the line of healthcare products, which encompasses four areas: human pharmaceuticals, veterinary, nutritional and dermatologic. The development project of refining for obtaining Hi Pur Sesame Oil impacts the veterinary area, and it was created after identification of a client's need that demanded important volume. The type of refining made by the company until then in Brazil – and which it continues to perform – serves the markets of topical use, mainly cosmetics. The client, world leader in the market of veterinary pharmaceutical area, uses the high purity sesame oil to produce injections for use in large animals.

The only alternatives of suppliers which the client had in Brazil to purchase the sesame oil were Croda (USA and England), which produces the oil from the process of Super Refining™, and a French company, which uses a different technology to obtain the same product. The new technology developed by the Brazilian subsidiary came as a third possibility.

Two elements contributed to identify the opportunity and create the Hi Pur Sesame Oil project: the confirmation that the company was losing market with its Super Refined™ imported product and the acknowledgment that the client was seeking a local alternative of supply for the production located in Brazil as well. For the pharmaceutical industry, specifically, the search for supply of local raw-material is due not only to economic and logistic matters, but also foreign

exchange, freight and stock. Quality of the product can also be impacted by import processes. Very natural products, which is the case of plant oils, have a short period of shelf life and, as import periods can take months, when reaching the final manufacturer the raw-material might not have the same characteristics as when it was produced. Thus, proximity between the supplier and the manufacturer in the veterinary injections market is an important differential for quality of the ultimate product.

Upon identification of the opportunity, several internal questions arose regarding feasibility of the project and development capacity for the product. Was it possible, with the same technology used to make cosmetic products, to meet the specifications of Super Refined™ oil? The difficulty ended up being a driver for the R&D team. The investigative and bold nature, inherent to the scientists, leveraged the two-year work to adjust the technology and available equipment and reach the refining level specified by the client. The history and success of the project are, therefore, evidences of the relevance of scientific know-how and personnel qualification for innovation in the technological basis industry.

3. THE PROJECT

The client's injection product, for which the product developed by the Brazilian subsidiary of the English chemical company is aimed, represents a great market for it, as it

refers to one of its most sold items. It can be considered as a market classic, already well-established for more than 20 years. And, since its launching, the product already used Croda's oil in its formulation as a vehicle for the active of the injection. The super refining process of the sesame oil was, also, developed for that client.

However, although the Brazilian product had the same characteristics of the one from the English parent company, for the client it is treated as new raw-material. For the pharmaceutical industry, the approval process for change of raw-material is extremely time consuming and expensive. In the specific case of sesame oil, for the client, as the injection is aimed at animals that will be used for human food, the validation parameters are even more demanding and the performed tests are stricter. Thus, for the Brazilian unit, besides the technical challenges of reaching the purity level and guaranteeing the stability intended by the client, it was necessary to conquer credibility so that it would elect to test the new raw-material.

What adds more value to the product specification is the fact that the set of the analyzed variables, associated to the strict and rigorous ranges of the specification, assures that it is high purity product, compliant with the strict quality parameters necessary for use as raw-material for injection products in the veterinary area. Some of the most relevant characteristics contained in the specifications are:

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- Identification (distribution of Triglycerides by HPLC – High Performance Liquid Chromatography³): it indicates that the product is obtained just from sesame seeds, that it does not have blends with other oils and that it has not been chemically changed. It is like a fingerprint of the sesame oil and it would be extremely hard to obtain equivalent triglycerides distribution from another material;
- Color (absorbance, in wave length of 400 nm): a very clear color is an indication that most of the impurities have been removed. Many impurities contained in plant oils present yellowish or reddish color, hard to be removed. That was one of the hardest parameters to be obtained in the developed work;
- Acidity Level (mg KOH/g): low content of acidity is an indicator of purity and refining level of the material, also granting higher stability and lower irritation when in contact with the living tissue;
- Humidity (%): low humidity increases stability and validity period of plant oils;

- Peroxide indexes: low peroxide indexes indicate that the product was processed with minimum contact with air and it will also have more stability;
- Fat distribution: it is also a characteristic of the product, more sensitive than triglycerides distribution, but less selective;
- Content of BHA (ppm – parts per million): the BHA is an antioxidant added to oil and it must have its content controlled within a certain specification range.

Hence, the client's specifications become guiding parameters for conception of the production process of the Hi Pur Sesame Oil. The project development strategy was to add several already existing and well-established technologies, added to chemical knowledge, seeking the best from each one of them, and combine them in a very specific manner to reach the utmost performance.

The challenge laid on the fact that the list of specifications involved almost 30 items and the technology alternatives are many; and, consequently, a very large number of combinations are possible. It must yet consider that, in some chemical processes, small details can generate totally diverging results. Therefore, the search for this new productive route demanded time and dedication, as each stage of the process is unfolded into several variables, which must be optimized one by one.

3 HPLC is a chemical equipment unit used to separate, identify and quantify the components of a blend.

It is necessary to make it clear, however, that the development is not limited to a method of trial and error. The team of scientists performs base researches and bibliographic surveys. Understanding of the product science, besides its theoretical foundations, provides the base necessary to know how to elect the better direction to follow.

In summary, the work involved answering several scientific questions: What makes the product work? What is the chemical principle governing formation of this product with those characteristics? What are the theoretical bases to perform refining of oil? What is the existing knowledge about it that can be used to accomplish the goal? Just after attaining the answers to those theoretical questions it has been possible to also answer practical questions about the process: How many stages are necessary? What are the most appropriate technologies? In which order are them to be used? What quantities or reagents must be used? Under which physical-chemical conditions work in each stage? To provide a dimension of the number of bench tests performed along the development, more than 20 different adsorbents were tested.

Besides the technologies for production of the Hi Pur oil, the actual raw-material is a variable of the process. The conditions of pressing of the sesame to extract the gross oil may vary a lot, influencing its characteristics and the refined product obtained from it. Temperature, type of pressing, use of seed with or without peel, toasted or natural, origin of the seed, and others,



are variables of processing that also have to be enhanced. Raw oils from six different suppliers were tested, each one of them rendering three samples of different qualities for tests.

The exhaustive bench tests of in the laboratory, using previously existing technologies, enabled large scale production in the plant with no need of heavy investments. The company was able to start production of Hi Pur oil using what it already had, with minor changes/adjustments in the plant and purchase of few equipment units. It was necessary to separate some areas and equipment of the plant dedicated to the new product, by the actual softness of purification and to guarantee that there would be no type of contamination. And also by the client's requirement, who audited the plant prior to beginning of the operation.



The whole process of development was close monitored by the client, who received samples for its own assessment to the extent that they were internally approved by Croda. The ultimate product of the requestor and its main active ingredient are extremely expensive, therefore any deviation or change in the sesame oil would be very financially heavy to it. Thus, one of its requirements, besides monitoring the development, was to audit the laboratory, the product, the plant and validate the large scale production. A validation in the client itself was also required for approval of the Hi Pur. The assessment was extremely detailed and long, as its product is already well-established in the market. Assessments of a pilot lot and its stability with the new sesame oil were performed. Then, the first industrial lot was submitted to detailed assessment, with very high level of requirements, including field-tests with animals. The investment dedicated by the client in this process demonstrates the quality identified in the oil refined in Brazil, compared to the English one. Just after approval in all the validation tests, the sesame oil of Croda do Brasil started to be sold in 2008, gradually replacing the product of the English parent company, obtained by the Super Refining™ process.

After approximately two years of regular use of the Hi Pur oil, a new variable appeared in the client's plant that, until then, was unknown itself. That factor generated several problems in a filtration line, which seriously impacted its production time and generated high maintenance costs. The supply used continued to serve the original specifications,

but the problem was observed when the client used it in its manufacturing process. Croda do Brasil, which already had good relationship with that company, mainly due to quality of the product that had been developed on demand, assisted the client to resolve the problem. Two other years were invested in joint research with the client until clarifying the nature of the variable and identifying what else was necessary to do, besides all the items that were already met in the specification. It was necessary to include another stage of refining in the process to reverse the problem.

Through that process enhancement, the company was able to resolve a problem that its own commercial partner had not been able to solve. The fact consolidated the client's confidence and enabled increasing the portion of Hi Pur oil supply, which currently corresponds to basically the entire production.

4. INTERNATIONAL SCENARIO

The most expressive plants in the plant oils refining market use soy, canola and sunflower, which jointly correspond to 80% of the world consumption of plant oils⁴. The sesame seed is an important crop due to its high content of oil, being the ninth most cultivated oil plant in the world. The global production of sesame in 2011 amounted to 4.1 million tons. The planted area covers more than 6.6 million hectares, with approximately 70% of the cultivated

4 MIELKE, T. The *global market for oilseeds and vegetable oils*. [S.l.: s.n.], 2013.



seeds being assigned for extraction of oil and the rest for nutrition. The main producing countries are China, India and Myanmar⁵.

The price of the sesame seeds is currently high in the entire world. It is believed that the main reason for this behavior is China's condition which has been accelerating its change from the position of agricultural producer to importer of commodities, such as sesame itself. Bad harvests of the largest world producer, India, in the last two years, are also considered as important factors for increase of the

5 SARKIS, J. R. *et al.* **Optimization of phenolics extraction from sesame seed cake.** *Separation and purification technology.* v. 122, 2014. P. 506–514.

product's price. The African sesame seed is a reference for the international prices. It is being currently traded at approximately USD2200 per ton⁶.

The sesame seed oil has been used as pharmaceutical product for thousands of years. It is naturally anti-bacterial and efficient against pathogens and ordinary skin fungi. It also has antiviral and anti-inflammatory properties. Today, many "natural" cosmetic products include the product in their formulations due to their antioxidant properties. It has been used in topical preparations in the traditional medicine of India, Africa and Eastern Asia. It is also an important ingredient for formulation of massage oils⁷.

Natural oils are ordinarily used as parenteral vehicles for many pharmaceutical products⁸. That is precisely the main pharmaceutical use today for the sesame oil: vehicle for injectable drugs or intravenous perfusion solutions. It is also used by the cosmetic industry as a carrier or as part of vehicles formulation⁹. The oil for pharmaceutical oil is

6 TANNOUE, I. **Sesame prices near six-year global high.** *Nikkei asian review.* May 12, 2014.

7 HANSEI, R.; HUNTRODS, D. **Sesame** profile. *Agricultural marketing resource center.* Iowa: Iowa State University, 2011.

8 KUPIEC, T. C. *et al.* **Dry-heat sterilization of parenteral oil vehicles.** *International journal of pharmaceutical compounding.* v. 4, n. 3, 2000

9 WARRA, A. A. **Sesame (*Sesame indicum* L.) seed oil methods of extraction and its prospects in cosmetic industry: a review.** *Bayero journal of pure and applied sciences.* v. 4, n. 2, 2011. p. 164-168.



extracted from high quality seeds and it is more refined than the oil assigned for human consumption or food level uses.

5. RESULTS FOR THE COMPANY

The high purity sesame oil of Croda do Brasil started to be traded in 2008. Today, the company is the exclusive leader in the domestic market for sale of this raw-material and, although not having exclusivity agreement with its client, it is responsible for the large volume of product sales. Since its first production until today, the sales increased by more than 300%.

Development of the Hi Pur was made after the local need of a commercial partner of the Brazilian subsidiary, but currently the company manufactures and exports its final product to the whole world and Croda do Brasil has become basically its exclusive supplier. The clients market – which consumes the injection – has not noticed any change in the product: it has not been necessary to have market publication about change of raw-material, as the ultimate product characteristics remained unchanged, evidencing quality of the Brazilian product.

The new Brazilian process, compared to the patent protected Super Refining™, has the differential of not using organic solvents, as refining involves only physical processes. That makes it more environmental friendly and the process can be considered to be “greener”. Furthermore, the original

process uses a single equipment unit for purification, but it is extremely expensive. The Brazilian one includes more stages and it is longer (approximately 48 hours), but the final cost is more advantageous.

Since the first sale of the sesame oil obtained by the patent protected method, 20 years ago – when the product was the exclusivity of Croda, and, therefore, was sold with excellent gross margin – until trade of the Brazilian Hi Pur, price of the product fell and enhancement of the process was extremely important to maintain its competitiveness.

6. OUTCOMES OF THE PROJECT

For Croda do Brasil, development of the new process for obtaining high purity sesame oil represented much more than just commercial gain. The Brazilian subsidiary was not recognized within the group as potential developer of technology, but attained power and credibility, domestically, by demonstrating its capacity of adaptation and development of solutions. After all, its researchers had conceived new technology to replace a much more expensive one, with which its client had actually lost business, because no other team within the group had been able to find an alternative.

The confidence acquired, not only internally but also with the client, represents consolidation of a work philosophy of the research and development department, which keeps itself aware

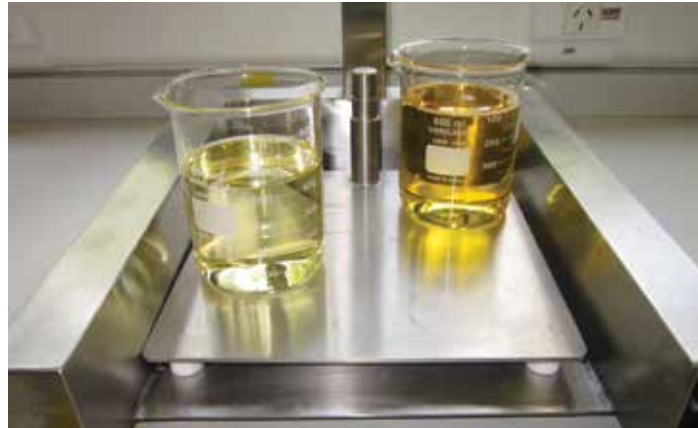


of opportunities and tries to bring everything that is possible to local manufacture. The internal recognition was reverted into receipt of other projects designed by the parent company. In addition, a restructuring of the company's R&D department, in Brazil, was enabled so that part of the team should work full time in innovation – something that did not happen before.

The outcomes of the company's philosophy in Brazil are many and show that development of the Hi Pur Sesame Oil was not



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a strike of luck. Another example of the company’s successful development served as basis for a product aimed for baby care, market leader of a well-known pharmaceutical multinational industry, and that, until then, was manufactured by itself – which is rare in the market. That company decided, in that event, to discontinue production of its raw-material and seek other suppliers. As it did not find any qualified supplier in the market, it opted for transferring the formula, the equipment and the technology to a company that was Croda’s competitor.

Croda then, based on a sample of the product, and even without having the equipment that was usually applied for its production, worked on development of the new route. Using the same strategy that was adopted in the sesame oil project, with the equipment they had in the plant, they were able to obtain a product that was similar to the competitor one, but with higher quality. Thus, it ended up conquering that market.

7. PERSPECTIVES

Commercially, the projections state that until 2015/2016, the sales of Hi Pur sesame oil will grow, and might even duplicate. There is also the expectation of receiving new projects for products and processes development. That perspective results from the main intangible gain derived from the project: the increased confidence before the group and before the client.

The key word for success of the company’s strategy, in Brazil, is credibility. To bet in the human capital as a differentiation to promote innovation, added to the efficiency in prospecting qualified and dedicated professionals, demonstrated to the market and to the parent company itself the value and capacity of the national subsidiary. Furthermore, in a reality where, despite arrival of the Lei do Bem (Law # 11196/2005), the investments in R&D, in Brazil, have not progressed yet¹⁰, Croda do Brasil is an example to prove that it is possible to develop quality science in the Brazilian industry and that innovation can be an important differential for the business and its expansion.

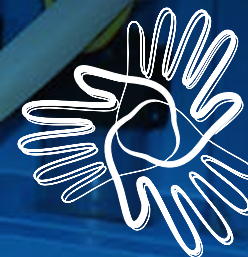
¹⁰ Available at: <<http://www.anpei.org.br/web/anpei/noticias/-/anpei/view/news?id=1015>>. Access on: March 17th, 2015.



EMIATEC EQUIPAMENTOS

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DEVELOPMENT OF ISOKINETIC COLLECTOR TO QUANTIFY EMISSIONS OF ATMOSPHERIC POLLUTANTS



If some years ago the concern with environmental impact was used only as marketing strategy by some companies, today this is a much more relevant matter and several legislations apply across the whole world and also in Brazil. Specifically, the industrial atmospheric emissions were put under the spotlight of the public opinion and of the environmentalists, due to the effect of the greenhouse effect gases in the global climatic changes and the increasingly higher pollution levels in the large centers. Within that context, implementation of Brazilian law for monitoring of industrial emissions, in 2002, was seen by two professionals with technical expertise in this type of work as a new market niche and a major business opportunity: that is how Emiatec was born. The company started only as measurement services provider and evolved to be an innovative and sophisticated technological solution provider embedded in new equipment. That diversification of the business was leveraged by economic matters leading to the necessity of nationalizing technology so that the company could establish itself in the market with sustainable perspectives. The success of that strategy is based on technical know-how, qualification and mainly in the establishment of partnerships and intensification of the relationship with its value chain.

1. THE COMPANY AND ITS SECTOR

Emiatec Tecnologia Ambiental is a small company operating in the areas of atmospheric emissions and air quality, located in the city of Curitiba, State of Paraná. The company from Curitiba was founded in 2003 by two professionals experienced in atmospheric monitoring services who identified a new market niche. That new segment started to be designed from the growing concerns of the governments and international agencies with environmental problems derived from the intense industrial activity, and of new law enacted in the State of Paraná, in 2002.

In the last decades, the manufacturing sector was remarked by environmental matters, which became very relevant for the industries, imposing a large effort on them to adjust to the new requirements. With increasingly demanding environmental laws, the organizations started to include the environmental responsibility into their strategic planning, which includes matters that have broader range than the traditional economic-financial targets. The companies started a strict environmental management process and implemented new conducts to reach targets of atmospheric pollutants emission reduction.

Although in other countries development of environmental laws has been leveraged in 1997 upon adoption of the Kyoto

Protocol, in Brazil, definition of the first legislation occurred in 2002, in the State of Paraná, by the Environment and Water Resources Secretariat (SEMA). The Resolution number 041/2002, by SEMA, created rules for emission of atmospheric pollutants emissions for the State, being revised in year 2006, through resolution 054/06. The 2002 resolution served as the basis for the later discussion held by the Brazilian Environment Council (CONAMA), giving rise to resolution 382/2006, which regulations were implemented in the national range.

Between years 2003 and 2004, when SEMA's resolution became effective, imposing rules on emission of pollutants for the territory of the State of Paraná, the industry was not clear yet about how to proceed. Many companies did not even have information about the resolution, i.e., they did not know how to get ready for a possible inspection. Within that scenario, two technicians familiar with the subject were driven to create Emiatec Tecnologia Ambiental. The founders, both with technical know-how and experience in liquid effluents analysis laboratories and air quality monitoring, perceived a market demand and organized themselves to offer services for measurement of atmospheric pollutants emissions and consulting on good manufacturing practices and prevention of pollution by readjustment of procedures, to be framed within the recently established standards.

The new company was thus included into the arising environmental consulting market, an area not well explored



yet, and found the difficulties inherent to a sector under development, such as, for instance, the lack of national equipment that could cope with the requirements of the applicable standards. To overcome that obstacle and consolidate its business, the company entered into partnerships with research institutes, constituted a local suppliers network and developed the first Brazilian

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The success of that strategy is based on technical know-how, qualification and mainly in the establishment of partnerships and intensification of the relationship with its value chain.”



equipment that uses a method accepted by the applicable standard, giving rise to a company's subsidiary aimed at equipment manufacture.

2. THE STRATEGY – THE PROJECT ALIGNMENT WITH THE BUSINESS

During its initial years, the company worked only in the services area. Following the parameters of the federal and state environmental laws, it offered to the manufacturing sector analyses that allowed measuring of the atmospheric pollutants emission, crucial for the companies' possibility of development strategies to comply with the standards, besides rendering advisory during planning and establishment of actions aimed for the targets of reduction of the concentrations released by the industries.

Quantification of particulate matter (PM) issued in pipes and chimneys of stationary sources enables the framing into the legal emission standards established in environmental standards. The data also allows the industry to assess the necessities and efficiency of its manufacturing process. Among the methodologies accepted for collection and analysis of the PM, the isokinetics has been proving to be the more adequate, as this principle enables collection sample that is representative of the entire flow of gases emitted by the chimney.

In the condition of being a small company without many resources, the investment in analyzers of particles for isokinetic measurements available in the market was unfeasible. The market for this type of product was also restricted: the company found just two options of commercial models capable of performing the measurements, which imposed constant challenges to its routine of activities. The equipment that presented better accuracy was imported from Germany and had high cost, which led the company to adopt, as its initial strategy, outsourcing of the measurement stage.

Hence, the company established partnerships with companies that held the German version of the equipment to perform this stage along the first years of action. However, that business model was very fragile, as the perspectives of financial gain and the possibility of attaining fidelity of the clients' portfolio were very pessimistic, considering that in any next contracting of the service, the client's chance to directly contact the company in charge of the measurement, avoiding the costs of a mediating company (in this case, Emiatec), was great.

It was at that instance that the businessmen, initially to stay in the market, initiated the project to develop a piece of equipment capable of performing analyses following methods accepted by the regulated technical standards. Adopting the principle of isokinetics, the first prototype of the



Criosfera 1



PARTNERS



collector, baptized as ER1, was designed in 2004, taking into account all the important functionalities to verify emission of particulate matter in pipes and chimneys.

After several tests and standardizations, the company's isokinetic collector was assessed and validated by the Environmental Institute of the State of Paraná (IAP). In what refers to collection and analysis of the PM, the standards suggested in the laws are the ABNT NBR 12.827/1993 and the ABNT NBR 12.019 or equivalent methodology, provided that it is approved by the environmental agency. In the case of the State of Paraná, as ER1 was a new equipment in the market, the IAP demanded that the methodology

applied in the equipment should follow the precepts of NBR 12.827/1993 and that its performance should be assessed by another independent official agency. After all the legal procedures, the request was submitted to the Mechanic Engineering Department of the State of Paraná Federal University, which issued a conclusive report on the measures. That document was registered with the IAP, which, after detailed assessment of the document, issued favorable opinion about the methodology applied and developed with the ER1.

With the validated method, the self-financing and inexperience in management became great hindrances for the company's development, despite of its recognized technical qualities. To overcome those bottlenecks, the company elected incubation with INTEC (Technological Incubator linked to the State of Paraná Technology Institute - TECPAR). The company maintained its prior structure, which was characterized as the first case of external incubation of INTEC. The incubator provided management consulting to the micro-businessmen, a valuable support to the company, which started to consider new sources of financing, besides being qualified in areas which they did not hold expertise in, changing their business view.

After the company's strengthening, new clients were conquered while financing lines appeared to enable improvements of the created isokinetic collector. The 2009







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The incubation environment enabled network expansion with potential partners for development of Emiatec's technological solution.”

PRIME was one of those, and enabled development of one part of the ER1, which still required attention for its better functioning. The Program for Support of Research in the Small Company - PAPPE/SEBRAE-PR, from 2009, complemented the needs both of supplies for the project and human capital to resolve matters that could become hindrances, being the main communication channel between SEBRAE and the company. Meanwhile, the incubation environment enabled network expansion with potential partners for development of Emiatec's technological solution.

The company used the measuring device during the services rendering and, thus, by quality and accuracy of the supplied reports, the ER1 became well-known and attained credibility in its segment. After the results from a survey developed, which involved comparison tests between similar products present in the market, made by agencies specialized in the subject, the company found a new opportunity: the possibility of changing the developed technology into a commercial product.

That is how Emiatec Equipamentos was created, an extension of the original Environmental Technology company; it was created with the purpose of producing and trading the isokinetic collectors. The company (with expertise in the services field) is tracing its sales strategy with the assistance of SEBRAE, aimed at consolidating itself as one of the main suppliers of pollutants metering devices, reaching the entire national territory.

3. THE PROJECT

Development of Emiatec's atmospheric emissions metering device was fundamentally based on nationalization of technology aimed at reducing the product cost, until then available only by import. Inspired on a German model, the product was built according to the provisions of ABNT NBR 12827/93 standard and its complementary documents, according to the Brazilian laws, which sets forth the maximum limits of atmospheric pollutants emissions for fixed sources. The equipment is aimed at determining concentration of particulate matter in gas flows, in pipes and chimneys.

The first version of the equipment, the ER1 prototype, did not have sophisticated technology, but already used the concept of isokinetics in the collector's structure. The methodology consists of collecting the particulate matter, point by point, in pipes and chimneys of stationary sources. The particles mass is stored in the filtrating system where it is removed and gravimetrically measured in analytical scale. The quantity of particles is, then, related to the collected gas flow volume, allowing calculation of emissions according to time. The product's differential feature lies on its capacity of equaling its collectors' aspiration speed to the gases emission speed by the chimneys and pipes automatically, providing the equipment with higher accuracy in the analysis of particulate matter in pipes and chimneys of stationary sources.

Along the project, the first prototype was being enhanced based on improvement of its adaptation to the industrial environment. Thus, besides the accuracy in collection of matter that was already offered by the ER1, improvement of the project was focused on making the measurement devices more compact, which is relevant from the perspective of its installation in industrial plants, besides fostering innovation in the software for automation, manipulation and automatic assessment of the data, with printing of reports. That work gave origin to the current version of the product, named as ER3 (figure 1), equipment with totally national technology, portable and easily handled, adapted to the conditions of the Brazilian processes.

Figure 1 - Isokinetic collector equipment ER3



Source: Emiatec's Institutional Presentation (2014)

Development of the isokinetic collector involved collaboration with software engineers, enabling adequate operating systems to the device, and product designers, responsible for the physical and functional configuration

of the ER3 and reduction of the device's measures and weight. Today, the collector developed and manufactured by the company has half the weight of its competitors or similar products.

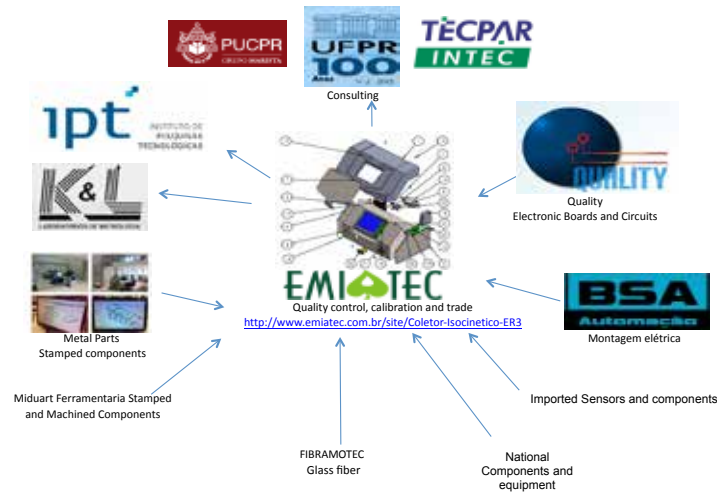
The company also has cooperative relation with research institutes aiming to implement improvements or new functionalities to the developed solution. The strategy for manufacturing the equipment in commercial scale involves functional partnerships such as those established with the suppliers of parts in Curitiba metropolitan region and with the Technological Researches Institute (IPT), in São Paulo, which performs the stage of machine gauging before its delivery. The stages of assembly and performance of the quality tests of the equipment units are performed in the company's headquarters.

The figure 2 presents the network established for creation of the ER3 isokinetic collector. Construction of relations with several agents of Curitiba's local economy enabled the project after several competencies already existing in the region and that, in some cases, had not been explored until then. Thus, development of the new technology did not only represent gain only for the innovating company, but also enabled all the participants of the involved value chain to identify new opportunities to expand their business.

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Figure 2 - Network constituted for production of the ER3



Source: EMIATEC Institutional Presentation (2014)

4. INTERNATIONAL SCENARIO

Emission of the pollutant gases by the industry is a global concern as it has direct incidence in the quality of the population's life, besides generating still non-assessable environmental damages, including those derived from global heating. Several cities across the globe suffer alarming consequences due to generation of residues from their plants' chimneys, which changed the subject into one of the most internationally discussed agendas on the sustainable development.

Despite the several previous international covenants, treaties and resolutions, it was just upon arrival of the Conference of the Parties (COPs), in 1995, that its relevance was recognized and became a relevant subject matter. The agreement also gave origin to several initiatives from international agencies to refrain advancement of the gas emissions in favor of the environment, such as the Protocol of Kyoto and the Agreement of Copenhagen.

Although being a signor of both agreements, Brazil is the sixth country with more emissions of greenhouse effect gases in the world. The country created the National Policy on Climate Changes (PNMC), by the Law no. 12.187/2009, which defines the national volunteer commitment for adoption of mitigation actions aiming to reduce its greenhouse effect gases emissions ((GEE) between 36.1% and 38.9% in relation to the emissions projected until 2020).

When demanding the industries to comply with this regulation, the Brazilian government opens the path for operations of companies in the field of Environmental Consulting, a market of US\$ 27 billion worldwide, which presents annual growth corresponding to 3.5%. The sector is well-divided into large and small companies: twenty-two firms hold 44% of the market share.

The Intergovernmental Panel on Climatic Changes (IPCC), a scientific agency under the authority of the UN, analyzes the

world scientific, technical and social-economic information to understand the climatic changes. In its last report, published in November, 2014, the organism indicated that emission of the three main gases that generate the greenhouse effect is at its higher historical level, and that use of renewable energies, increase of energy efficiency and development of other measures aimed at limiting the emissions would cost much less than facing the consequences of global heating. This affirmation and the numbers used for its basis reflect the growing global concern with the environment and the search for new technologies that allow reaching economic prosperity in ecologically correct manner.

Several business lines appeared, in a manner similar to that of the innovative company headquartered in Curitiba, with the increase of the global focus to mitigate emission of atmospheric pollutants and greenhouse effect emission gases (GEE). The sectors most emitting those gases are those of the Iron and Steel, Paper and Cellulose, Textile, Food and Beverage, Construction Material and Oil Refining.

5. RESULTS FOR THE COMPANY

Development of the ER3 granted significant gains to the company regarding quality of the services rendered, as the equipment previously used did not have its functionalities and versatility. In addition, use of an isokinetic collector,



created internally, during the measurements became an important competitive advantage, conveying credibility and strengthening the company's name in the market.



The visibility granted to the company by its equipment – which became a national reference in the atmospheric emissions area – consolidated a new clients' portfolio and increased its revenue. The users' recognition of the device's quality stimulated the company to expand its range of activities, which stopped working just in the services sector and started to adopt the products sales strategy by the end of 2013. Since then, a transition of the group's focus has been occurring, from the services sector to the manufacturing sector.

As Emiatec uses, in its works, the same equipment traded by it, all the problems faced by its users are also experienced by the internal users. The feedback of that business model caused the improvement to become a constant condition in the process of development, whether in the area of software or of parts.

In less than one year of manufacturing production the company has already made the first sales and it has been receiving increasingly higher number of requests for quotation, driven by the increasing agreements of measurement services rendering and their consequent authentication by the served (and satisfied) clients. The company already makes plans to increase the number of equipment units in the Brazilian market and it aims to reach the Latin American market in the medium term.

The application for industrial property registration of the developed technology was registered with the Brazilian Industrial Property Institute (INPI).

6. OUTCOMES OF THE PROJECT AND PERSPECTIVES

The product development enabled Emiatec to participate in the Criosfera project, organized by the Brazilian Space Researches Institute (INPE) and performed by research groups from Brazilian universities. The project involves an expedition into the Antarctic continent and non-stop monitoring of the atmospheric parameters variation to understand better the climatic changes in Antarctica.

Seeking expansion and distribution of its markets beyond the national borders, the company entered into partnership with an important representative of measurement and analysis instruments that works across the entire Latin America.

Another important gain was the establishment of strategic partnerships with players of its value chain. Those collaborative relations enable the company, besides constantly improving its equipment, to make possible development of new products.

The company projects a very expressive level of revenue by sale of equipment in year 2015. It is a courageous signal for such a young company.



FIT NETWORKS

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DEVELOPMENT OF INNOVATIVE SOLUTION FOR POPULARIZATION OF OPTICAL FIBER INTERNET ACCESS



FIT Networks developed a solution that makes cheaper and enables popularization of optical fiber internet, enabling the Internet providers to take this technology to more communities at cost up to 70% lower than the conventional one. With this project, the company created an alternative solution in the consolidated telecommunications market. The company is an example of the fact that a startup company, with the proper technology and entrepreneurship can challenge the paradigms of a sector and develop a singular and exemplary business model.

1. THE COMPANY AND ITS SECTOR

FIT Networks (abbreviation for Fiber Technology) is a small company that offers technical solutions for ISP (Internet Service Provider), focused on the development of equipment for distribution of optical fiber internet. The company was founded in March, 2012, by two students of the engineering course from the Brazilian Telecommunications Institute (Inatel). Located in the city of Santa Rita do Sapucaí, south of the State of Minas Gerais, Inatel offers the Companies and

Projects Incubation Program, which stimulates and supports students, ex-students and other entrepreneurs to develop their own companies.

Despite being an extremely young startup company, born out of a companies' incubator, the company grew fast and already counts with 21 employees' structure, serving 300 internet providers (mainly small and medium) in 20 Brazilian states. In January, 2014, for the first time, the company reached monthly revenue above BRL 200 thousand and exited the category of micro-company.

One of the advantages found by the innovative company to develop its business was its geographic location. Santa Rita do Sapucaí is a technologic hub known as the "Electronics Valley". The figures are impressive: about 150 micro and small companies of the IT area in a city with less than 40 thousand habitants, to a good extent "overflowing" from its colleges and its technological center. Those companies employ about 10 thousand people and they are expected to generate revenues of BRL 2.7 billion in 2014¹.

1 Union of the Electrical, Electronic and Similar Devices Industry of the Electronics Valley (Sindvel)

Santa Rita do Sapucaí's history with the technology started in 1959, when the first Technical School on Electronics (ETE) in Latin America was created. The idealizer and financial provider of the project was Sinhá Moreira, a visionary that changed the environment of the production centered in the binomial milk and coffee into a technology hub². The school was the embryo that gave origin to Inatel – Brazilian Telecommunications Institute, created in 1965 by José Nogueira Leite, aiming to supply the need for specialized manpower necessary for the technological development of Brazil. The Institute is currently one of the largest research, development and education centers on telecommunication in Brazil.³ Therefore, the region became known as the "Electronics Valley". Today, the technology companies located there launch, in average, 25 products every fifteen days.

Being included into a market where the products' lifecycle is very short, the need to be constantly innovating is inherent to the business of the manufacturer of innovative equipment and solutions. In 2013, its investment in Research and Development – R&D corresponded to approximately 40% of its revenue. The PACPON (Point of Attendance to the Client – Passive Optical Network) is the first innovation developed by FIT Networks, and became its main product. It refers to a technological solution aimed at reducing the cost of delivery of internet access connection by optical fiber. The product has potential to make feasible the offering of high speed and quality access to consumers that do not have access to the conventional solutions, moreover the people from the C, D and E social segments.

In telecommunications, the final connection between the data transmission high capacity crossings and derivations and the consumers is known as "the last mile problem". This name is derived from the fact that, although being basically easy and cheap to extend a new line with large band capacity and speed in a region that is distant from a city, distribute it and connect them to each residence or company of that region is proportionally much more expensive and challenging to the connectivity services provider.

The problems are multiplied by the quantity of installation points and service quality sometimes is impacted by the low technical and economic feasibility of unfolding in a

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2 Available at: <<http://www.otempo.com.br/capa/economia/santa-rita-do-sapuca%C3%AD-vive-boom-de-inova%C3%A7%C3%A3o-tecnol%C3%B3gica-1.912038>>. Access on: October 15th, 2014.

3 O VALE BRASILEIRO DA ELETRÔNICA. Revista Engenhar, v 19, n. 4, October, 2013.



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The optical fiber
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capillary distribution network capable of serving demand of users' traffic. That demand is increasingly more involving transmission of high quality multimedia data. Despite several technological advancements and improvements that have been granting survival to the traditional cables of copper pairs type, legacy of the “traditional” telephone system, this capillarity system, which has not changed a lot in the last 100 years, gives signs of exhaustion. The alternative to offer superior connection speeds is the optical fiber.

The optical fiber is the higher world trend in the telecommunications sector. Its data transfer capacity, which also attains magnitude orders higher than the previous technologies used in this market, improves the speed of data transmission to the ultimate consumer. That enhancement is translated into higher satisfaction of the users in relation to the services of the providers that use such distribution technology.

In Brazil, the costs of raw-material and manpower make its implementation so expensive that the internet providers use more economic means to take their signal to the final users, impairing the experience of the clients and the image of the companies.

The solution for this technological difficulty, which was presented by FIT through the PACPON, provides the internet provider with the possibility of supplying broadband by optical fiber at low cost. The market's acceptance to the

PACPON demonstrates that there is strong adherence between the demand and the solution developed.

2. THE STRATEGY – THE PROJECT ALIGNMENT WITH THE BUSINESS

There is a major need to improve quality of internet access in Brazil, as well as to increase the number of subscribers. Access to information has direct relation with social inclusion and growth of the economy. In this sense, several governmental initiatives were created to incentive the research and innovation in IT, such as the Brazilian Broadband Plan - PNB⁴, aimed at the so called democratization of the internet. But, some technological and economic hindrances are presented to this objective.

The arrival and adoption of the optical fiber alone do not enable popularization of the internet. There are some obstacles to increase quality and quantity of accesses. Installation of passive networks of optical fiber up to the residences has high cost per subscriber and the internet access provider cannot transfer it to the low income client. Meanwhile, the provider is not able to finance that cost, because the time of return on investment is, in average, two years.

4 Um Plano Nacional para a Banda Larga: O Brasil em Alta Velocidade. Ministério das Comunicações – Governo Federal do Brasil (2010).

The innovative company from Santa Rita do Sapucaí, born in the environment of the Electronics Valley, was familiar with this reality of the providers and the need to have more economic alternatives for distribution of its services, without compromising quality. That condition leveraged the development of PACPON, which adoption, by the provider, can reduce in up to 70% the cost of conventional implementation of optical fiber distributors' networks. The solution consists of taking out the signal of optical fiber internet in the post, on the public street, and distribute it for up to eight houses. The energy that makes the equipment work comes from the houses of the clients by the same cable where the internet data circulates, which makes the product and its installation cheaper. Being an innovative product where the company has been concentrating its entire technological, commercial and management efforts, the paths of the company and the product development are even confused.

3. THE PROJECT

FIT Networks' two founder partners met inside Inatel's Incubator, in the beginning of 2012. While one of them already had an incubated company and was seeking a new project to develop, the other reached the incubator with an idea, seeking for partners to change it into a

tradable product. The initial project involved just one of the components of what today is the PACPON.

Participating in the environment of the incubator, the partners were able to adhere to the Nagivale – Nucleus for Support of Innovation Management of the Electronics Valley project, which is intended for assisting the companies of the LPA – Local Productive Arrangement of Santa Rita do Sapucaí to implement innovation processes and learn how to manage the related questions.⁵

*Nagivale is coordinated by the Bureau on Information, Development and Innovation of the Local Productive Arrangement of Santa Rita do Sapucaí - BIDI, a program of FAI – Management, Technology and Information Superior Educational Center, in partnership with the Nucleus on Technological Management of USP - PGT/USP and the Sciences, Technology and superior Education Secretariat of the State of Minas Gerais and FAPEMIG – Foundation for Support of Research of the State of Minas Gerais. The resources are funded by the Studies and Projects Financer - FINEP, by the Brazilian Scientific and Technological Council - CNPq and by FAPEMIG.*⁶

5 Available at: <<http://www.difusora1550.com.br/noticias/jornal-noticias-dodia/?id=3065>>. Access on: October 9th, 2014.

6 Available at: <<http://www.tecnologia.mg.gov.br/noticia.php?idNoticia=758>>. Access on: October 9th, 2014.

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*The project works in partnership with the Union of Electrical, Electronic and Similar Devices Industries of the Electronics Valley - Sindvel and Inatel's companies incubators of Inatel, Municipal of Santa Rita do Sapucaí and INCIT – Technological Basis Companies' Incubator of Itajubá, with the main purpose of developing and implementing an Integrated Innovation Management Program to benefit the 50 technological basis companies associated to those institutions*⁷

Nagivale's impact on the company involved not only its internal structuring, but mainly enhancement of the PACPON's project, which first prototype was concluded in November, 2012. Already in the subsequent month, the equipment was validated by the tests performed by a small internet provider, belonging to the family of one of the partners. The subsequent stage of the project consisted of structuring the product manufacturing process.

At that instance, they were faced with the difficulty to find a supplier for GEAPON processors, which are key parts for the manufacture of PACPON. Being still a very small company, they could not get access to the manufacturers' technical documentation that also refused to supply in small volumes. The pathway found by the company to bypass that adversity was to internationalize manufacture in China. Another factor

was also decisive for adoption of that strategy: the cost of the parts. As a significant part of the PACPON's components is comprised by low value parts, the costs of parts and of manufacture are crucial to have margin in the sale and business sustainability.

Seeking alternatives, the company found, also in China, a manufacturer with potential to supply the printed circuit boards according to the project's requisites. After intense round of negotiations, the Chinese company signed a products' exclusivity, manufacture and supply agreement, meeting the project specifications. That commercial agreement had supply limit of 5,000 boards. After that, it was agreed that the technology used in the manufacture would be delivered to the Brazilian company. The argument used to conquer that benefit was that the costs of import in Brazil made the operation unfeasible in the long term and that purchase of the boards, without the printed circuits, would be continued (the tax burden for the board without the circuit is smaller).

The next stage was to guarantee the intellectual property of the product. The application for patent of the PACPON was registered with the INPI – Brazilian Industrial Property Institute in 2012. Thus, with the manufacturing structure guaranteed and after taking all the precautions to protect the invention, FIT Networks decided that it was the time to present its solutions to the market. The first efforts were focused on offering the product to the members of the

⁷ Available at: <http://www.fai-mg.br/portal/download/pub_dw_nagivale.pdf>. Access on: October 10th, 2014.

Brazilian Internet Providers Association, which counts with approximately 600 associates in Brazil as a whole. That event was a landmark for the Company. Businessmen from all the regions were willing to know the innovation and, even before the first sale was closed, two of the contacts became business angels, which provided the necessary capital to initiate the production and definitely enter in the market.

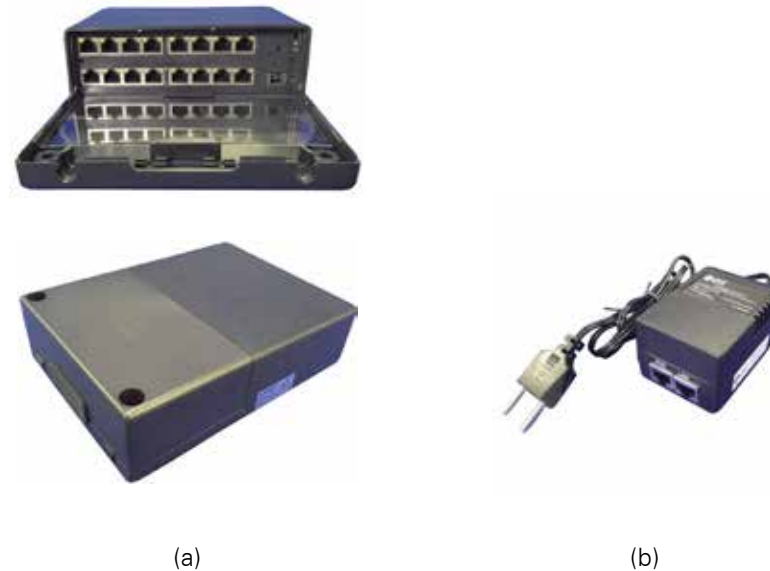
The PACPON equipment (Point of Attendance to the Client – Passive Optical Network) is a unique solution in the sector. It consists of taking the optical fiber only up to a post on a public street and distribute the data through traditional network cables, of the copper pairs type UTP (Unshielded Twisted Pair), to up to eight neighboring residences. The large differential of the solution is the Reverse POE concentrator, a system that energizes the equipment through a source in the house of each subscriber, which transmits energy through the same network cable where the data is transmitted. The system provides the internet provider with the possibility of supplying broadband, by optical fiber, at cost 68% lower than the alternative system FTTH (Fiber-To-The-Home), which delivers the optical fiber in the house of the subscriber.

Technically, the PACPON gathers 3 equipment units in a printed circuit board:

1. The optical fiber terminal, which transforms the light signal that comes from the fiber into a treated electrical signal;

2. The switch, which divides the electrical signal to 8 users;
3. The reverse POE concentrator, which is the great differential of the technology, for energizing the PACPON from the POE feeding sources that are installed inside the subscribers' residences.

Figure 1 - The equipment units (a) PACPON and (b) reverse POE



Source: FIT Networks Institutional Presentation (2014)

The costs saving to the internet providers offered by PACPON is due to the lower number of equipment units necessary to take the optical fiber signal to the ultimate client, compared to the other methods. In addition, the equipment exempts the provider from the installation and maintenance of the electrical network in



the street posts. The supply is made by the POE source installed in the ultimate client's property by the UTP cables, which are the cheapest and more viable for the distances of up to 100 meters.

4. INTERNATIONAL SCENARIO

The technology of the PACPON is unique and innovative, as it is a multipoint service system by which the internet accesses provider can render several other services such as telephone, paid TV, interphone and video monitoring. However, every type of service that takes internet to the client's house is a potential competitor. There are several technologies with lower level of development which are competitors of PACPON, with most of them coming from international companies. That is the reason for the necessity of search for national competitive advantages such as accreditation with the network of suppliers of the BNDES Card and the production in Brazilian territory.

The structure of distribution of broadband by optical fiber, where FIT Networks is included, can assume more than one configuration. The general term FTTX (Fiber to the X) is used to name the several possible configurations of optical fiber installations. The industry of telecommunications differentiates the FTTX structures according to the following categories⁸. The

PACPON replaces the signal distributors used in the FTTN and FTTC categories.

- FTTN (fiber to the neighborhood): The fiber ends in a street cabinet, usually hundreds of meters from the ultimate consumer. The final connections are made with copper or coaxial cables. This method guarantees more economy to the providers, as a single distributor can distribute the broadband signal to several clients in a region;
- FTTC (fiber to the cabinet): It is very similar to the FTTN, but the street cabinet or post is closer to the ultimate consumer, within up to 300 meters radius. This method is also somewhat economic. However, this point attached to the post requires electrical energy to issue the signal to the clients and the cost is transferred to the internet provider;
- FTTB (fiber to the building): The fiber ends within the limits of the building, such as the garage of a condominium. In this case, the signal can be distributed across several points in the same building. There is no cost of electrical energy for the provider, but the expenses with infrastructure are greater;
- FTTH (fiber to the home): The optical fiber reaches up to the ultimate consumer's house, such as, for instance, a power switch panel in the wall of a house. This is the method that guarantees the best broadband quality to the

8 Available at: <<http://www.dslreports.com/faq/3383>>. Access on: October 2nd, 2014.

ultimate users, but its cost is even 10% more expensive than the FTTN for each client served, due to the costs of the optical fiber and the equipment used in the center.

The FTTN and FTTC broadbands are largely used in the global market. Their advantage towards the FTTH service is that they have lower costs to the providers. The disadvantage, however, is that the connection speed is limited to the capacity of the conducting cables – an UTP cable, today, can transmit maximum connection speed approximate to 100Mb/s, while in a direct connection by optical fiber it reaches up to 5Gb/s.

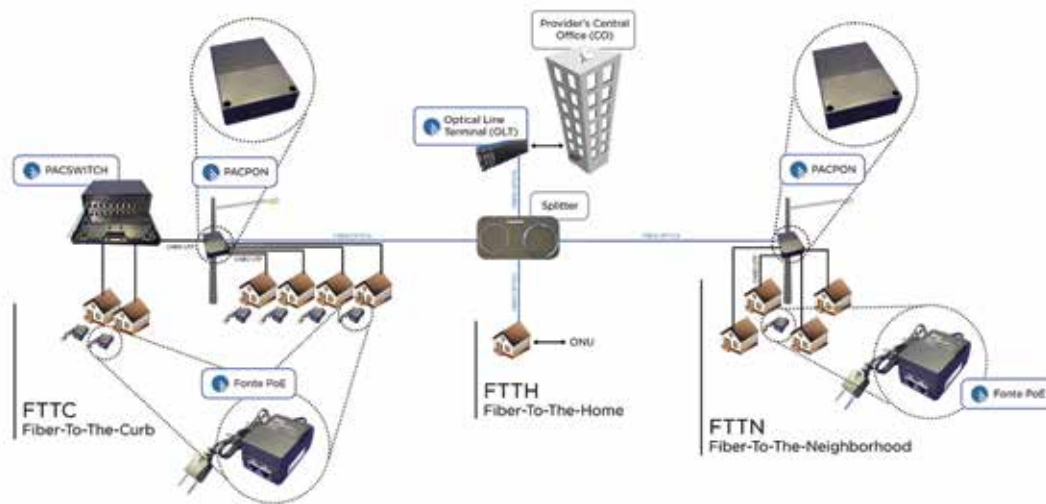
Most of the developed and emerging countries started to implement FTTH systems after the decade of 2010, but the estimate is that in most of them the transition process will be extended up to approximately 2020. In Italy, for instance, the FTTH exists since 1999 and in September, 2012, the four largest internet providers announced a national plan to take the connection at 100Mb/s to 10 million subscribers until 2018. In New Zealand, the government started, in 2013, a FTTH project that will cover 75% of the population until 2019⁹.

The scenario of the Latin-American countries is similar to that of Brazil: the FTTH optical fiber is available only in



large urban centers and for a limited audience. The main hindrance to the change from FTTN/FTTC to FTTH is the high cost of large scale implementation of the optical fiber and low densities of use. The PACPON is presented as an intermediary solution for this problem, positioned closer to

⁹ Available at: <<http://www.dslreports.com/faq/3383>>. Access on October 2nd, 2014.



the subscribers' residences than a traditional FTTC solution and without the costs of equipment energizing, usually associated to that modality. However, an innovative company from Santa Rita do Sapucaí understands that today, in the telecommunication area, renewal and appearing of new technologies happen too fast. The company expects that, in the long term, a technological advancement will arise which will enable implementation of optical fiber with much more affordable value and that computer processors' capacity will overcome the limit of the UTP cables. For those reasons, the company invests on research and innovation, aiming to keep its portfolio updated and well-administered in order to follow-up the changes and renewals of the market.

5. RESULTS FOR THE COMPANY

The PACPON quickly raised FIT Networks from the category of startup to newcomer in the market. In a little more than one year the company became known in Brazil by a good portion of its target audience. Its monthly revenue went from BRL 35 thousand in June, 2013 to BRL 545 thousand in June, 2014.

In the second half of 2013, the average monthly production volume was 200 PACPONS, 200 switches and 1000 POE adaptors. Due to ANATEL's registration, the company attained credibility in the market, reinforced by its accreditation for sale through the BNDES card and conquering of Futurecom's

award. Already in the first half of 2014, its numbers raised to 1000 PACPONS, 500 switches and 3000 POE adaptors per month. FIT Networks currently has client portfolio that includes 300 providers (from a total of 4500 internet provider in Brazil). Its current market share is 0.5% and the estimate is that it shall reach 5% in the next three to five years, but that share is associated to market expansion.

With the financial gains derived from its solution, the company started to invest in diversification of its portfolio. Today it manufactures a product that expands the PACPON and has 3 projects of new products underway to increase the number of users served by equipment. With the PACPON, in October, 2013, the company was the winner of the StartUp Session award, promoted during the Futurecom, the largest and more qualified Information Technology and Communication event in Latin America. The award brought along prestige and recognition to the company and, mainly, contributed to strengthen the image of the newly created product.

Another important accomplishment during 2013 was to be assigned funding approximate to BRL 80 thousand from SEBRAE-MG, accessed through the notice to bid of the SEBRAETEC. The money was used to update the PACPON device and the company's portfolio.¹⁰

¹⁰ Available at: <<http://www.inatel.br/empreendedorismo/noticias-sp-1789509489/sp-551/page-11>>. Access on: October 13th, 2014

In the beginning of 2014, the company exceeded the limit of monthly revenues of BRL 200 thousand assigned for the micro-company category. Yet during the first half it reached a number of orders enough to nationalize manufacture of one PACPON's components. By the end of 2014 the company achieved a 12-fold increase in its incomes compared to 2013.

6. OUTCOMES OF THE PROJECT

The fast business growth exceeded the growth of the organizational structure and impaired balance of the company's management. To bypass the problem, in a pioneer manner within the Brazilian incubation environment, it adopted corporate governance practices. The partners participated in training session in the area and incorporated to their calendar monthly meetings with the shareholders under the guidance of an expert. In addition, an independent advisor and a business consultant started to work together with the executive board, supporting implementation of the main management practices.

A real structural assessment of the company was prepared in the first half of 2014, which enabled its managerial control and implementation of best practices in structure, according to the reality and objectives of the organization. As part of this new innovation management model, the company started to use tools



such as the SWOT Matrix (Strengths, Weaknesses, Opportunities and Threats) and the Innovation Funnel to prepare its projects.

The product became the company's mainspring. Today, besides being registered by ANATEL (Brazilian Telecommunications Agency), its sale can be financed by the BNDES card – Brazilian Economic and Social Development Bank. After reaching the milestone of 5000 units sold, in May, 2014, FIT Networks stopped importing switchboard from China and started to outsource its production to a Brazilian company. That fact reduced the logistical costs of the manufacturing process and the product became more competitive.

This is an interesting maneuver as it goes against the flow of the world logistics trends. The western companies have been trying to reduce their manufacturing costs by partnerships with China due to the low cost of manpower and raw-material, supplies and components.

7. PERSPECTIVES

FIT Networks is currently focused on expanding its products mix. SEBRAE's support, through the SEBRAETEC, and the protocol of intentions with the government of the State of Minas Gerais, which grants deferral of the ICMS tax for three

years, are incentives so that the company can invest in its growth and in diversification of its portfolio.

In some months, the company will be graduated and leave the incubator. Several large distributors were interested in reselling PACPON, however, the distribution channels would add another cost to the product and, for now, there has not been feasible to establish this type of partnership.

For 2015, the purpose is to purchase machinery to internalize manufacture of the components and reduce the manufacturing cost in order to gain competitiveness. Also in 2015 the operation of the tax benefit of the Basic Productive Process (PPB) starts, granted by the Federal Government to all electronics companies, so that their products can be more competitive with respect to international competitors.

The growth rate observed in 2014 is also expected for 2015. That estimate of fast growth is impressive as this is a small company, still undergoing the process of manufacture internalization. This outlook demonstrates the market's acceptance of the new technology and validates FIT's business model, focused on the small and medium internet providers. The PACPON project and its success exemplify the importance of incentive to innovation in one of the most growing sectors in Brazil and in the world.



FOTOSENSORES

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THE CHANGE OF AN EQUIPMENT AND SERVICES COMPANY INTO A PROVIDER OF STRATEGIC INFORMATION BASED ON BIG DATA – THE STORY OF FOTOSENSORES’ REINVENTION



With an increasingly higher number of vehicles and drivers travelling on the Brazilian and worldwide roads, management of those territories of conflicts requires adequate tooling that enables ubiquitous coverage and guarantees enforcement of the law. Fotosensores was born out of creation of devices that assist the authorities to enforce the laws and thus it has been facilitating the coexistence in those circulation spaces which are still the stage for thousands of daily accidents and deaths. After contributing for creation of a market specific for this type of equipment – which was then very innovative in the Brazilian urban environment – the company started an orthogonal path, but totally integrated into its history and products portfolio, reinventing itself as a supplier of intelligence solutions for urban mobility, traffic engineering and public safety.

1. THE COMPANY AND ITS SECTOR

The Brazilian cities have been experiencing the phenomenon of fast increase in their automotive vehicles fleets. Just between 2003 and 2010, the general fleet of vehicles registered in Brazil grew almost 77%. From that total, 82% belong to the individual transportation segment. That is the numerical expression of another economic and social phenomenon. Significant portions of the population have adhered to having their own car as the transportation means, which is paradoxically becoming increasingly more necessary in the large urban centers, while also becoming more ineffective, due to the traffic jams. The economic growth, more accessibility to credit and insufficient investments in good public transportation alternatives leverage and catalyze this reaction, resulting into increasingly alarming figures, whether by the hundreds of kilometers of streets with traffic jam, or by the deaths and severe injuries of which pedestrians, passengers and drivers are victims.

Fotosensores Tecnologia Eletrônica Ltda. is a company from the State of Ceará, established 21 years ago, developer of technologies and solutions to assist the public authorities and managers in the challenging mission of monitoring, repressing and educating millions of vehicles and drivers that circulate across the entangled mazes of streets, avenues and roads.

In the beginning of the 1990's, adoption of equipment, currently known in Brazil by the nicknames of "sparrows", "radars", "owls", started to show good results in England and in Australia, registering sharp reduction in the number of fatal victims of traffic accidents. During that same period, one of the company's founders, researcher of the State of Ceará Federal University, aware of this type of technology and its positive impacts, conceived a system to make photographic records of some traffic infringements, such as crossing of red light and disrespect of speed limits on the streets and roads. A technological basis company was then born, in 1993, from this project's university spin-off. First, the company was incubated in PADETEC (Technological Development Park of the State of Ceará Federal University), where it remained until 1995.

During that initial period, the company from Ceará attained a business Angel, Francisco Baltazar Neto, a businessman and entrepreneur from Fortaleza, who soon noticed the great potential of the business under formation, by the possibilities of economic return and also by the gains for the society. With implementation of the electronic assessment devices, the city of São Paulo reduced by more than 30% the number of fatal victims between 1996 and 1998, one year after the devices became operational, in 1997.

The business view and the experience of the new partner were essential for the company's development. However,

after a certain period, the founder partner decided to withdraw from the business. The partners made an agreement whereby the researcher responsible for the initial project would sell his share to a third-party.

A consulting company was hired to find an ideal substitute partner, according to criteria defined by the company: (i) to be from 10 to 20 years older – presumably more mature and experienced; (ii) to have international view and experience and, preferably, to be a foreigner – aiming to expand the business beyond the Brazilian borders; (iii) to have already worked in the transit and traffic sector – thus bringing the necessary network and specific knowledge of the area; and (iv) to hold capacity for investment and capital contribution in the company – thus assuring the support for the company to face the challenges that would come ahead.

The new company worked well, but, likewise what happens in every company that is emerging, Fotosensores faced difficulties. Some of them are typical of the really innovative businesses that, besides financial difficulties, have to overcome legal, technological and cultural issues. For instance, only in 1997 the Brazilian Traffic Code started to acknowledge electronic and physical-chemical evidences as a way of proving infringements. After much argument with legislators, the company was able to influence and convince them about the benefits that the technology would bring to the country and on September



23 of that year, the Brazilian Traffic Code – Law no. 9.503 set forth in its art. 280, § 2:

“The traffic infringement must be proved by declaration of an authority or agent of the traffic authority, by electronic device or audiovisual equipment, chemical reactions or any other technologically available means previously regulated by the CONTRAN”.

During these last 17 years, the technology in which the company was pioneer in Brazil contributed to change the drivers’ behavior and to help prevent and reduce the accidents. Today, there are more than 25 domestic and international companies working in the market of equipment and services for detection and registration of infringements. Some of those competitors were, in the past, assisted by the very pioneer company – a strategy found by the company to overcome the financial difficulties while being able to expand and reach a self-financing level. The company has developed and today it counts with 78 employees, two subsidiaries, two manufacturing units and two research centers, one of them located in the São José dos Campos Technological Park.

The Research, Development and Innovation unit of the São José dos Campos Technological Park was launched in early 2012 and it supports some of the company’s development lines, contributing with urban mobility solutions. Its

location is aimed at favoring and increasing interaction with companies and universities, something that is in the core of the company’s structure, but which can always be reinforced to assure renewal of ideas, access to intellectual capital diversity and expand the company’s possibilities to innovate.

Despite the large territorial extension, divided into more than 5,500 cities with varied demands, the number of competitors has become uncomfortable for the market. What could be alone reason enough for the company to seek new horizons started to make full sense with the perspective of the SINIAV – Brazilian Vehicles Automatic Identification System, which sets forth that every new vehicle will be manufactured with a radiofrequency identification transponder (RFID). Fotosensores thus saw itself no more as a supplier of detection equipment and services, but as a company that provides information and technology to assist the public managers with their work, make adequate interferences and define policies.

2. THE STRATEGY – THE PROJECT ALIGNMENT WITH THE BUSINESS

The combined products-services offered by Fotosensores include the Fixed Intrusive Radar - SMTD and laser Radars and guns - FITES, Electronic and Educational Speed Bumps, Embedded Blitz, Laser Static Radar, Control and Monitoring

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Fotosensores provides information and technology to assist the public managers with their work, make adequate interferences and define policies.”



← Litoral Leste
BR 116 →
Aeroporto →
Serras →

FOTOKORRE

CÂMARA

ESCOLAR

SEDEX

HXV-2200



“
FotoSiga®
is a system
that enables
monitoring of
vehicles upon
detecting their
passing by
strategically
determined
points on the
road system.”

Center – CCO and Traffic Monitoring Center – Monitran and Controllers for exclusive lanes of Bus Corridors and Bike Tracks.

The SMTD – Digital Traffic Monitoring System performs automatic reading of license plates and it is capable of classifying the vehicles into six classes (motorcycle, passengers vehicle, medium vehicle, heavy vehicle, bus and truck), according to their magnetic profile. The system also allows real time monitoring, generation of vehicles flow statistics and video recording.

The Intelligent Electronic Blitz system supports performance of blitz, improving approach of the vehicles. By performing automatic reading of plates and database of automotive vehicles under irregular or violating conditions, the system indicates to the traffic agents which vehicles must be stopped.

The electronic speed bump is a device equivalent to the SMTD, measuring speeds and recording the infringing vehicles' images. However, there is a highly educational additional element: a lighting panel that indicates the measured speed to the driver.

While those products were and still are innovative, the business based on electronic equipment that uses mere and directly the concepts of classical mechanics, Laws of Newton or Doppler Effect – the same one that changes the sound of an ambulance's siren that approaches or gets

distant from us – finds in the market a level of competition and trend for standardization that will necessarily impair the company's notorious position in the future.

There is yet an imperious change in the automotive law with the SINIAV. Implementation of the Brazilian Vehicles Automatic Identification System, previously expected to start its operations in 2014, was postponed. However, the system's startup continues to be in the horizon of the coming years. The RFID technology (already adopted in tolls, parking lots and fuel stations), when applied in mass and under legal support, must complement some technologies currently applied in the products of Fotosensores, such as automatic reading of license plates. In that scenario, the company rediscovered itself as a company that supplies intelligence information on traffic and also that, hidden behind that hill of information – Big Data -, to use a modern expression, there are analytical pearls that can outbreak the manner by which traffic engineering is currently made, as well as enforcement of the traffic laws and repression of crime.

From that view and rediscovery, a new product was created, baptized as "FotoSiga® Segurança Pública". FotoSiga® is a system that enables monitoring of vehicles upon detecting their passing by strategically determined points on the road system. Based on the gathered information, it is possible to trace, by the license plate, the sites whereby the vehicle passed and, thus, assist the police to resolve cases of

kidnapping and theft. Alone, the tracking function would already be an irrefutable argument for adoption of the system, but the more interesting advantages lie on the detection of standards of behaviors that might be signs of criminal activity performed or to be performed. The same Big Data technology used by large corporations to analyze and forecast consumers' behaviors can be used to prevent and solve crimes based on specific standards verified in the behavior of the vehicles involved in suspicious or criminal actions.

The movement to become a company more directed to information and intelligence than to equipment puts the company ahead of the competitors. Besides creating another important appeal for procurement of its equipment and solutions – which are integrated to FotoSiga®– the company turns the competitors into potential partners, as their products and services might start to provide data for intelligent processing by FotoSiga®.

3. THE PROJECT

The FotoSiga® security system project started in 2011, from that new view of the company, which was originally addressed for “traffic control”, built out of its experience and many errors and hits. Noticing that the volume of data gathered by its networks of detectors positioned along the road systems had value by itself and concealed other richness waiting to be extracted and explored, the

company structured a database that centralized the whole information produced. The next step was, naturally, to extract the values hidden in deeper data layers which require algorithms and statistic and mathematic tools carefully build and applied.

Based on that infrastructure, very similar to what occurs in a Business Intelligence (BI) system of the corporate world, the company analyzed, researched and tested functional solutions for some of the problems faced by the managers and police forces that work in the cities.

Maybe the simpler and more direct functionality is the vehicles tracking. In this function, given a license plate numbering, the system is capable of making the partial reconstruction of the vehicle's route, as a network of detectors has photographically recorded all the plates that passed by their cameras and sensors.

Even with that simplicity, this resource helps the police in solving problems that were almost impossible with the traditional approaches – such as unassisted blitz, which works by sampling. However, this does not mean that the system does not work by sampling. The great difference refers to the size and coverage of the sample. It is virtually impossible to hide oneself or avoid passing by one of the detectors. Thus, it is practically certain that the vehicles stolen will be identified and located or



even those that are in process of judicial search. The following figure depicts one of the screens included in this functionality, displaying the photographic records, location and other information of two vehicles considered to be robbed or stolen.

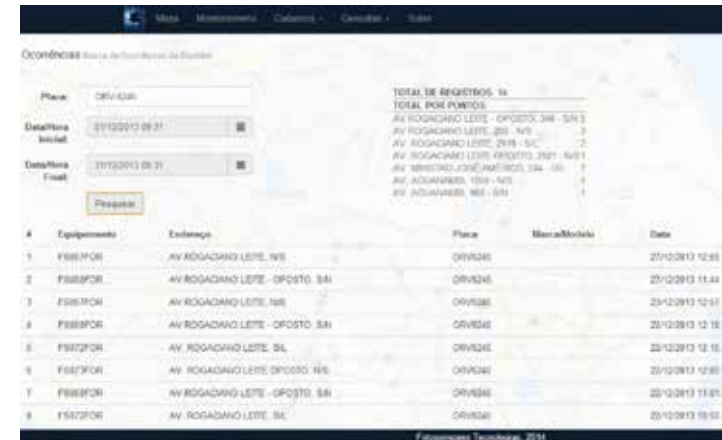
Figure 1 - One of the vehicles' tracking screens: photographic record, location and information on robbed vehicles



Source: FOTOSSENSORES' (2014) Institutional Presentation

Another possibility of this function is to reconstruct the route followed by a certain vehicle, based on the number of its license plate. The following figure depicts a report of a vehicle's route, during the month of December, 2013.

Figure 2 - Report of a vehicle's route



Source: FOTOSSENSORES' (2014) Institutional Presentation

Another important functionality developed by the project is the electronic fencing. It refers to an algorithm that issues alerts and makes records whenever an unauthorized vehicle enters a prohibited area or leaves an area allowed for its circulation. Besides police applications, it is possible to implement and guarantee compliance with a license plates rotation system, such as the one valid in the City of São Paulo during business days. The following figure shows the geo-referenced interface, with overlapping of layers of roads and satellite pictures, for configuration of prohibited and permitted areas.

Figure 3 - Geo-referenced interface for configuration of prohibited and permitted areas in the electronic fencing resource



Source: Fotosensores' (2014) Institutional Presentation

Based on a Control and Monitoring Center, all the applicable aspects of the system previously described and handled by the operators, who can also view the occurrences, obtain reading of the detectors and watch the filming on real time. The figure depicts one of the screens where it is possible to view, live, the images captured by the cameras of a detection equipment unit.

Also, in the Center, the operators can detect cloned vehicles, based on analysis of the movement standards recorded and processed in the system – there are standards of movement which are only viable if there is one, two or more clones of the relevant vehicle.

The FotoSiga® project also sets forth integration to previously existing databases, such as the ones of the Traffic

Departments (DETRANs), Federal Road Police, Public Security Secretariats and records of judicial searches and seizures. Hence, the system operates synergistically with the topology of existing information systems.

4. INTERNATIONAL SCENARIO

In the world, likewise what happens in Brazil, the urban spaces, mainly those aimed for circulation, are increasingly converted into conflict zones: a relation among parties that have different targets, goals, motivations, interests but who share (and dispute) the same physical space during a certain period of time.

Cities such as Singapore, London and Oslo have adopted the urban toll as a way to incentive use of the collective transportation means and to mitigate the issues caused by the growing number of vehicles. Singapore has the urban toll system since 1975. London adopted the system in 2003, for an approximate area of 20 square kilometers. To monitor that relatively small region and impede the violators, the city installed more than 900 cameras in more than 230 points. Good results were attained in the case of the English capital city, with reduction in the number of accidents, improved flow and greater adhesion of the collective transportation means. This type of measure is already under discussion in Brazil, in cities like São



Paulo – which adopts the system of license plates rotation likewise other large cities across the world.

This might be a fertile field for the action of a system such as FotoSiga®, because its electronic fencing function can fully meet the needs of ticketing and punishment system for users and invaders of the perimeters subject to the urban toll.

Between 1993 and 2000, the company submitted seven applications for patents registration to the INPI (Brazilian Industrial Property Institute). Recently, in 2012, it lodged another application for patent registration, which was published in October, 2014.

During the period from 1993 to 2012, in the WIPO (World Intellectual Property Organization), a search for patents on traffic control and excess speed detection systems, with photographic record of the vehicle, accuses approximately 699 documents from 13 countries, 60 being for the PCT (Patents Cooperation Treaty). The international patents are distributed according to the following table. Brazil holds a prominent position in this subject matter.

Table 1 - International patents on traffic control and overspeed detection systems with photographic record of the vehicle, segmented by country of priority

COUNTRY	PATENTS
United States	85
China	84
European Patent Office	80
Germany	62
PCT (Patents Cooperation Treaty)	60
Republic of Korea	59
Brazil	56
Canada	27
Spain	23
Japan	10
Russia	8
Argentina	3
Mexico	1
Singapore	1

Source: WIPO¹

The time series of publications shows that there is a flow of international applications at least since the middle of 2002, with an average number of 37 patents published every year, as shown by the following table.

1 Available at: <<http://www.wipo.int/portal/en/index.html>>. Access on: November 15th, 2014.

Table 2 - Time series of international patents on traffic control systems and overspeed detection with photographic record of the vehicle

YEAR OF PUBLICATION	PATENTS
2004	31
2005	45
2006	24
2007	28
2008	30
2009	51
2010	38
2011	44
2012	48

Source: WIPO²

5. RESULTS FOR THE COMPANY

FotoSiga® is today in the initial phase of trading, being currently operating in the city of Fortaleza. Putting it simpler, the project resulted into diversification of the company's activity; however, it was not limited to that. The expansion of the focus also places the company in a level above the competition while opening a window of possibility for the competitors to be by the company's side, as it is technically and commercially possible for the current competitors

² Available at: <<http://www.wipo.int/portal/en/index.html>>. Access on: November 15th, 2014.

to become partners of the company, supplying data for processing by FotoSiga®.

Hence, Fotosensores ceases to be merely a supplier of combined equipment and services and becomes a company which is also provider of Big Data solutions for traffic engineering and public security. The company has already discovered and developed solutions for a relevant set of problems of those two "disciplines", but certainly there are more hidden applications and behavioral standards, waiting to be discovered and turned into products. Hence, FotoSiga® might be seen as a platform of innovations for the company, as it will enable performing this type of discovery and value creation, based on the information.

6. OUTCOMES OF THE PROJECT AND PERSPECTIVES

The project of the innovative company from the State of Ceará has generated several results for the company and for the society. One of them is the reduction in the number of accidents. To use an example of the company's original city, between 2006 and 2007 Fortaleza recorded approximately 50% reduction in the deaths of pedestrians, 31% in the deaths of cyclists and 32% in the deaths of motorcyclists.

Reduction of deaths, injuries and accidents is good for the society, for the individuals and their families, reducing



irreversible losses and extended suffering. The public treasury is less burdened with lower pressure in the public healthcare network and social security system.

Another benefit generated by Fotosensores with the FotoSiga® project was to provide the public security agents with information and tools that enabled solving several cases of thefts and robberies of vehicles and also a significant number of cases of kidnapping. That reflects in the population's feeling of security, which contributes for better life quality. In addition, by significantly reducing the chances of success of this type of criminal action, FotoSiga® has direct influence in the analysis of risks and cost-benefit performed by the criminals: to increase the certainty of punishment is maybe the most efficient way to fight crime.

The project also teaches an important lesson about the relevance of establishing internal policies of industrial property protection of the technological basis companies. The strategy adopted by the company for expansion and distribution of its business has privileged, in its commercial area, the construction of partnerships; however, the difficulties found to assure protection of its object, even disregarding the typical difficulties of the Brazilian protection system, allowed many of the players to become, on the medium term, actual competitors. That fact forced the company to structure a new internal policy on industrial protection. Although the new policy will not recover the



losses from the past, the company expects that its present and future investments on innovation such as FotoSiga® will be protected against the competition.

The company expects the FotoSiga® to be broadly adopted by the Brazilian States and Cities, which would guarantee huge advantages to everyone and options to fight crime and violence in traffic. For the company, its mission of remunerating the shareholders while contributing for sustainability of the urban mobility and improvement of life quality of the society might continue to be complied with.

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The project also teaches an important lesson about the relevance of establishing internal policies of industrial property protection of the technological basis companies.”



FRASLE
Uma Empresa Randon

FRASLE
Uma Empresa Randon

FRAS-LE 6 ×





INNOVATION TO ASSURE MARKET PRESERVATION TOWARDS THE NEW TECHNICAL REGULATION



A change in the stop distance of the tractor trucks regulated by law in the USA was the starting point for Fras-le, the largest global producer of brake lining, to develop new high performing lining. The product, which attained performance superior to the traditional ones without losing its durability, broke a technological paradigm and strengthened the company's image towards the market. An example of incremental improvement based on governmental requirements, the case of the company from the State of Rio Grande do Sul, manufacturer of components for brakes, shows how the technological innovation was used as the strategy to guarantee its permanence and increased its market share in the US market.

1. THE COMPANY AND ITS SECTOR

The Italian settlement in the State of Rio Grande do Sul's Mountain Area brought along the strong heritage of economic entrepreneurship. In time, several activities were consolidated therein, besides the well-known production of grapes and wine. An economically successful example is the industrial

hub in the region of Caxias do Sul (RS), currently one of the most important hubs of the country, where manufacture of car parts, components and vehicles is prominent.

That hub is the home of the largest global manufacturer of brake lining for commercial vehicles, which also works with manufacture of friction material for light vehicles, motorcycles, trains and subways, airplanes, special vehicles and industrial equipment. Fras-le results from the entrepreneuring boldness of a restless and creative entrepreneur of the car parts industry: Francisco Stedile. Italy was its source of inspiration when, in 1953, during a trip to that country, he was introduced to the technology of FINAFF (*Fabrica Italiana Nastri e Anelli per Freni e Frizione*) for the manufacture of brake lining. In the next year, he created the company "Francisco Stedile e Cia", which object was to "explore the field of car parts manufacture and any other convenient related item"¹.

The company was already born, in the currently well-known expression, "with the DNA of entrepreneurship and innovation". In 1954 "Francisco Stedile e Cia" (the embryo of the company currently existing) after obtaining a license to manufacture from FINAFF – traditional manufacturer

¹ RELA, Eliana. Fras-le: 50 anos formulando sucessos: 1954-2004. Caxias do Sul: Maneco, 2004..

of automotive friction located in Ciriè (province of Turin) – started the manufacture of friction material for vehicles braking. The initial know-how about processing of resins, blending of components and pressing techniques was obtained by the owners' brief internal on-the-job training in the Italian company. The industrial plant initially counted with machinery imported from Italy and with others made in Caxias do Sul. After development of local raw-material and implementation of the manufacturing processes, the first lot of manufactured parts was released in 1955. For twenty years, the technologies and products in the company's portfolio remained the same as initially licensed from FINAFF.

In December, 1995, the company was purchased by Randon Implementos e Participações S/A, which curiously had been the company's first client, 40 years before – at that time named as Mecânica Randon. The brake components manufacturing company's inclination for growth was always guided on continuous enhancement of its products and processes. Therefore, the technological competencies are taken seriously by the company. The company's investments on tangible and intangible technologies are actively part of the company's strategy, being essential for its productive qualification and its market inclusion. Quality of the products and its expertise in commercial management make the company from Rio Grande do Sul a preferred supplier with technological credibility for development of specific



products' demand in the histories of the most well-known manufacturers of commercial vehicles in Brazil and abroad.

Today, the company has global presence, counting with four plants: two of them located in Brazil (Caxias do Sul and São Leopoldo, RS), one in China and another one in the USA, besides commercial offices and distribution centers in Argentina, Chile, Mexico, Germany, South Africa and United Arab Emirates. The company holds broad portfolio of products in the segment, with more than 10 thousand items in friction products for automotive, railway and industrial use. Assembly of efficient commercial structure also qualifies the

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The company's investments on tangible and intangible technologies are actively part of the company's strategy, being essential for its productive qualification and its market inclusion.”



company to serve the clients in about 100 countries spread across the world under the Fras-le and Lonaflex trademarks.

In 2005, the company was awarded with the Diamond Trophy of the PQRS (State of Rio Grande do Sul Quality Award). In 2006, it was acknowledged as finalist of the Brazilian Quality Award and, in 2007, it was awarded and acknowledged as world-class company. In 2008, it was awarded double diamond in the PQRS. In addition, it was the first manufacturer of friction material in Brazil to obtain certification by the ISO-9000 standard, also obtaining the ISO-14001, OHSAS-18001 and the ISO/TS-16949, confirming the company's constant concern with quality, environment, social responsibility and technology.

The pursue of safe and progressive growth of the company induced it to make several strategic decisions that enabled its enlargement and creation of technological, productive and commercial qualification, allowing the expansion and diversification of its products portfolio, as well as compliance with more refined and complex demands from car manufacturers and systems providers (the manufacturers of "systems" and "modules" that integrate the vehicles). The following examples can be cited in this sense:

- The agreement with the German company Textar, in 1968, which allows the company to access the most modern German machinery for its manufacturing plants, as well

as the company's qualification for manufacture of several types of clutches lining;

- Creation of the Francisco Stedile Research and Development Center in 1974; an institutional landmark for generation of technologies, innovation and in-house technological learning. This action allowed meeting the needs of the Brazilian automotive industry which demanded, in larger scales, increasingly complex automotive components in the technical items and in those related to quality and design;
- The technology transfer agreement entered in 1978 with Don International, an English company manufacturer of asbestos-free lining and pads. That agreement allowed using the raw-material blend formula for the brake lining and access to development of the English company's products. Specially, it allowed qualification of the company from Caxias do Sul to manufacture non-asbestos products, and thus to adjust its products to the requisites of the main vehicles manufacturing companies in the world, as well as to the laws of the concerned countries;
- In 1980, the company purchased Lonaflex – its main competitor in the domestic market at that time;
- In 1989, the company entered into another international transfer of technology agreement with the American

company Abex Co. for the manufacture of blocks and lining for cars;

- The purchase, in 2011, of Freios Controil, company working with manufacture of car parts, components for brakes and automotive polymers for the Brazilian, Argentinean and Mexican markets. The purchase of Controil enabled the company to expand the diversity of its products portfolio.

Historically, the manufacturer from Rio Grande do Sul invests about 2% of its revenue in resources for Research

and Development (R&D). In addition, the company is always seeking to develop competencies that are closely related to the “to know how to do”. The partnerships with Universities have been allowing advancement of in-house knowledge in several areas related to innovation in friction material. The company holds broad technological domain of the manufacture processes, research and development of composition of friction material, as well as the tests for assessment of friction components in benches and in vehicles, referring to the mechanic and tribological characteristics – coefficient of friction and wearing out – and characteristics of NVH (noise, vibration and harshness).





The company develops and manufactures friction material for a broad range of segments. However, its focus of action is directed to commercial vehicles (trucks, buses, trailers and semi-trailers), mainly in lining for drum brakes systems. Its main trademarks are, besides the products with the company's name, "Lonaflex", "Best Brake" and "Controil".

The company's consolidate net revenue amounted, in 2013, BRL 717.3 million. The company works in two main market channels: the assembly line segment, serving the demands of car manufacturing companies and system providers, and the components replenishment segment. The latter is the most important of the company, corresponding to approximately 70% of its revenue. Counting the sales for the spare parts market and assembly line, the company assigns 25% of its products to the passengers' vehicles and 60% to heavy models, the remainder is assigned to other sectors.

In the Brazilian marketplace, the company is leader in the OEM² market of commercial vehicles, with almost 90% market share. The domestic market corresponds to 55.5% of the company's net revenue, which percentage is formed by 39.8% from the spare parts market, and

15.7% from the assembly line market. The external market corresponds to 44.5% of the net revenue, with 37.9% coming from the spare parts market and 6.6% from the assembly line market. The countries of the Nafta were accountable for receiving 51.3% of the company's exports in 2013, while the countries of South America accounted for 25.1%, Europe 6.2%, and Africa 7.2%. The North-American market continues to be the main destination of the manufacturer's exports, corresponding to 43.0% of the total exported in 2013.

2. THE STRATEGY – THE PROJECT ALIGNMENT WITH THE BUSINESS

In the United States, the company has held partnership, for 10 years, with the centenary company named Meritor, one of the main suppliers of brake systems for the largest manufacturers of bus, trailers and trucks in that country. Nowadays, about 30% of those vehicles that exit the American assembly lines are equipped with brake lining made by the company from Rio Grande do Sul. In the tractor trucks market, its share of the assembly line in 2010 was close to 34%. The American market is, thus, fundamental for the company's growth strategy and to consolidate both the trademark and the manufacturer.

2 *Original Equipment Manufacturer*, or OEM, is a differentiated modality of original products distribution by which they are not traded to the ultimate consumers. They are sold to other companies that assemble the ultimate products and sell them to the ultimate consumer.

BRAKING IN THE FUTURE

Innovation in automotive brakes is strongly connected to the technological dynamics of the vehicles. There is a co-evolutionary dynamic between diffusion of new technological concepts of the vehicles and the innovation of the braking systems (stricto sensu) incorporated in the vehicles, whether being light or heavy. The literature shows that sovereignty of a certain technological path is not always conquered by purely technical factors. It is usual to have economic and social factors being decisive to make a certain technology the controlling one, even if technically inferior.

The current technological paths for brakes can be classified in two types: the first one, more traditional, related to manufacture of larger, more robust and stronger brakes, adequate to projects of more powerful and faster vehicles. This course is based on the need for use of new (and more efficient) concepts in the manufacture of the pads (or lining) as well as technologically more advanced material.

On the other hand, the growing penetration of the electrical and hybrid vehicles has been leveraging the researches and innovations in braking systems adequate to this type of vehicles. One of the most significant technological advances is that of the brakes based on electrical-mechanic energy (brake-by-wire), which are displacing the current and conventional hydraulic systems, thus being characterized as

“dry breaks”. This technology replaced the function of brake pistons and cylinders – which use brake fluid as the principle of action – by autonomous electrical motor units that have the role of supplying the needs for the new braking systems.

The eventual commercial strengthening of this last path will have the more evident result of creating a technological “dependence path”, and thus increasing diffusion and adoption of non-friction braking systems. In the economic area, the larger scale of those products’ offer might generate several types of savings – whether in the companies, or even systemic – inducing to growth of the non-friction brakes market and, simultaneously, to the relative reduction in the market of brakes based on lining and pads.

The future, by its nature and dimension, cannot be precisely and accurately seen in its totality. However, the History has been showing that one of the few certainties present in the future is the undoubted action of “creative destruction” logic of the technologies, which is inherent to the competition dynamics of the markets. For the entrepreneuring companies, the victorious solution has been to escape from the old and conscious building of the path towards the new.³

3 STOCKMAR, Jürgen. **Developments in Automotive Brake Technology: The Future of Braking**. Available at <http://www.automotive-iq.com/braking/articles/developments-in-automotive-brake-technology-the-fu/>. Access on: September 7th, 2014



3. THE PROJECT

In 2003, approximately 5,000 deaths occurred in traffic accidents involving heavy trucks in the United States. From those deaths, more than 85% were of people that were not in the trucks (the pedestrians represented 8% and the occupants of other involved vehicles, 77%). The great difference between braking distance of trucks and passengers' vehicles was considered to be the prevailing factor in that scenario.

Due to that scenario, the National Highway Traffic Safety Administration (NHTSA), the United States Transportation Department agency that controls various automotive technical aspects, established, in 2004 several targets related to reduction in the number of accidents, number of deaths and material losses involved in them. In order to guarantee accomplishment of the defined targets, the tractor trucks' stop distance allowed by the laws was reduced by 30%, becoming effective in August, 2011, for most of the market's vehicles configurations and reaching the totality of the models in August, 2013.



Although this might look like a simple change, the laws of physics have their details and complexities. Reduction by 30% in the vehicle's stop distance results into approximately 43% increase in its braking capacity. Those requisites represented a great challenge for the engineering teams of the system providers, as they involved increment in the braking efficiency that could not be accomplished by mere improvement of the performance or minor changes to the vehicles. It would be necessary to conceive a new configuration of braking system, requiring redefinition of the sizes and, mainly, of the friction material. The new braking systems project would be awarded by the economic benefits of pioneering in the market and greater market reputation of the product, but those were major challenges.

Meritor, on its side, determined additional demands to its partner and supplier from Rio Grande do Sul, namely:

- The new configuration of the brake system should be kept in the technical course of "drum brake", due to the cost difference in relation to the disk brake system – simulations showed that use of drum brake would result into increase of the vehicle cost by US\$ 211, while use of disk brakes would result into US\$ 1,475. Further to the cost factor, maintenance of the drum brake technology would avoid a systemic transition cost, as more than 95% of the heavy vehicles assembled in the United States still used drum brake;
- Composition of the new friction material should meet the ecological regulations of the states of California and Washington, especially meeting the item of lower cost of copper;





- The new configuration of the brakes system should be adequate to the vehicles produced by several car manufacturers (International, Volvo, Paccar, Freightliner, Peterbilt) served by Meritor. That requirement considerably increased complexity of the project, as the different vehicles present huge range of configurations of load distribution in

the axes, distance between axes, types of tires and different brands and compositions of brake drums.

These were the terms presented for Meritor's technological challenge to Fras-le. It added the requirements of the new standards and their certifications to the company's own requirements.

THE VALUE OF INCREMENTAL INNOVATION

The values of a new product and the new correlated "services" are not necessarily linked to introduction of radical technical changes, redefining the concepts of use or even the design of the old product. Frequently, the innovations referred to as incremental – in general the ones occurring in components and sub-components of a part or parts system – are the ones that become more relevant for the good economic, commercial and market results.

While the new and/or differentiated technical elements, in general, can be totally defined and measurable, the new services generated by the innovation are less clear, more intangible and, thus, less subject to economic quantification in the market. For instance, what is the actual economic value of a safer braking process? Or the reputation of a company that counts with braking system which is more reliable than the competitors?





It is under that perspective that the innovation success case presented by the manufacturer from Caxias do Sul is projected – the new brake lining MA1201 and MA 2001. The drum brake system of Meritor (SFTM) should meet the new requisites of the North-American standard. For the company from Rio Grande do Sul, the main challenge was to design a new component (brake lining) comprised by an innovative sub-component (mix of friction material).

In principle, the belief that increased braking power of the trucks would have a strong impact on durability of the brake lining and drums led Meritor to elect working with re-dimensioning of the brakes. Changes were made to the width of the rear brakes, without modifying the diameter or mechanic configuration. As for the front brakes, their diameters were increased by 1.5 inches. However, that approach resulted into an increase corresponding to just 3% of the vehicle's braking capacity.

Those results demonstrated that, effectively, increase in the vehicle's braking performance should be attained by use of high performance brake lining. For the brakes, the braking performance and durability are competitor requisites and the work temperature affects both: higher temperatures improve performance and reduce durability. In general, what is observed is that the lining braking performance is enhanced after being submitted to temperatures above 250°C. This is due to driving of chemical reactions in the friction surface.

Meritor decided to focus on keeping the durability. Thus, there was the necessity to accomplish the desired performance even at somewhat low temperatures. Those conditions of the project demanded development of friction material for the new pack of brakes that would have the characteristic of fitting into the performance condition required since the beginning of its useful life, without being submitted to favorable thermal background. That represents the breaking of an important technological paradigm for brake lining.

In this sense, the new MA1201 brake lining (for use in the front brakes) and MA2001 (use in the rear brakes) was capable of providing the necessary balance among all the technical requisites. In 2011, the products were accepted by Meritor and by the client automotive manufacturer companies.

4. INTERNATIONAL SCENARIO

Despite the recognized technical superiority, use of disk brakes in the heavy vehicles, in North America, is very low, corresponding to approximately 10% of the total. In Europe, precisely the contrary is verified, where 90% of this type of vehicles use disk brake. The sovereignty of drum brake for the American case is due to the specific traffic and land conditions of the American territory, associated to the lower relative cost of those types of brake systems. In addition, in the USA there is also broad system of repair

and maintenance mechanic services based on the drum brakes system. The change to another system would require increment of time and costs for technical training.

Many people considered that the new requirement of stop distance generated by the changes of the National Highway Traffic Safety Administration (NHTSA) could be the point of inflexion for greater diffusion of the disk brakes in the USA market, but that did not occur. The manufacturers of brake systems, instead, dedicated themselves to innovating the drum brakes system, mainly with new and more efficient friction material in the brake lining. That fact resulted into reorganization of the vehicles' brakes but, on the other hand, guaranteed survival of the technological condition of braking based on drum brakes.

5. RESULTS FOR THE COMPANY

In the economic sphere, the outcome of the project was Fras-le's growth in the truck-tractors segment in the American assembly line market, which estimated increment went from 35% to 50% share. The increment of the annual revenue for the company is estimated to be approximately US\$ 3 million.

Besides the increased market share, development of this project enabled the company to attain better projection with the direct client, and also with the ultimate client – the truck manufacturing companies. Previously referred to as

“follower” in the technology and new products' area, the company has shown its potential for development by offering high performance products at competitive costs, besides being one of the two single manufacturers of friction material to count with complete portfolio of brake lining, for all the configurations of heavy vehicles affected by change in the North American market law on stop distance.

6. OUTCOMES AND PERSPECTIVES

The challenge verified for performance of the project demanded Fras-le to develop more complex technological competencies. That is a reality for the company since it started to develop its own products, in the 70's. An important pillar for the company's development and innovation process is the maintenance of external technological partnerships, such as the agreements held with the Physics and Material Engineering laboratories from the State of Rio Grande do Sul Federal University (UFRGS), which enable the company both to have greater knowledge on basic research of friction material performance properties, biological properties, and NVH, as well as characterization of those properties and development of new methods and equipment for their measurements. Those partnerships, in general, include investments in laboratories and in human resources specialization, which result into new knowledge applicable

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An important pillar for the company's development and innovation process is the maintenance of external technological partnerships.”



for development and innovation of new products, besides scientific publications.

Thus, from the technical point of view, the project provided overflowing of knowledge to develop a new platform of technologically superior products, and, hence, it both expanded the products' portfolio and added value to the company's commercial brands.

One of the markets' recent characteristics – and more prominent – is the configuration of more complex, comprehensive and strict regulatory structure. Technical standards, rules and regulations related to quality, innocuousness and other features of products and productive processes become actually new constitutive and structuring elements of the domestic and international markets. As a result thereof, there is the creation of more connected and specialized supply chains, whether to meet the requisites of the technical standards more efficiently or to profit from the collective learning and the economic and commercial externalities generated. Depending on the strictness and coverage of the technical and standardization regulations, they might seriously affect competitiveness of manufacturers and supply chains, causing different economic and social impacts in countries and/or regions.

It is within that perspective that the success of the technological innovation developed by the company is to be

considered – it is a technological development oriented (or determined) by a regulation. It is the requirement in the utmost market, imposed not by the user (the manufacturer of trucks or the transportation company), but by the regulatory authorities. In the European market, the leading braking system is the disk brakes, technologically more advanced, but more expensive. In the North-American market, centered by the United States, the regulation imposed very expressive increase for the efficiency of the drum braking systems. And it was to that regulatory challenge, based on road safety objectives, that the company had to respond. That was a high impact challenge, because the loss of the United States market would accelerate loss of importance for the company's products and the eventual restrictions to its products would cause secondary effects in other markets. The response enabled extension of its products' useful life in a traditional technological path and, due to retreat from some of its competitors, the company was awarded with increased share in this market segment. The test has shown that its competencies, gradually accumulated by its own efforts and third-parties acquisition, were ready for greater challenges. But, the company only mobilized its competencies when they became a requirement. And maybe this is one of the most important lessons learned during this episode of Fras-le's history, with teachings for the total Brazilian industry: to gather competencies and energies to face and overcome the presented challenges. Hence, Fras-le has not only overcome a threat, but it has also been able to win the competition and conquer market share.

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One of the markets' recent characteristics – and more prominent – is the configuration of more complex, comprehensive and strict regulatory structure.”



FUMAJET

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INNOVATIVE SOLUTION FOR PLAGUES CONTROL

Fumajet

Fumajet's innovation case consists of using motorcycles to spray insecticides and pesticides to control urban and agricultural plagues. The project's course illustrates development of that technology interconnected to the company's establishment and consolidation in the market. Its history shows that a good idea can be an excellent starting point, but it is not the guarantee of success. Establishment of partnerships, identification of market opportunities and raising of financing funds, added to the entrepreneurs' perseverance, are determinant factors for the success of a startup company, as well as for its growth and new products' development.

1. THE COMPANY AND ITS SECTOR

Fumajet is a small company founded in early 2009, incubated in and graduated by Universidade Veiga de Almeida, in Rio de Janeiro. It is specialized in technological solutions for control of epidemics, agricultural plagues and for servicing the public health, working with the development and industrialization of innovative products, systems and services for those two areas (public health and agriculture).

The epidemiological problems in the tropical regions and in Asian countries of large demographic dimensions are currently on the top of WHO's concerns. Malaria and dengue, together, infect more than 220 million people in the world every year and kill more than 1.5 million people¹. Global resource requirements for effective malaria control is estimated in US\$ 5.1 billion per year until 2020. There aren't yet efficient vaccines for those diseases, and thus, fighting of the vectors (mosquitoes carrying the virus) is still the only possible strategy.

In Brazil, one of the most frequent infectious diseases is dengue². Until the middle of the 1990's, the Asian Southeast was considered to be the region most affected by dengue in the world. After that, the countries of Central and South America started to become notorious in that scenario, starting to contribute with more than a half of the cases of the disease notified in the world. During that decade, in just one year (1998), Brazil recorded more than 700 thousand cases, spread across 22 states^{3,4}.

1 WHO. *World Malaria Report 2014*. Access on: April, 2015.

2 REVISTA DA SOCIEDADE BRASILEIRA DE MEDICINA TROPICAL. v. 44, n. 4, p. 471-474, Jul/Ago, 2011.

3 ESTUD. AV. São Paulo, v. 22, n. 64, Dez.. 2008.

4 MINISTÉRIO DA SAÚDE. Fundação nacional de saúde dengue: instruções para pessoal de combate ao vetor: manual de normas técnicas. 3. ed, 2001.



Observing that scenario with entrepreneurial look, the businessman named Cícero Victorio da Costa and his son, Marcius Victorio da Costa, decided to import thermal fogger equipment to fight the vector mosquito. However, due to the difficulties found in the economic scenario of that time, the project became unfeasible, resulting into financial loss that could have been fatal. Faced with the adversity condition, during an instance of reflection that is also a revelation of the typical perseverance of the entrepreneur, Cícero launched the challenge of installing the equipment units in motorcycles and turn them into fogger vehicles. That was the starting point for careful study about the vectors' fighting market and the state-of-the-art of the available technologies, giving rise to the perception that use of a motorcycle could be an advantage as it is a moving equipment unit that would allow combining some critical aspect to this sort of use: flexibility, efficacy, autonomy and cost. That is how development of motorcycle-fogger was started, which would become the first product traded by Fumajet.

The chemical control by application of fog is indicated when other less aggressive actions have not been effective to reduce population of vectors.⁵ The product, named as Motofog Fumacê, is currently an alternative for the spraying in the urban areas, with costs for acquisition, handling and maintenance which are lower than the fogger car, maintaining a similar functioning autonomy. Furthermore, the main advantage of the motorcycle in comparison to the car in the urban spraying is that its dimensions allow penetrating and reaching difficult or restricted access areas, where usually the focus of the mosquitoes have higher proliferation index. In brief, the Motofog equipment is especially appropriate for unplanned urbanization regions, with slopes and narrow streets, hills, alleys, abandoned land, scrap iron shops, channels edges and other areas where conventional vehicles find difficulties or barriers.

5 FUNASA. Controle de vetores: procedimento de segurança. [S.l.]: Funasa, 2011.

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The chemical control by application of fog is indicated when other less aggressive actions have not been effective to reduce population of vectors.”



But spraying involves other elements that make the process complex and many times not efficient. It is a process that includes intense use of the human resource, occurring by decentralized manner, with efficacy essentially depending on compliance with the activity planned by the “campaign” – how is it possible to assure that the planned content will be performed? How to perform it in the necessary manner, in terms of intensity? Bearing those problems in mind, the entrepreneurs dedicated themselves to the challenge of developing a technology complementary to the Motofog, aiming at the remote management of their operations. The resulting product is the monitoring system named as MECE – Strategic Monitoring for Control of Endemics. It is a web platform interconnected to a tracking moving system (GPS) installed in the motorcycle that allows real time monitoring of the applications, by automated data collection system. The reports from the field works and consumption of supplies generated by the System enable controlling and improving the spraying actions. As the team did not have know-how on information technology, the system was developed through partnerships: with Addtech, for creation of the web platform, and with ER2, a spinoff company of the Laboratory for Advanced Collaboration – LAC of PUC/RJ, for conceiving of the GPS system.

The know-how and experience attained during the project of the motorcycle fogger, as well as the developed technology, allowed identification of another application

for the same technology: the agricultural sector, through spraying system to control plagues and soil treatment in cooperatives and lands of family agriculture. This is a highly promising market: Brazil has more than 5.6 million small farmers and very important agriculture and livestock fairs are held every year, enabling a great window for exposition of the products.

In the whole world, the market of agricultural machinery amounts to approximately US\$ 80 billion per year, with approximately 20% of those represented by agricultural spraying. Today, two types of equipment control this market of agricultural sprayers, each one aimed for a specific property size. For large crops, there are the self-propelled heavy machines, usually adapted in tractors, which demand high investments for purchase and maintenance. For small crops, there are the backpack sprayers, which present more affordable cost, but which have small functioning autonomy, demanding more time for the applications. The Motofog Agro, in the final phase of development, is presenting itself as a new alternative for this market.

2. THE STRATEGY – THE PROJECT ALIGNMENT WITH THE BUSINESS

The Motofog and Motofog Agro equipment units were developed maintaining the focus on three main goals:

1. To enable, with the governmental and private agencies, an efficient and low-cost techniques for control and prevention of proliferation of the main plague and vectors in Brazil and in the world, reducing the indexes of disease transmission in the population caused by mosquitoes, mainly for the poorer social layers;
2. To provide the small farmers with quick and efficient method to apply pesticides in difficult access areas, reducing the working time, enabling better use of the area by reduction in the number of times to pass along the plantations, and reducing the necessary investment for purchase and maintenance of the equipment;
3. To develop resources capable of raising the control level of the application processes.

The target audience of Fumajet's business model are public health agencies and private institutions that are in charge (or sometimes obliged by national and international laws) of spraying insecticides in their areas, which is the case of port areas, airports, hydroelectric power plants, mills, plants, condominiums and also small farmers. In the commercial model developed by the company, sales are differentiated for each type of client:

- Public Agencies and Exports – through regional exclusive service providers and governmental programs. Sale and charging of royalties associated to Exclusivity License;





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The market penetration strategy is strongly based on product uniqueness, which brings along several advantages not offered by technologies used for the same purposes.”

- Private (pesticide spraying companies) – Sale and charging of royalties associated to Exclusivity License;
- Agribusiness – through regional distributors.

The market penetration strategy is strongly based on product uniqueness, which brings along several advantages not offered by technologies used for the same purposes. Some important aspects can be highlighted from those:

- Economy (costs): the need to have just one operator and lower consumption for the same autonomy;
- Operational and Logistic: higher mobility in hard access lands (such as plantations, irregular lands, alleys, lanes, etc.), facility of transportation and sending to more remote sites;
- Social-economic: due to the lower cost of the equipment, compared to others with the same function, it is a feasible tool of fighting of vectors for the poorer cities;
- Ecologic: lower consumption of fuel and tires and 72%⁶ less emission of CO₂, compared to the fogger car;

- Strategic: the company has benefitted from an important sales argument, associated to its innovative and singular character, because the equipment can be sold to public agencies without bidding proceedings, as it is an exclusive and patent protected technology, through the certificate granted by ABIMAQ – Brazilian Association of the Machinery and Equipment Industries.

An important issue faced by the business derives from its very nature of new and small company: as it performs low scale manufacture, the company does not profit from the capacity of purchase and power of negotiation with the suppliers to enable reduction of the unit cost. The solution found to bypass that adversity was to increase sales by national and exports commercial strategy. That alternative required the development of marketing strategy directed to each sector and contracting of commercial managers with market experience.

As for the area of sales to public agencies, it is necessary to consider that matters of different natures are involved, which affect the public purchases policies. The company was able to present the technology to the Ministry of Health and included the innovation in the guidelines of the endemics control programs in Brazil. Just in the Program for Fighting Dengue, for instance, the Ministry of Health invested, in 2013, BRL 1.08 billion and, even with the whole effort

6 Fumajet's Institutional Presentation (2014).





revealed by that investment, more than 200 thousand cases of contamination were registered.

For Motofog Agro, the difficulty to be faced is the non-familiarity with the agricultural market and the need to have distribution network focused on this market. In this case, the strategic solution to bypass that deficit was the establishment of partnership with EMBRAPA to map Motofog's operations market in agriculture. The partnership is also extended to the development and improvement of the equipment, based on knowledge about the producers' demands.

The market is extremely attractive: besides the 5.6 million small producers existing in Brazil, there is also the fact that, in the country, family agriculture represents 84% of the rural properties and one-third of the primary sector's GDP. In addition, considering the scope of governmental incentives, there is the PRONAF – Brazilian Program for Strengthening of Family Agriculture, which, through the More Food Program (Programa Mais Alimentos) grants credit facilities with 10-year term, counting with 3-year grace period and maximum interests of 2% per year for purchase of agricultural equipment.

Besides the partnership with EMBRAPA, the history of the Brazilian company has several other technological partnerships such as with Instituto Genesis - PUC-Rio, Ativa Tecnologia e Desenvolvimento, ADDTECH, SEBRAE-RJ, SENAI, FAPERJ, REDETEC, INT, ABIMAQ, FIRJAN,

UNIGRANRIO, ENDEAVOR, just to mention the more important ones. This array of partnerships reveals an important capacity by which the company developed bonds of cooperation and fund raising in all the possible entities, after accurate knowledge of the existing support instruments in the Brazilian innovation system and more precisely in the innovation ecosystem of Rio de Janeiro.

3. THE PROJECT

The path followed by the companies born in technological incubators usually starts by development of project in academic environment, passing by fund raising from funding agencies to change the project into a product, until reaching establishment of the business. Fumajet's history was made by a much more winning course, showing the importance of combining several elements for the success of the business: the entrepreneur's perseverance, the view and acknowledgment of market opportunities and the economic support and subsidy, by business angels and funding agencies.

Although the idea of changing the motorcycle into a fogger vehicle has arisen in 1999, development of the equipment and its technology started only in the middle of 2006. During that interval, Marcius faced adverse conditions, of personal and financial nature, that impeded him from being totally

dedicated to the project. But, the idea remained latent and, simultaneously to his daily life, he decided to dedicate himself to studying the status quo and the state-of-the art of the technologies used to fight vectors of urban plagues by spraying. As he did not have access to the academic environment, the search for information was basically done by reading machines' manuals, field surveys to prospect technical market information and broad internet research.

Based on his knowledge as a mechanic engineer, he noticed that if he could use the portion of energy that is usually lost,



as heat, from the explosions and compressions that occur inside the motorcycle's engine, the vehicle could work as a thermal fogger. The key of the idea was, therefore, to change the motorcycle into a sort of energy generator.

Thermal fogging is a method of large scale fighting of adult mosquitoes. The mist is produced by a device (thermal fogger) that uses heat to "break" the chemical product (pesticide) into very small drops, usually within 5-30 microns diameter range, which are dispersed in the air. When the chemical product, usually diluted in an oil base vehicle, is heated, it is vaporized in a combustion chamber and then expelled through an output tube to form, when condensed in contact with the environmental air, a fog in the form of dense cloud. When the mosquitoes contact small drops during the flight, the drops are deposited on them, overthrowing them and causing their death⁷.

Believing in the potential of his conception, he registered the patent of the idea and followed on, seeking partners/financers. However, he faced the disbelief of the investors and finally decided, by the end of 2006, to start the project on his own, from scratch. He asked a friend to lend him a motorcycle and started to work on a prototype, using

⁷ Agriculture, Fisheries and Conservation Department of Hong Kong. Plant and Pesticides Regulatory Division. Manual: Pesticides used for outdoor mosquito control. (2010)



scrap, with trial and error, in another friend's garage. At that instance, he noticed that it would be important to be associated with another professional having an education complementary to his own and who believed in the idea, being willing to undertake the risk of the project. Thus, he established a partnership with Marcelo Machado, graduated in Industrial Design, who he had previously worked with in a design firm. They then started to work together in the conception of the product.

At that time, the first opportunity appeared for establishing a partnership with Ativa, a company incubated in Instituto Gênese of PUC-Rio. In the celebrated agreement, Ativa undertook development of an injection system and held 10% share in the project.

The prototype was finished only in 2008. It had a totally handmade structure, but operated well. Then, it was necessary to pursue financial resources to turn it into a tradable product. As they did not have an open capital company, they could not use financing lines such as FINEP or FAPERJ and that was the reason for electing to seek for the support from SEBRAE-RJ. Through that contact, they became familiar with the environment of the technological incubators and identified, in that model, the best alternative for their project. Thus, in 2009 Fumajet was created, a company incubated in Universidade Veiga de Almeida – UVA, in Rio de Janeiro – a determinant landmark for the project's and the

company's future. Afterwards, in the company's retrospective analysis, counting with the possibility of applying for funding lines, a structuring process was created, with the company ceasing the condition of "backyard company" and becoming a real company, with proof of residence".

The first attempt to seek for funding, however, failed. During the same year 2009, they were not accepted in a notice to bid from FAPERJ and neither in PRIME's program, from FINEP. Not due to the project itself, but for inexperience in matters of documentation and project formalization. That moment forced the partners to recognize that technical know-how is not enough for the success of a project. The preparation for the new attempt, in the next year, 2010, included further details, it was more mature and successful: the Motofog Project was accepted by the Notice to Bid "Support to Technological Innovation in the State of Rio de Janeiro" from FAPERJ, receiving BRL105 thousand.

That was another important milestone for the project, as the entire capital from the Notice to Bid was invested into the transformation of the Motofog into a tradable product, which, until then, had a totally handmade aspect. The parts were defined and parameterized, considering maintenance and serial production, but a document was still lacking which could prove efficacy of the system. The machinery and equipment for control of endemics are regulated by WHOPES (World Health Organization Pesticide Evaluation

Scheme), an agency of the World Health Organization and the reports required to attain that certification are expensive. The capital attained from the Notice to Bid had been totally invested on enhancement of the equipment – the entrepreneurs were, therefore, once again facing the obstacle of the need for financing.

Figure 1 - Motofog fumacê



Source: Fumajet's Institutional Presentation (2014)

Still in 2010, focusing on the possibility of contacting business angels, Marcius enrolls the Motofog Project in 'Brazil Challenge' a competition of innovation startups organized by

Intel®, in association with FGV – Fundação Getúlio Vargas. The project won the 1st place, being granted awards of legal and market advisory, besides being ranked for the The Intel®+UC Berkeley Technology Entrepreneurship Challenge - IBTEC, in Berkeley University (USA), where it was ranked within the 15 best startup companies of the world in innovation. The financial support for the trip to Berkeley was given by RedeTec, after the company's participation in a congress held at FIRJAN – the State of Rio de Janeiro Industries Federation, where the entrepreneurs were introduced to Mr. Armando Clemente, at that time the Director of RedeTec-RJ (Rio de Janeiro Technology and Innovation Network).

Besides the financial prize, the participation in the Challenge brought along an intangible benefit for the company: visibility and spontaneous media, through interviews by several respected communication vehicles and participations in events, which contributed to consolidate the success of the new technology. With the support from FAPERJ, Rio de Janeiro Science and Technology Secretariat, SEBRAE-RJ and REDETEC, the technology had its patent registered with the INPI and, still in 2010, reports issued by LACEN (RJ) – Laboratório Central de Saúde Pública do Rio de Janeiro Noel Nutels, by the Inmetro and by ANVISA, proved the efficacy of the Motofog and its adequacy to WHOPES. The first unit of the Motofog Fumacê was sold in November, 2010, almost five years after the project development started.



After the award from the IBTEC and winning the first notice to bid from FAPERJ, Fumajet's entrepreneurs identified that Brazil was following the global trend towards funding of innovation, with investors looking at startups, more accessible governmental funding lines, programs in the institutions, etc. After that moment, they started to study all the institutions and the tools available in the market to foster innovation. With the visibility of the Desafio Brasil / Intel 2010 award, they entered a round of presentations to the business angels.

In five months of negotiations, after contacting several groups, they elected to associate themselves with an investor that had great experience in sales, which, in the view of the two partners, would be important for the future of the business. The investor, by then a partner of the company, was determinant for financial feasibility of the company's Action Plan. Besides the financial resources, the investor also contributed by bringing marketing competencies, in a relationship market where personal knowledge and networking are important for the product's and solution's penetration into the governmental agencies.

With an investor and financial resources in cash, it was possible to generate new financial opportunities, such as loans through Banco do Brasil and BNDES. Meanwhile, the company was declared winner in another Notice to Bid from FAPERJ, through which an evolution of the Motofog

was developed: the FLEX version. It refers to a technology that operates with oil and water, allowing application of the product in the agricultural market.

But the commercial barriers continued to be strong. Breaking of paradigms of a new technology to fight dengue, added to the fact that the product was addressed for sales to governmental agencies represented major barriers and, therefore, the sales continued to be weak. It was necessary to establish new institutional partnerships to overcome those hindrances. In 2012, a new commercial strategy was implemented, from which partnerships with regional distributors were started in the States of Rio de Janeiro, Espírito Santo, Amapá and Goiás. The strategy proved to be effective and the number of sales of Motofog in Brazil increased.

Also during 2012, the company performed its first export transaction. Through the Rio de Janeiro Trade Association (ACRJ), it contacted some groups of companies in Angola, Africa, through which the company could trade its products in that continent. As a strategy to guarantee success of the operation and avoid problems with default, the company pursued guidance from the Brazilian Agency for Promotion of Exports and Investments – APEX. The support received by the Agency was determinant to identify the best commercial partner and consolidate internationalization of the sales.

To continue with the production, once more the entrepreneurs found themselves needing to raise capital, as they required working capital and purchase of supplies. During a congress held at FIRJAN, the businessmen became aware of the lines available from the BNDES for small and large companies. They requested one of those lines to Banco do Brasil, BNDES' financial agent, but several formal barriers were presented, impairing the operation. However, the interest rates were extremely attractive and the entrepreneurs dedicated themselves to that negotiation, attaining, after eight months of the process, approval of BNDES. During the same period, supported by SEBRAE-RJ, through the SEBRAETEC program, the company registered several projects' technological results with the INPI – Brazilian Industrial Property Institute. As a result of that policy, by the end of 2012, the company counted with credit and more than ten patents registered in Brazil and in other countries.

In early 2013, the company was invited to participate in the television program Pequenas Empresas Grandes Negócios [Small Companies Great Business]. The article was broadcasted in the national territory, generating great commercial opportunity, but the company was not structured to simultaneously serve a large volume of clients. Once more, it faced an adverse condition that demanded immediate response: to establish Internal Management that could monitor its growth. And, once more, they looked

for help at SEBRAE-RJ, through which they were selected to participate in the program named SEBRAE Mais. The program consists of theoretical and practical qualification, with more than 200 hours coaching by SEBRAE's consultants, analyzing all the sectors of the company, from the warehouse to the human resources department.

As part of the program, using the tool named FGA – Advanced Management Tool, the company's Action Plan, Balanced Scorecard, mission, values, objectives were defined. The culture of segmentation and division of tasks was introduced in the company and the processes were systematized and standardized. Besides the direct impact on the revenue, the company used the know-how attained from the studies and the structure generated by the program to prepare the briefs for new notices to bid on innovation funding and entrepreneurship programs.

4. INTERNATIONAL SCENARIO

According to the World Health Organization⁸, diseases transmitted by vectors are responsible for about 17% of the estimated gross total of infectious disease.

8 WORLD HEALTH ORGANIZATION. Department of control of neglected tropical diseases. *Pesticides and their application: for the control of vectors and pests of public health importance*. 6. ed. (WHO Pesticide evaluation scheme (WHOPESES)).



Operational, financial and management issues, together with environmental changes, resistance to pesticides and increase of population mobility have been contributing to increase prevalence of those diseases in the last decades. The diseases that are usually transmitted by the vectors or intermediary hosts include dengue, filariasis, Japanese encephalitis, leishmaniasis, malaria, river blindness, schistosomiasis and trypanosomiasis.

Dengue, specifically, has been drastically increasing in the whole world, in the last decades. More than 2.5 billion people – more than 40% of the world's population – are now under the risk of suffering dengue. The WHO estimates that today there might be from 50 to 100 million infections of dengue in the whole world, every year. Cases in the Americas, Southeastern Asia, and Western Pacific exceeded 1.2 million in 2008 and more than 2.3 million in 2010 (based on the official data presented by the Member States). In 2013, 2,350,000 cases of dengue were notified only in the Americas, from which 37,687 were cases of severe dengue⁹.

The vector control is an important component of the program for control of diseases transmitted by vectors. Its implementation includes the specific use of the available methods, based on feasibility, resources and technical and

operational infrastructure. The programs must be applied following the principles of integrated control of vectors, a decision making process based on evidences, adapted to local configurations, which rationalizes use of methods and resources for control of vectors and emphasizes participation of the communities.

One of the methods presented as an alternative, by the WHO, for vector control is spraying of pesticides using thermal fogging equipment, which is among the preferred methods used in cases of epidemics. Thermal fogging is also common for application of pesticides in rural areas.

The thermal foggers used are transported in vehicles, such as cars or airplanes (the latter mainly for the large agricultural properties), or manually by the sprayers. No record has been found, in the world, of using motorcycles as vehicles to apply spraying of pesticides by the thermal fogging method, to control endemics or either to control agricultural plagues.

5. RESULTS FOR THE COMPANY

Today, Motofog is aimed for:

- Fighting vectors such as dengue and yellow fever (*Aedes Aegypti* and *Aedes Albopictus*), malaria (*Anopheles* sp), Nile fever (*Culex* sp), mosquitoes, black flies and others;

⁹ Available at: <<http://www.who.int/mediacentre/factsheets/fs117/en/>>. Access on: September 24th, 2014.



Vector and prague control station



- Spraying of insecticides in sewage mains, gutters and general underground pipes;
- Controlling ants in sugar-cane crops, termites, pastures and reforestation;
- Application in general agriculture and fruit culture against insects, fungi, bacteria, etc.;
- Spraying of insecticide in port areas, mills, sheds, warehouses, industries, food industries, garages, residences and others.

The equipment is traded in Brazil, in Central America (Dominican Republic) and in Africa (Angola and Equatorial Guinea). The company has also registered 16 patents in Brazil, with offshore extension. The total of sold units is 122, from which 80 were sold in Brazil, 30 in Africa (26 in Angola and 4 in the Equatorial Guinea) and 12 in the Dominican Republic. Its distributors' network in Brazil currently reaches all the regions.

Besides the award conquered in 2010 from IBTEC, Motofog has also received other awards as Latin Moot Corp 2011 – international contest of Business Plans, the MPE Brasil 2013 Award, where the company was one of the finalists. In 2014, it was the winner for the Southeast region of the FINEP Award in the Small Company category.

Since its first technology notice to bid, in 2010, the business consolidation, by the success of Motofog, enabled the company to be granted several other funding lines, not only the one from FAPERJ, but also from FINEP and from EMBRAPII, where it was the first small company to receive it. The total capital raised from those programs exceeds the milestone of BRL 1 million. By that condition, today, 80% of the investments dedicated to Research, Development and Innovation – PDI come from allowances generated by non-reimbursable notices to bid.

6. OUTCOMES OF THE PROJECT

After development of the Motofog, the technical and market know-how enabled diversification of the company's portfolio and market. A services rendering segment was created inside the company, named as Fumajet Serviço, with the role of meeting ANVISA's resolutions to control endemics in airports, ports and vessels. To add value to the service, new innovative tools were developed: a management and tracking system for the equipment and an UBV COSTAL (sprayer) for works in confined areas, a project that was approved in the notice to bid from FAPERJ, back in 2012.

The tracking system was developed in partnership with the ICT – Science and Technology Institute of Universidade Unigranrio and the IT company named AddTech. The new technology is aimed at tracking the actions of the Health Secretariats

for fighting dengue, and it was named M.E.C.E (initials in Portuguese for Endemics Control Strategic Monitoring). This project gathered doctors, biologists, engineers and more than 40 students of biology working together. Unigranrio presented the project to FAPERJ, who supported implementation of the program. The project was put into practice in the city of Belford Roxo, State of Rio de Janeiro and presented 38% reduction in the cases of dengue in that region.

In the end of 2012, the company, with the Motofog project, participated in the International Congress of Neglected Diseases, held in Rio de Janeiro. During that event, the entrepreneurs had the opportunity to know the work of the NGO – Doctors Without Borders – MSF and to acknowledge the difficulties of rendering medical care in remote areas, transportation of vaccines and holding of exams. In partnership with the MSF, they initiated the MOTONURSE project, an equipment unit for activities of outpatient care in hard access areas for campaigns of vaccination, diagnosis strategy and transportation of vaccines. The technology, which enabled creation of auto-sufficient cooling system, is based on the same principles of the Motofog's operation: use of the motorcycle as energy generator.

To develop this new project, using the credibility accomplished by the project of the Motofog, the company was selected, in 2013 by the EMBRAPII program (Brazilian Industrial Research and Innovation Company) and it works in partnership with FAPERJ and INT (Brazilian Technology Institute).

Another service developed as an outcome of the Motofog concerns maintenance of the equipment. To assure good operation and efficacy of the products, all the distributors are trained on technical qualification regarding proper operation and maintenance, besides being supplied with spare parts, in order to render the services.

7. PERSPECTIVES

The company has extraordinary growth potential in its original market of operation – the public healthcare campaigns to fight the disease transmitting vectors. But that is not the only market segment for Fumajet's development and construction of new opportunities.

As an extension of the original idea for the agriculture, the Motofog Agro presents great advantages in the application of insecticides, with the possibility of circulating across crops with narrow passages, alleys and in sandy and irregular lands. The equipment, besides counting with the same technology and characteristics of Motofog Fumacê, uses a trail type motorcycle for sandy and irregular land and agricultural spraying rods systems enabling new types of application of herbicides, fungicides, leaf fertilization, chemical grass cutting and others. Probably its use might occur moreover in fruit orchards and coffee crops. The company estimates that in



the near future 70% of its business will be represented by the agriculture and livestock market.

In 2014, the 'SAP Expoentes Global' project, in partnership with ENDEAVOR, selected Fumajet among the first five companies of the world to receive the Global SAP Acceleration Program. The company will receive three years of investment from SAP, through implementation of the SAP B1 platform (Business One) and mentorship. With the arrival of that ERP (Enterprise Resource Planning), the action plan for the next years is focused on the structuring for growth, divided into 4 activities:

1. Implementation of the resources and personnel management plan;
2. Planning of products development and launchings;
3. Development of the distribution and export network and of Fumajet Serviço e Agricultura; and
4. Inclusion of the technologies into the governmental healthcare programs and partnerships with international agencies.

To raise funds to execute the action plan and expand the market, the company is in the final phase of negotiations with a Venture Capital Investment Fund.

The experience attained along development of the moto-fogger project was converted into a well-structured business strategy, addressed for growth. The horizon of future possibilities is diversified and promising, and the company is ready for the next challenges.

The experience presented in this chapter discloses some of the determinant factors for the possibility of success in small companies based on innovation. No matter how promising the initial idea is, it is just that: an idea. And to turn it into an enforceable project and business with potential for success much more than an idea is required. The entrepreneur spirit reveals, as one of its main features, the perseverance, the unshakable conviction of the initial idea and of the rewards to be conquered. That trust in the efforts is what enables the search for solutions for the set of problems and difficulties identified along the path of the enterprise.

An important characteristic is the capacity of mobilizing the external supports, both from private entities (investors and commercial partners) and from public institutions. It should be possible to see, in the case herein, high capacity to negotiate all the supports verified in the ecosystem of regional innovation around an entrepreneurial project. Fumajet's case is clearly a role model for all the entrepreneurs who are aware of the difficulties existing in the operation of those systems.

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FUTURAGENE 8

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THE DEVELOPMENT OF FORESTRY HIGH PERFORMANCE GENETICALLY MODIFIED EUCALYPTUS: THE SUCCESS OF A PARTNERSHIP THAT GENERATED NEW COMPETENCIES TO A GREAT CELLULOSE COMPANY



Biotechnology is one of most promising scientific areas – and it has been like that since the scientists deciphered (in 1953) the DNA. Since then, this science has been promising to contribute for the human being in facing challenges such as cancer, improvement of quality and yielding of animals and plants, production of substances relevant for health, food consumption, sanitizing or removal of environmental pollution.

As this is a field of the scientific knowledge where the discovery is so directly linked to possible industrial applications, a large number of promising ideas were born in universities, research institutes and, many times, in startup companies, with founders coming from those environments. However, all that potential has not yet been effectively unfolded into products and processes streamlined with the expectations. There are frequent disappointments of investors seduced by business plans associated to

discoveries in this area. The path between the discovery and the commercial results is long and filled with obstacles.

FuturaGene's pathway, from the university seat up to the current stage of development, has very relevant and useful lessons about Brazil's possibilities in the field of biotechnology, so fertile and so promising in global terms. To follow close, when not leading, the frontier of scientific knowledge represents an extraordinary opportunity to idealize products or services that might be very competitive. However, the quick and safe following of that path does not depend only on the entrepreneur scientists or on the created startup companies; there are conditions of the economic and institutional environment which are determinant for the success of the business.

Institutions capable of understanding the risks of the enterprise and accepting them as an integral part of the innovation process are essential for the high technology sectors to succeed and comply with what is expected from them: the generation of highly competitive new products and processes.

1. THE COMPANY AND ITS SECTOR

FuturaGene nowadays is a Brazilian company, but its first seed was born in the high performance scientific environment of Israel, more than 20 years ago. The company was then named CBD Technologies and its

team of researchers, led by Professor Oded Shoseyov – with notorious experience in plants genetics, protein engineering and nanobiotechnology – was dedicated to proteins engineering.

In parallel to that Israeli origin, FuturaGene was born in the USA, as a spin-off from Purdue University. After the listing in the London Stock Exchange (2004), the company was merged with CBD Technologies. Suzano Papel e Celulose made the first investment in CBD Technologies in 2001 and, in 2010, acquired FuturaGene, which now has as its main focus, but not the only objective, the enhancement of forestry assets of Suzano.

The scientific knowledge about modification of plants growth is of special interest to the forestry sector. And forests are, in Brazil, an important subject for several companies. That is the case of Suzano, which has worked for decades with eucalyptus classical breeding. Other companies were doing the same; and the actual Brazilian forestry sector, collectively, defined a set of actions to guarantee advancement of the agenda of researches on their interest. Even thus, the collective actions may be insufficient to guarantee progressing of process at the speed adequate for the company's purposes.

Hence, Suzano, determined to enter into a new path, invested in a solution that was already under development

and could make a shortcut towards the relevant results for the company.

Suzano's acquisition allowed FuturaGene to access genetic material of high quality eucalyptus, thanks to the large number of clones available in its germplasm bank and to a captive market of its technologies. In that sense, the reunion of the companies offers the opportunity for negotiating assets and competencies of two phases of the research and development process: Suzano's forestry matrix, which represents the platform on which the company can, actually, develop its innovative concepts; and the forestry basis, considered to be the laboratory where it will be possible to know what the technology will be able to add.

FuturaGene has thus become a Brazilian company, with internationally rooted technologies and competencies. And its strategy, since then, was increasingly directed to the technological challenges of the Brazilian subtropical agricultural world. The biotechnology company's bet is to face the challenges of the different agricultural crops and regions, with technologies that more and more incorporate the best of science.

The adopted business model is based on the discovery and acquisition of technologies, prototyping in commercial plants and transfer of know-how, as well as creation of partnerships with the main companies of the forestry sector to expand

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coverage of its products. The company also cooperates with institutions from sectors that are not within its core activities, by licensing technologies to those segments.

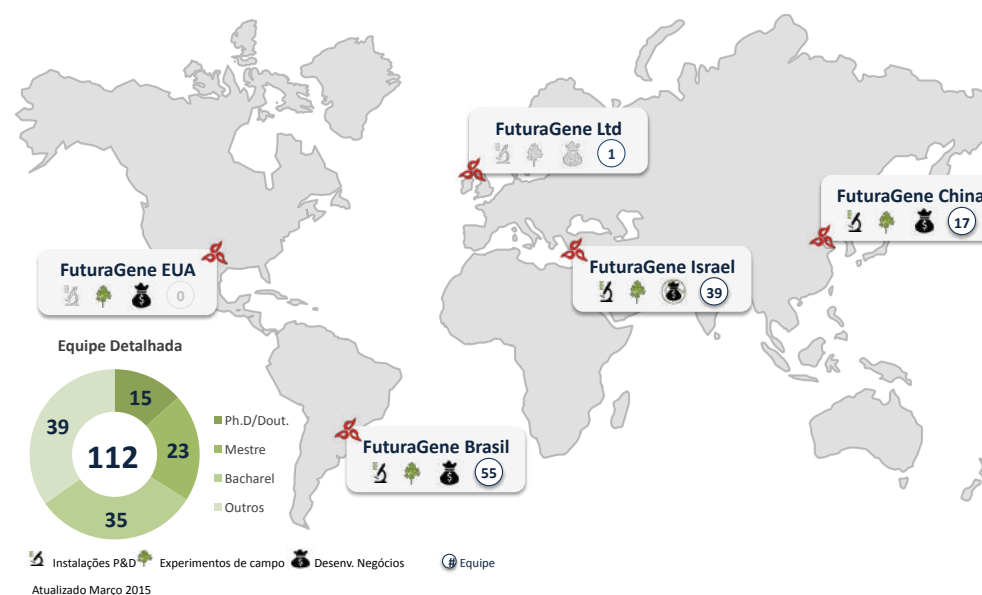
FuturaGene's business model enables engaging partners in all the stages of the biotechnology value chain.

Besides in-house development of technologies, the company purchases licenses to develop and trade technologies with universities and corporate partners after initial feasibility studies. Today, it has institutional and academic partnerships in several countries, such as the United States, Canada, Australia, Israel, China and Brazil. Those Brazilian institutions include Embrapa, São Paulo University (USP), and São Paulo State University (UNESP) and Viçosa Federal University (UFV). FuturaGene holds agreements with international leaders on silviculture and agriculture, such as China Academy of Forestry (CAF), AA Alliance, BioCentury Transgene, and other forestry basis companies, under confidentiality agreement.

The company's activities are distributed into corporate and R&D structures in Brazil (São Paulo and Itapetinga, both in the State of São Paulo); China (Shanghai) and Israel (Rehovot). The field trials are performed at several sites inside the three counties and in the United States. The most advanced technologies of the Group are to improve productivity of the forestry plantations in a sustainable manner. The company counts more than 110 direct

employees distributed across its advanced research centers, most of them in Brazil. From that total, about 40% hold Master and Doctor degrees.

Figure 1 - FuturaGene's global presence



Source: FuturaGene's Institutional Presentation (2015)

2. THE STRATEGY – THE PROJECT ALIGNMENT WITH THE BUSINESS

Brazil holds the largest world productivity in culture of eucalyptus, resulting from the climatic conditions and technologies developed by companies and research institutions in the country. The classical breeding, by



selection and propagation of the best individuals, offered an important contribution for the productivity gains; however, exceeding of those events is increasingly harder. Therefore, it is essential to create new research lines and development of technologies so that the country shall maintain its competitiveness in the forestry sector. In that sense, biotechnology has been presenting promising results, indicated as an important tool to maintain the country ahead in the market of wood and of its byproducts.

FuturaGene holds prominent position in the area of genetic research and development of plants for the global markets of the forestry, bioenergy and biofuel sectors. The company develops solutions to meet the growing demand for raw-material producing cultures for those three purposes, within a scenario of progressive reduction in the availability of new land and incremental unavailability of water resources. The developed technology is focused on two main platforms: i) increased productivity during the plant's growth and/or increment of the processing capacity, after the harvest; and ii) protection of the crop as a response to climatic changes and reduction of natural resources¹.

The purchase by Suzano, Brazilian paper and cellulose company, leveraged the mission of becoming world leader in the genetic research and development of plants in a sustainable manner.

1 Available at: <<http://www.futuragene.com/pt/>>. Access on: September 24th, 2014.

To accomplish that target, the company counts on the skill in the use of its technologies for selecting elite events in superior genetic material and establishing channels with the market by its broad operation in Brazil and in partnerships in the South of Africa, Southeast of Asia and South of China. The scientific and technologic assets of the two companies form a combination of extraordinary potential to add values to the businesses of that platform, while both partners reduce their risks.

The company developed know-how on genetic transformation of plants and has been able to establish different uses for its technologies in strategic cultures, including the culture of eucalyptus, which is the largest sustainable plantation of forestry species for the paper and cellulose industry and the culture of poplars, a tree increasingly used for production of bioenergy or biofuels. The developed techniques apply also to corn, which is broadly used in the animal nutrition and biofuels markets².

3. THE PROJECT

The Brazilian forestry basis industry is weakened towards its main competitors, losing the status of lower world cost.

2 Available at: <<http://www.bloomberg.com/apps/news?pid=newsarchive&sid=aPV5VK3RZ3fU#share>>. Access on: September 9th, 2014.

Even though, figures from 2013 disclosed by Brazilian Trees Industry (IBÁ) reinforce the irrefutable economic and social-environmental relevance of the sector. More than 4.4 million direct and indirect jobs were generated. The sectorial gross domestic product reached the milestone of BRL 56 billion and taxes collection exceeded BRL 8.8 billion.

The eucalyptus is the forestry culture occupying the largest planted area in Brazil. According to the IBÁ, between 2006 and 2013, the crop presented average growth of 2.8% per year, totaling about 5.5 million hectares of planted forests, in 2013.

The planted forests are responsible for supplying almost half of the Brazilian wood market and, in the paper and cellulose sector, they are the single raw-material³ source. It is over that broad forestry basis that the company defined its technological priority.

FuturaGene developed the first genetically modified eucalyptus with increased productivity, which performed tests evidenced about 20% gain in wood production when compared to the conventional eucalyptus.



³ ABRAF – ASSOCIAÇÃO BRASILEIRA DOS PRODUTORES DE FLORESTAS PLANTADAS. Anuário estatístico ABRAF 2013: ano base 2012. Brasília: ABRAF, 2013.



CHART 1. FUTURAGENE'S SCIENTIFIC DEVELOPMENT AND ITS APPLICATION TO THE EUCALYPTUS

The genetically modified eucalyptus was developed through expression of a plant enzyme (1,4- β -endoglucanase) which operates in the cellular elongation process during the plant development.

The genetic modification performed in eucalyptus, by the company, was directed to the cell wall (or cell membrane) aiming at increasing yielding of the varieties. The cell wall is responsible for the cell structure and its semi-rigid character impedes morphological changes of the organisms, providing structural strength to the plant and creating an important physical barrier against diseases and plagues – which is the reason why they developed natural resistance to destruction, a fact that creates a major obstacle for the industrial processing of their fibers or for availability of the simple sugars that form them. The difficulty derived from the very nature and evolution results into adverse economic effects.

In terms of chemical composition, the plant cell membrane is formed by cellulose, hemi-cellulose and lignin⁴. This complex composition is responsible for stiffness of the

plant cells, which is relaxed only during the plant's growth and development. Formation of the wall in the plants cells starts with deposition of primary cellulose coverage, allowing the plant growth during that stage. After this phase, the membrane receives new layers of cellulose and other substances (suberin and lignin), granting more resistance to it.

*FuturaGene's technology involves the capacity of producing modified plants that activate relaxation and reconstitution of cell walls during growth. The company developed a new approach to attain plants with that profile. Through Genetic Engineering, it included the gene of a plant, *Arabidopsis thaliana*, which codifies one of the specific enzymes that participate in chemical composition of the cellulose, the endoglucanase. The insertion of the exogenous⁵ gene and the expression of the enzyme result into early growth and higher production volume (in case of species such as the eucalyptus). The genetically modified eucalyptus makes it possible to obtain the same amount of timber than conventional eucalyptus using smaller area.*

4 CARVALHO, W. et al., 2009.

5 It belongs to another species and it is inserted into the receiving organism to lead it to express a new protein.

» **CHARACTERIZATION OF THE BIOTECHNOLOGICAL EVENT**

FuturaGene obtained, in 2003, the H421 event genetically modified eucalyptus, developed to increase biomass accumulation. The technology enabled greater productivity of wood per planted area, at shorter time when compared to its conventional parent lineage. The higher growth characteristic is due to the expression of Cel1 gene of Arabidopsis thaliana, which codifies the 4-β-endoglucanase enzyme that acts in the cell elongation process during the plant development⁶. The expression of this protein results into the larger cell growth and into consequent increased productivity in wood volume per production area.

The genetically modified eucalyptus (H421 event) has been assessed in containment since 2001 and in the field since 2006, demonstrating excellent plant profile for intensive cultivation and wood production. Tests performed by the company confirmed that the event does not have potential to become a weed and its cultivation does not present any adverse environmental impact when compared to the conventional eucalyptus cultivation. The composition analysis confirmed that the tissues of the modified eucalyptus are equivalent, in composition, to the tissues of the conventional eucalyptus.



The H421 eucalyptus was produced by the method of transformation mediated by agrobacterium tumefaciens, using the pBI121 plasmid and invariability of the integrated DNA confirmed by the PCR technique (Polymerase Chain Reaction)⁷. The constructions included into the eucalyptus DNA, as well as their insertion regions were maintained in the tested progenies obtained in controlled crossings with different species and conventional commercial varieties. The stability was confirmed by molecular analyses, demonstrating that the genetic heritage follows the Mendelian⁸ segregation principle, as expected.

6 SUKNO, S. *et al.* Expression and Regulation of the Arabidopsis thaliana Cel1 Endo 1,4 β Glucanase Gene During Compatible Plant-Nematode Interactions. The journal of nematology, v. 38, n. 3, set. 2006.

7 DNA amplification method (creation of multiple copies) without use of living organism.

8 Law of recombination or independent segregation, by which, in a crossing involving two or more characters, the factors determining each one of them are independently separated during formation of the gametes and recombined at random, to form all the possible recombinations.



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The benefits of the modified eucalyptus variety drive the interest of the paper and cellulose industry, considering that the cellulose extracted from the plant wall is the raw-material for the industrial fiber used to manufacture paper. In addition, it generates material for several other agricultural products, including sugars that might be used to produce second generation ethanol or yet to produce chemical compounds obtained by biotechnological routes.⁹

The genetically modified eucalyptus developed by FuturaGene is responsible for approximately 20% increase in the forestry productivity for the cellulose, energy and biofuel markets.

This is a worldwide innovative initiative. It is the first genetically modified forestry species submitted to commercial release in the country, besides being the first private Brazilian company to submit a genetically modified plant to commercial approval.

The developed eucalyptus has been assessed in the field since 2006. After executing the performance and biosafety tests – which resulted into a dossier - the company initiated the regulatory process with the CTNBio (Brazilian Technical Biosafety Commission) in January, 2014. The event was

9 Evanildo da Silveira. Mais celulose por centímetro quadrado. Revista Pesquisa FAPESP. ED. 204 – FEVEREIRO 2013. http://www.ctnbio.gov.br/upd_blob/0001/1947.000202-201471%20part%201.pdf



approved after evaluation by the Commission, in April, 2015 for planting for commercial purposes becoming the first genetically modified eucalyptus in the world approved for commercial use¹⁰. It is important to highlight that this process and all the other activities involving Genetically Modified Organisms (GMOs) in Brazil are regulated by the Law on Biosafety, which defines the parameters for performance of the studies. The Brazilian regulatory system is considered to be one of the most complete and strict in the world.

Chart 2 presents a brief summary of the adopted model and the Brazilian regulatory process.

10 Available at : <<http://www.futuragene.com/CTNBio-aprova-eucalipto-GM-da-FuturaGene.pdf>>. Access on: April 10th, 2015:

CHART 2. REGULATION OF THE GENETICALLY MODIFIED ORGANISMS IN BRAZIL

Brazil signs the Cartagena¹¹ Protocol and it incorporates the approach of precaution in its laws regulating the transgenic products. The adopted precaution model sets forth procedures for GMOs risk assessment for activities in containment or with planned release to the environment. The matter of biosafety is governed by Law no. 11.105, dated March 24, 2005 (BRAZIL, 2005). Among other questions, the law sets forth the safety rules and mechanisms for inspection of activities involving genetically modified mechanisms and their by-products. That law is responsible for creation of the Brazilian Biosafety Council - CNBS and the Brazilian Technical Biosafety Commission - CTNBio, besides considering the Brazilian Biosafety Policy - PNB (BRAZIL, 2005).

The CTNBio is responsible for assessing and analyzing the risks of any and every activity related to GMOs and to issue previous conclusive technical opinion about any release in the environment – the principle of precaution is applied by CTNBio in its assessment and monitoring, case by case, of any and every genetically modified organism’s safety. Brazil holds one of the most complete regulatory processes in the world. The Law on Biosafety sets forth several control mechanisms ranging from product development up to its monitoring in the market. They include the requirement for any research institution to have an Internal Biosafety Commission (CIBio), responsible for guaranteeing safe handling of the GMO; the need to attain prior approval and registration of installations and qualified personnel to perform the research activities, through the character of the Certificate of Quality on Biosafety [CQB] issued by the CTNBio.¹²

11 The Cartagena Protocol on Biosafety is a treaty on biosafety signed during the Convention on Biologic Diversity (CDB) held in Cartagena, Colombia. Approved on January 29, 2000 and valid since September, 2003, the text regulates matters involving the study, handling and transportation of genetically modified organisms (OGM) between the countries signors of the agreement.

12 Available at: <<http://www.ctnbio.gov.br>>. Access on: September 1st, 2014.



4. INTERNATIONAL SCENARIO

Expansion of the genetically modified cultures was extraordinarily significant in the last two decades. Between 1996 and 2013, the total land surface with transgenic crops increased from 1.7 million hectares to 175 million hectares. Its growth rate was close to 10% per year in the last eighteen years¹³. Approximately 60% of the world population lives in the 27 countries that implemented biotechnological crops in their agriculture, during this period.

Brazil holds the 2nd place in the rank of the largest producers of genetically modified crops (behind the USA only) and it is being positioned as a strong world leader in the market. In 2013, the total area planted with genetically modified crops reached 37.1 million hectares, representing 14% increase, compared to the former year, which, on its turn, had already recorded more than 21% growth compared to the 2010/2011 harvest.

The paper and cellulose industry uses plantations composed, mainly, by exotic species – usually hybrids and clones of eucalyptus and pines. Those species have been, in time, selected by the forestry improvement programs to obtain

more productive trees, with characteristics adapted to the several regions and resistant to plagues, diseases and adverse weather conditions. In Brazil, the wood from species of Eucalyptus genus is highlighted as one of the main sources of raw material for the forestry basis industry, due to its high capacity of adaptation to different environments.

The main difficulties of the forestry species breeding programs are due to the long life cycle of the species, the size of the trees and high complexity for analysis of the descendants, after the crossing and back crossing – and consequently the high costs of that activity.

Since the end of the 1980's, when the first transgenic plants were released for commercial cultivation, it is estimated that more than 800 field trials have been performed across the world with genetically modified trees, in about 40 species.¹⁴

In Brazil, eucalyptus and pines planted forests are the primary source of fiber and our forestry biotechnology researchers are focused mainly on those crops. Nowadays, the country has several forestry product companies engaged in the development of researches related to forestry biotechnology;

13 International Service for the Acquisition of Agri-biotech Applications (ISAAA). Global Status of Commercialized Biotech/GM Crops: 2013. Available at: <<http://www.isaaa.org/resources/publications/briefs/46/executivesummary/>>. Access on: September 25th, 2014.

14 Evanildo da Silveira. Mais <http://revistapesquisa.fapesp.br/2013/02/11/mais-celulose-por-centimetro-centimetro-quadrado>. Revista Pesquisa FAPESP. ED. 204 – FEVEREIRO, 2013.

however, there are not yet genetically modified species of trees traded.

China is prominent in the trade and plantation of genetically modified trees. The first transgenic tree released for commercial plantation was the Poplar, in 1989 (with introduction of the Bt event, known for driving resistance against insects deemed to be key plagues and intensely used in crops such as corn, cotton and soy). China then launched 1.4 million of genetically modified poplars in an area counting from 300 to 500 hectares.

Historically, the United States has always been ahead in biotechnology. In terms of forestry biotechnology, the country

is simultaneously working in several fronts. There are already profitable biotechnologies available for commercial plantation – papaya trees resistant to the mosaic virus are available since 1997. In the field of forestry biotechnology, selection of events that provide increased productivity and important changes to the plants composition has been (for decades) an ongoing research line. Governmental agencies, private companies and universities are studying biotechnological trees with those characteristics – there is already genetically modified eucalyptus in the stage of regulatory process^{15, 16}

15 Available at: <<http://www.forestbiotech.org/>>. Access on: September 9th, 2014.

16 Available at: <http://www.centerforfoodsafety.org/files/ge-tress-one-page-spread-final_67649.pdf>. Access on: September 9th, 2014.





5. RESULTS FOR THE COMPANY

The developed technology puts the company into a leadership positioning in the forestry biotechnology area, making it the first in the world to trade a genetically modified eucalyptus species with increased productivity.

From the economic perspective, the product increases competition of the Brazilian eucalyptus forestry sector and of the national industry as a whole – as the technology may be diffused to other non-competitor forestry basis companies. Considering the increased productivity and costs saving enabled by the solution, Brazil may resume the position of wood producer at lower cost in the global cellulose industry.

The product also brings important social and environmental gains, as the technology enables producing of more wood, using less area, which represents reduction in the use of chemical supplies and water for irrigation, resulting from the lesser use of land; reduction in carbon emission during transportation of wood, due to reduction of the average radius up to the plants; and the potential for higher sequestration of carbon dioxide due to the fast growth of the forestry. By requiring smaller areas for plantation, it will also be possible to provide land for other uses, such as for production of food or preservation.

6. OUTCOMES OF THE PROJECT

The company intends to develop new clones, using conventional breeding methods. The purpose is to perform crossing of the modified eucalyptus (and which presents high yielding) with others that are better adapted to different soils and climatic conditions (using Suzano's rich germplasm base), adding social and economic interest characteristics, such as increased productivity, resistance to diseases and plagues and tolerance to stress conditions. Suzano's comprehensive germplasm base enables searching plants with different characteristics and enhances the project's chances of success.

The company is working on the development of new events, i.e., in the identification of new genes responsible for important characteristics for forestry cultivation, fostering increased competitiveness in the sector. Breeding of new varieties with high yielding and resistance to insecticides is in the phase of research.

7. PERSPECTIVES

FuturaGene's expertise is used to seek technologies that may be applied to improve quality of wood aimed for manufacture of cellulose and paper, besides the specific changes of the



biomass characteristics, in order to attain gains in bioenergy production, mainly the second generation ethanol and other wood by-products. The lingo-cellulosic biomass is a source of renewable carbon, potentially convertible into biofuels or bioproducts, such as chemicals, polymers and other material.

The company uses its biotechnology know-how and the experience attained during the creation process of the H421 eucalyptus – such as implementation of experiments in the field to identify elite events, elaboration of studies and tests to assess biosafety of the product and establishment of partnerships - to develop other agricultural crops, such as the poplar and the sugar-cane – considered to be strategic for Brazil's growth and economic development.

The main lesson from this project connects the high competitiveness of the Brazilian forestry sector to a shortcut to attain more advanced results that allow reinforcing that competitive level. For that matching, two others have joined forces: a high technology and next generation scientific basis company and a knowingly competitive cellulose company. One of the parties obtains access to research funds and high potential plant varieties base while the other is able to, by controlling of advanced biotechnology techniques, accelerate its transition to a higher level of development.

Would that be a role model path for the Brazilian industry? Apparently, it represents a healthy alternative, as it allows, in several cases, the companies to strongly leverage their competencies in new areas, with modest investments for their economic dimensions, where Brazil, for different reasons, is still crawling (such as in startups acceleration) or yet is lost into institutional difficulties (such as, for instance, the intellectual property; or the relations between science and technology institutions, on one side, and companies, on the other).

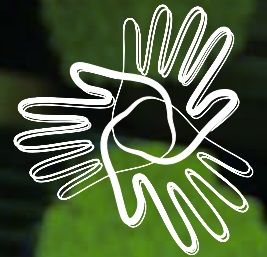
The FuturaGene model and its association with Suzano seems so innovative in the Brazilian business models matrix that possibly it would be the first of the kind in the large institutions for funding of scientific, technological development and in the development banks. And here we should make a suggestion for those agencies to carefully assess evolution of that partnership that might represent a valuable alternative for the public policies on industrial development promotion.



GERDAU

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STRENGTHENING OF THE STEEL SUPPLY CHAIN AS STRATEGY FOR SHARED GAINS



One of the main producers of steel in the world, GerdaU understands that efficiency of its value chain is essential for sustainability of its business. To guarantee productivity and competitiveness of its suppliers, and clients, the company develops several initiatives, in partnership with SEBRAE and SENAI, mainly aimed for the micro and small companies. The projects and programs are structured focused on managerial and technical qualification, aimed at improving quality of processes, products and services. This chapter addresses two initiatives that impacted important links of the chain in the Steel Industry from the State of Rio Grande do Sul: Suppliers and Clients. With positive results for the company and for the participating businessmen, these projects evidence that growth of such a large company's value chain is not just a social responsibility action, but it has significant impact on the company's own strengthening.

1. THE COMPANY AND ITS SECTOR

The company was created in 1901 by João GerdaU after purchase of a nail manufacturing plant, located in the city of Porto Alegre (State of Rio Grande do Sul). Expansion of the plant's production and business, along the following years, led to the purchase of Siderúrgica Riograndense, in 1948, which initiated the company's successful history in the steel manufacture segment.

GerdaU is today the leader in long steel segment in the Americas and one of the main suppliers across the world. The company's international expansion over more than ten countries, distributed across the Americas, Asia and Europe allows totaling the production capacity of 25 million tons and counts with more than 45 thousand employees. In Brazil, the recently started operations in two new markets, with direct production of flat steel and iron ore. Those initiatives are expanding the company's portfolio of products offered to the market and strengthening competitiveness of its operations.¹

The products and services are exported to all the continents and used by the most diversified sectors of the industry. From the small manufacturers of handicraft to

¹ Available at: <<http://www.gerdau.com.br/sobre-gerdaU/perfil-da-empresa.aspx>>. Access on: November 17th, 2014.



the manufacturers and suppliers of the automotive chain, including the general consumables, the company counts with more than 130 thousand clients across the world. Evidently, conquest and maintenance of a large number of consumers requires any company to have consistent strategy and actions. In the case of Gerdau, those strategies and actions involve strengthening of the steel business chain, with actions to become prominent towards

the competitors through products, services and uses². It is within that environment that the company dedicates itself to keep its differentiated market positioning.

2 Available at: < <http://www.gerdau.com.br/relatoriogerdau/2013/ra-br/download/RelatorioAnual2013Completo.pdf>>. Access on: November 17th, 2014.



CHART 1. SUMMARY CHART OF STEEL INDUSTRY IN BRAZIL³:

- The steel manufacturing hub counts with 29 plants, distributed in 11 groups;
- The installed manufacturing capacity is 48.4 million tons/year of raw iron, with 34.2 million tons in year 2013;
- In year 2013, the number of employees reached 124 thousand;
- The sector presented positive commercial balance of US\$1.3 billion;
- Brazil is the 17th largest world exporter of steel and the 6th largest net exporter (exports less imports);
- The main sectors that consume steel are civil construction, automotive, capital assets, machinery and equipment (including agricultural) and household appliances and commercial appliances.

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The efficiency of that value chain is seen by the company as a guarantee of its business' and of the society's sustainability.”

3 Available at: < <http://www.gerdau.com.br/relatoriogerdau/2013/ra-br/download/RelatorioAnual2013Completo.pdf>> . Access on: November 17th, 2014.

2. THE STRATEGY – THE PROJECT ALIGNMENT WITH THE BUSINESS

To develop its business, Gerdau relates with an extensive network of suppliers and clients from several segments. Those are companies of all sizes, cooperatives and other organizations. The efficiency of that value chain is seen by the company as a guarantee of its business' and of the society's sustainability. For that reason, it invests on the clients and suppliers through structure programs to foster management quality and adoption of the best social responsibility practices. Those projects are aimed at providing methodologies and tools that enable improvement in productivity, competitiveness and quality of the products and services.

Development of the initiatives related to the programs aimed for the company's value chain is performed by the Gerdau Institute, a division responsible for the company's social responsibility policies and guidelines. The accumulated experience and learning motivated standardization and internationalization of the development practices of its chain. Monitoring of the results is aimed at making the developed actions increasingly effective. The company intends, thus, to reinforce establishment of mutual gain relations and create shared value.



Within that context, two national initiatives were highlighted in the recent years, in the program for strengthening the business chain in Brazil: the PDF (Program for Development of Suppliers) and the Locksmiths Project [Projeto Serralheiros]. Both are aimed for technical and managerial qualification of small companies, the two projects counted with Gerdau's expertise (which is the chain leader) and the support from SEBRAE, as the manager. Respectively impacting suppliers and clients, the PDF and the Locksmiths Project exemplify the concern and the effort to develop the business chain wherein the company is inserted, adding value from the first up to the last link.

3. THE PROJECTS

The companies that form the ends of the business chain for the steel industry from Rio Grande do Sul are small, in the majority

and, although counting with great technical capacity, present managerial difficulties at varied levels, not including innovation in their agendas. Therefore, the conceived projects are aimed at stimulating the strategic view, the entrepreneur behavior and the development of the businessmen's managerial skills.

GERDAU SUPPLIERS DEVELOPMENT PROGRAM (PDF)

The suppliers that form the value chain for the steel industry deliver different types of material: productive, non-productive and maintenance services. Due to its relevance for the company's industrial operation, qualification of suppliers has become a key point in the project. Gerdau performs a detailed process of suppliers' selection and approval. That process involves assessment of the potential partners' technical capacity, but it does not consider matters of their own internal administration.



Along the years, internal monitoring actions performed by the company identified a separation between its demand and what was being offered by the suppliers. In general, the main limitations found included delivery term, the non-compliances in the delivery and the need to increase the revenues and the job positions. In addition, a verified matter of concern was the high level of financial dependence that many suppliers had towards Gerdau, mainly micro companies, even exceeding fifty percent.

Within that scenario, aiming to improve the supply relations, the company implemented, in 2006, the Suppliers Development Program, aimed at providing the micro and small companies with improvement of their managerial performance and also of their main competitive dimensions (delivery term, reliability, flexibility, innovation, cost, quality and services), also contributing for sustainability of their businesses. Initially limited to the Southern region of the country, the program was later expanded to the national level and, after 2010, entered the process of internationalization.

The project's expectations regarding results and outcomes are moreover directed to assure the structuring and continuity of qualified suppliers that meet the technical specifications of the steel company and the market as well. The idea is that the companies should increment their supply standards, engaging them in markets with high competitiveness standards. The positive impacts on the participants include reduction of 'non-quality' cost and unproductiveness and improvement in the

quality of their products and services. In general, the program proposes also to disseminate practices of use of the labor and safety standards, propagate best management practice and the supply relation, and also to drive innovation within the steel value chain.

LOCKSMITHS PROJECT

Gerdau's clients are distributed across diversified sectors. However, there is a segment that presents major opportunities to improve the productive and managerial qualification: the locksmiths. Therefore, the company, since 1999, has programs related to professionalization of that sector, such as the projects "Value your Locksmith" [Valorize seu Serralheiro], "Gerdau Quality Locksmith Shop" [Serralheria de Qualidade de Gerdau] and "Steel Professionals" [Profissionais do Aço]. In 2007, the Locksmiths Project was implemented with the purpose of increasing productivity, competitiveness and sustainability of small carbon steel locksmith shops which are, or which could be, consumers of material from the company's value chain. The project seeks to improve the activities of the professionals and of the locksmith shops, with important results into the life quality and social inclusion of the concerned businessmen. The target audience encompasses from well-structured and established companies up to informal micro-companies.

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The project's expectations regarding results and outcomes are moreover directed to assure the structuring and continuity of qualified suppliers that meet the technical specifications of the steel company.”



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The Locksmiths Project is an initiative aimed at increasing the revenue and saving costs, incrementing the companies' profit; promoting improvements and expansion of work opportunities.”

In Brazil, there are more than 10,000 locksmith shops and the profile of those entrepreneurs frequently involves deficiencies of school education; work limited to the local market; limited business focus and those conditions end up being converted into the poor status of its professional and business condition. Other characteristics are also verified, such as large concentration of individual micro-entrepreneurs, eventually family business; high informality; predominance of locksmith shops with limited market and product focus, and many businessmen that do not perceive the need to update and innovate.

Other problems identified during the survey performed prior to implementation of the project include deficiencies in management techniques; inexistence of standards and procedures; isolated work; low level of motivation or even lack of interest; high idleness in the production; loss of capital and high indebtedness level; improper conditions in the work environment and existence of vulnerability by non-compliance with the laws applied to the activity (labor, tax, occupational safety and medicine and consumer defense code).

In light of that, the Locksmiths Project is an initiative aimed at increasing the revenue and saving costs, incrementing the companies' profit; promoting improvements and expansion of work opportunities; helping to strengthen the relationship with the clients, expanding the business to new markets; implementing management tools; strengthening the technical capacity of the locksmith shop and fostering exchange of experiences with professionals of the area.

PROJECTS STRUCTURE AND DEVELOPMENT

The PDF and the Locksmiths Project involve offering of qualification courses and consulting by experts from SEBRAE and SENAI, wherein management tools and technical training is offered. The focus is to change the view and behavior of the small businessman who, many times, does not have adequate administrative organization, which impairs his correct assessment of the business' progress.

For both projects, the starting point to define the actions to be taken in each participating company is the institution of the KPIs – Key Performance Indicators, which enable broad viewing of the improvement points in each case. After that, each company's action plan will be prepared, monitored by SEBRAE's local manager. The activities developed along the projects involve specific qualification and individual consulting services according to the diagnosis and to the results from the indicators.

For the Suppliers Development Program, the actions involve courses and practices in the areas of innovation, market prospecting, financial management, productivity and competitiveness, competitive intelligence.

As for the Locksmiths Project, improvement of the business administration is developed through implementation of management practices; by the entrepreneurs' granting of access to information and cooperation mechanisms; by improvement of practical and technical activities for the





locksmith shop and enrichment of the locksmith's perception of the sector, after visits to fairs and events that are relevant for the sector. In addition, holding of lectures on subjects of interest (such as access to credit, machinery, equipment and work environment safety) stimulate the segment's entrepreneurs to develop new view about their business activities.

Although the PDF and the Locksmiths Project reach the opposed ends of the value chain, the approach adopted in both projects is very similar, as the identified necessities are also similar. Along consolidation of the projects actions, each company, according to its possibilities, advances through each one of the stages of their projects and their results are monitored in order to enable verifying and guaranteeing their development.

The positive impacts reported by the participants of the two initiatives present several congruencies. It is worth mentioning the identification of some environmental necessities and the raising of awareness about the need to have management and organization for good progress of the business. Yet, some aspects were, until then, neglected and after the projects were incorporated by the companies in their agendas, such as strategic planning; organization of the work and of the space; qualification of employees; control of finances, sales and stock, by defined indicators; concern with occupational safety.

The incorporation of performance indicators into the companies' routines, in fact, is cited by basically all the

entrepreneurs as the main accomplished gain. They all report observing that the indicators are an essential tool to improve personnel and processes management. Hence, the companies' decision making process that, until then, was intuitive, started to be guided by figures and perspectives that now can be easily viewed and monitored.

In practice, many of the actions performed during the projects bear very simple character. One example of that is the increase in productivity and reduction of costs by restructuring and organization of the physical space, outlining specific areas for each activity performed and facilitating control of items input and output. Implementation of financial control spreadsheets is also a highlight, mainly for micro companies of the Locksmiths Project. Businessmen that before adhering to the project did not differentiate the company's capital from the personal capital and that did not have effective cash control, have started to adopt proper financial administration.

More complex measures, such as preparation of employees' jobs description and definition of mission, values, goals and targets are also implemented and recognized by the participants as very relevant for consolidation of their business. In addition, there are reports of expansion in activities and reach of some companies' operations, resulting from implementation of strategic planning, prices composition techniques and sales tools. This is an interesting fact, as it confirms the success

of the project to stimulate entrepreneurship and enable new opportunities for the business.

4. INTERNATIONAL SCENARIO

In the competitive market of steel, usually formed by large companies strongly based on scale economy of their production and increasingly internationalized, reinforcement of competitiveness depends on incremental gains of productivity. There are different paths to guarantee those incremental gains and Gerdau, along its path, elected the path of processes management as its main guideline.

Some studies from consulting firms specialized in management, such as Accenture⁴ or Deloitte, consider strengthening of the steel value chain as a way to make the companies more productive and profitable. However, the operating manner of each company from the sector is much more directed to its own decision than to a general and unique standard. Companies from the sector usually keep important partnerships to develop solutions and products, but, until this moment, none of them presents such an intensity of courses and consulting as Gerdau, in partnership with SEBRAE.

Certainly, certification of its members is a concern faced not only by the company, but those efforts are usually at the production level and not at the managerial level. The company has, itself, other types of partnerships, but what makes those two projects so important and examples for other sectors and companies is the differentiated focus of action presented by them: the management.

5. RESULTS

The results from both projects – Suppliers Development Program and Locksmiths Project – to improve the steel value chain are directly observed, moreover by the companies that participated on them. For the company, the benefits are indirect and expressed by increased productivity of suppliers and clients, which make all the stages of the process more efficient and thus reinforcing the steel value chain, in its entirety. More efficient and more productive services suppliers start to perform maintenance faster, thus reducing the possible production shutdown period. As for the clients, now more organized, they can expand and reinforce the basis of relationship with their main supplier. The new relationship, richer, is capable of fostering growth of the value chain in all of its stages.

The combined results from all the companies that participated in the PDF project in the various states of Brazil were very productive:

⁴ Available at: <<http://www.accenture.com/SiteCollectionDocuments/PDF/Accenture-Metals-Supply-Chain-Optimization-Restore-Steel.pdf>>. Access on: November 19th, 2014.



- Average revenue growth of 29.4%;
- Increase of 25% in the number of jobs;
- Increase of 17.1% in the companies' productivity;
- Growth of 13.6% in the companies' profitability;
- Reduction of 12% in the average expenses;
- Growth of 6.3% in the compliance with the delivery term;
- Reduction of 70% in the non-compliance of product delivery;
- Reduction of the average level of dependence on Gerdau to 25.2%.

Concerning the Locksmiths Project, between the years 2011 and 2013, the following results were accomplished:

- Increase of 129% in the number of participating companies and of 206% in the number of qualified people;
- 94 companies formalized, which employed 376 workers;
- Average growth of 22% in the revenue of the locksmith shops;

- Increase of 126% in the use of PPE (Personal Protective Equipment).

The indicators of the 2014-2017 cycle will be prepared at the end of the project, but it is already known that during 2014, 240 companies participated in it, more than 650 qualification and consulting sessions were rendered, with the participation of approximately 730 individuals trained.

6. OUTCOMES OF THE PROJECT

Internally, the project was started based on values already shared by the employees and externalized to part of their networking. Therefore, the impact was much broader and capable of generating cultural change in the supplier and client companies, much more than for the steel company itself. Implementation of the participation for all the spheres of employees in each one of the companies participating in the project resulted into greater engagement by everyone, creating a new productive enchaining environment, with motivation and commitment of all the involved participants.

The process for strengthening of the supply chain and the new interaction with the supplier segments, in the upstream and with the industrial consumer sectors, in the downstream, leads to the analysis of new developments. The first would



be multiplication in the number of involved entrepreneurs and companies, by the multiplication effect that naturally might be generated from this sort of project. The professionalization, formalization, the new service standards, the reinforcement of the technical competency are direct gains for the participants of the project and that shall be disseminated to others, by the effect of demonstration. A second development involves new rounds of gains in the very participating companies, as they attain, after the project, new competencies and capacities. New products, new solutions, improvement of their processes are some of the results expected due to the new conformation of the segments, promoted by the projects. At this point there is, evidently, a lesson for the value chains headed by large companies, related to the social responsibility, on one side, and to the business view, on the other. Structuring of a certain company's value chain on more solid basis is an indirect advantage, as it is reversed into its actual strengthening.

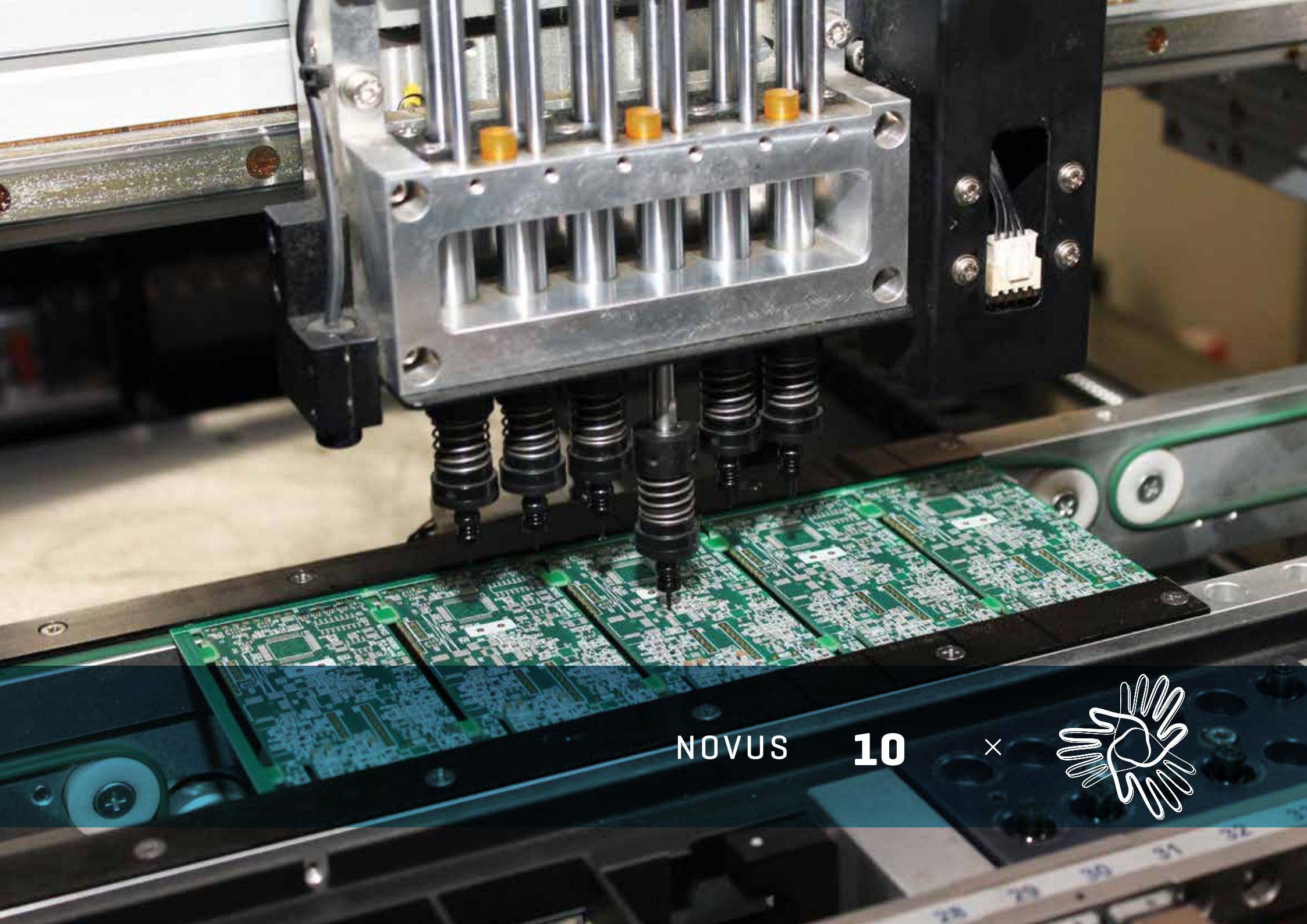
7. PERSPECTIVES

Both projects were very well accepted by their participants and their results are observed as soon as the classroom teaching is put into practice. Hence, maintenance of the partnership with SEBRAE proves to be efficient and it promises to be a long-lasting relation.

A new cycle of works is planned both for the Locksmiths Project and for the PDF, which shall now be named as "Gerdau Excellence Suppliers" [Fornecedores de Excelência Gerdau]. In this new phase, the focus remains directed to Management. Companies that have already previously worked with the project will be assigned deeper attention and new companies will be included in both projects.

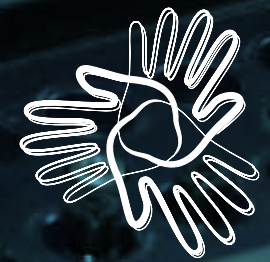
The participants of the project are interested in continuing with the learning offered in new versions of the work. The transforming power of the project, although located in a specific chain, demonstrates how much room there is for public policies focused on the micro and small businessmen. Although initiatives do exist, many of them led by SEBRAE itself, the opportunity to expand this type of activity is still very large. And the integrated manner of the large company leader of the supply chain, with its suppliers and clients assures effective results and superior multiplication capacity.

Gerdau evidences, by its business leadership, that the companies do not have to wait for the initiatives from the public sector. Competitiveness of the national industry can and must be expanded by incentives from all of its agents. The project's collaborative behavior demonstrates that identification of shared goals and sharing of responsibilities can foster strengthening of a sector or of a chain in benefit of everyone.



NOVUS 10

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INNOVATION AND BUILDING OF GLOBAL COMMERCIAL PLATFORM



NOVUS represents a victorious and innovative case of organizational (re)engineering: to turn a shy national company, with commercial basis grounded on the domestic market, into a global player, with broad array of competitive products traded in more than 50 countries. This successful story is based on a creative mix of technological and commercial ingredients that make the electronics company from Rio Grande do Sul an example of success for the technological basis medium companies. In the technology area, the company generated its technical-productive capacity 'in-house' or with academic partners, which ranges from reverse engineering procedures to the genuine scientific and technological efforts. In the commercial area, the company was able to create commercial relationship forms and market insertion strategies that are differentiated in new markets or already with the presence of competitors.

1. THE COMPANY AND ITS SECTOR

Along the History, the human being's guiding principle has been the desire to be free from its sensorial, interpretative limits and from his work applied to the physical, chemical

and biological nature that comprise the world. Creation and use of innovative technologies in new transportation means, radars, microscopes and more powerful telescopes, or systems of machines are in the core of this path towards progress and freedom. In the most recent stage of this evolution, the technologies of electronics and automated processes become prominent. Their potential uses are allowing progressive dismissal of the need for command and of the actual human action in the productive processes, or even in other dimensions of life. The conception and use of various electrical-electronic devices allow receiving information from the nature, processing it and automatically taking action towards that same nature.

Bearing multi-disciplinary nature, those technologies involve broad range of sectors of the human knowledge other than the electronics, such as mechanics, physics, chemistry and computing. The first steps were taken with application of analogical electronics, since the 1950's. The digital electronic instrumentation that appeared in the 1970's and its development in the 80's determined creation of extremely dynamic market based on the endless possibilities of using that technology, whether in the productive processes, in commercial activities and services rendering or even in the other dimensions of human activities. After introduction in the central economies, the products with technological basis were diffused to some less developed economies already in the middle of the 1980's.

The company currently named NOVUS Produtos Eletrônicos was born at that initial instance of electronics diffusion in Brazil. The company, created in April, 1982, in the city of Porto Alegre, State of Rio Grande do Sul, was idealized by two engineers – Miguel Fachin Jr. and Sérgio Zimmermann –, then researchers of the digital electronics laboratory from the Physics Institute of the State of Rio Grande do Sul Federal University. Supported by strong scientific education and motivated by their entrepreneuring spirits, Miguel and Zimmermann dared to go beyond the duties of the academic life, entering into a world that was not well-known, by then, to most of the people, but economically attractive to the eyes – always focused on the future- of the young scientists-businessmen.

Initially, the company was named E.C.I. Equipamentos Científicos e Industriais Ltda. The good initial dynamics of the business soon required additional collaborative strengths. The team was joined by the talents of Aderbal Lima – at the time graduating student of Electronic Engineering of the same university, and colleague of the company's pioneers – whose tasks was to study the administrative and commercial activities, and Marco Antônio Pinheiro (holding Electronics Technician education background), who was dedicated to enhancing the organization and monitoring the industrial production.

Since its initial stages, E.C.I. was dedicated to the development, manufacture and trade of automated measurement and control electronic devices, mainly for



temperature, with applications for laboratories and several industrial activities. Its growth, until the 90's, was supported by the local market conditions and by the action of Brazilian market protection generated by the market reserve policy. The changes verified in the institutional environment in the early 1990's – whether, primarily, by the sudden opening of the Brazilian market to imports or by the negatives consequences in the macroeconomic variables – impacted several industrial segment. Several companies pursued productive restructuring and changes in their organizational and competitive strategies.



Not all of them were successful. And the early 1990's can be considered as an instance of disappearance for many business initiatives that had been conceived in the closed model of market reserve and protection.

That was not the case of NOVUS, the company organically born out of E.C.I, in 1994, which became a symbol and the starting point for its newer and more challenging paths. With successful commercial and technological strategies, the company currently trades products bearing its brand in more than 50 countries. It counts with approximately 160 employees, 15% of those directly working with new products' development. The company was the first in the segment to count with registration of the BMP – Basic Manufacturing Process – approved by the Ministry of Science and Technology and thus confirming its command of the technology applied to the products manufactured by it.

Sixty new products were launched in the last eight years, six of them in the first half of 2014. Those are innovative products not only for the national market, but many of them also for the global market, whether by the set of technical features or by the design and application architecture, or by the competitive price or yet by the possible combinations of that set of features. A clear evidence of the technological and commercial success of the company are the various awards received by its products, highlighting the recent “Brazilian Innovation Award 2011”, granted by the Brazilian Industry Confederation (CNI) together

with the Competitive Brazil Movement (MBC), and the “RS Export Awards”, conquered in 2013 and 2014.

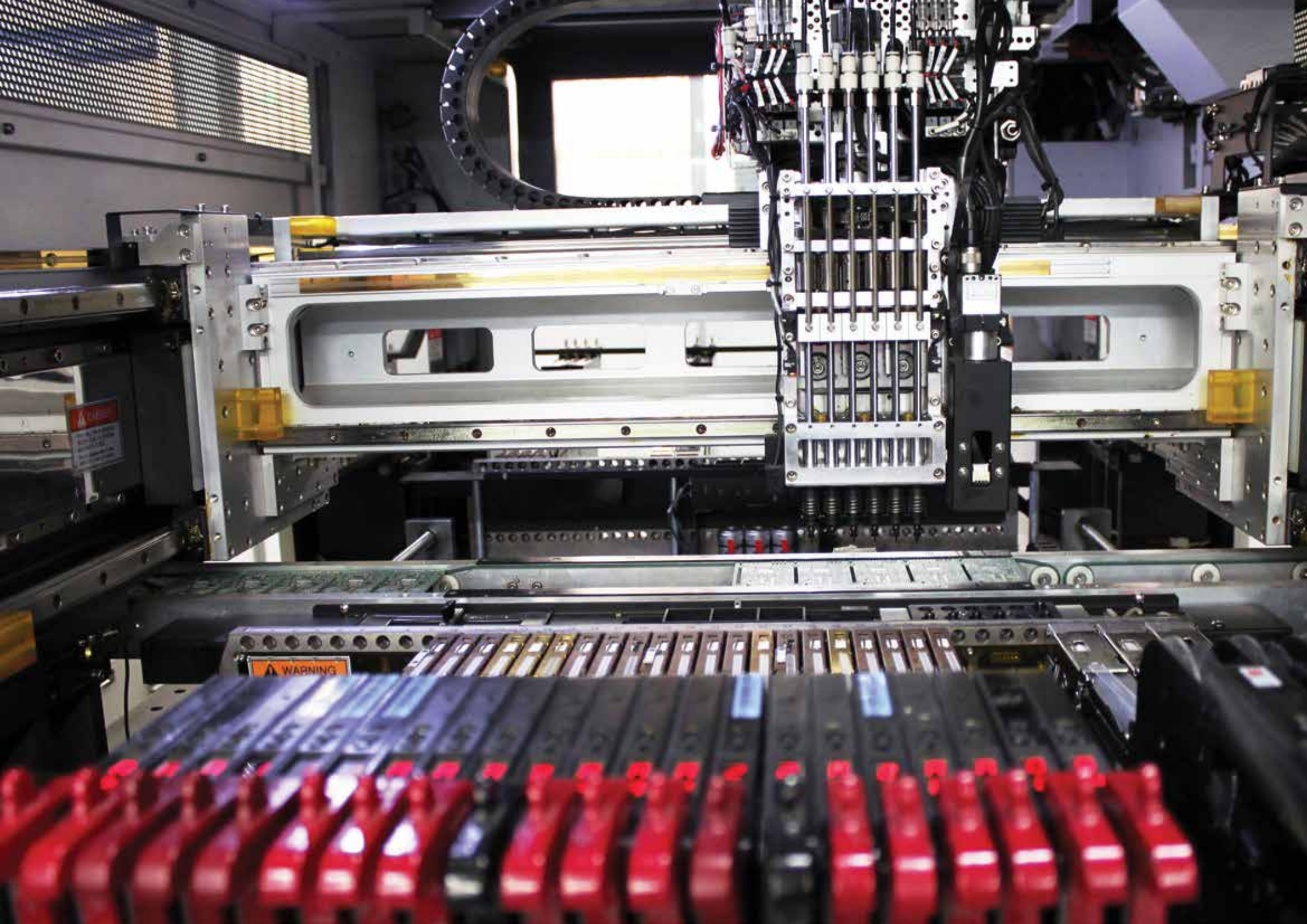
2. THE STRATEGY – THE PROJECT ALIGNMENT WITH THE BUSINESS

The Brazilian electrical-electronics industry gathers about 4,000 companies, where 80% are small companies with less than 100 employees each.¹ That industry reported revenues approximate to BRL127 billion between 2006 and 2013, corresponding to average GDP share of 3.7%.² The electrical-electronics industry can be segmented into two groups of products, according to their technological levels. The first group encompasses the products of the electrical area such as industrial equipment; electrical energy generation, transmission and distribution; installation electrical material and electrical consumable goods (large and small household appliances) which are considered to have relatively more mature technologies.

The second group refers to the electronic area products, characterized by fast technological development, systematic

1 Available at <<http://www.abinee.org.br/programas/imagens/abinee20.pdf>>. Access on: March 17th, 2015.

2 Available at: <<http://www.abinee.org.br/programas/50anos/public/panorama/index.htm>>. Access on: March 17th, 2015.





launching of new products and faster innovation dynamics based on more complex and transversal technologies. This group includes the industrial automation products, electronics and computing components, telecommunications and electronic consumable goods and others. This last group of products has two remarkable features. The first one, in the productive area, is the great transversability of use and/or application of its products with the other sectors of the economy, as increasingly more electronic components are embedded into many goods, equipment, machines which, on their turn are used in several types of services such as banking, communication, energy generation and distribution, etc. The second one, in the industry's productive and commercial area, is the major – and growing – dependence on import of components and supplies, mainly from China and from other Asian countries. Between 1996 and 2013, the industry's commercial deficit went from US\$ 10.5 billion to US\$ 36.2 billion. During that period, while the exports fell from US\$ 9.2 to US\$ 7.4 billion, the imports figures jumped from US\$ 19.6 to US\$ 43.6 billion.³

NOVUS is part of the automation electronic products productive segment. This industry is comprised by companies that manufacture controllers and sensors used to coordinate, monitor, change, measure, register and analyze data and

the conditions and performance of machines, products and processes. Data from Abinee (2014) shows that the average revenue from that segment, between 2006 and 2013, amounted to BRL 3.42 billion. Likewise in the electrical-electronics industry set, this segment experiences structural growth of the commercial deficit, basically associated to the volume of imports. Between 2006 and 2013, while the exports grew from US\$ 269.80 to US\$ 553.50 million, the imports incremented from US\$ 1.66 billion to US\$ 4.40 billion.

Since its origin, NOVUS survived and developed supported by the local market conditions and protected from competition due to the Brazilian market protection. Thus, along the 80's, NOVUS was technologically and commercially structured on a business model essentially based on two vectors: the first one, directed to designing of automation products aimed at the "substitution of imports" strategy – i.e., - manufacture of local products that were imported. The second vector, complementary, was based on supply of a limited array of products, focusing on the localized markets (the so called 'market niches') and the markets of 'on demand' products (the company was characterized as being a competent 'specialized supplier' of automated components for some productive segments). In that productive and commercial architecture, it conceived and manufactured more than twenty thousand units of controllers, mainly for applications in temperature, for the most diversified industrial and laboratorial activities.

3 Available at: <<http://www.abinee.org.br/programas/50anos/public/panorama/index.htm>>. Access on: March 17th, 2015.



With the sudden opening of the Brazilian market, in the early 90's, the company faced frailty of its commercial basis – centered in the domestic market – and the inherent limitation of its future growth. With market opening and strong presence of global companies, added to the local presence of several international suppliers, the company's possibility of survival was reduced. At that instance, a hard decision crossroad was presented to the company: either it would become fundamentally a company for trade and distribution of imported products; or, in a more courageous perspective, it would redeem its genuine

entrepreneurial strengths and depart to productive, technological and commercial flights to new and higher levels, far beyond the strict limits of the domestic market; which limits had been significantly reduced by the opening.

3. THE PROJECT

The company's second option had always been in the most genuine core of one of its idealizers; to him, the second option had always been 'the' only option.

Between recognition of the change and its actual implementation, there was a far distance to be travelled. In 1994, NOVUS Produtos Eletrônicos was established, at that time just a new corporate name, but injected by the challenge of putting into practice a project of internationalization of a medium company, with still very naive commercial features, in order to turn it into a global and bold player.

The project presented here is identified with the actual 'history' of productive, organizational and commercial re(engineering) that led a medium company from Rio Grande do Sul – with commercial basis set on the restrict and not very demanding Brazilian market of the 80's and early 90's – to turn it into a commercially global company and to have broader technological hopes: to be a global quality reference in measurement and control electronic and automated devices.



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The company decided to invest at least 8% of its revenue in Research, Development & Innovation, both internally and in projects of partnerships with Universities and Science and Technology Institutions.”

That condition becomes more relevant as the history of the sector is filled with examples of companies that have long disappeared from the industrial scenario, or decided for the immediately more feasible option, which was to become sales agents of imported products.

NOVUS' case will be presented based on construction of the main strategic vectors – those, necessarily interconnected and complementary – constructed by the company along its path of commercial internationalization.

4. TECHNOLOGICAL STRATEGY AND THE INTERNATIONAL DIMENSION

Two strategic decisions were crucial for the company. The first one was the strengthening, coherent diversification and expansion of its technological bases. Leveraged by the Lei da Informática (Law on Computing), since 1997, the company decided to invest at least 8% of its revenue in Research, Development & Innovation, both internally and in projects of partnerships with Universities and Science and Technology Institutions.

The Lei da Informática (Laws # 8248/91, 10176/01 and 11077/04) grants reduction of the tax burden for companies of the technology sector that work in the areas of hardware and automation electronic components and which have the

practice of investing on Research and Development (R&D), fostering the national industry's innovation in the sector. Those benefits refer to reduction of the Tax on Industrialized Products - IPI. The Law is aimed for every company that invests on Research and Development, which is under tax good standing and which is a manufacturer of any item which MCN (Mercosur Common Nomenclature) is included in the list of products subject to the benefit. The investment to be made in R&D, until 2014, is 4% or 4.35% of the annual revenue of the benefitted products (depending on the region), discounting the trade taxes (ICMS, IPI, PIS and COFINS).

Another condition for the company to receive the benefit is to comply with the BMP (Basic Manufacturing Process). That is a process that determines the level of nationalization required for each type of product so that it can be considered as 'subject to benefit', as the initiative is aimed at granting benefits to locally manufactured products. The BMP is defined in an Ordinance issued jointly by the Ministry of Sciences and Technology and the Ministry of Development, Industry and Trade.⁴

Those investments generated more power for the company's technological basis, enabling leveraging of 'in-house' know-how and its applications to the design and development of 'global products'. In other words, those which technical and

⁴ Available at: <<http://leidainformatica.com/a-lei-de-informatica/>>. Access on: October 14th, 2014.

commercial features were the most possibly compatible with the range of the necessities from the several external markets – i.e., the company adopted a less domestic and more international approach.

The second strategy, complementary to the former, was to substantially expand the array of products traded, gradually building the concept of “NOVUS’ families of products”. Hence, the company also created and benefited from significant saving in the scope and, simultaneously, departed from the trap and instability of the local market niches. The company clearly defined a strong commitment with change towards products that can add functionalities and, through them, add values to its clients’ processes. Added to that, the

company seriously invested in complementary assets, those crucial for differentiation of the products in terms of quality, but also the services rendered by the company and attached to the products. The following can be highlighted:

- the investments in ‘software technology’ that allow differentiation of the products in the items related to functionality and application, simultaneously making it harder for the competitors to imitate them; ii) the construction of international quality and credibility standards by the constant investment in metrology technology and technical international certificates (mainly for the USA and European Union markets);





- preparation of technical manuals, commercial catalogues, Internet websites and the rendering of consumer services in different languages, allowing faster diffusion and expansion of relevant technical information, consequently reducing the risk level of the companies at the instance of purchasing the products, and increasing the products' use safety. That is extremely important in markets of products with strong technical and technological dimension, which choices have nature strongly associated to performance, safety and reliability. That priority is totally understandable as any failure produces high costs and risks.

» **"COMMERCIAL ENGINEERING" STRATEGY**

Upon expansion of its commercial areas, the company worked in two fronts, closely connected: in the first one, it adopted the practice of participating in international business fairs (with highlight to the more important in Europe and United States) and promotion of Road Shows in several countries, mainly those of Latin America. Hence, the company was able to regularly not only advertise its new products and the commercial brand, but also compare its products range concerning items of technological quality and/or complexity with those of the international competitors.

In the second front, together with opening of some subsidiaries, NOVUS assembles 'in-house' an efficient

heuristic used for construction of a tacit “global supply channel’ for its products. The company assembled a system for search and formation of expandable basis of ‘distributors’ in several parts of the world, establishing commercial relations with them, most of the times more attractive and differentiated, when compared to the other competitors. Especially, the international distributors were capable of frequently receiving a broader array of products than the usual ones from the other companies of the sector – the company created the concept of “NOVUS’ families of products”. That was economically attractive for the distributors, as the commercial leverage derived from the larger portfolio of products in the distributors’ stocks, reduced its costs of transaction and the uncertainties in the transactions comparatively to the other suppliers.

» **STAGES OF THE PROCESS PERFORMED**

BY NOVUS TO EXPAND ITS COMMERCIAL AREAS:

1. *Identification of countries with strategic interest for the company’s business;*
2. *Creation of promotional materia lof the products offered by the company with technical specifications in the languages of the identified countries;*
3. *Prospection of potential distributors of its products after mapping of the commercial and industrial references of the sector;*

4. *Initial contacts by e-mail for presentation of the company;*
5. *Telephone conversations with potential distributors;*
6. *Sending of samples catalogues and products;*
7. *Beginning of the commercial activities with small lots;*
8. *Carrying meetings to close deals;*
9. *Fidelity programs for the global representatives implementation;*
10. *Scheduling visits to the headquarters of NOVUS in Brazil;*
11. *Follow-up distributors’ performance, by use of standardized indicators.*

» **STRATEGY OF “MINIMALIST LOGISTICS”**

In the channel for exporting of its products, NOVUS (despite the various fiscal, tax and bureaucratic hindrances of several types related to the so called ‘Brazil cost’) was able to implement a system of sending flows based on packages of products in reduced scale, but frequently adequate and at internationally very competitive prices. In the channels for importing of components and supplies, the search for qualified suppliers, capable of coping with the evolution of NOVUS’ products quality and at competitive costs was of primary importance. The company’s international expansion objective cooperated for its demand of global standards in the supply of components. Compliance with those necessities required construction of close relationship with suppliers. NOVUS innovated, creating semi-direct platform



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four commercial
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for supply of components and inputs eliminating four commercial stages between the supplier offshore (usually located in Asia) and beginning of the manufacturing line in Brazil, sharply reducing the manufacturing costs.

5. RESULTS FOR THE COMPANY

In the decade of 2000, the positive results started to be evidenced for the company. New investments in productive, technological and commercial infrastructure were made, together with opening of national (in the cities of São Paulo, Curitiba and Campinas) and international (in Argentina, United States and Colombia) subsidiaries. The average annual revenue of NOVUS in the last five years was BRL 30 million, with average growth rate of 20% per year.

In 2010, NOVUS exported 40% of its physical production (in part units) to more than 50 countries, through solid network of distributors strategically organized since its initial instance. In terms of revenue, the external market share already corresponds to approximately 20% of the revenue, and the company's perspectives are of growth (despite the level of the foreign exchange rate in the recent period).

The revenue in strong currency obtained with the exports is higher than the expenses with import of supplies, and

NOVUS has a very important natural protection against the exchange variation.

The main external markets are: Argentina, United States, France, Australia, Poland, Colombia, United Kingdom, South Africa and India, responsible for approximately 70% of the revenue. Other 40 countries generate the rest of the exports' revenue. As verified, the commercial strategy of an electronics company that is eccentrically situated when compared to the global electronics hub – which is, obviously, Asia – can overcome the geographic disadvantages through differentiated features and persistence. Nothing in the corporate reality occurs more gradually than accumulation of clients. And that accumulation depends basically on continued efforts and maintenance of the undertaken commitments.

6. OUTCOMES OF THE PROJECT

The project has been enabling consolidation of very profitable form of innovation management for the company, in terms of design and feasibility of new products. A committee transversal to the organization, involving the areas of trade, marketing, R&D, and financial area analyzes and prioritizes ideas and suggestions of new products (or renewal of the ones already existing) originated from multiple sources: commercial channels, clients, competitors, employees and

the strategic planning lines of the company. The efforts of the NOVUS R&D team – comprised by electronic engineers, physicians, computing engineers and technicians in electronics and mechatronics – added to the partnerships with Universities and to the public development financing (with highlight to the financial supports from FINEP) – have been generating qualification for the company to expand its insertion in international markets and, in several products lines, to overcome competition of large traditional suppliers.

Last, but not least, the investments made both in genuine technological resources, as well as improvement of its technical qualification have been allowing NOVUS to have its horizontal diversification, mainly by use of new economic opportunities derived from technological synergies of complementary assets. That is the case of the investments made by the company in implementation of sophisticated systems of final tests of products and equipment of metrology laboratory – recently certified by INMETRO – which has been allowing NOVUS to render several technical services of measurement and tests of temperature, humidity, pressure and electricity for national and international companies. In broad expansion, this recent new business unit of the company already represents about 3% of NOVUS' revenue. It reveals the technical capacity of the company and recognition of that competency by other companies and institutions of the industrial system.



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The investments made both in genuine technological resources, as well as improvement of its technical qualification, have been allowing NOVUS to have its horizontal diversification.”



7. PERSPECTIVES

NOVUS' commercial and productive internationalization strategy, by developing a global commercial network on original manner – while internationally consolidating the company's brand in a solid manner – is an example of genuine construction of competitiveness in technologically more complex productive sectors, and usually identified with those sectors where the national companies would be, in a conventional view, considered 'losers'.

The curiosity about the world was already in the background of idealizers of the newly created NOVUS; the offshore always represented, since their academic lives, curiosity and challenge. Those characteristics were strongly

transmitted to the company under formation, becoming differentiating elements in relation to so many others with inclination for growth. However, the path of restructuring and internationalization was not outlined and performed in a straight line manner. The uncertainties and the challenges were overcome through determination, through creativity in problems solving and through collective and organic learning of the company's team. Those are fundamental aspects of NOVUS' differentiated organizational characteristic and they last until our days.

There is an important double lesson to be extracted from NOVUS' path. It involves negotiation between the industrial and commercial dimensions. Although being located outside the ruling economic hub of the world industry, which is Asia, the company was able to establish an internationalized commercial network based on its reputation as a manufacturer of reliable products. The industrial reliability preceded, in this case, the conquest of markets. However, the new commercial basis paves the way for more ambitious industrial paths, which the company is getting ready to follow. The adequate question, in this case, is whether the Brazilian industrial system, therein including the set of supporting institutions, is ready to acknowledge, in the commercial dimension early constituted in international range, an element of recognition that deserves mobilization of its best instruments and, moreover, a coordination of efforts.





PRED ENGENHARIA

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INNOVATION IN RENDERING INDUSTRIAL MAINTENANCE SERVICES



Pred Engenharia is a role model case of a business created out of an internal activity in a large company. The combination of an idea well developed internally, with the courage of the entrepreneur spirit led to the creation of new and promising business. Its founder noticed a gap in the market and determined to renounce the stability of a secure position in order to undertake the risks and uncertainties of creating a new company. The history of the company from the State of Espírito Santo demonstrates the importance of theoretical grounds for innovation, but also that other features, experiences and knowledge are required. The association between the practice and the theory is one of the strong points of the software product internally developed, the Industrial Intervention Intelligent System (S3i). Despite its not very common beginning, this case is an example of how the companies can explore the possibilities that are found around them, of how courage and correct interpretation of the moment can be essential and of how it is necessary to join practice and theory when building new technologies.

1. THE COMPANY AND ITS SECTOR

Pred is an industrial maintenance engineering company specialized in Maintenance Planning and Control (PCM). It was founded by the engineer Ozório Rezende Corrêia Filho, in 1993, in the city of Vitória (State of Espírito Santo), after a contract named as full service¹, which, at that time, was still arriving in the Brazilian industrial scenario. Its founder, and main Director, had been, for many years, a professional qualified in the technical area of a large forestry and cellulose industry. During that period, due to his developed sense of observation, the businessman gathered know-how and experience enough to become an entrepreneur in the area.

The decisive step for that company was taken with the support from Aracruz Celulose (currently named Fibria), to which he had dedicated himself under the condition of employee. That partnership generated benefits for both sides. On one side, it provided quality gain to Aracruz in the outsourced services and development of advanced solutions for the company's demands in the maintenance. On the other side, the company grew up, becoming business success with huge potential of contributing for productivity

¹ Long-term contracts based on performance by which the provider undertakes to maintain and improve performance of all the manufacturing equipment units.

and competitiveness off broad segments of the Brazilian industrial structure.

A newly created company can rarely count on the set of assets held by a well-established and consolidated company. Even when it has the competency, almost always it lacks many of the other necessary assets. Pred coexisted for a long period with limited capital – which is usual in the Brazilian system of small and medium size companies – and not very receptive clients, as it had an innovative product distant from the immediate needs, commonly found in the Brazilian business culture.

To overcome those obstacles, the company used technological and managerial competencies and developed its own method to manage maintenance of physical and logical assets, named as Maintenance Conditioned to Inspection (MCI), and attained self-sufficiency along the years, expanding its business in Brazil and in the Latin American countries. Nowadays, it provides technical services on inspection and essays, maintenance engineering, besides software and hardware trade and agency, essential to its management and operationalization.

The company participates of a very promising market which has solutions aligned with the technological trends for its area of activity. According to the Brazilian Association of Assets Maintenance and Management (Abraman), the

companies spend, in Brazil, about 4.5% of the GDP with maintenance². The sector, which participates in other segments of the economy, became notorious in the last decades, changing from the status of being a costs center to become a strategic area of the organizations that depend on their assets to keep their businesses competitive.

2. THE STRATEGY - THE PROJECT ALIGNMENT WITH THE BUSINESS

The corporations are pursuing clear improvements of their maintenance processes in order to increase the productive capacity and improve their market performance.

Aiming to support this initiative, the companies dedicate themselves to structuring an information system adequate for maintenance management through implementation of specific systems or through integrated management software (the so called ERP - Enterprise Resource Planning).

Maintenance is necessary to guarantee the non-stop production process. Industrial equipment breaks, this is unavoidable, likewise the losses associated with the

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To overcome those obstacles, the company used technological and managerial competencies and developed its own method to manage maintenance of physical and logical assets.”

² Available at: <<http://www.jb.com.br/economia/noticias/2013/10/16/abraman-lanca-pesquisas-que-mapeiam-manutencao-e-gestao-de-ativos/>>. Access on: November 13th, 2014.



breakdown. They might be minor, large or huge, but they contribute for defective operating performance and for deterioration of the financial results. This is especially true in the continuous processes industries (cellulose, cement, petrochemical, steel manufacture), where a piece of equipment is enchainned with others and a punctual break represents shutdown of the entire process.

The differences towards the manufacturing industries that have discontinued processes are clear: no matter how expensive a loom may be, for instance, its breakdown will rarely cause chain losses. Therefore, continuous process industries enabled development of more effective and accurate techniques. The Industrial maintenance sometimes represents 40% of the total cost of manufacture and in average 25% of that cost can be improved by simple practices, but they need to be traceable^{3,4}. The impact of that activity, when performed in adequate and efficient manner, may define the profitability of the business' and the enterprise's survival. Its concept has several meanings and levels, adapted to the culture of the companies that have evidenced strong migration to the use of predictive techniques. The main types of maintenance are:

- Corrective: acts only after a piece of equipment is broken. This type of maintenance is the most ineffective for the industry as a whole – equipment breakdown means shutdown of the entire production line, besides many times incurring into higher costs for the repair;
- Preventive: it is a type of scheduled control. Based on the manufacturer's information, an agenda of previously scheduled maintenances is created. That idea is based on the fact that the review does not need to be done after the equipment presents problems, it can be done periodically when it is known that the equipment is already worn;
- Predictive: it is the periodical monitoring of the mechanical and electrical conditions of machines and equipment through data gathered from a set of monitoring techniques.

The company developed very special skills to work in the predictive dimension. The equipment units announce, by subtle signals (such as noises, vibrations, changes in the temperature and reduction of performance), that they are approaching a critical moment when they might break and thus compromise the entire industrial processes.

3 Pred's Institutional Presentation (2014). <http://www.pred.com.br/>

4 MOBLEY, R. Keith. *An introduction to predictive maintenance*. Butterworth-Heinemann, October 2002.





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Pred, which started operating in the services market using thermography⁵ as its main technique, acquired new competencies and next generation technologies for planning, inspections, analyses, calculations, assessments and management for the most diversified industrial uses. With over twenty years in the market – working with inspections based on predictive methods – the company formed a valuable database, which includes detailed technical information on the machines and equipment units

5 The thermography is a technique that allows mapping a body or a region in order to distinguish areas with different temperatures, therefore being a technique that allows artificial viewing of light inside the infrared spectrum. The tool has a very important role in the area of predictive maintenance.

of different industrial plants. It enhances its database along the partnerships for services rendering established with industries from the different segments. With every new agreement, a stage of research and development is started to define adequate predictive methods and main indicators, assuring valuable information not only for good progress of the rendered service, but also to maintain competitiveness of its business in the future.

Pred created its own method to manage maintenance through strong technical knowledge of the volume of stored data. The company changed the data gathered during the years of service rendering into intelligence and defined its business: planning and control of industrial maintenance.

The management model of assets maintenance developed in-house was based on a principle that has been refined for a long time: many times, the business routines represent what can be named as ‘formalist management’, based on bureaucratic procedures, far from effective actions. The list of tasks is prepared, formally complied with, the managerial report is produced, but the indicator of the task performed is more important than actual performance of the task. The indicator of the action holds the position of the action itself.

Based on the assumption that a good maintenance plan must be prepared in the field, by experienced professionals

and following formally defined procedures, the company developed a simple model that involves four lines of planning.

Within that context, the predictive maintenance performs tests to assess what is the best moment to repair the machines and equipment. During performance of those assessments, minor changes are captured, either qualitative and/or quantitative, which the equipment starts to present before the problem actually becomes operationally visible. Such information, when gathered for a period of time and processed, informs very accurately and in precedence the best instance to perform maintenance in each equipment unit.

The process is not just previously scheduled; it is built along the production. Its differential feature lies on joining obtained information and technical and routines know-how to the perceived signals, identifying the best instance to shut down the production for repairs, impacting, and a lot, the cost saving of this stage, for the industries. The method allows increasing the interval between repairs by breakdown and preventive maintenance.

Pred's business was developed and enhanced along the 2000's, during the second phase of the company's life, soon after its stabilization, with headquarters and team of employees. Today, it counts on a set of techniques to work in the segment, providing services and products for inspections and essays, maintenance engineering, automation

by thermography and moving computing (traceable operationalization of the maintenance plans of the ERP).





3. THE PROJECT

The main targets of the predictive maintenance are the expensive equipment units and, moreover, the ones crucial for the company's industrial processes. The involved technologies are usually sophisticated and demand mobilization of specific equipment and qualified operators. Although the machine does its duty, it is necessary to assure that the operator and the maintenance provider shall perform the prescribed tasks according to the defined plan.

That was the view by which Pred combined sophisticated methods for management of the industrial maintenance (derived from the long experience in the area) to operating systems for planning and control of the process. That is how the Industrial Intervention Intelligent System (S3i) was born, a software product capable of integrating all the modules and fault mechanisms of the industrial equipment units. Originally, the system was developed for internal use, aiming at assisting the essay and inspections activities performed by the company, but it soon became obvious that the system had autonomy for independent trade.

The development of the system started in 1997 and it was, along the years, improved and incorporated into the company's predictive maintenance activities routine. The use of the tool, associated with the developed management model, enabled the business consolidation in the market.

In 2003, its clients portfolio already encompassed large companies, including the Gerdau Group, considered to be a strategic partner, as it enabled perfecting of the product, making it even stronger. The possibility of launching the S3i as a product emerged during execution of a services rendering agreement to Gerdau. The shrewd entrepreneur noticed the client's need and was able to turn it into a solution offered by its industrial intervention intelligent system. The company then adapted the system to meet Gerdau's requisites and in a short time the system was approved and became part of the group's maintenance management system.

The S3i became effectively a product and part of the portfolio, assuming, in a short time, strategic role in the development of the company's business. It is a system capable of autonomous operation and real time, full time audits, performing post-repair inspections, i.e., the system itself assesses if the task has been effectively performed. If there is a new (or old) problem, it is automatically reported. This maintenance can be assessed post-repair, because it is predictive; therefore it is based on inspections that do not need interruptions in the production line or disassembly of equipment. The S3i works with management and operationalization of all sorts of inspection (Predictive, Planned, Autonomous, Non-Destructible Testing - NDT, Rounds).

The tool presents several advantages, highlighting the possibility of integrating the maintenance with all the other information systems used by the clients. The software presents an easy handling interface that allows management of the predictive maintenance and transfer of the information obtained in the inspections to a database of the ERP – maintenance planning module. Hence, it is processed, generating new information that allows the decision making towards the necessity, or not, of repairing the inspected equipment.

As this is an autonomous system, the S3i, when integrated to the management systems used by the company, allows better control of the activity's performance, improving effectiveness of the maintenance management system adopted by the clients.

The developed software is unique in the market performing quality and effectiveness audit of all types of inspection in real time, by specific methodology. The application for industrial property registration with the Brazilian Industrial Property Institute (INPI) is in progress.

Development of the S3i enabled conquering new clients and moderate increase of revenue. Although the business did not present major deficiencies in the structuring, the cost to maintain it was still high. In 2011, the company was invited by Vale to participate in SEBRAE's National Program of

Productive Enchaining, aimed at putting together small and large businesses.

The project enables the small companies to contact large companies which are part of its value chain, besides

Figure 1 - Data traceability during performance of the inspection



Source: Pred's Institutional Presentation (2014)



offering qualification in advanced management practices. One of the characteristics of the project offered by SEBRAE is the customization, which allows adherence to ventures with different needs and growth levels.

The program included twelve months of training that ended up with redesign of Pred's business model. The new model led the industrial maintenance engineering company to see the actual potential of the developed technological solution – mainly, considering the momentum experienced by the industries (which adopted austerity measures) and the huge impact on costs reduction that adoption of the system represents for the productive sector. The program enabled establishment of new corporate relations, essential for the development of the company's market, which was internally disseminated.

4. INTERNATIONAL SCENARIO

The industries used, for a long time, corrective maintenance systems, i.e., the repair was provided only after occurrence of the faults. During the 1980's, Brazil started to be influenced by administrative models from other countries, and the scenario received the presence of models such as the Total Productive Maintenance and Reliability Centered Maintenance. The two methods unleashed studies and investments on preventive and predictive techniques

programs, besides detailed analyses of equipment units and installations, in order to identify the functional faults, causes, effects and importance⁶.

The industrial maintenance market experienced intense change in the last years. Its performance started to be planned and periodicities for intervention in the equipment were defined. Nowadays, the use of the predictive technique is much more relevant for the companies than it was ten years ago. The industries' growing concern with the high costs of maintenance and production idleness, due to faults and breakdown of equipment, enabled important market growth to the predictive solutions, being indicated as a trend for the reliability engineering.

ABI Research⁷ expects US\$ 9.1 billion revenue for the sector, in 2014. The spotlight is on the use of advanced maintenance forms, such as the predictive and prescribed methods. Those will be expanded from 23% of the total market, in 2014, to 60% of the entire revenue until 2019⁸.

6 Available at: <<http://www.mutua.com.br/associado/item/6961-o-papel-da-tecnologia-na-evolucao-da-manutencao-industrial>>. Access on: November 12th, 2014.

7 ABI Research is a company focused on research in the technology market and is for 24 years in the business..

8 Available at: <<http://www.reuters.com/article/2014/03/28/abi-research-idUSnBw285407a+100+BSW20140328>>. Access on: November 12th, 2014.

The use of software to handle a large amount of information became mandatory in the maintenance departments. Those tools are considered to be the professional's main point of support to register occurrences, measure times, produce statistical data, consult histories and technical forms, and to assure performance of routine maintenance.

The most promising niches of this market include the equipment for monitoring of vibration, which has the largest market share among the products. The thermography equipment (infrared scanner and images generator) represents the segment with the largest growth. It is expected that the market of equipment for monitoring machines conditions will exceed US\$ 2 billion in less than five years.

The large companies recognize the value of the predictive maintenance. In 2009, Boeing and GE Aviation united to develop monitoring standards for equipment conditions. In the oil refinery plants, the maintenance and operation departments represent 30% of the industry's human capital⁹. The USA spends approximately US\$ 200 billion per year with

its performance, and more than 30% of that amount is spent in improper manner, by faults or lack of inspections¹⁰.

Although the United States and Europe represent the largest portion of the market of equipment for machines and equipment monitoring, the sector does not have an isolated leader. Instead, it is comprised mainly by small and medium suppliers¹¹.

5. RESULTS FOR THE COMPANY

Success of the development of the Industrial Intervention Intelligent System (S3i) can be measured according to its economic growth. In 2013, the company's revenue experienced increase of 78% and clients' fidelity rate of grew by 90%. The potential for application of the system, added to participation in the productive enchaining program promoted by SEBRAE, granted visibility and allowed establishment of strategic partnerships with large companies of its value chain.

9 DEKKER, Rommert. Applications of maintenance optimization models: a review and analysis Rotterdam: Erasmus University, 1996

10 MOBLEY, R. Keith. *An introduction to predictive maintenance*. 2. ed. [S.l.]: Elsevier, 2002

11 Available at: <<http://www.simafore.com/blog/bid/204618/Why-predictive-maintenance-is-more-relevant-today-than-ever-before>>. Access on: November 13th, 2014.



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The project led the company to prepare a new business model, more comprehensive, that enabled construction of safe foundations for its growth and consolidation of clients’ portfolio.”



Pred received the Competitiveness Awarded for Micro and Small Companies (MPE Brasil 2013), promoted by SEBRAE, in the Services and Innovation categories. This award has national range and recognizes businesses that promote increment of quality, productivity and competitiveness, by dissemination of management concepts and practices¹².

¹² Available at: <<http://www.pred.com.br/conteudo.asp?C=85&M=&Ct=Pred%20Engenharia%20%C3%A9%20vencedora%20em%20duas%20categorias%20no%20Pr%C3%AAmio%20MPE%20Brasil>>. Access on: November 10th, 2014.

The project led the company to prepare a new business model, more comprehensive, that enabled construction of safe foundations for its growth and consolidation of clients’ portfolio.

6. OUTCOMES OF THE PROJECT AND PERSPECTIVES

The successive uses of the tool along the years in different segments allowed creation of solid database with technical information on a large and varied range of industrial machines and equipment.

The company identified that the management model of physical and functional assets maintenance, known as MCI – Maintenance Conditioned to Inspection, can become a franchise and it is working to prepare the business plan in order to make the S3i a franchise, as of 2015. To strengthen the business, the company is tracing, with SEBRAE’s assistance, a new internal policy on industrial property protection.

The expansion plans include establishment of strategic alliances with large software companies. The purpose is to introduce the S3i tool in the market using well-known brands and highly diffused products, providing larger coverage to the developed system and strengthening the company’s name in the national and international market.

Protect



PROTECT

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DEVELOPMENT OF NANOTECHNOLOGIC FABRIC FOR THE EUROPEAN MARKET



Innovation is aligned with the company's business model within the strategy of consolidation as provider of differentiated solutions, in the personal protective equipment (the so called PPEs) market for the agricultural sector. In this sense, Protect established well-structured contact network that allows it to identify opportunities and advance trends, providing basis for enhancement and development of new products. The new nanotechnology fabric, developed focused on the company's penetration in the European market, is the result from this strategy, and the success of that project validates the model of differentiation by innovation.

1. THE COMPANY AND ITS SECTOR

Protect is a small company that manufactures and trades clothes and accessories for protection of agricultural workers. Located in Sumaré, a city close to Campinas and about 100 km distant from the State of São Paulo's capital city, the company turned 20 years in October, 2013. Along its history, it accumulated broad knowledge about the



industry and the market of personal protective equipment in the agriculture, currently holding approximately 10% share in that market. Along the last years, the company has been experiencing annual average growth of 15% and its productive capacity amounts to 200 thousand units/year.

The company was created by Paulo Formagio, agronomics engineer, after a long period working for a large chemical multinational company of the agricultural area. During that work experience, Paulo had the opportunity to observe and become familiar with the practices of the agricultural workers in Europe. Comparing the activities of pesticides application



in Brazil and abroad, he could observe the huge gap between the two realities. While in Europe the workers used protective outfit even for short works in greenhouses, here the reality was totally different.

The businessman was familiar with the problems faced by the Brazilian agricultural workers during performance of their duties: low adhesion to the use of personal protective equipment and improper use, symptoms of the problem with equipment not well adapted to the field activities, to ergonomics, habits of people, to their movements and routines. When comparing that environment to the

international scenario, he noticed that there was the opportunity to make it different and, leveraged by the adversity of the severance, he decided to become an entrepreneur in the area: that is how Protect EPIs Agrícolas was created.

The personal protective equipment for the agricultural worker presents important challenges in order to effectively have the protective effect. The main issue lies on assuring its use: the worker has to wear the PPE, he/she needs to be willing to dress a different outfit, put on a cap and a hood, a beaver or goggles. That individual willingness is crucial due to the difficulty of supervising the field activities. In 2004, a research¹ was published, which studied the Brazilian agricultural workers' behaviors towards the personal protective equipment. When questioned about the use, almost 90% of the workers simply answered that they did not use it. The main reasons indicated for that attitude included 'it is uncomfortable' (22%), 'it is hot' (18%) and 'it makes the work difficult' (16%).

In the urban zones, the workers are concentrated in productive units where there is supervision by the hierarchical structure, with direct and immediate relation among those who mostly use the personal protective equipment and the ones responsible for assuring its use. In

1 CAD. SAÚDE PÚBLICA. Rio de Janeiro, v. 20, n. 1, Jan./Feb., 2004. p. 180-186.



the field, differently, the workers perform their duties far from supervision of any hierarchical chief. That condition ends up contributing for the possibility of the worker not using the PPE or using it wrongly.

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As direct and natural consequence of the concern of adding comfort and safety to its products, the culture of innovation was also born.”

The level of adhesion to the equipment increases when it is adequate, comfortable and ergonomic. Aware of that, Protect assumed the challenge of adding comfort and safety to its products, and the entire project development starts by a detailed analysis of the reality of each activity performed by the professionals. The company believes that, by developing equipment designed for each type of application, based on identification of the clients' demands, the use of the PPE stops being a burden to the worker. It is based on that philosophy that one of the company's main differential features appears: an extensive and diversified range of products, offering more than 30 kits, each one specific to one rural activity.

As direct and natural consequence of the concern of adding comfort and safety to its products, the culture of innovation was also born. In this sense, the company holds contact with research centers and establishes partnerships with professionals inside the large universities of the country, as well as agronomic engineers experienced in field works. Furthermore, as a way of including innovation into its internal structure, it adhered to the Local Innovation Agent Program (ALI) from SEBRAE, by which it systematized the whole process of innovation management.

Innovations were then born, both by means of incremental improvements and by means of totally new products. In what refers to improvements, one of the highlights is the development of the standup pouch type packaging, which can be reused, having hermetic closing and which, after opened, can be used to keep the contaminated equipment. Until then, the products were traded in cardboard boxes that did not offer the functionality of reuse. For its innovation management process, the company was granted, in 2013, the Brazilian Innovation Award, in the category of Local Innovation Agent (ALI) – Industry, promoted by CNI and by SEBRAE.

Protect's commercial range is currently national and international, through exports to Asia, Africa and Central America. The main clients are found in the fruit and greenery farmers, encompassing since the small family properties and cooperatives up to large agricultural regions. The company maintains a network of suppliers and representatives whose responsibility, besides direct services to clients, is to identify new demands and opportunities for improvement of the products in the field. It was after the report of a representative that, by the end of 2012, a possibility to diversify its business was identified: the rental of PPEs.

Use control and maintenance of agricultural PPEs imposes several types of care in handling and logistics, including special washing, with proper disposal of the water used, and control of useful life of each equipment unit. Such type of care is very





expensive for the large producers, who have to deal with a large number of PPEs and, therefore, sought for a solution that could enable reducing time and cost of those operations. There were already companies that offered the services of rental. When one of those companies extinguished its activities, Protect, that had until then been its supplier, identified that opening in the market and decided to grab the opportunity. Entrance into that new market generated fast return, reaching the impressive figure of 16 thousand units rented after the sixth month of implementation. In 2014 about 200,000 items were rented, with an outcome around R\$1 million in revenue.

Added to the rental, in an action aligned with its concern with environmental sustainability, the company also developed a type of reverse logistics, whereby it receives back the used equipment and packaging, both for hygienization (properly treating the water used) and for proper final disposal (incineration or reuse).

Along its 20 years of history, the company experienced important and deep changes, from the products portfolio to the business model. The entry of the entrepreneur's heirs in the business, in the middle of 2008, was one of the remarkable changes. The man was an engineer and the woman was an administrator, they undertook leadership positions and, with fresher and more contemporary view, leveraged the company's renewal, strengthening focus on the client and bringing new ideas to increment quality of the products and services.

Through the connection held with researches of the academic environment and partnerships with large multinational companies from the agro-chemical segment, added to the in the field presence through the representatives, the company keeps itself updated towards the market and the available technological advances. That market driven approach allowed identifying the need for development of more 'user-friendly' PPEs and led to the pursuit of cooperation in the academic environment to accomplish that goal. That was how, in April, 2010, the Ultra products line was born. After that, a complete range of lighter and more comfortable solutions started to be offered, which today represent more than 50% of the monthly sales revenue. It was also the beginning of an evolution path of the technology included in the offered outfits, ending up with the European certification of the PPE produced with nanotechnology fabric.

2. THE STRATEGY – THE PROJECT ALIGNMENT WITH THE BUSINESS

The key characteristics required by fabric used to prepare the agricultural PPEs are resistance and water-repellence. They assure that the equipment will not be ruptured (tears, holes) during work and that the agricultural pesticide does not pass through the fabric and contact the worker's skin. Until 2012, the fabrics used by Protect received treatment

based on fluocarbon polymers, a technique commonly used to grant resistance and water repellence to fabrics and other materials. During that same year, a new technique was also incorporated, the treatment of the fabric with nanotechnologic product, which allows formation of more uniform water-repellent pellicle and, therefore, longer-lasting. Today, the company has different lines of products for each type of treatment.

The companies that supply agricultural insecticides have been working on projects of responsible action and initiatives to assure correct use of their products, developing programs that work directly in the application activities. Those companies started to foster use of the PPE seeking to reduce accidents provoked by application/contact with agricultural pesticides. The awareness of the rural worker is seen as the best way to build sustainability in the field. The support and partnership with companies with responsible action are presented as alternatives to improve the safety aspects in the work environment². In this sense, through partnership with the large multinational companies of the agrochemical sector, Protect is constantly participating in events where it offers training and lectures to qualify the suppliers and ultimate users regarding the correct use of the products

supplied by it. That action enables not only advertisement of the products, but also guarantees good market penetration.

Through those large partner multinational companies, a networking is maintained with key people abroad and with the European market. In Europe, the best diffused PPEs are produced in impermeable and non-waterproof material.



² BARBOSA, L. D. S.; MACHADO, J. G. *Analysis of agrochemical industries programs for promoting the use of personal protective equipment*. 48^o Congresso da Sociedade Brasileira de Economia, Administração e Sociologia Rural, Campo Grande/MS, julho/2010.



Impermeability is a characteristic of the material of impeding the passage of liquids in any quantity through it. The impermeabilizing material acts by eliminating or reducing porosity of the material, filling infiltrations and isolating humidity of the medium.

Waterproof refers to the protection against drops and mist and not intensive wetting. The waterproof acts by reducing superficial tension of the material, impeding spreading of the drops and consequent penetration of the liquid.

Being waterproof, the fabric allows exchange of the body heat with the environment, a quality that an impermeable fabric does not present.



Protect already held the technique to apply nanotechnology for waterproof in the fabric and it already traded, in the Brazilian market, PPEs with that technology. That condition motivated the company to investigate the possibility of entering Europe using the same type of product. That was the starting point of the project for development of outfit aimed at the European market, using the strategy of presenting a new alternative to the products that are currently traded in Europe.

3. THE PROJECT

In 2010, a team from Protect visited France, Switzerland and Portugal invited by some of the large companies from the agricultural segment with whom it had partnership established. Accompanied by stewardships (department leaders) of those companies, the purpose was to know and identify the European market of agricultural PPEs and its demands, and also seek references and more advanced solutions in nanotechnology. Thus, it has been possible to identify *in loco* that the market lacks waterproof PPEs. The most diffused products are produced with impermeable material and, despite the application of nanotechnology in fabrics being in advanced level of development, its use in agricultural PPEs is still insufficient;

After the team's return to Brazil, a decision to develop a new product was made, aiming to pursue certification

in Europe and internationalize even further their sales. As there was already a contact established with a nanotechnology supplier to develop the company's products for the Brazilian market. The team worked together with that supplier searching for the best alternative to meet the requirements of the European standards for product approval. The standards that regulate the personal protective equipment in Europe, following the guideline 89/686/EEC, are much more restrictive than the Brazilian ones;

There are several nanotechnology alternatives for treatment of fabrics. Application of waterproof product can be made using procedures that are traditionally used for textile finishing. One of the main methods is that of simple immersion, where the fabric is dipped into a bath containing the nanotechnologic product in solution with the fabric remaining immersed for a certain period of time. Then, the drying of the material is performed under environmental conditions or thermally, so that the nanotechnologic product can be cured;

The procedure adopted by Protect uses the immersion followed by thermal curing. With evaporation of the solvent, during drying, complemented by the curing period, the nanoparticles (maximum diameter of 100nm) form a three-dimensional mesh in the surface of the product. That mesh increases the superficial tension,

which induces formation of spherical drops of liquid when in contact with the surface, those drops slide down without being absorbed. Thus, the liquid is not able to spread on the surface and, consequently, it does not penetrate the fabric.

The prefix "nano" comes from the Greek and means "dwarf". A nanometer (nm) corresponds to the one billionth part of one meter ($10^{-9}m$). To better understand its dimension, a human hair thread is 80,000nm width and a red globule blood cell is approximately 7,000nm width.



The logo for 'Protect' is displayed on a green wall. It features the word 'Protect' in a white, bold, sans-serif font, enclosed within a white, stylized, rounded rectangular border that resembles a protective shield or a speech bubble.

Protect



The definition of the product that would be sent for certification was made based on tests performed in Brazil, following the parameters of the European standard specifications. One of the main prerequisites for assessment of waterproof quality is the washing test: the fabric must maintain its property unchanged even after it is submitted to successive number of cycles of washing. The sample sent had been tested and approved in Brazil, meeting the specification even after it was submitted to 50 washing cycles (for test approval, in Brazil, the standard test is to have thirty washing cycles). However, it was rejected in waterproofing, in Europe.

After the rejection, a development strategy totally aimed at complying with the standard was adopted, in a design by certification model. First, the project team performed an internal research to understand in which aspect the technology had failed. The adopted approach was to submit the sample to field tests, under severe use situations and follow-up the aspect of the material in time. After months of use and successive washing cycles, it was possible to identify that the cotton that formed the fabric suffered a lot of wearing out by abrasion, generating points of loss of the waterproof quality. The sample had been prepared with polyester-cotton fabric, very similar to what is used in the products that form the company's current portfolio. The alternative of removing cotton and using a 100% polyester fabric was unfeasible, as that material does not comply with the requisites of thermal comfort for field works. Thus, it was understood that a totally new fabric had to be sought.

The inspiration came from the sports market, where polyamide has become popular as a highly resistant, light and malleable fabric, which offers good thermal comfort to the user. But, the ordinary polyamide did not prove to be resistant enough and the option was to work in the development of new material, more resistant and that would enable more adherence of the nanotechnologic product to the surface. The survey of alternatives started in the national range and was extended abroad, through contact with large fabric manufacturers in Asia. In Taiwan, a supplier was identified who counted with broad range of differentiated fabrics, including a very high mechanical resistance polyamide, manufactured with fiber technology that does not exist in Brazil. And that was the fabric selected for the new stage of tests for the European certification.

This new material was submitted to the same nanotechnologic treatment that had been used in the former attempt. Samples were sent for tests in Brazil, in the laboratories of the IAC (Campinas Agronomy Institute) in Jundiaí, according to the ISO 27065³ standard and in Europe, according to the EN 13034⁴ standard, for a new attempt of validation. This time, it was totally successful: the product was approved in both tests. A totally new

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- 3 ISO 27065: Protective clothing – Performance requirements for protective clothing worn by operators applying liquid pesticides.
 - 4 EN 13034: Protective clothing against liquid chemicals – Performance requirements for chemical protective clothing offering limited protective performance against liquid chemicals



technology and product were born. According to the company's General Director, the new product "is not an improvement of the PPE currently manufactured, it is actually a technology breakthrough. It is something that did not exist in Brazil before".

4. INTERNATIONAL SCENARIO

The industry of personal protective equipment (PPE) was one of the less affected sectors during the 2009 recession. Investment of the employers in purchase of that material is due to the higher cost of injuries related to the work, compared to the cost of the equipment. The range of available protective equipment is extremely broad, encompassing different sectors of the economy such as industry, health and agriculture. Design of the products is personalized for each application, in order to provide the desired safety and the necessary comfort to the workers⁵.

According to projections prepared by market experts of the *Global Industry Analysts Inc.* - GIA, the world PPEs market is supposed to reach US\$23 billion in 2020. That growth has been mainly leveraged by the laws, which imposed occupational safety rules, by the increased awareness regarding safety among the workers and by the high costs associated to occupational

accidents. Globally, Europe is the largest global market of PPEs, while Latin America appears as the most prosperous regional market, at an average annual growth rate of 7.3%⁶.

Today, the mainly used fabrics to manufacture PPEs for application of agricultural pesticides are cotton, polyester, cotton/synthetic material mixes or non-fabric material, such as the Tyvek[®]. The world textile industry has been focusing on new trends and more promising technologies to reach functional and high performance characteristics that include special coating, plasma based products, intelligent technologies and nanotechnologies. There are two points of the textile production value chain where nanotechnology can be applied: for production of fibers or for application as coating over the surface of the thread or fabric, during the finishing stage. In any of the cases, nanotechnology does not affect the properties of the fabrics that are affected by other types of finishing/coating.

Sharp changes have been observed in the last five decades in the applications of fabrics and clearly in the next years the nanotechnology will penetrate all fields of the textile industry. Development of functional finishing based on nanotechnology has infinite possibilities.

5 Available at: <<http://www.transparencymarketresearch.com/personal-protective-equipment.html>>. Access on: March 17th, 2015.

6 Available at: <http://www.prweb.com/releases/protective_equipment/protective_clothing/prweb11743898.htm>. Access on: March 17th, 2015.

Within the family of the personal protective equipment, the protective textiles represent a specific area in the sector of the so called technical fabrics. This is a strongly growing market for the textile industry, which seeks to satisfy the growing demand for high performance requisites. Textile products with new surface treatments and coating, nanocompounds, nanoscale fibers and functional nanoparticles provide better levels of protection added to lower weight, more comfort, new and multiple functionalities or more environmental friendly processes.

The protection textile products were selected by the European Commission as one of the areas of the Pioneer Markets Initiative, aiming to create market structure opened to innovation and to reinvigorate and increase competitiveness of the traditional industries⁷.

5. RESULTS FOR THE COMPANY

From the economic point of view, the product must provide large business opportunities in exports, not only to Europe, but also to other countries that do not recognize the ISO 27065 standard, but accept the European standard EN

13034. As the used fabric is purchased through import, the final cost of the product will probably be high for the standards of the Brazilian market and, therefore, it must be assigned solely to the external market.

The product shall also have positive impact on the company's image, strengthening marketing strategies for the internal market. Upon approval of the product in the essays, according to the European standard, Protect becomes the only Brazilian company in its segment to use nanotechnology with European certification in its products.

6. OUTCOMES OF THE PROJECT

The certification process was successfully concluded by the end of 2014, so that Protect is capable of trading the product for countries that accept the European standard related to the agricultural protection outfits. Obtaining of the certification included a stage where the company had its process audited. An European team visited the plant to follow-up and validate the entire manufacture chain during production of one lot of the PPE, in order to guarantee that the product is identical to the one that was sent for certification and that the process is traceable. Therefore, it was necessary to formalize the entire process, generating documents that describe each stage in details. The documents are written in a clear and direct manner, so that

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Upon approval of the product in the essays, according to the European standard, Protect becomes the only Brazilian company in its segment to use nanotechnology with European certification in its products.”

⁷ CHINTA, S. K.; LANDAGE, S. M.; SWAPNAL, J. **Water repellency of textiles through nanotechnology**. *International journal of advanced research in IT and engineering*. v. 2, n. 1, Jan. 2013. p. 36-57.



any duly trained employee shall be capable of performing a certain stage. That is the guarantee that the process is well-established and can be reproduced.

During this stage of process formalization, an important lesson was recognized as the project's legacy: the actual process of certification as a whole. The bureaucratic stages, following the patterns of the European standard, provide knowledge that will be extremely relevant in future certifications.

Another indirect gain derived from the project was the development of international suppliers, both for nanotechnology and for the fabrics. That action enabled expansion of the networking, strengthening its productive enchaining and enabling global view of business and opportunities.

7. PERSPECTIVES

First, the company is submitting just one sample of PPE to the certification tests, simpler, in a tailoring similar to what is currently predominant in the European market. That option is due both to the fact of this experience being totally new for the company and for the high cost and extended duration of the tests. Therefore, diversification of the models to be offered to the European market is a project considered as being from medium to long term.

In the short term, a marketing and sales project shall be started for penetration in the European market. The strategy is to sell the products by distributors spread across several countries. The contact with those suppliers will be made through the commercial partners, large multinational companies working with agrochemical products, well established across Europe. The company already has contacts in Portugal, expecting sales of 10,000 units, which would already pay-off the expenses of the project itself.

In the long term, there is also the idea of nationalizing manufacture of the fabric, when volume of exports reaches important levels. Today, the import is the only alternative found by the company to purchase the special polyamide, but it is a process that makes the final product very expensive. Meanwhile, the national companies that manufacture polyamide demand an attractive sales volume to dedicate themselves to develop new technology.

Irrespective of terms, the certification and the entry in the European market open a universe of possibilities and all the perspectives are promising. The project evidences the success of its strategy and the business model based on partnerships and productive enchaining. In addition, it consolidates Protect's image as an innovating and diversified company in its sector.

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The patterns of the European standard, provide knowledge that will be extremely relevant in future certifications.”



RECEPTA BIOPHARMA

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ASSOCIATION OF COMPETENCIES FOR DEVELOPMENT OF INNOVATIVE MEDICINE FOR TREATMENT OF CANCER



RECEPTA is a company that works with biotechnology applied to health, gathering scientific competencies and expertise in research projects management. Created in 2006 from an association between Brazilian investors and a renowned institute of researches on cancer, it depicts an important case of Brazilian entrepreneurship based on sciences with real chance of generating innovative and highly valuable solution. Its competitive advantage lies on integration with its value chain, through establishment of mutually beneficial partnerships with public and private institutions.

1. THE COMPANY AND ITS SECTOR

RECEPTA Biopharma is a Brazilian company working with research and development of new drugs for the oncologic sector, based on the advances of cellular and molecular biology. Born out of the interaction between an important institution of research on cancer and a group of Brazilian businessmen, it develops biomolecules capable of

recognizing and attaching themselves to specific targets in the tumoral cells, acting directly on them or stimulating actions of the immune system, aiming to make their survival and reproduction unfeasible. That is the principle that characterizes the so called directed therapies, the company's focus of activity¹.

Its founder, the physicist and engineer José Fernando Perez, held, for approximately twelve years, the position of Scientific Director of São Paulo State Research Support Foundation (FAPESP), where he launched several new programs for the support of research in public institutions and companies. One of those programs involved creation of a broad range of competencies in genomics and biotechnology, which approached the entrepreneur to the company's area of activity.

In January, 2004, José Fernando Perez held a meeting with leaderships of the Ludwig Cancer Research Institute (LCR), one of the largest international research centers dedicated to understanding and control of cancer. The institute was changing its operational model in order to improve the number of products that reach the market, considering the large number of projects for the development of new molecules which are interrupted at

¹ Available at: <<http://www.receptabiopharma.com.br/site/a-empresa/>>. Access on: November 10th, 2014.

the initial stages. The researchers saw the establishment of partnerships with pharmaceutical industries and the creation of biotechnology companies as a potential path to overcome the barriers imposed by the stages of development and clinical trials, and they identified several competitive advantages in Brazil and also opportunities for biotechnology companies.

Brazil had reached global visibility after the success obtained in two projects: the sequencing of the *Xylella fastidiosa* bacteria, the plague responsible for the variegated chlorosis of the citrus, commonly known as 'amarelinho' in Brazil, which enabled a group of Brazilian researchers, for the first time, a cover article in *Nature*, one of the more important scientific magazines in the world. Likewise, performance of the Human Genome of Cancer project, a partnership between the LCR and FAPESP, positioned Brazil, at that time, as second ranked in the world, behind the United States only, in the number of expressed genes of the human DNA. Those two projects were also accountable for qualification of hundreds of professionals in biotechnology and creation of Brazilian companies within the segment².

The momentum lived by the country also included the State's growing concern with construction of institutional



environment adequate to development of technological basis product for health. Highlighting the resuming of industrial policies, after the Industrial, Technological and Foreign Trade Policy (PITCE) in 2004, and the Productive Development Policy (PDP), that became effective in May, 2008. The PDP sets forth guidelines and actions for the development of

² Available at: <<http://revistapesquisa.fapesp.br/2008/05/01/jose-fernando-perez/>>. Access on: November 10th, 2014.



several sectors of the economy, including the Health and Biotechnology Industrial Complex³.

Although Brazil's potential was recognized, the proposal was very bold, as the companies with that profile are not very common in the country. The idea of creating a biotechnology company in human health area aimed for research and development of innovative compounds with potential for fighting cancer had to be enhanced then.

In April, 2005, José Fernando Perez met with two Brazilian investors - Jovelino Mineiro and Emílio Odebrecht – and created PR&D Biotech, with the mission of preparing a feasibility study for the project. The businessmen prepared the company's business plan, identified the necessary scientific and technologic competencies, potential sources of financing and negotiated with the Ludwig Institute the terms of a partnership to create the RECEPTA, founded in October, 2006. Also during that period, an important stage was the validation of the business model, performed by MBA students of the Global Entrepreneurship Lab – GLab of Sloan School of Management of the MIT - Massachusetts Institute of Technology. The team came to Brazil to study and assess the company's project and to prepare its valuation model.

3 http://www.bndes.gov.br/SiteBNDES/export/sites/default/bndes_pt/Galerias/Arquivos/conhecimento/bnset/set32106.pdf Available at: http://www.bndes.gov.br/SiteBNDES/export/sites/default/bndes_pt/Galerias/Arquivos/conhecimento/bnset/set32106.pdf >. Access on: October 22nd, 2014.

Currently located in São Paulo, the company counts with 16 researchers, the majority holding Doctor degree, working in projects developed in-house and distributed in laboratories of partner companies, monitoring all the stages of the process for generation of new medicine.

2. THE STRATEGY - THE PROJECT ALIGNMENT WITH THE BUSINESS

The relevance of innovation in the productive chain of the pharmaceutical industry can be measured by the intensity of the investments in research and development. The sector is among the ones that invest the most in research and development, losing only to the automotive, electronics and software industries⁴.

Strongly remarked by the high technical-scientific content, high dependence on the basic research and long time of maturing until introduction of new products in the market (period between 10 to 15 years)⁵, the segment presents large need of capital, both for development of new products and

4 Available at: <http://www.totalbiopharma.com/2013/12/10/top-50-pharmaceutical-companies-2013/> >. Access on: October 22nd, 2014.

5 PHARMACEUTICAL RESEARCH AND MANUFACTURERS OF AMERICA. Biopharmaceutical research industry profile. Washington, PhRMA, 2014.



for further trade of the produced medicines⁶. However, those companies are notorious among the more profitable ones in global scale.

The growing knowledge about the mechanisms of the diseases at the molecular level and arrival of biotechnology and its tools applied to human health leveraged the business' technological path. The potentialities of application of biotechnology are many and they have been attracting the interest not only of researchers, but of the industries as well of private investors and managers of public policies across the world⁷.

6 Available at: <http://www.funcex.org.br/material/redemercosul_bibliografia/biblioteca/ESTUDOS_BRASIL/BRA_150.pdf>. Access on: October 22nd, 2014.

7 Available at: <http://www.funcex.org.br/material/redemercosul_bibliografia/biblioteca/ESTUDOS_BRASIL/BRA_150.pdf>. Access on: October 22nd, 2014.

Biotechnology applied to health has been making a revolution in the processes for obtaining medicine, vaccines, diagnosis kits, cancer and self-immune diseases therapies, among others; it might also add value to the industries and services related to healthcare. Today, it is possible to state that this new research front is mandatory to maintain competitiveness of the productive sector.

That is the scenario in which RECEPTA is included, focused on research and development of technologies applied to the human health field. The company's business model does not include large scale production and trade of new drugs, being limited to a very delicate stage of the process: the development of projects with potential for creation of new medicine, passing by hard work stages and with high cost involved, allowing those technologies to be accessible to the pharmaceutical industries. The company makes the interface between the research developed in the academy and industry.

RECEPTA focuses its business totally on science, therefore, it is necessary to live with the risk and implement efficient management system – crucial for the success of the enterprise. This scenario of uncertainties led the company to prepare an innovative business model, which mobilizes scientific competencies, adding up business competencies – management of projects, establishment of partnerships, protection of intellectual property, and attraction of private and public investors.

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Hence, to overcome the challenges imposed to a company that has science as a business, the company associates leadership and management with experience and competency to establish mutually beneficial partnerships with research institutions and hospitals and a team of scientists working internally and in the laboratories of partner institutions. Particularly, the partnership with the *Ludwig Cancer Research – LCR* institute granted competitive advantage to the company by acting in an area that had not been largely explored in the country yet.

The company conciliates private investments, from two large investors, with funds from governmental agencies such as the Financer of Studies and Projects (FINEP), the Brazilian Scientific and Technological Development Council (CNPq), the State of São Paulo Research Support Foundation (FAPESP) and the Brazilian Economic and Social Development Bank (BNDES).

In the business model proposed by the Brazilian businessmen, Ludwig becomes a shareholder of the company – the institute transfers the technology in exchange of shareholding. This format – besides the relevance during the first steps for creation of the company, which counted only with private investments – provides double scientific and clinical validation of the projects in progress and new ideas, and also enables its immediate insertion into the international context. The process implemented by the company during

the initial stages of a project, or at decision making points, includes holding of meetings with experts on the area from the different research centers, increasing the chances of successful performance of the project, or interruption at the initial stage.

The partnership provided to RECEPTA the licensing of the intellectual property of molecules potentially efficient for treatment of some tumors, and transfer of scientific and technological know-how for its research and development activities. RECEPTA counts with strong business capacity, enabling continuity of a company of biotechnology applied to human health in Brazil.

The company gathered a team comprised by experienced professionals and implemented its business model – based on technological cooperation as an agent that mitigates the difficulties of technological adequacy, enabling reduction of the costs and risks inherent to the innovation process – and formed a network of partner institutions formed by R&D and hospital centers.

Today, RECEPTA has national and international research cooperation with renowned institutions such as the Ludwig Cancer Research Institute; Butantan Institute; College of Medicine from the São Paulo University; São Paulo Federal University (Unifesp), Hospital Excellence Centers: Hospital Sírio-Libanês (SP), Instituto Nacional do Câncer





(INCA, RJ), Instituto do Câncer de São Paulo - ICESP; Global Entrepreneurship Lab (G-lab) of the MIT (Massachusetts Institute of Technology) – Sloan School of Business; Memorial Sloan-Kettering Cancer Center (MSKCC-NY); Group of Directed Therapies of the University of Gothenburg in Sweden, and others.

The experience of the company from São Paulo is a role model on open innovation, with some specific ingredients, including:

- Leadership and management, with experience and competency to establish mutually beneficial partnerships with research institutions and hospitals;
- Specific team of experienced scientists working in the company and in the laboratories of partner institutions;
- Scientists belonging to the structure of the partner institutions, cooperating with RECEPTA's team in the R&D projects;
- Strong management and monitoring.

3. THE PROJECT

Production of humanized monoclonal antibodies (mAbs in the English acronym,) for treatment of cancer is RECEPTA's main research front. The action of those biomolecules is based

on their capacity to recognize tumor specific antigens⁸ and to induce immune answer against the cancer cells. Today, the market has few mAbs approved for therapeutic use. However, there is a large number of research institutes and biotechnology companies performing studies in the area, across the whole world.

RECEPTA started the project for development of the monoclonal antibodies in 2006, and today the company's portfolio is comprised by five promising mAbs, which include performance of immune-histochemical tests – broadly used for diagnosis of abnormal cells, such as the ones found in tumor – and pre-clinical and clinical trials in the country.

The company's path has an important learning dimension. Although it's still a company without revenues, it represents an important case of a science-based Brazilian company with large chances of producing an innovative and highly valuable solution. That possibility started to be designed out of the success from the cooperation with the Ludwig Cancer Research Institute, which started to transfer technology and know-how to the company.

8 An antigen is every particle or molecule that when introduced in an organism, is capable of initiating an immune response, inducing formation of specific antibodies.

RECEPTA counts with monoclonal antibodies in different stages of research and development. The generated molecules include the compound named as RebmAb200, which is a monoclonal antibody that recognizes an antigen highly expressed in ovarian tumors, with large specificity, efficiency and sensibility. It has become prominent in the tests performed by the company's researchers in animal models, suggesting that the antibody's activity is translated into reduction of the tumoral growth rate, including the product into the next stage of the process of approval and regulation, which refers to performance of tests in a small number of volunteers.

The RebMab200 will be tested in human beings until the end of 2015 at the University of Gothenburg, in Sweden. Women submitted to surgery or chemotherapy to fight ovarian cancer shall receive experimental compound developed by research institutions and a Brazilian company, which is an important stage to advance in the research, enabling the product to proceed to the stages that will allow reaching the market. This is the first time in Brazil that a humanized monoclonal antibody with high affinity for ovarian tumor cells will be used in a clinical trial, enabling development of new medicine with unique characteristics.





MODES OF ACTION OF THE REBMAB200

Direct action: it works as a transportation mean – a sort of auto-guided microscopic missile bearing chemical elements capable of destroying the tumor cells. A process known as directed therapy.

Indirect action: activation of defense cells of the human organism that attach to the tumor particles. The antibody attaches the tumor proteins to which it has high affinity, marking the malign cells. This stage is responsible for activating the cells of the immune system (lymphocytes) which recognize the antibodies and identify them as a signal of danger. Once activated, the lymphocytes launch a 'bath' of toxic substances over the tumoral cell. The toxins unchain a scheduled cellular death mechanism.



The process of generation and development of the RebMab200 involved interaction with teams from renowned public research institutions, such as the Butantan Institute and the University of São Paulo - USP.

Its development enabled attaining unique competencies in Brazil, which involve command of technology to obtain cells lineages capable of producing in large quantity, and with the same quality and stability standard, antibodies to be used in human beings – the so called humanized antibodies, which present lower risk of provoking reactions. That was the first lineage of stable and efficient cells that produce monoclonal antibodies developed in Brazil, which represents overcoming of an important technological bottleneck for the country, according to the oncologist Roger Chammas - professor of the College of Medicine from the University of São Paulo and researcher of the ICESP⁹.

However, according to José Fernando Perez, we don't have yet the necessary conditions to produce it in Brazil with the level of quality required for use in humans. Today, thanks to those ten years of combined work, the country controls one of the stages for production of those compounds, but there are still hindrances to overcome. The country does not have infrastructure to produce,

9 Ricardo Zoreto. A construção <http://revistapesquisa.fapesp.br/2014/09/16/construcao> <http://revistapesquisa.fapesp.br/2014/09/16/construcao> de um medicamento. Revista Pesquisa FAPESP. ED. 204 – Setembro 2014.

even in pilot scale, the monoclonal antibodies, which led the businessman to develop that part of the process abroad.

4. SCENARIO OF THE GLOBAL BIOPHARMACEUTICAL MARKET

In the last decades, use of biotechnology applied to health has generated important advances in the therapeutic and diagnosis areas, enabling early detection of many diseases and more accurate treatments, which act by directed means. The biotechnological methods enable determining the molecular causes of the diseases; the development of new diagnosis techniques and the generation of innovative medicine directed to specific molecular targets.

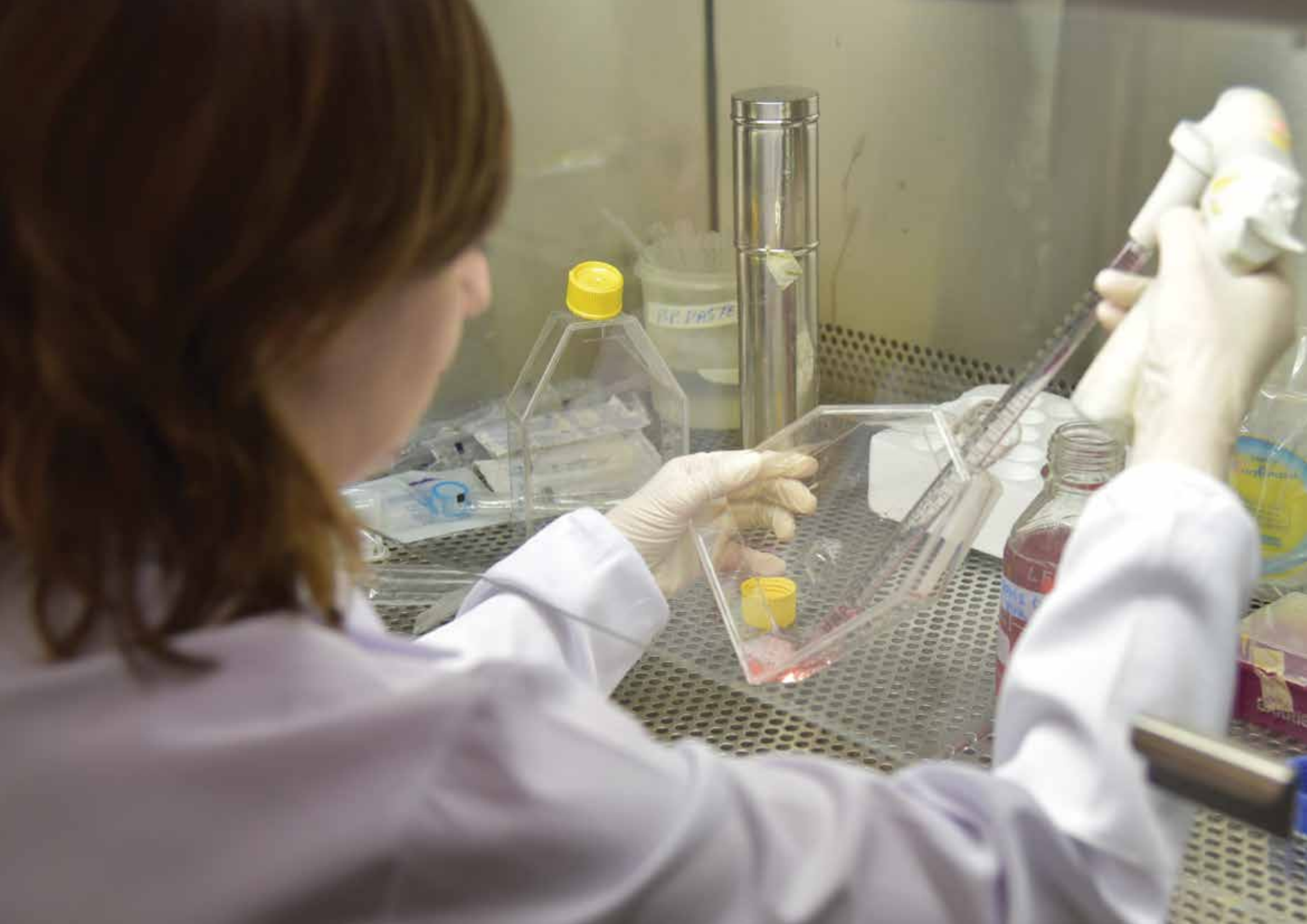
The pharmaceutical products obtained by chemical synthesis are still accountable for the largest part of the pharmaceutical industry's revenue. However, among the different segments of the global medicine market, the biotechnological products are the ones presenting the higher growth rate. Between 2002 and 2012, they increased sales by 64% and it is estimated that in 2017 they shall represent about 20% (US\$ 220 billion) of the market¹⁰. Within that group, the therapeutic proteins – signaling substances, enzymes and monoclonal



antibodies – undoubtedly form the most important biotechnological agents currently in use.

The monoclonal antibodies are known as directed therapies, thanks to the high level of specificity per target proteins in the surface of the cells that shall be subject to the treatment. Those biomolecules have been successfully used in the treatment of cancer and of other severe diseases and they have huge market potential. Today, the

¹⁰ Available at: <<http://www.abrasco.org.br/site/2014/10/biotecnologia-e-industria-farmaceutica-no-brasil/>>. Access on: October 24th, 2014.





global industry of antibodies is ruled by European and North-American companies¹¹.

In 2012, there were more than 30 monoclonal antibodies approved by the FDA (Food and Drug Administration), generating annual sales above US\$ 40 billion¹², and approximately 286 monoclonal antibodies in phase of development and clinical trials. The oncologic area is the

11 <http://www.paradigmglobalevents.com/events/monoclonal-antibodies-americas-2014/> Available at: <<http://www.paradigmglobalevents.com/events/monoclonal-antibodies-americas-2014/>>. Access on: October 24th, 2014.

12 Available at: <http://www.researchandmarkets.com/research/m2s98r/global_monoclonal>. Access on: October 24th, 2014.

one that receives the most applications, with some of the antibodies being aimed for treatment of inflammatory and autoimmune diseases. As those molecules already play an important part in therapies for cancer treatment, besides existence of researches in progress and the new proposals of indication of use, the number of industries of biotechnology applied to human health which shall develop monoclonal antibodies is estimated to have significant growth in the coming years¹³.

5. RESULTS FOR THE COMPANY

The project allowed identification of highly qualified professionals and the establishing of strategic partnerships, which enabled the company to advance in areas not well known yet, exceeding barriers that the company would hardly be able to overcome alone – the work developed in synergy with the research institutes and hospital centers was essential to increase the potential of value creation for the business.

The fact of the humanized monoclonal antibody Rebma200 successfully passing the pre-clinical trial phase, suggesting

13 Available at: <<http://www.insightpharmareports.com/monoclonalantibodiesreport/>>. Access on: October 22nd, 2014. <http://www.insightpharmareports.com/monoclonalantibodiesreport/>

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The work
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potential of value
creation for the
business.”



that the candidate to new medicine is safe for tests in humans, can already be considered as a winning case of development for a biotechnology company, due to the fact that many of the developments of new drugs are interrupted at this stage.

The control of all the phases required for the complex clinical trials preparation and performance enabled RECEPTA to become the first Brazilian company to perform Phase II clinical trials with monoclonal antibodies for cancer treatment, with registration with the Brazilian health Surveillance Agency (ANVISA) and with the American Regulatory Agency, the FDA (Food and Drug Administration). That fact caused RECEPTA to be elected as a partner company of the Brazilian Health Ministry and Brazilian Scientific and Technological Development Council (CNPq) in the Oncologic Clinical Research Network, to perform the clinical trial with its monoclonal antibody RebmAb 100 in patients with breast tumor. According to the terms of that partnership, RECEPTA authorizes use of the antibody and transfers its know-how on performance of multi-centric clinical trials to the institutions that participate in the network¹⁴.

In 2012, the Brazilian Social and Economic Development Banks (BNDES), through its subsidiary BNDESPAR, invested BRL 28.9 million in the purchase of shareholding in RECEPTA. This investment confirms the importance of the company and of the project for development of new biological drugs for the country.

6. OUTCOMES OF THE PROJECT AND PERSPECTIVES

Along development of the first mAbs, peptides were identified with potential to generate immune response against different types of cancer and then the investments were directed to those molecules, creating a research and development program for new peptides with oncologic interest. The company has already identified and submitted an application for patent registration of two peptides– RebPep 9 and RebPep 10 – which, during vitro essays, have shown activity against cells of glioblastoma (the type of primary brain tumor that is more common and more aggressive in human beings); melanoma (the most severe form of skin cancer), breast and ovary carcinoma, and, in vivo, they were effective against melanoma metastasis. Today, 23 other peptides are being investigated for potential use in cancer treatment.

14 Available at: <<http://www.receptabiopharma.com.br/site/pt-br/empresa/22>>. Access on: October, 2014.



ROMI

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ROMI PRODUCTION SYSTEM: THE CHALLENGE OF FLEXIBLE MANUFACTURE FOR PRODUCTION OF INDUSTRIAL MACHINES



The company, an industry operating in the metal-mechanic sector, specialized in the manufacture of machines-tools, developed an innovative project that completely reformulated its manufacturing structure, granting productive flexibility and reduction of stock. This new model, named as SRP – Romi Production System, enabled increased productivity and reduction of time for delivery of products to the client. The key points for the success of the project were the engagement and commitment of employees and suppliers, demonstrating the importance of productive enchaining for the business success.

1. THE COMPANY AND ITS SECTOR

Established in 1930, in the city of Santa Bárbara d'Oeste (State of São Paulo), by Américo Emílio Romi, from a car repair shop, Indústrias Romi S.A. has the pioneering and the innovation as parts of its history. The company was accountable, in 1948, for beginning of the tractors manufacturing in Brazil and also for producing the first Brazilian car, the famous "ROMI-HSETTA",



in 1956. It was also the pioneer in the machines-tools field, launching, in 1973, the Brazilian manufacture of numerical command lathes (CN).¹

Today, it is an internationally known company, which products and services are exported to all the continents and used by the

¹ Available at: <<http://www.romi.com.br/index.php?id=historico&L=pajmbqkvwsaotoj>>. Access on: September 23rd, 2014.



most diversified sectors of the industry, including manufacturers and suppliers of the most varied metal-mechanic chains (such as the automotive chain, general consumable assets, agricultural and industrial machines and equipment).

The company is constantly seeking solutions for the markets wherein it operates: it has a large number of invention patents and, therefore, invests about 4% of the annual net revenue in research and development. Besides directly

developing the technology for its products, the company invests on the relationship and partnerships with the academic environment and with technology institutes.

It has eleven manufacturing units (nine in Brazil and two in Germany), four for final assembly of industrial machines, two foundry plants, three for mechanic components milling, one for steel plates manufacture and one plant for electronic panels assembly. The production installed capacity of industrial machines is approximately 3,450 machines/year and of foundry corresponds to approximately 50,000 tons/year.

Trading of products is performed directly by the company in the domestic market, also offering the clients pre- and after-sales services, technical assistance services and spare parts. It has been operating in the foreign market since 1944, through a network of distributors located in all the continents and subsidiaries for trade and services located in the USA, Mexico, Germany, England, Spain and France.

The company's businesses are comprised by the following products: machines-tools (machines and equipment to work metal by chip removal) mainly lathe centers, CNC lathes, conventional lathes, machining centers and milling machines, machinery and equipment to mold plastic by injection and by blow, and gray cast iron parts, nodular and vermicular, supplied either gross or machined.



The machines and equipment segment has been suffering strong variations in the demand, since 1990, mainly influenced by the global economic scenario and by the technological development. After a period of low activity, in the 90's, the company experienced excellent performance in the 2000's, driven by industrialization of the emerging countries. According to the United Nations Industrial Development Organization – UNIDO, the average growth of the global production of machines and equipment went from 1%, between 1995 and 2000, to 4.8% between 2000 and

2008. The emerging country's share in the total produced has also been continuously increasing².

China's arrival as an important global player and the decrease in the demand after the 2008 crisis remarked strong worsening of the competition at the international level³. That scenario was determinant for Romi's decision to seek internal restructuring in order to reinforce its market position. The adopted strategy was centered in reformulating the manufacturing process and planning of the supply chain, seeking to make the manufacture flexible and offer the best solution for the client.

2. THE STRATEGY – THE PROJECT ALIGNMENT WITH THE BUSINESS

The production and the market of machines-tools present certain peculiarities when compared to other industrial sectors. Compared to the automotive production, for instance, the production of machines requires higher number of components and variability of models, while the annual production volume is lower. In addition, as purchase of machines is mainly motivated by the need to increase the manufacturing capacity in the clients – which are, on their

2 AGÊNCIA BRASILEIRA DE DESENVOLVIMENTO INDUSTRIAL – ABDI. Relatório de Acompanhamento Setorial – Máquinas-ferramentas. [S.l.: s.n.], 2011.

turn, affected by the economic scenario – the market of machines-tools is not predictable.

Romi offers almost hundreds of optional features for its machines, which result into numberless possible combinations³. Until 2012, the company adopted the scheduled production scheme, under the “pushed production” model, with assembly of the machines irrespective of linked purchase orders, focusing on availability to serve the market. That production system generates advantages for a period of continuous growth in the domestic demand for machines-tools (2002 to 2008). However, during periods of economic oscillation and unpredictable demand, this system generated some disadvantages such as, for instance:

- Wait: there were frequently queues in the production, with production scheduling being complex, difficulties of synchronization were verified;
- Inventory: the production was made in lots, to reduce the high setup times (preparation of the machines);
- Transportation: due to the plant’s layout, there was a large flow of material until conclusion of the manufacture, resulting into time wasted without value adding;

- Overproduction: as the resources were not used in an efficient manner, there could be production capacity above the demand;
- Talents: manpower much dedicated to specific activities, without flexibility to meet variations in the market demand.

Thus, the productive system model, at reduced demand instances, resulted into increase of finished machines stock. In addition, those machines, many times, were not available in the configuration intended by the ultimate client and thus had to return to the assembly line for customization. That rework process ended up impairing the continuous flow of the line.⁴ Consequently, even if the company had a technology vs. average price ratio equal or better than its international competitors, the delivery terms for some models could be longer. That market analysis was the main reason for seeking a new productive model that could add promptness to the process and faster servicing of the clients’ demands. The idea, added to the self-assessment of its internal structure, led the company to identify the production flexibility strategy as the best alternative to accomplish the purpose. The project included adaptation of the entire productive chain, so that all the links could work interconnected. That structuring enabled flexible manufacture

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The project included adaptation of the entire productive chain, so that all the links could work interconnected.”

3 ROMI’s Presentation – Paradiso/Vulcano Project

4 ROMI’s Presentation - PLSS DMAIC: 1247 – Development of Make to Order Planning System. (2012)



to serve the ultimate client, with the model adequate to its need, at the desired term, and with the lowest investment in working capital.

3. THE PROJECT

The project's structure combines concepts of Lean Manufacturing to the MTO (Make to Order) process. Differently from the mass production industries, where standardization of the productive processes and demand stability are more evident, the option for the make-to-order process usually involves large obstacles for the company, demanding adaptation of the Lean Manufacture tools exclusively for this type of production⁵. In Romi's case, this adaptation was made by stages, initially involving the supply chain and being extended, along the project, to all the company's departments.

The project started by restructuring the Internal Management, through a process of unification of the managements. The Supply Chain management was created, which incorporated the departments of stocks management, production planning, production control management, purchases management and

spare parts planning. Hence, planning, control and suppliers from all the manufacturing units were subjected to the same management. That structure avoids the condition where each department is independently efficient, but which, in the general scope of the production, might be inefficient to serve the clients' orders.

It has been identified that manufacture's flexibility to reduce the lead time would demand combined actions in several areas of the company, such as projects, planning, production, logistics and manpower management, so that the project was dismembered, generating several 'child projects'. To allow simultaneous supervision and control of those several projects, the Lean Six Sigma Projects Portal was used, where it is possible to identify and easily monitor all the pieces of information from each project, the participants, the stages and their development.

From the perspective of production, a highlight of the project was the purchase of the Flexible Manufacturing System (FMS), comprised by 03 Horizontal Machining Centers with storage capacity of up to 360 tools (each) besides 01 MLS (Multi Level System), which is interconnected to the three centers, supplying them with the parts that will be machined. The system works as a robot for preparation of machines that selects and prepares the tools that will be used in the next production while the current production is still in progress. That conditioned

⁵ SAIA, R. *O Lean manufacturing aplicado em ambientes de produção engineer to order*. Trabalho de Conclusão de Curso – Escola de Engenharia de São Carlos – USP, 2009



enabled the parts manufacturing process in the FMS to reach zero setup time – the time required for preparation of the machines. The shorter the setup time, the higher the variety of items that can be manufactured, the simpler and the more flexible the system and, consequently, the lower the risk of obsolescence due to overproduction⁶.

Part of the flow improvement encompassed the flexibility of the assembly lines: lines that produced just one machine started to produce other machines with similar components.

By the commercial aspect, the company's purpose was to reduce the total lead time, from six to three months. To reach that target, it has been necessary to attain commitment of the suppliers with compliance with the agreed delivery terms. To work with that focus, a Purchases Planning department was created and a formulation system with weekly priority windows was established, so that purchases can be planned and confirmed within due time.

Concerning the suppliers, training sessions were held with the purpose of explaining the terms of the new delivery system, showing to the supplier its importance within the company's value chain. A Purchases Portal was also created, wherein the suppliers 'sees' Romi's entire purchases planning.

6 Available at: <<http://www.rtdonline.com/BMA/MM/13.html>>. Access on: September 23rd, 2014.

Within the scope of manpower, aware of the project's magnitude, which includes change in the culture involving all the hierarchical levels of the Company, the company held specific training sessions on production management, with more than 800 people trained and engaged in the project, in order to understand the importance of their participation and to become agents of change.

4. INTERNATIONAL SCENARIO

The decrease in the demand derived from the 2008 global crisis remarked the worsening of international competition in the machines-tools sector. China, Germany and Japan are currently the greatest producers of the sector, jointly being accountable for more than 60% of the global production⁷. To give an idea of the scenario regarding the presence of international competitors in the Brazilian market, it is interesting to compare the internal production and the imports. Brazil now holds the 17th position in the global rank of machines-tools producers, with businesses generating USD 420 million in 2013. Simultaneously, the country is the sixth largest importer, with expenditures amounting to USD 1.5 billion.⁸

7 AGÊNCIA BRASILEIRA DE DESENVOLVIMENTO INDUSTRIAL – ABDI. Relatório de acompanhamento setorial: máquinas-ferramentas. 2011.

8 GARDNER RESEARCH. The world machine-tool output and consumption survey. 2014.





The concern with the Chinese advance is not based only on the fact that increase of its exports has been quickly accelerated. The Chinese production is also walking fast in the technological update, whether by acquisition of foreign companies, or by establishment of joint-ventures. Thus, the country currently presenting itself as more competitive in the low technology segment will soon be working in the medium technology segment. Also, it is estimated that in 10 years China will also be a large producer and exporter in the high technology segment.⁹

Within that competitive marketplace, the pursuit of increased productivity seems to be a business strategy elected by several multinational companies. In addition, construction and purchase of manufacturing plants in other countries, in order to take its operations closer to the main consumers has also been an option used by companies of the sector to face the fierce competition.

5. RESULTS FOR THE COMPANY

The manufacturing process reformulation has been reverted into flexibility as competitive advantage, which resulted into:

- Higher assertiveness of sales: due to greater flexibility in products' configuration and greater availability of products to the clients;
- Cash flow gain, with reduction in the values of the company's stock by 28.7%, in 18 months (between the 2nd semester of 2012 and the fourth semester of 2013);
- Greater efficacy in the use of manpower: the employees became multi-functional;
- Reduction of the lead time (confirmation) from six to three months.

Besides attaining flexibility of the manufacture and reduction of the lead time, which were the main initial purposes of the project, several other gains can be accounted:

- Flexibility in the machining of bodies: through the new Flexible Manufacturing System (FMS), which enables zero setup time (machine preparation);
- Impact on the Product development: with flexible manufacture and reduction of finished products' stock, it is necessary to standardize components, in pursuit of making the most of the components that are already used in other machines. This means that there is no more planning and development isolated by product,

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⁹ AGÊNCIA BRASILEIRA DE DESENVOLVIMENTO INDUSTRIAL – ABDI. Relatório de ACOMPANHAMENTO SETORIAL: máquinas-ferramentas. 2011.

which results into reduction in the number of stocked items (reduction in the number of components), positively affecting reduction of the working capital;

- Human Resources: besides training related to the project itself, there was the need for know-how complementation. For instance: an assembly line that previously manufactured just one machine started to produce more different machines; hence, the line employees were trained to work with all of them, increasing their qualifications.

6. OUTCOMES OF THE PROJECT

Internally, the project resulted into changing of the company's culture. The necessity to attain participation from all the spheres of employees resulted into larger engagement by everyone, creating an environment surrounded by motivation and commitment.

An important impact was also verified in the value chain, mainly with the suppliers. Romi basically has two types of suppliers: the large and the small ones, the latter responsible for the higher number of items purchased. With establishment of shorter lead time, some of those smaller suppliers had, thus, to reformulate their internal processes as a way of attaining qualification to meet the delivery terms. In some of them, Romi directly participated in that process,



performing kaizen ¹⁰ events, training for improvement of the suppliers' internal processes.

Another point was the restructuring of orders management with the main suppliers, where in the cases of critical items

¹⁰ Kaizen (from the Japanese "improvement" or "change for better"), refers to the philosophy or practices applicable on continuous improvement of the manufacturing, engineering, business management processes or any process. By improving the activities and standardized processes, kaizen is aimed at eliminating waste – available at: <http://pt.wikipedia.org/wiki/Kaizen>



in terms of lead time and high added value, the company prepares purchase schedule with the expected consumption for the next twelve months and undertakes to assume the first three months, even if there is a reduction in the demand.

The focus on the lead time also led to a change in the purchases culture: previously, election of the supplier was solely based on price and quality of the material; today, the delivery lead time and the supplier's response time also became prerequisites for its qualification.

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The investment on continuous enhancement is one of Romi's cultural pillars.”

7. PERSPECTIVES

The success of the new Production System is reflected on the accomplished results which are supposed to continue contributing for reduction of the stocks and strengthening of the company's competitiveness in its sector. The investment on continuous enhancement is one of Romi's cultural pillars, so that the System shall continue to be improved.

The System also generated important lessons for the company and its chain, which shall contribute to strengthen its relations in the future. Suppliers recognized their importance in the manufacturing chain and adopted new practices that may increase their competitiveness.

Due to the need of granting flexibility to the assembly lines and the need to reduce the number of components, the company has, as part of its long term Strategic Planning, to make the sets modular. That process is already in progress and it shall be reinforced during the 2015-16 period. That project shall, besides reinforcing the company's flexibility concept, result into remodeling of the machines' families.

Yet, as part of the logistics reformulation, the company shall implement the automated parts storage system MiniLoad. As handling of parts is greater due to reduction in the size of the produced lots, the purchase is aimed at granting faster pace to the process, generating efficiency gain in the machines assembly manufacturing unit, besides better use of the manpower. The equipment has already been purchased, and the estimate is for it to startup in early 2015.

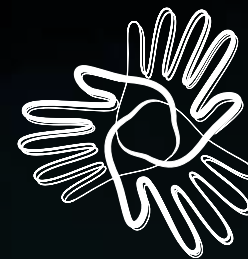
The pioneering that accompanied Romi since its origins has not been tested in the form of new manufacturing processes. A challenging market, with low industrial growth, high unpredictability of the demand and increasingly stronger competition has presented the company with an urgent need to qualify its manufacturing processes and assure its competitiveness in an increasingly globalized world. The SRP represents a new competitiveness level, with effects – and many lessons – for the metal-mechanic chain of the Brazilian industry.



SCODA AERONÁUTICA,
SUCCESSOR OF EDRA AERONÁUTICA

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MODEL OF DESIGN BY CERTIFICATION FOR THE DEVELOPMENT OF THE BRAZILIAN AMPHIBIOUS AIRCRAFT



When Scoda was created (under the name of Edra), as a trade representation of helicopters, its founder, recently graduated from the aeronautic engineering course and a pilot, fond of airplanes, had a single dream of building and conducting his own plane. That remote dream was soothed but without the conditions for its realization being at his reach. How, then, differently from so many other dreamers, did that dream of Edra's founder come true?

This chapter tells the successful history of the company and how the trade agency for sale of helicopters gave rise to a school for pilots and, finally, an industry that manufactures small planes that created the Brazilian project of an amphibious aircraft. Baptized as Super Petrel LS, Scoda's amphibian is the company's current mainstream, responsible for its entrance in the North-American market. With a project totally idealized to comply with the American standard, the development of that aircraft is a successful example of application of the design by certification concept.

1. THE COMPANY AND ITS SECTOR

Scoda Aeronáutica, successor of Edra Aeronáutica, is a medium company specialized in the manufacture and distribution of aircrafts and in the offering of helicopter pilot training courses. Founded in 1997, by the aeronautic engineer and pilot Rodrigo Scoda, the company whose name is now associated to the founder is located in the small city of Ipeúna, in the countryside of the State of São Paulo, 195 km distant from the State capital. The company's employees are comprised by 100 professionals including engineers, mechanics, pilots and administrators that work in three segments: pilots training and graduation, maintenance technical support and manufacture of aircraft in composites.

Providing graduation as Private Helicopter Pilot and Commercial Helicopter Pilot, Scoda Aeronáutica's Instruction Center is a reference among the helicopter piloting schools in Brazil. It has graduated more than 2,000 pilots, exceeding 100,000 hours of flight. The aircraft manufacturing division has already traded 450 aircrafts that operate today in 23 countries.¹

The idea of creating the company appeared soon after Rodrigo's graduation, at an instance when aviation, in Brazil,

¹ Available at: <<http://www.scodaeronautica.com.br/>>. Access on: November 11th, 2014.

was experiencing very expressive growth, mainly derived from the foreign exchange – the newly launched Brazilian Real was highly valued in the comparison to the US Dollar. That growth was sustained for almost ten years, which ended up positively impacting the establishment of the company then named Edra in the sector.

In the beginning, the market entrance was enabled by the agency work for a North-American helicopters' trademark. Those were small helicopters that were purchased by Edra for sale in the domestic market. Due to the favorable economic conditions, that first business model was successful, motivating and enabling diversification of the activities, through creation of a piloting school, which used the helicopters that already belonged to the company.

At a first instance, Scoda's Instruction Center profited from the demand of the Brazilian public defense forces, which largely lacked well-qualified helicopter pilots and offered training to several agencies, such as the Federal Police, Federal Road Police, Fire Fighters, in several states of the Federation. Still nowadays, 75% of the pilots of the national public defense force graduate from Scoda, a landmark for the company's positioning in the market and leverage to its business.

The success of the sales of helicopters and training school provided subsidies for investment in what had been Rodrigo's dream since his graduation in aeronautic engineering:



to design and build airplanes. Thus, in 2001 the work for assembly of foreign aircrafts was started and, later, the development of proprietary project, which is the object of this chapter. Today, besides manufacturing the aircrafts, Scoda render maintenance services, which are essential and scarce in the aviation segment, offering commercial synergies to the company.

An interesting differential feature that the company has in its Training Center and which demonstrates the entrepreneuring and innovation inclination of its team is the UTEPAS Simulator – Unit for Training of Escape in Submerge Platform, which simulates emergency landing of a small helicopter on the water. In Brazil, only the Navy has that type of simulator.



Figure 1 - Simulator UTEPAS



As a pilot, Rodrigo attended a course where the equipment was used and took it as the inspiration to manufacture a similar one for Edra's piloting school which became, then, the only private company to have this type of equipment.

The team qualification is essential for Scoda's business. It started to be structured when the company's main activity was still exclusively to assemble foreign aircrafts. That was an essential period of learning, which enabled attaining know-how and technical expertise feeding the idea and enabling the project of manufacture of aircrafts, when that new business opportunity was identified. Today, Scoda trades two models of airplane: the Dynamic WT9 and the Super Petrel LS.

The Dynamic was created yet during the period of expertise development, when the focus was to assemble aircrafts. It is manufactured in partnership with a company from Slovakia, where it was developed and Scoda is responsible for 61% of the manufacturing process, under license. It is a small aircraft, included into the light sport cross country category.

The Super Petrel LS is a very different plane. Although belonging to the same certification category of the Dynamic, it is an amphibious airplane. The project has been totally developed in Brazil by Scoda, which is responsible for 81% of its manufacturing process (just the mechanical parts are imported).

The Brazilian light sport aircrafts sector currently has about 20 manufacturers, and from those just three manufacture amphibious airplanes². The airplanes of that category correspond to 24% of the Brazilian fleet, which has been recording average increase of approximately 5%, in the last five years³. The national market is essentially focused on entertainment, as those airplanes are small and fly at low speeds. The aircrafts are traded through a network of agents, distributed across seven states of Brazil and more than 16 countries.

2. THE STRATEGY – THE PROJECT ALIGNMENT WITH THE BUSINESS

The manufactured aircrafts are small, framed within Light Sport Aircraft category. All the projects are performed by using solely compound material, also known as composites. The composite used in the manufacture, constituted by carbon fiber and aramid fiber (Kevlar), is imported and the company proceeds with its conformation according to the parameters defined in its projects.

The use of composites in the aviation has been gradually adhered to, also by manufacturers of large aircrafts, due

to their features of light weight and high resistance. Thus, it is a new approach, alternative to the conventional use of aluminum, which is already a reality across the whole world.

Composites are the material composed by at least two components, also referred to as phases, which individually present clearly different physical and chemical properties. When combining the two materials, the deficiencies of one end up being offset by the qualities of the other, thus creating a composite material with particular properties. Some examples of composites are metals and polymers, metals and ceramics or polymers and ceramics. In the case of aviation, the mostly used composites are constituted by polymers and carbon fibers.



2 Available at: <<http://www.abul.com.br/abul/mercado.asp?tipo=Fabricante>>. Access on: November 11th, 2014.

3 Available at: <<http://www.anac.gov.br>>. Access on: November 11th, 2014.



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The largest manufacturers are progressively increasing the percentage of composites in all of their aircrafts, including Airbus, Boeing and Embraer⁴, in a trend for change that demonstrates to be permanent. The fact that Scoda has started its projects with the assumption of using the most modern and updated material signals the company’s strategy to be ahead in the sector. Super Petrel is also an example of that.

There are very few amphibious airplanes in the market, making this niche very appealing, despite its more complex technology. The development of the product, inspired in a French model from 1983, was initially performed without concern with standardizations. Differently from the commercial aviation aircrafts that must meet detailed and complex legal requirements, the category in which Scoda’s aircrafts are included did not require certification in most countries, with the equipment’s owner being responsible for its maintenance and operation.

But, that scenario started to change in 2005, when a new form of certification appeared in the United States. At that instance, the company already planned to enter the international market and, therefore, decided to work for readjustment of Super Petrel. That work of refining of the

project resulted into an apparently similar model, but totally different from the initial one, by the perspective of the engineering. The new project was conceived based on the requisites of the North-American standard (also adopted in Brazil) – design by certification – and made a revolution in the company’s way of designing and manufacturing, changing the market perception and reception.

3. THE PROJECT

Development of Super Petrel LS was inspired in an also amphibious French model, from 1983, the Hydroplum. Although being from the 80’s, that plane already used the composites in its manufacture. During the aeronautic engineering course, Rodrigo became familiar with that aircraft, noticed that there was great development potential in that original project and conceived and performed a reengineering process, which was his final graduation essay. Continuity of that development and the implemented improvements, based on the concept of the Hydroplum, led Edra’s engineering team, headed by the also engineer and pilot Fernando Abbud, to design, in 2001 the Super Petrel in its first version, not yet certified by an internationally valid standard and which was traded in the form of kits.

The project for adjustment to the standard was started in 2005, when the United States made a change to the certification

4 Available at: <<http://www.aviacao.org/article/materiais-compositos/>>. Access on: November 11th, 2014.





process configuration, which ended up becoming a global trend. Instead of the aeronautic authorities generating all the requisites for the certification, which was the practice until then, the items started to be defined by a standardization agency (such as the ASTM - American Society for Testing and Materials), and the aeronautic authority became responsible just for checking its compliance.

The standard to which Scoda adjusted itself is the American FAR 21.190, to which most countries in the world adhere and that started to be effective in Brazil in 2011. The detailed study of the standard was the starting point for the project of adjustment of the Super Petrel. That was an essential phase for all the rest of the development, as it referred to a totally new standard, until then unknown in the market. During the deeper study of the standard it also became clear that the new Super Petrel LS would be basically a new project, with minor use of the former model's project.

The study and understanding of the normative requisites were determinant to define the methods that would be used for compliance. In aviation, depending on the category of the aircraft, the manufacturer may elect the methods to prove its compliance with a standard. The criteria for that selection might be economy, safety and time related. That assessment has to be very well structured before the project is conducted. The next step, complementing the definition of the methods for compliance with the standard, was the definition of a

detailed and extensive compliance checklist, which includes the requisites and their respective acceptance parameters that must be observed in all phases of the project.

These first three stages of study and planning – study of the standard and requisites, definition of the methods for compliance and preparation of the compliance checklist – demanded basically two years of work. Only after that period the team started to work with the actual aircraft, developing its structural and aerodynamic design, subsequently performing structural and in-flight essays, to prove its good functioning. Some of those essays could be performed through simulations in 3D modeling software, which were accepted by the certifying agency with no need to perform real test with the aircraft. Other essays, due to their nature, cannot be simulated and necessarily have to be performed during flight. That is the case, for instance, of diving speed tests, performance essays, structure resonance (if the structure resonates, it might be ruptured during the flight), screw essay. Those essays were performed by Embraer's pilots, specialized in this type of activity, as Scoda did not have that expertise yet.

The last instance of the project, already in 2013, encompassed the certification itself, initially performed by the Federal Aviation Administration (FAA) in the United States and by the Brazilian Civil Aviation Agency (ANAC) in Brazil.

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The study and understanding of the normative requisites were determinant to define the methods that would be used for compliance.”

An interesting particular feature of the project is that during the first four stages, 90% of each work load was performed by trainees from the 4th and 5th years of engineering courses, mainly from USP São Carlos –São Carlos Engineering School (EESC). That action was possible only due to the quality of the North-American standard, which is very detailed and well written, very similar to a project manual for the students under final phase of graduation. That fact is an interesting example of the perspective to be applied to the design by certification in Brazil: to use international standards as guides for performance of the project.

Development of Super Petrel LS presents some interesting aspects that can be used as examples for companies working with innovation, in sectors with relevant certification dimension. Within the activities flowchart, it is important to observe the fundamental necessity of dedicating effort and time for deeply knowing the standard and its requisites, as well as to plan the methods to comply with it, in order to assure that the subsequent states will be correctly adequate to the normative parameters, thus assuring success of the ultimate product. Regarding project execution, the fact of ‘seeing’ the standard not anymore as several requisites to be observed, but of also using it as a manual and guide is considered to be an intelligent solution, particularly for cases where the Brazilian standard does not present clear references.

4. INTERNATIONAL SCENARIO

The LSA - Light Sport Aircraft was recognized as individual category only after 2005, when the United States Federal Aviation Administration (FAA) defined ‘light sport aircrafts’ as the ones with maximum 600 kg take-off weight. This group includes airplanes, gliders, gyroplanes, motorized parachutes. Standard of proportional licensing and training, maintenance and aeronavigation were applied, the latter based on ASTM standards. The outcome of this new category’s implementation was that in less than ten years the LSA market in the United States reached 20% to 25% of the sales of propeller airplanes with forecasts of growth. Among all the light Sport aircrafts sold in the United States, 60% are domestically manufactured, which makes the market attractive for manufacturers from other countries.⁵

The concept and the LSA category were quickly spread to Canada and Australia and other nations that now operate in a regulatory scenario harmonized with the category. The main countries that adopted the FAA’s standards are Australia, China, New Zealand, Brazil, Colombia, Peru, Canada, Israel, South Africa, Chile, Malaysia and Mexico. The category is currently known not

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5 EUROPEAN FEDERATION OF LIGHT EXPERIMENTAL AND VINTAGE AIRCRAFT (EFLEVA); THE EUROPEAN MICROLIGHT FEDERATION (EMF); THE EUROPEAN POWER FLYING UNION (EPFU). Introduction of a light sport aircraft category in Europe. Jun. 2012. (Position Paper and proposals for a Light Sport Aircraft Category in Europe). Jun/2012

only by countries wherein aviation has advanced technologies, but also in the emerging countries. Adoption of the standards defined by ASTM enabled revitalization of the segment through manufacture of new projects. That was followed by traditional manufacturers such as Cessna, which introduced in the market new models dedicated to the LSA category.

Differently from the other aviation categories, the LSA is not strictly controlled by sector giants. For each large manufacturer there are dozens of smaller companies, with next generation innovations and manufacturing methods that enable them to be competitive. The fact that technology and information are increasingly more accessible and as the cost of the LSA aircrafts is much lower, when compared to other categories, makes the segment attractive for small entrepreneurs. The costs of an LSA airplane may vary from USD 15 thousand to USD 400 thousand.⁶

In 2008, the number of light sport aircrafts in the United States, according to the FAA, was approximately seven thousand. For 2025, the estimate is that such figure will exceed 15 thousand units, at annual growth rate close to 5%.⁷

⁶ Available at: <http://www.planeandpilotmag.com/aircraft/best-buys/lsa-buyers-guide-2014.html#.VGs1L_nF854>. Access on: November 11th, 2014.

⁷ NATIONAL AIR TRANSPORTATION ASSOCIATION (NATA). National Air Transportation Association. General aviation in the US. May, 2009.

Within the LSA category, the sector experiencing the greatest growth is that of amphibious airplanes. In that segment, American, Chinese, Spanish and Finish manufacturers are prominent, competing with one another to develop bolding designed and high technology equipment.

5. RESULTS FOR THE COMPANY

In case of amphibious aviation, Super Petrel LS currently holds 85% market share in Brazil. Considering that the Brazilian market does not have many players in this segment of amphibians (just two other national manufacturers, besides Scoda), Super Petrel LS' share in the market is very expressive.

The project for certification and compliance with the North-American standard enabled the company to enter the North-American market. The fact of following a standard that is accepted worldwide (except for countries of the United Kingdom and Germany) also allowed certification of the aircraft in Australia, South Korea and Malaysia as well. The entrance in external markets has resulted into increase of exports and, consequently, sales margins.

Another relevant element derived from the certification project is the alignment of Super Petrel LS with the global



technical requisites and global market, adding credibility and global recognition to a national product.

6. OUTCOMES AND PERSPECTIVES

The next stages of Scoda's strategic planning towards the Super Petrel LS include reaching 60% export index and conquer 20% market share in the United States, in the coming years. In number of units sold, 20% of the American Market corresponds to 100% of the Brazilian amphibious light sport aircrafts market. Therefore, the growth target in the North-American market means significant increase of the company's manufacturing capacity, basically duplicating the production volume.

Furthermore, the company is already working on certifying of the product in more than five countries and it intends to reach the target of 1,000 units sold until 2020. Launching of Super Petrel iS version is also in progress, which is an innovation for the world aviation, being the first aircraft with electronic injection and ignition engine.

The manufacturing plant from Ipeúna, the neighboring city of São Carlos, is also working in projects for certification of other models of Super Petrel and of Dynamic, the SPLS4 and the WT10, which have both four seats, instead of just two. In this case, the aircrafts are no more framed within the LSA



category and, therefore the certifying standard is the FAR 23, American as well and accepted in Brazil.

Finally, as long-term perspective, the company has studies for projects using electrical engines, believing that aviation evidences a trend (still in the initial stage) to follow in that direction.

The work developed by Scoda for certification of the aircrafts is an example of the fact that adequacy to standardization is an innovation element, as the company would not be able to enter a new market if it did not include this adaptation. Evidently, it is also necessary to have broad and consistent market view that enables foreseeing changes and identifying trends. Hence, it is possible to keep the strategic planning aligned to the sector's reality and to be constantly prepared and well-positioned towards the changes that effectively take place.



SIGMARHOH
FIELD, PARTS AND SERVICES

calmena
BIG 167

SIGMARHOH 16 ×





TECHNOLOGICAL INNOVATION IN THE OIL AND GAS SECTOR BY A COMPANY FROM THE STATE OF SERGIPE



Discovery of the pre-salt unchained, in Brazil, efforts dedicated to research and development seeking for solutions for its exploration. The initiative, which generated excellent results, contributed for the country's positioning in the oil and gas production international scenario. This fact enables Brazil to be in a new level: no more being prominent as supplier of raw material, but also as supplier of next-generation technology. Within that context, the work of micro and small companies – many of them accountable for technologies that are unique in the whole world - has been breaking the paradigm that this chain is limited to the large multinational groups. The case in this chapter is a good example of a small company from the Northeast of Brazil that, supported by a covenant between Petrobras and SEBRAE, changed the five-decade duopoly between North-American giants, becoming a reference in product innovation in the oil and gas sector.

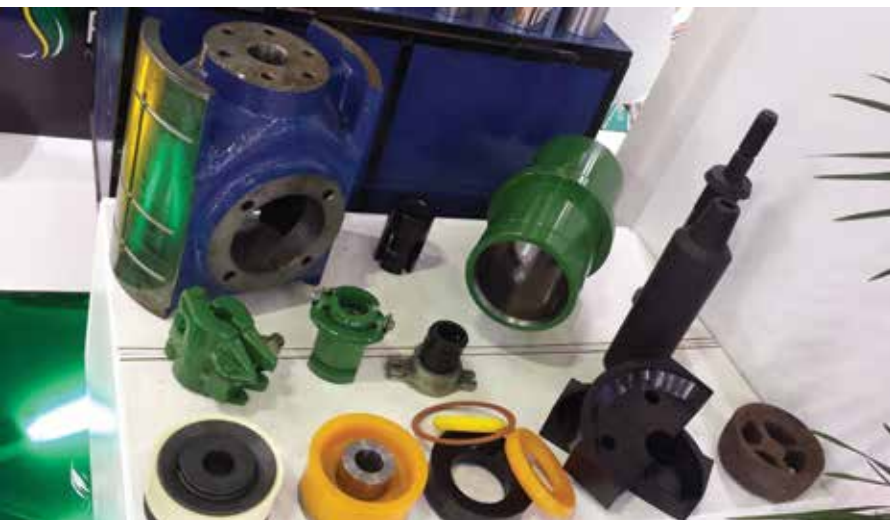
1. THE COMPANY AND ITS SECTOR

Sigmarhob do Brasil is a company that manufactures equipment for the oil and gas exploration and production.

Established in Aracaju, State of Sergipe, in 1994, the small company, at that time, faced the hindrances and limits of being established in a region without industrial tradition, using the know-how of its founding partner, Sandro Tojal. Graduated in Business Administration from the State of Sergipe Federal University – UFS and holding technical specialization from Universidade Petrobras, in the oil equipment area, his career was totally directed to the segment of alternative pumps and centrifuges applied to oil drilling and production, working for large companies of the sector such as Petrobras and multinational companies from the Gulf of Mexico and Texas.

The familiarity with the market enabled him to identify an unexplored business opportunity in Brazil. The oil producers that work in the country imported all the components used in the drilling operations. The company was born out of the idea of nationalizing such equipment and offering it at more attractive prices. However, just technical know-how would not be enough to sustain the business: it was necessary to face the difficulties derived from its geographic location.

The State of Sergipe does not have remarkable industrial culture, which makes the manufacturing line extremely dependent on the South-Southeast axis to supply raw-material and services. The logistics of the supply chain was complex and impaired the process, and the competitive advantages – the technical know-how of projects and the



cheapest manpower in the region – supposedly would allow its products to compete in terms of price with the international suppliers and those from the South of Brazil.

For the large oil explorers, however, the components price is not a priority at the instance of the purchase. The operating cost of drilling can reach US\$ 25 thousand/hour and the companies are not willing to risk their business in the name of savings that would represent less than 1% of that value. In the last instance, reliability of the suppliers dictates the rule and that makes entrance into the oil sector difficult.

In that sense, Sigmarhoh knew that its products needed a differential feature in order to be established in the market. It could not compete with the international suppliers in volume

or distribution and its minor cost advantage was irrelevant for its clients. In the pursue of competitiveness the company developed a new type of elastomer polymer that presents twice the useful life of the one used in the imported components, and which can also be used for different types of drilling fluids.

The solution was very well accepted by the market and the company experienced strong growth in sales. There has also been verified the need to expand its industrial park. Today, the company has 28 employees and its revenue, in 2013, reached BRL 2.5 million.

Sigmarhoh do Brasil's success gave rise to the Sigmarhoh Group, a set of three companies working in the oil and gas sector with services that complement and leverage their own growth. The Group includes, besides Sigmarhoh do Brasil, Sigmarhoh Well Testing, which renders special oil services, with emphasis to well testing operations and CYS Brasil, specialized in professional training and technical education.

WTS was created in 2008, during the international financial crisis. The sale of equipment for oil was sharply reduced and Sandro joined a partner with expertise in the market to start a company that not just resumed the courage of the Group but also challenged the international duopoly that lasted for more than 50 years in the services of oil reserves formation tests.

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attractive prices.”



Besides rendering services to Petrobras and other large oil exploration companies, the new company has been dedicated to a market niche formed by small and medium operators of onshore marginal fields¹. Its clients include Petrogal, Grantierra, Imetame, Alvopetro, Petroreconcavo, Petra Energia and Nova Petr leo.

Sigmarhoh Well Testing Services use several types of equipment of the oil Exploration and Production industry

¹ Marginal Field is the one that, for several reasons (including reduction of the production) a field stops being profitable for a certain operator. That profitability depends both on the 'size' of the field and of the company, i.e., a field might not be economically interesting for a large company, but it might be very feasible to a smaller company.
Source: <http://camposmarginais.blogspot.com.br/2012/03/diferenca-entre-campo-marginal-e-campo.html>

in its operations, and purchases many of them from Sigmarhoh do Brasil. As the well testing company has been growing at 200% per year rate, its demand for components is also incremental, i.e., the operations of one support' the growth of the other.

Another new solution created consists of a mini-station of anticipated production, which enables the operator to start production and sale of oil in just one week. Hence, the oil exploration company is able to raise capital in order to pay for the definite station.

2. THE STRATEGY – THE PROJECT ALIGNMENT WITH THE BUSINESS

In Brazil, the drilling market functions through notices to bids of the oil fields, with Petrobras operating in approximately 35% of them. The wells are divided between the ones located onshore and those located offshore, the latter with much more volume and, therefore, more valuable and disputed.

The pumping system is crucial in the drilling process of an oil well, as it moves the drilling fluids that keep the mechanic stability of the well, cool down the bit, convey hydraulic power and remove the debris from the way. The drilling fluids (also known as drilling muds) are divided into three types, which are used according to the depth of the excavation and

composition of the geological layers, which become more and more resistant:

- Water based fluids – constituted by water, clay and thickeners, presenting very low cost of production and broadly used during the initial drilling phases;
- Oil based fluids – their basic product is an oil by-product. They present better lubrication and higher capacity of cleaning with lower viscosity;
- Synthetic fluids- made of synthetic oils, these are the fluids mostly used in the offshore drilling rigs, used on the stages of drilling at deeper regions.

For each type of mud, the mechanic components use one elastomer ² specific for sealing – the deeper the drilling, the more expansive the sealer. Every time a new layer is reached, before changing the drilling mud it is necessary to open the pump and replace the sealer by another one with adequate elastomer. In addition, due to the intense wearing out of the equipment, there is recurrent need to purchase spare parts to avoid affecting the operation.

2 Elastomer – Polymeric material that quickly recovers its initial form and dimensions, after ceasing application of tension on it. Standard ISO 1382:1996 – “Rubber Vocabulary”

Sigmarhoh developed an elastomer that can work with the three types of mud with no need for replacement, which increases productivity and practicality of the operation. In addition, its useful life reaches up to twice the elastomers of the competitors and its price is equivalent to the cheapest type of elastomer (the one that is used in the phase of water-based mud). Today, the company uses the new material in all of its equipment units.

After duly validated and tested in the field, the innovation convinced many oil producers to replace their foreign suppliers and, thus the small company from Sergipe entered one of the most inaccessible markets of the world, being recognized as a reliable provider of innovative solutions.

3. THE PROJECT

In 2007, Sigmarhoh was included into the Cooperation Network of the Oil and Gas Productive Chain in Sergipe – Rede Petrogas-SE, created by a covenant between Petrobras and SEBRAE/SE. As an associate, the company was able to participate in the TDI – Technological Development and Innovation action in the micro and small oil and gas companies, within the Oil, Gas and Energy Productive Chain Program.

Structuring of Rede Petrogas-SE started in 2003, after a diagnosis of the Oil and Gas Chain was prepared. The



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purpose of Rede is to integrate its associates into actions that enable development of the oil and gas productive chain, stimulating expansion and starting of new enterprises, as well as investment in R&D and quality. In this sense, focusing on incentive to innovation, the program “TDI Action: technology and innovation development in the oil and gas small and medium companies” was created, initiated in 2007, aimed at fostering competitive and sustainable inclusion of those companies into the oil productive chain. The program puts together technicians from Petrobras, businessmen and academic researchers for identification of the oil company’s demands and for supporting the innovation process³. The companies benefit from one end to the other: from refining of the administrative and financial management, by participation in trade shows and events of the sector, up to access to excellence laboratory, like the Research Center of Petrobras (Cenpes).⁴

Assisted by the project, the company improved its administrative and financial processes, conquered quality certificates and expanded its contact with other companies through participation in national and international fairs. Another important outcome of the work developed with

3 Available at: <<http://redepetrogas.com.br/institucional/>>. Access on: November 7th, 2014.

4 Available at: <<http://www.protec.org.br/noticias/pagina/29929/Empresarios-criam-tecnologias-ineditas-e-ganham-mercado>> (acessado em 02/10/14)>. Access on: November 12th, 2014.

the support of the Petrobras-SEBRAE covenant was the identification of the opportunity to resolve an old problem of the drilling equipment sealing system: the need to use different material for each stage of the process.

The idea of developing a new elastomer that could apply to different drilling fluids appeared in 2011, aiming not only to be a differential feature, but as a strategy to grant credibility and confidence to the small company from the State of Recife before the oil exploration companies. An elastomer that did not need to be changed at each stage of the drilling would reduce not only complexity of the operation, but also costs with stocks for its clients and their dependence on international suppliers.

The technology development was made in partnership with the State of Sergipe Federal University. A student from the industrial chemistry course started the theoretical studies still under the condition of trainee. After his graduation, financed by the company, the student attended a specialization course with the Polymers Technological Center of SENAI - CETEPO, located in the city of São Leopoldo, in the State of Rio Grande do Sul, specialized in technology of rubber, plastic, adhesives and foams⁵. With the know-how obtained regarding production of elastomers

5 <http://www.cetepo.rs.senai.br/>



SIGMARHOH
WELL TESTING SERVICES

MC-11 FLOW ANALYZER
CORIANDER
CORIANDER
CORIANDER



and ideas for formulation of the product for the intended use, Sigmarhoh structured its first handmade production cell, inside its own industrial plant, with all the equipment required for the serial production of the polymer.

The raw material selected for the project was imported from Australia. With the necessary material and facilities, numberless pilot trials were performed in-house, until establishing formulation and process that could meet the demand of a product adequate to all the drilling muds. To validate the new product, application tests were performed in the laboratories of State of Sergipe Federal University and also in the facilities of the Australian supplier. The samples' performance in the field, in Brazil, confirmed the functionality in the different drilling fluids. After that, Sigmarhoh started to use the elastomer in the sealing systems of all the equipment units manufactured by it.

The next step consisted of seeking a large client that believed in the product and that would put it into operation in its drilling rig. Therefore, the first samples were distributed free of charge (a significant investment for the company, as each part costs from BRL700 to BRL 1,100 to be produced) under the condition that its consumers should provide an assessment and performance report.

By the end of 2011, the report from the first client – a consortium from the State of Minas Gerais that operated

some rigs in onshore oil fields – indicated that the components of the innovative equipment had useful life of 1200 hours, while its imported similar products, working under the same conditions, lasted only 600 hours. Holding such data, the company was able to embrace a great opportunity that appeared in 2012. A foreign producer was starting exploration of its first oil well of Sergipe in deep waters and Sigmarhoh profited from the opportunity, granting three parts for tests and, when the exploration company verified its quality, it purchased other 50 parts and performed the entire drilling process with the Brazilian components, without occurrence of any fault.

That drilling was a landmark for Sigmarhoh do Brasil. Its parts had finally operated in deep waters, which granted it the recognition and credibility it needed to enter the market. With its image renewed and a modest, but reasonable history of operations, the company invested in the goal of trading its products to Petrobras.

Some initial discredit had to be faced. It is not an easy task to replace an already established international supplier, mainly for a small manufacturer from the Brazilian Northeast with a unique solution in the market. However, quality of its product was prominent. After delivery of some samples for test, the company was approved and Petrobras started to use its parts by the end of 2012.

4. INTERNATIONAL SCENARIO

The development of the pre-salt layer set forth a new condition for Brazil in the international market, expanding its reserves and duplicating the production capacity until 2020. Until then, large investments in the files of pre-salt are programmed. A total of more than US\$ 250 billion is estimated for development of oil and natural gas production, including the entire transportation infrastructure. The published investments include:

Petrobras - US\$ 53.4 billion (2011-2015); BG Group- US\$ 30 billion; Repsol YPF - US\$ 14 billion. ⁶

THE OIL EXPLORATION AND PRODUCTION (E&P) MARKET

Several businesses follow the demand of the large global exploration companies. As those companies purchase about 70% of its equipment and services, a market named as 'suppliers of the E&P industry' was created, which has high level of specialization and transacts US\$ 231 billion per year.

As a direct consequence of the increased global investment in E&P and the high penetration of services and equipment

contracted by the operators (even if with some oscillation and tendency to fall) the revenues of E&P services and equipment suppliers have been incrementing at an annual weighted average rate of 19% in the period from 2002 to 2007, reaching US\$231 billion in 2007.

The market of E&P equipment and services is comprised by the several segments that divide the exploration stages of an oil reserve:

1. Information of containers: identification of potential reservoirs;
2. Drilling agreements: drilling of wells;
3. Drilling services and associated equipment: activities and equipment for support of drilling, measurement and registration;
4. Lining and completion⁷ of wells: preparation of wells for the production;
5. Infrastructure: design, construction, assembly and installation of the infrastructure aimed for the production;

⁶ Available at: < http://fgvprojetos.fgv.br/sites/fgvprojetos.fgv.br/files/estudo_20.pdf>. Access on: November 7th, 2014. Ernst & Young Terco. "Brasil sustentável – Perspectivas dos mercados de petróleo, etanol e gás". 2011

⁷ Wells logging consists of the set of services offered in the well since the instance when the bit reaches the basis of the production zone. Source: http://www.tecnicodepetroleo.ufpr.br/apostilas/engenheiro_do_petroleo/completacao.pdf



6. Production and maintenance: operation and support of the production infrastructure;
7. Decommissioning: finishing of a well's productive phase.

Sigmarhoh do Brasil works in the segment of Drilling Services and Associated Equipment, one of the largest in the market (annually transacting US\$ 42 billion). It involves bits and drilling muds, solids control, well tools, rental of tools, directional drilling and logging. The companies that offer their products and services in this area present profit margins of approximately 20% to 25%.

The largest representatives of the sector are Schlumberger (19% market share), Halliburton (15%) and Smith Int'l (15%).

Schlumberger is the market leader and also the largest integrator employer. It has 9% of the total revenues and significant presence in four of the eight segments of the E&P services and equipment sector.

Halliburton is the second largest company in the sector and the second largest integrator, with about 6.5% of the revenues. It has significant activities in two segments and it is present in more than 100 countries.

With the increment in Sigmarhoh's business and the need for expansion, the Group created the company named



Sigmarhoh Well Testing Services, which works in another segment of E&P Equipment and Services – it is a supplier of services in the initial segment, that of Reservoirs Information – with its technology.

The segment of Reservoirs Information includes attainment and processing of seismic data, imaging of reservoirs, management and integration of the reserve data and the geophysical equipment. This segment corresponds to US\$ 13 billion per year – 5.6% of the total revenue of the E&P market-, and the companies working in that segment have from 25% to 35% profit margins.

The largest players of the Reservoirs Information of the sector are Schlumberger (32% Market share), CGVeritas (19%), PGS (12.5%). Halliburton corresponds to just 5% of that sector, being more present in the rest of the value chain.⁸

5. RESULTS FOR THE COMPANY

After the tests in onshore and offshore rigs, in 2012, the company started to disclose the performance results of the parts manufactured with the new elastomer in the subsequent

⁸ BNDES. Estudos de alternativas regulatórias, institucionais e financeiras para a exploração e produção de petróleo e gás natural e para o desenvolvimento industrial da cadeia produtiva de Petróleo e Gás Natural no Brasil. [S.l.: s.n.], 2009.



year. The return from the large oil companies (mainly Petrobras) was positive, creating a significant clients' portfolio.

The elastomer started to be used in other parts of oil equipment and other industrial equipment, such as swivel (connection that allows the connected object to turn horizontally and/or vertically), hydrocyclones, rollers of conveyor belts for fertilizer plants, which expanded



Sigmarhoh's portfolio and consolidated efficiency of the composite due to its physical-chemical characteristics with excellent cost-benefit.

The impact of the elastomer's inclusion on the company's revenues was very relevant. After reaching revenue of BRL 3 million in 2008, in the subsequent year, due to the global economic crisis, the company registered decrease of more than 50%, with revenues a little over BRL 1.4 million. In 2012, when the first units of pumps with elastomer were traded, that value increased to BRL 2 million. In 2013, when the polymer was incorporated into the other oil and industrial equipment units, it reached the revenue of BRL 2.5 million.

6. OUTCOMES AND PERSPECTIVES

Development of the innovation process, since the academic research up to trade of its final product, benefitted the company in several ways. First, they started to apply the used methodology in other innovation processes within the Group, enabling the creation of more than 100 items for drilling equipment, offering entire solutions to its clients, instead of isolated parts.

Regarding the new elastomer, new applications in several industries other than oil and gas were discovered such as the chemical and farming industry. The company's executive



board is prospecting possible businesses to expand its horizons. The most recent example is the manufacture of the first units of conveyor belts rolls for ammonia based products, aimed for the fertilizers industry.

Today, the company is well-positioned in the market, with great growth expectation. The Brazilian Oil Agency - ANP closed, in 2013, a five-year period without bids of oil wells (in 2009, the auctions and concessions were suspended due to discovery of the pre-salt) and the estimate is that there shall be substantial increase of the drilling activities in the next years.⁹

Competition in the market which Sigmarhoh do Brasil is included is aggressive, but the business stands strong due to quality of its differentiated elastomer, its main competitive advantage.

⁹ Available at: <http://brasileconomico.ig.com.br/ultimas-noticias/uma-dose-de-otimismo-na-exploracao-de-petroleo_139431.html>. Access on: November 12th, 2014.

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Development of
the innovation
process, since
the academic
research up
to trade of its
final product,
benefitted the
company in
several ways.”



TNS NANOTECNOLOGIA 17

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THE IMPORTANCE OF THE APPLICATIONS DEVELOPMENT STRATEGY AND THE BUSINESS MODEL FOR THE SUCCESS OF A NEWBORN COMPANY IN THE NANOTECHNOLOGY SECTOR



TNS Nanotecnologia is a startup born out of an attractive idea generated by a group of researchers of the Chemistry and Engineering area from the State of Santa Catarina Federal University. To reduce the uncertainties or risks inherent to this kind of enterprise, the company structured a business plan that counts on the participation of strategic partners for the development of applications and validation of the technologies, enabling the use of the technology in different ultimate products. TNS' nanotechnology can be thus considered as a technological platform: the same technology allows uses in many products and clients.

1. THE COMPANY AND ITS SECTOR

TNS is a small Brazilian company that develops solutions in nanotechnology for the industrial sector. It is established in Florianópolis, the capital city of the State of Santa Catarina, in



the South of Brazil. The company is installed in the Business Center for Elaboration of Advanced Technologies (CELTA), incubator of CERTI Foundation – created in 1986, with the purpose of enabling the State's technological potential, using the talents and knowledge generated by the Santa Catarina Federal University (UFSC), and enabling their change into opportunities for the different sectors of economic activity. Santa Catarina is a state with strong industrial tradition and varied hubs with very outstanding sectorial specializations, which coexist with an equally dynamic agricultural sector.

The company was created in 2009 as an idea of the Inorganic Synthesis and Nanocomposites Laboratory of the UFSC Chemistry Department and its origin in the scientific environment is verified in the development history and solutions developed by it to enable its business model.



The laboratory develops researches in nanoscience and nanotechnology since 2005.

In 2008, a graduation course conclusion essay under the mentoring of Professor Cesar Vitório Franco – enabled studies about preparation and characterization of nanosilver.

The proposal with the silver nanoparticles was presented and awarded in the Innovation Synapses Award – a contest promoted by the State of Santa Catarina Scientific and Technological Research Support Foundation (FAPESC) and performed by Certi Foundation, intended for prospecting and changing good ideas into successful

businesses¹. The project, which was also recognized in the university with the Distinction Award of the Scientific Initiation, ended up in the creation of the nanotechnology company TechNano Solution, which lends its initials to TNS.

During the company's first two years, the focus was on the understanding of industry needs and the appropriateness of its product for this purpose. In 2010 and 2011, two facts leveraged the company's growth: the entrance of Gilberto Heinzmann as a company partner. As a senior executive, Gilberto brought the experience and knowledge necessary to direct the company in its efforts in the market. Another important milestone was the participation in the RHAЕ project (Human Resources for Strategic Activities) from CNPq. This initiative aimed to develop all necessary grounds to scale up production at industrial level. It was through that program that Gabriel Nunes, currently the Executive Director, initiated his path in the company.

Those two events were key parts for the company's repositioning, driving the definition of its business model, strategic focus, consistent approach with customers as well

1 Available at: <http://www.fapesc.sc.gov.br/index.php?option=com_content&view=article&id=764:1805-equipe-da-ufsc-estuda-producao-de-nanoparticulas-de-prata-e-impregnacao-em-diversos-materiais&catid=8:noticias&Itemid=20>. Access on: October 8th, 2014.



as leveraging the production capacity to the level of several tons of product per month.

The nanotechnology sector is considered to be one of the most attractive in terms of its application to the most varied segments – it is a platform that might result into an actual industrial revolution in several sectors. The technology refers to material and devices with physical dimensions of up to 100 nanometers. The definition mostly used for the term sets forth that a particle is considered to be nano if its diameter is between 1 and 100 nanometers (one billionth of meter). Those particles have very special chemical and physical properties that might be very important for the chemical, textile, automotive sectors, among many others where the opportunities are being gradually explored².

Nanotechnology is multi-disciplinary, gathering areas of knowledge such as chemistry, physics, biology and engineering, and it applies to a large number of consumable products, including plastics, tires, paints, fabrics, cosmetics, medicines and sport material³. The nanoparticles can be formed from different material and have very different functions, depending on the scale changes and the form assumed by the particles.

2 PISCOPO, M. R. et al. O setor brasileiro de nanotecnologia: oportunidades e desafios. XXXVII Encontro da ANPAD. Rio de Janeiro: Set. 2013.

3 Available at: <http://ec.europa.eu/health/scientific_committees/opinions_layman/en/nanotechnologies/l-2/3-nanoparticle-properties.htm>. Access on: October 8th, 2014.

Among the changes to the properties, the following are emphasized: thermal behavior, material resistance, solubility, conductivity and catalytic activity⁴.

The special properties of those particles derive from their high proportion between the surface area and volume⁵. They also have a considerably higher percentage of atoms in their surface, when compared to other particles, which can make them more reactive. Those features make nanotechnology a very attractive field for the development of new businesses.

The importance and the advance of nanotechnology in the world are already remarkable. The technology is present in large variety of consumable products and in several fields of activity. The estimate is that such outlook will be intensified due to the incremental research in the area involving different segments of the economy. For Brazil, this new technology area might represent an excellent opportunity to leverage competitiveness of several companies in different segments or, in case the opportunities are not used, the companies of those segments might experience weakening, with their markets being occupied by new products from other countries.

4 PEREZ, F. S. et al.. Nanotechnology: applications for the food sector. *Disc. Scientia*. Santa Maria, v. 13, n. 1, p. 1-14, 2012. (Série Ciências da Saúde).

5 Available at: <<http://www.bv.fapesp.br/namidia/noticia/32100/novas-definicoes-nanotecnologia/>>. Access on: October 8th, 2014.



2. THE STRATEGY – THE PROJECT ALIGNMENT WITH THE BUSINESS

The company developed competency in nanotechnology aimed for industrial uses and it has a platform of antimicrobial products based on silver nanoparticles. The coverage of that technology enables the company to work in a large number of industrial sectors, highlighting the textile, polymers, paints, veterinary, medical-hospital and ceramics segments. It is important to recall that the same technology enables uses in much diversified products and solutions, characterizing nanotechnology as a transversal area, likewise biotechnology and computing.

It is currently in the expansion phase, investing a large portion of its resources in activities of research, development and innovation to guarantee the continuous growth and to strengthen its presence in the prospect markets. In fact, they are multiple markets, in process of development, and TNS' commercial capacity, grounded on its technical capacity, is essential to guide the use of those opportunities. The adopted innovation strategy is directed by the challenges imposed by segments of the industry deemed to be potential for expansion of its business. The focus is to develop nanotechnology to add functionality to its clients' products, generating solutions based on the environmental, social and

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economic pillars ^{6,7}. The solutions portfolio of its platform serves different segments:

- Antimicrobial: aimed for textile, polymers, paints, hospital, ceramic and veterinarian;
- Anti-static: used in the textile industry;
- Anti-Corrosive: functionality in metal surfaces;
- Hydrophobicity: applications in textile industry, polymers and metal surfaces;
- Resistance to yellowing: an important characteristic for the household appliances industry and inox;
- Resistance to risk: ideal for metal surfaces and polymers.

The antimicrobial line is developed by TNS, therefore being products with totally national technology. The other solutions are imported from Germany and implemented in the national industry by its collaborators.

6 <http://www.assintecal.org.br/noticia/tns-nanotecnologia-e-a-mais-nova-empresa-associada-na-assintecal>

7 Through technical-commercial partnerships established with European companies leaders in the nanotechnology segment, the company incorporates to its portfolio new products in the areas of surface functionality and incorporation of carbon nanotubes for production of engineering polymers.



The company works in the B2B (business-to-business) market, i.e., the products are traded only for companies that incorporate the nanotechnology functionalities in their ultimate products, adding more value and granting them properties that are considered to be competitiveness differential⁸. The proposal is to supply an alternative to the already existing antimicrobials. That involves stages for customization of its products in the client's productive process, besides offering improvements during incorporation of the additive, when compared to the application methods

8 Available at: <<http://www.tnsolution.com.br/>>. Access on: October 8th, 2014.

of the competitor products. Customization is, therefore, a differential feature in the company's business model. Versatility of its products and the capacity of adapting them to different applications expands the array of business opportunities concerning conquering new clients.

3. THE PROJECT

The antimicrobial action of silver has been known and its compounds have been used for centuries as medication. However, consumption of those compounds was sharply reduced by the frequent use of antibiotics and other antibacterial agents that, many times, present toxic effects. In the last years, the concern with increase of cases involving resistance to antibiotics has been strengthening the search for safe antimicrobial agents and among those, the silver nanoparticles are being specially studied and used⁹.

The nanosilver presents excellent antimicrobial action, enabling formation of new generation of antimicrobial material. Today, it is common to find the metal incorporated as nanocomposites in domestic accessories, fabrics,

refrigerators, dental and hospital products¹⁰. The silver nanoparticles are considerably more effective than the silver salts used in several formulations, presenting much longer action time and acting at concentration level much lower than the safety limits defined for that metal.

The changes of size and surface of the particles can directly affect the material's behavior and functionality. That fact can be explained by two main reasons: effects of the quantum mechanics that manifest themselves and start to act in the very small dimensions (leading to new physic and chemistry) and the relation between a very large surface and the volume of the nanomaterial¹¹. The surface effects become more important, granting specific characteristics to such material which are desirable for certain applications.

Use of nanotechnology provides silver with greater antimicrobial action, guaranteeing better efficiency in fighting microorganisms, when compared to the "conventional" silver. Another important gain is the mitigation of the chances for development of resistant bacteria, likewise what happens with other antibacterial agents.

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Versatility of its products and the capacity of adapting them to different applications expands the array of business opportunities concerning conquering new clients.”

9 RAJAWAT, S.; QURESHI, M. S. Comparative study on bactericidal effect of silver nanoparticles, synthesized using green technology, in combination with antibiotics on salmonella typhi. *Journal of biomaterials and nanobiotechnology*, v. 3, p. 480-485, 2012.

10 TRAN, Q. S. et al. Silver nanoparticles: synthesis, properties, toxicology, applications and perspectives. *Adv. Nat. Sci.: Nanosci. Nanotechnol.* v. 4, 2013.

11 Available at: <<http://www.pratacoloidal.com.br/>>. Access on: October 10th, 2014.



The mode of action of the nanoparticles is connected to the metal's interference with the bacterial metabolism, unbalancing and breaking the cell membrane of the microorganisms, inhibiting cell respiration or connecting to its DNA and interrupting the replication process of the genetic material and protein translation, therefore, impeding multiplication of microbial cells¹². Although the fundamental knowledge is old, its translation into attractive businesses involved migration from the university laboratory benches to the companies of professionals graduated and capable of developing economically useful applications of these technologies.

The nanoparticles can be found in the cylindrical, spherical and triangular forms – a fact directly related to their effectiveness. The company developed spherical particles, known by their stability and high antimicrobial activity. This material is characterized by high versatility, and it might be incorporated during formulation of several material, in the textile, veterinary, medical-hospital, paints, polymers markets and so many others, considering that the antimicrobial functionality is of interest for several segments.

The company started development of the nanoparticles in 2009. However, the product was introduced in the

market only in December, 2013. During that interval, the research and development team – formed by doctors, masters and engineers – performed studies to identify what is the most active form of the nanoparticle and ideal concentrations – respecting safety margins and product effectiveness.

Those were decisive years for establishment of the technological competencies and the knowledge of the market that assured, later on, the company's growth. Another determinant factor for the technology's success was the discovery of a new encapsulating agent for the nanosilvers, which enabled significant gain in the product's useful life. The first particles developed used a chlorine sensitive agent during recovery of the nanoparticles - a fact considered to be a potential hindrance for trade in the industrial market. The chlorine is an easily found product, present in cleaning material, in the water at small concentration and, mainly, being part of the cleaning protocol of some applications.

For the industrial market, wherein the company is active, the validity term and product stability are crucial factors. The supplied product must be incorporated into the client's formulation during stages of its productive process, demanding that the nanoparticles shall not be subject to variations during that period. That characteristic reduced the chances of success

12 ZHOU, Y. *et al.* Antibacterial activities of gold and silver nanoparticles against *Escherichia coli* and *Bacillus Calmette-Guérin*. *Journal of Nanobiotechnology*. v. 10 n. 19, 2012.



250
APPROX

200

150

100

50



of the first samples of nanosilver produced, as they became unstable in somewhat short periods (three months).

To overcome or at least mitigate that frailty, TNS went back to the laboratory and managed to develop a new encapsulating agent with highly promising properties for the industrial market. The compound, baptized as Alfa, granted an expressive increase of stability to the nanosilvers, and, therefore, to their validity. Today, the antimicrobial additive is stable for more than 12 months for application, and the term for maintenance of the nanoparticles functionality, after their incorporation into the client's product, is connected to the characteristics of the material that received the technology. In most cases, that period is coincident with the product's useful life.

Besides the stability, the new encapsulating material brought a unique characteristic to the products: the Controlled Release System. Availability of the silver ions is now controlled by changes of the pH occurring in the medium, where the active compound is released only in the presence of substances that change the pH in the medium– such as in the beginning of microorganisms proliferation. Once the pH of the material's surface is changed, the nanoparticle is opened releasing the ion and interrupting the microbial growth.

The progresses of the research enabled the company to reach an ideal product for the B2B market. The controlled

release of the silver ions, an extremely important property for the products with antimicrobial action, became a market differential feature.

The compounds with antimicrobial activity exhibit two modes of action: bacterio-dynamic, the action strategy of the antibiotics characterized by the constant release of the active principle; and controlled release, regulated availability of the compound at proper concentrations – which has a huge potential for the numberless results in the efficacy of the antimicrobial action.

During the period of nanoparticles development, the company entered into partnerships with companies from high potential segments, either commercial or for development of partnerships. Those collaborations were aimed for industrial tests and adaptations of the technology for each case – as the proposal was to have an initial product and to be able to incorporate it into the formulations of clients from several segments. The partnerships established by the company were fundamental for establishment of the business. The collaborations enabled validating the product directly with the client, generating important feedback and which, many times, resulted into improvement of the additives and later on the market growth. Today, those development partners are regular clients of the company.

TNS' technological solutions development is customized, which involves partnerships with companies from different segments. The company tests the technology directly with the client – by providing samples and following-up the laboratorial and industrial analyses. During the collaboration, clients and suppliers open their R&D laboratories: the company presents the specifications of its product and manufacturing process, while TNS' researchers develop a solution that will meet the client's specific demands.

The company elected to outsource the industrial process to specialized chemical company. At this instance, its business model does not accept investing on a plant for manufacture of nanotechnology based products. The initial difficulties faced include growth of the production volume during the first years and the difficulties found for staging. This strategy increases the chances of success of its business, as it uses the competency of companies with processes already established, while TNS continues to advance in the research and development of its portfolio and opening of new markets. The reliable industrial partner becomes, thus, a foundation for the business model, avoiding TNS' dispersion of its attention to very different activities that would involve competencies distant from the company's core objective.

4. INTERNATIONAL SCENARIO

Nanotechnology is a relatively new science in the market and it has been making a revolution in several industrial sectors. The perception that technology represents a new threshold of knowledge, with expressive scientific and economic gains, leveraged investments amounting to billions of dollars from several research and development funding entities and funding agencies in the different areas of knowledge across the whole world. It is estimated that the global sale of products containing nanotechnologic compounds will reach US\$ 2.4 trillion in 2015¹³. The dimension of that market can only be appreciated in comparative perspective: much higher than any agricultural products market (wheat: US\$ 135 billion), at the magnitude of the global commercial oil trade (US\$ 1.9 trillion).

The international governmental financing for research on nanotechnology reached US\$ 65 billion in 2011, and the estimate is that it will reach US\$ 100 billion until the end of 2014¹⁴. The United States, Russia and China are countries that invest in this sector, aiming at new thresholds of competitiveness of their companies. Likewise, several emerging countries implemented national programs to

13 Available at: <<http://www.plunkettresearch.com/nanotechnology-mems-materials-market-research/industry-and-business-data>>. Access on: September 2nd, 2014.

14 Available at: <<http://cientifica.com/wp-content/uploads/downloads/2011/07/Global-Nanotechnology-Funding-Report-2011.pdf>>. Access on: September 2nd, 2014.

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This strategy increases the chances of success of its business, as it uses the competency of companies with processes already established, while continuing to advance in the research and development of its portfolio and opening of new markets.”



accelerate researches in the areas of Nanotechnology and Nanosciences (N&N), focused on sectors considered to be strategic (according to the perspectives of each country), such as agriculture, energy and health.

Despite its great economic potential, the sector presents some difficulties that are inherent to creation of new technologies. Universities and research institutes center their investments in basic researches, validation of concepts and production in laboratorial scale; however, the number of developed technologies capable of overcoming the staging step and reach trade is still small.

Several governments have been using this scenario to develop their own nanotechnology bases and conquer market space. Russia, particularly, identified as an opportunity the low indexes of use for the technologies generated in other countries. Through Rusnano, a multibillionaire governmental fund, it is purchasing intellectual property of North-American nanotechnology companies for amounts that many analysts deem to be insignificant, at least compared to their market potential.

The United States has a background of leadership in nanotechnology – research and development of patents, public or private investments or academic productivity. From 2000 to 2013, the North-American Congress assigned US\$ 18 billion

to R&D on nanotechnology (although the budget of US\$ 1.7 billion for 2014 has been 8% lower than the one for 2012). The participation of its private sector, however, is unique in the world: it is estimated that the United States private sector has invested about US\$ 3.5 billion per year in the sector, since 2010.

According to a report from the National Science Board, China's market share in next-generation technology increased from 8% to 24% between 2003 and 2012, approaching the one of the United States, of 27%¹⁵. Another government prominent for being a leader in nanotechnology financing is Japan. In Europe, the European Nanotechnology Trade Alliance (ENTA) leverages the European industry. The Asian governments of Singapore, South Korea and Taiwan are also prominent.

In Brazil, the Brazilian Initiative for Nanotechnology (IBN in portuguese) was launched in August 2013, with a forecast of R\$ 440 million investment in the sector¹⁶. The forecast for 2015 is that the businesses with nanotechnologic products in

15 Available at: <<http://www.businessinsider.com/a-new-report-warns-that-america-may-lose-the-nanotechnology-race-2014-2>>. Access on: September 2nd, 2014.

16 Available at: <<http://www.ibe.usp.br/index.php/pt/noticias/313-governo-vai-investir-r-440-milhoes-em-nanotecnologia>>. Access on: September 2nd, 2014.

the country will transact about US\$15 billion, i.e., 1% of the world estimate¹⁷.

5. RESULTS FOR THE COMPANY

The developed antibacterial additives based on silver nanoparticles present high efficiency in controlling microorganisms proliferation. The antibacterial activity is proven in independent and certified laboratories, using international technical standards, which enabled the product to attain the market recognition and credibility with the consumers. It is possible to state that the nanosilvers promoted opening of new trade channels for the company.

The success of the researches and establishment of key partnerships enhanced TNS' business model. Through creation of alliances, the company generated customized solutions in the most diversified segments, which enabled very expressive growth. TNS started the year 2014 with three clients and in October of the same year its portfolio already counted thirteen Brazilian companies and multinational companies from different segments. The initiatives performed allowed placing the company in another revenue



17 Available at: <<http://www.abdi.com.br/Estudo/Panorama%20Setorial%20Biotecnologia.pdf>>. Access on: September 2nd, 2014.



level. The second semester of 2014 presented 498% growth in comparison to the same period in 2013.

Another important landmark for the company was the establishment of the regular supply for an important industry operating in the segment of tablecloth, towels and linen, which then incorporated the antimicrobial in its products lines. This partnership will provide international cover – the company will export its articles for countries of Europe and Latin America – strengthening the company's trademark in the world market.

6. OUTCOMES OF THE PROJECT

The developed technological solution generated important gains for its value chain. Companies from different segments successfully replaced the antimicrobial that they used for new additives.

Among the partner clients, there is a group of companies that obtained very significant results. An important Brazilian multinational company, working in the market of paints, used an antibacterial agent imported from Japan. Incorporation of that product required 23 hours processing time to obtain the paints with the antimicrobial functionality, a fact which the company considered to be one of the main bottlenecks in its process. After signature of confidentiality agreement

with the CLIENT, TNS' team of engineers started visiting its facilities and in some months proposed a new additive. The proposal generated significant gain in quality and reduced the processing time from 23 to 11 hours, therefore, a very considerable cost saving for a large company.

Another very interesting thing related to the outcome in the client is a Belgian company operating in the market of carpets, and which has one of its global facilities in Brazil. In this case, the client uses a powder bactericide that caused clogging of the industrial plants' piping, requiring that at every three months, the process should be shut down for the cleaning, with the worsening condition that implied into use of large volume of water and chemical products. TNS also signed an agreement with the company and developed an antimicrobial agent in water solution, totally eliminating the inconvenient caused by the former product.

7. PERSPECTIVES

At this instance, the company has its focus directed to the market opening and for its consolidation as provider of nanotechnology solutions. Today, it is developing three new products that shall be launched between 2015 and 2016. In addition, the company studies a new commercial strategy that involves establishment of commercial partnerships with suppliers that work with leader players in its operation sectors.



In the company's current model, the products are directly offered to the clients, in a basically capillary distribution system. In the new approach, once the technology is approved by a supplier, it becomes a new distribution channel, as the suppliers' sales team ends up becoming responsible for capillary distribution of the antimicrobials. In summary, it is a strategy to increase the market share keeping the team lean and that, besides reducing costs, indirectly provides fidelity of the large players, which would be improbable considering the company's size and short period of existence.

TNS took its first steps in the internationalization process. In May, 2014, a first visit to France, Germany and Belgium was made with that purpose and, after that, the company has been working to meet the standards required for distribution of any chemical product to the European Union.

The project strengthened the company's name in the nanotechnology market. The next steps involve using of the attained know-how to generate new material in nanometric scales. Today, the research is divided into two products lines:

- Conventional: aimed at creating solutions for already existing markets, promptly absorbed by the market;
- Strategic: includes subjects defined as being strategic for the company to continue innovating and remaining competitive in the market. The ideation process involves visits and participation in scientific and commercial events.

TNS has been successful in establishing itself through a strategy that links its scientific-technological knowledge to the industrial and market reality of its main clients. Those are, in fact, development partners; and the celebrated partnerships promote, at the same time, improvement of the solutions and development of their markets of application. Without dispersing material resources to the functions it can outsource (such as manufacture of nanoparticles), TNS is able to center its efforts in the development of the applications and solutions for its clients.



TOTH TECNOLOGIA 18

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TOTH TECNOLOGIA – INNOVATION MANAGEMENT IN TECHNOLOGICAL BASIS STARTUP COMPANY



TOTH's history is similar to that of many technological basis companies born out of what we can call the wave of young entrepreneuring, which has been consolidating itself along the recent years, in Brazil. A team of professionals with market expertise identified a business opportunity and, after applying their technical know-how, created a startup company. Its business model is based on the technical know-how added to partnerships: with professionals from the healthcare area, researchers, universities and research centers for the development of technologies; and with large players of the sector that, besides being clients, guarantee the products' entrance in the market. The company develops its equipment being responsible for prototyping, transferring of technology and technical support, receiving royalties related to sales of the ultimate product, which production is the client's responsibility. An important aspect of the adopted strategy is, profiting from the fact of being installed in an university technology park, to access lines of funding and financing aimed at research and innovation for the development of its products.

1. THE COMPANY AND ITS SECTOR

TOTH is a small company working with the development of hardware and software projects, components and solutions for the productive chain of medical equipment. Born in 2008, it is installed inside the technological park of Pontifícia Universidade Católica in Porto Alegre, the Tecnopuc. Currently occupying an area of about 500 m², the startup was created in a 72 m² room, the outcome from the union of four partners (three engineers and one administrator). The professionals had met when they attended the electronic technician high school and met again working in the medical equipment sector. As they had different occupations, the experiences and the professional and personal profiles complemented one another. That provided broad understanding of the segment, ending up by motivating and feeding the idea of starting their own business. They started, then, to develop what would become the first products offered: cardiac monitor, defibrillator, monitoring center and other projects.

Medical equipment offers broad field for the development of technical solutions. On one hand, being constituted by combination of technologies from different areas, the equipment offers successive opportunities for development and improvement. On the other hand, the environments for healthcare are very diversified, with specific professionals and medical cultures, demanding specificity of the

equipment as well. Combination of those two factors helps to explain the opportunity observed in the specialization for the development of technological solutions adequate for hospital, outpatient treatment centers and medical clinics.

Another important finding that motivated and enabled the business is the fact that the medical device development and manufacture is very insufficient in Brazil. The sector is strongly submitted to several regulations, which seems to reduce the interest on research and development for this area. Thus, to be one of the few working in this area, added to the fact of being a small company, ended up becoming an advantage in terms of fund raising by economic subvention notices to bid and research funding agencies.

Since its birth, TOTH's growth has been very intense, with positive results every year, since 2008. The gross revenue, which during its first year was close to BRL 740 thousand, reached BRL 1.75 million in 2013, which value was 100% derived from new products launched in the market. The company can, in fact, be considered as a solutions research and development center, which solutions are then licensed to third parties for manufacture and trade. Hence, the revenue corresponds to investments for development of new products and revenues from licensing of already developed products.

The small technological basis companies and the innovative companies based on new products usually face several



adversities, which include commercial difficulties, typical of the new products, the absence of clients 'in the portfolio' (this means, which have performed prior purchases and thus have overcome the hindrance of the first purchase), the actual new characteristics of the products. Curiously, even when a new product meets a previously existing demand, it might face resistance from the market.



Such resistances have several origins. A natural distrust towards the novelty is always possible: has the product been tested? Will it perform the same operations of the former? Will it be easy to operate? Or demand slow and expensive learning processes? What about strength and durability? In addition, when the purchaser is integrated to a complex, hierarchical organizational structure, a new option has direct risks, being easier to justify a conventional risk than the error of an alternative solution, even if the latter is smaller than the former. To make a mistake towards the convention might result into greater charge.

A second resistance is associated to the innovation's origin – an innovative, new, emerging, startup company has no name, no consolidated brand, no tradition. It has a brief past and an uncertain future, and that puts several uncertainties on the table: Will it be able to render assistance to its products, when that becomes necessary? Will it provide the next generations of the technology, regularly incorporating desired functionalities and required by the actual product when in use?

TOTH resolved most of those problems, typical of an emerging company in the technology area, depending on image and technical relationship, through successful commercial partnership with a company already consolidated in the sector: Lifemed.

Lifemed has annual revenue corresponding to hundreds of million Brazilian Reais, holding, as one of its main assets,

consolidated industrial history and much varied client portfolio. Its history and products portfolio allow the clients to see it as a company inclined to last. Therefore, the partnership represents an opportunity of profits for both companies. On one side, Lifemed has the possibility of continued development of new products, which adds new industrial and commercial opportunities to its portfolio, forming, with other research, development and innovation companies, partners of TOTH, a sort of externalized innovation centers, working in partnership with the contracting company. On the other hand, TOTH overcomes the commercial frailty typical of the emerging companies and is able to center its human resources in the core competencies that are connected to new products development.

2. THE STRATEGY – THE PROJECT ALIGNMENT WITH THE BUSINESS

As a research and development company which revenue is 100% derived from new products, innovation is the heart of the business and guides its strategic planning. Each technology's development flow follows a standard: the idea is generated, its business plan is developed, a funding source is found (economic subvention, FINEP, FAPERGS, CNPq, SEBRAE) and, with that package, partnerships with companies are established. Therefore, the business model is to work in the research and development and, as they do not

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TOTH resolved most of those problems, typical of an emerging company in the technology area, depending on image and technical relationship, through successful commercial partnership.”



have working capital to produce, establish partnerships with companies that will be in charge of the manufacturing area, receiving royalties over the revenues of the ultimate product.

Since the first products, every year new developments have been winners of economic subventions notices to bid, enabling gradual increment of the portfolio. If, on one side, adoption of this fund raising model might demonstrate some frailty, due to the dependency on launching of notices

to bid to continue a certain project, on the other side it has been verified as a successful strategy, mainly when considering the fact of being a young company, without capital for self-financing.

TOTH keeps its view constantly focused on the market, monitoring trends and identifying opportunities. In addition, variety of the developed pieces of equipment reveals also the varied technical structure of its founders and their proximity



with the healthcare system. Installed in the incubator of PUC in Porto Alegre, the company has, among its partners, one physician that has active participation to identify opportunities and to define their proper characterization.

With growth of the business, as the number of development projects increased, the partners identified the need to expand the scope of the work and improve the people/ talents, ideas and creation management. They then decided to begin identifying key persons in the area and integrating them into the team, besides trying to better 'listen' to the surrounding market, in order to systematize the procedures, directing the flow of ideas.

Another demand that indicated the need to perfect the knowledge and innovation process management was the development of projects in cooperation with the university and public funding agencies. In those projects – following the model of triple helix - FINEP released the financial resource, the university was responsible for managing that capital and performing part of the project, TOTH was in charge of performing the other part and the university hospital validated the developed technology. That relation of university-company-funding agencies led to the pursuit of more qualified management.

Thus, the company started to develop management tools and techniques, establish controls for the

development process and systematize the innovation processes, integrating them with the strategic planning. That progressive structuring enabled establishment of innovation and planning nucleus baptized as INOVAR TOTH, which is the innovation management model that will be explored in this chapter.

3. THE PROJECT

Aimed for value generation, the INOVAR nucleus is responsible for management of innovation and it fosters the search for new ideas that might add value to the business and to its collaborators. Several objectives led to creation of the INOVAR TOTH: to keep the innovation management linked to the company's strategic planning; to prospect new technologies, scientific researches and new partners for development of products; to conduct the relation with Universities, Research Centers, Science and Technology Institutes; to systematize knowledge management; to obtain results through defined criteria; to manage an opportunities capturing network; to develop tools to guarantee efficacy of Projects Portfolio Management and to perpetrate the culture of valorization of Innovation.

According to those well-defined objectives, some key processes were identified and systematized, and they are described below.

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The business model is to work in the research and development and, as they do not have working capital to produce, establish partnerships with companies that will be in charge of the manufacturing area, receiving royalties over the revenues of the ultimate product.”



IDEAS MANAGEMENT

The company has two main types of methods to capture ideas:

1. External capture: by visits to fairs inside and outside Brazil (performed by the partners and some employees); to prepare benchmarking; market monitoring (through tools such as the twitter, quickstarter and similar tools), in order to identify technology trends.
2. Internal capture: through annual internal publications to capture and select ideas of employees.

Selection of ideas of the employees is performed by stages: first, the 10 best ideas are selected, which are submitted to verbal explanation by the proponent to the Board of the Inovar, after that, five proposals are selected, and then awarded (awards of BRL 1 thousand per idea), entering a Bank of ideas.

The Bank of ideas is a spreadsheet containing all the ideas that might be developed. The main ideas entered into that spreadsheet are internally generated, but TOTH also prospects ideas with experts in PUC, such as with the head of biomedical engineering, physicians from the hospital and also with physicians from Instituto do Coração in Porto Alegre.

Input of ideas in the Bank is made by filling a form, created following the pattern of the forms used to submit technologies to subvention notices to bid. The form includes:

- Who is the target audience;
- What is the technical feasibility;
- Brief description of the technical demand of the idea;
- What is the area of interest.

To assess and categorize the ideas of the Bank of ideas, a Board has been created. That group is comprised by a fixed nucleus, composed by the partners and a representative of the employees. The Board holds annual or six-month planning meetings to discuss operational and systematic activities, and monthly, with the attendance of physicians, people from clinical engineering and other professions, such as employees of the medical area.

To assess the ideas, the Board has previously established scoring criterion, which measures the impact on the market (possible financial return), innovation level (different in relation to what already exists in the market), technical capacity internally available to perform the idea and the financial feasibility for execution of the idea. All the previously selected and characterized ideas stay in stand by and the

developments advance when compatible funding notices to bid are identified.

PROJECTS MANAGEMENT

Methods based on Open Innovation principles were incorporated, with management tools such as SCRUM and others from the PMI – Project Management Institute. As the company's main products are based on electronic hardware (electronic boards) and software, development of the projects has iterative character and short cycles, which allows performing a retrospective with the project team every month, along the development. Those meetings give rise to reports that record the points for improvement and the main difficulties experienced, which work as lessons learned that have, directly or indirectly, the potential to improve development of a next project.

TALENTS AND COMPETENCIES MANAGEMENT

The company has formal assessment system which measures performance, commitment and generation of new ideas. All the employees participate in the results, proportionally to their salaries towards global accomplishment of the annual targets. The employees involved in products development further participate in the results from the sales of those products

through royalties. In addition, the ones with prominent performance might be granted scholarships for specialization or master degree courses.

The company tries to maintain a stimulating environment to drive the employees' innovative thinking. With a system inspired in Google's model, it implemented an entertainment room (interaction), flexible working hours and the possibility of working in the projects with the professionals have more affinity.

Yet focusing on creation of an environment that favors creativity and innovation, TOTH created the TechDay. It is a half-year event for exploration of knowledge, seeking to complement the employees' education. During that day an employee, client, physician, healthcare area engineer or even a supplier makes a presentation to all the employees regarding a specific subject, previously elected.





4. INTERNATIONAL SCENARIO

The industry of medical equipment covers a broad variety of products used in patients' treatment. It includes cardiovascular devices, dentistry equipment, diagnosis equipment, medical equipment and supplies, ophthalmologic, orthopedic, respiratory devices and surgical equipment. The United States hold the leadership of the sector due to the next-generation technological innovation and the demand of the emerging markets such as China and India. The industry, as a whole, has been growing due to aging of the population and increase of the environmental risk factors. In special, chronic diseases related to the diet, such as cardiovascular diseases and diabetes, continue to increase the world demand for medical products and services.¹

In special, the global industry of cardiovascular devices is experiencing fast growth and shows signs that it will continue to evolve and expand, reaching US\$ 97 billion until 2015 (going from approximately US\$ 85 billion in 2010). This growth is largely the result from several health problems related to the heart that are exponentially increasing across the world: more than 80 million people suffer from cardiovascular diseases in the world, according to the

1 CLEARWATER; IMAP. Medical Equipment and Supplies Report 2013: a clearwater healthcare team report. [S.l.: s.n.], 2012.

American Heart Association, with more than 17 million deaths every year.

Cardiac diseases are one of the main causes of death in the world, which motivates governments and investors to fund research and development of cardiovascular devices.²

In 2008, and in the subsequent years, likewise what happened to most of the industries, the sector of medical devices suffered the impacts of the economic crisis. In particular, the small companies, which until then paid for the products developments with capital from venture capital investors – now more reserved in the post-crisis – were obliged to restrict their activities. Some other small ones, however, elected to merge with the large ones, thus continuing the technological advances without having to bear the total burden of the cost. A strategy, to a certain extent, similar to the one adopted by TOTH in its business model, when developing products in partnership with its clients. National and international mergers and acquisitions allowed sharing of resources and knowledge, facilitating continuous innovation of medical technology.³

2 Available at: <<http://www.who.int/mediacentre/factsheets/fs317/en/>>. Access on: September 19th, 2014.

3 Available at: <<http://www.reportlinker.com/ci02249/Medical-Devices.html>>. Access on: September 9th, 2014.

5. RESULTS FOR THE COMPANY

Professionalization of innovation management, by implementation of the INOVAR TOTH, generated the following main results:

- Delivery of projects with better technical quality to the clients;
- Reduction of the period for development of the ideas;
- Greater capturing of ideas.

The better structuring of the projects also had positive impact on systematization of the procedures for prospecting of financial resources, through economic subvention notices to bid, which are important contributions aimed for the development of new products. Today, 25% of the total from more than BRL 1.5 million invested annually in research and development comes from those notices to bid.

The Inovar project received two awards, which granted more visibility to the company and contact with potential partners and clients:

- FINEP Innovation Award 2012, in the Micro and Small Company, during the regional stage;





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The good internal structure, implementation of the Innovation Nucleus also play an important part in TOTH's perspective of expanding its activities, as it demonstrates its maturity and grants credibility to a young, but very promising company.”

- Brazilian Innovation Award 2013, promoted by the Brazilian Industry Confederation – CNI and by SEBRAE, as the small company with the most innovative Innovation Management System in the country.

6. OUTCOMES AND PERSPECTIVES

Many ideas captured by INOVAR have become projects that were winners in subvention notices to bid and generated new products for the company's portfolio:

- Capnogram⁴– first equipment of the kind developed in Brazil;
- Lifeschock Pro – first defibrillator with touch screen technology;
- DEA – defibrillator for places with large circulation of people with intelligent algorithm to detect cardiac arrest;
- Sixth Sense – system of remote monitoring for elders in watch or necklace format;

4 Capnogram is a device that monitors the carbon dioxide inhaled and exhaled by the patient during surgeries. Source: <http://www.capnography.com/new/capnography-introduction/definitions>



- Gases and anesthetics monitor – first gases analyzer with national technology.

For the next years, TOTH plans to replicate to other markets the model of products and technologies creation and development in partnership with large players, which is currently adopted for the medical equipment segment.

The strategy of partnership with key companies of each segment guarantees fast entrance in the markets to the business, and that is what enabled the company's establishment as technology provider in the medical area, clearly controlled by large multinational companies. The good internal structure, implementation of the Innovation Nucleus also play an important part in TOTH's perspective of expanding its activities, as it demonstrates its maturity and grants credibility to a young, but very promising company.



TOTVS **19**

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THE STIMULI TO INNOVATE ARE EVERYWHERE: TOTVS' LEARNING TO BECOME A GLOBAL COMPANY



Being on the top might be a very challenging condition. To reach a level of excellence and remain there, it is not enough just to follow the state-of-the-art. It is necessary to build it, define it, to be one step ahead. For TOTVS, it was crucial to go beyond the borders of Brazil to seek new visions, realities and necessities. The company knows that to keep itself competitive and grow in a market disputed by giants it is necessary to constantly innovate and therefore it is essential to seek the drivers, experiences and new stimuli in the four corners of the world. Its internationalization path

includes this and other important lessons for the national companies that, traditionally, consider that the Brazilian hugeness and diversity are enough to guarantee their future existence. Irrespective of Brazil's broadness, in a gradually globalized world and with increasingly shortened distances, the companies' competitiveness will be every day more and more associated to their presence in the world.

1. THE COMPANY AND ITS SECTOR

The segment of software for corporate management or ERP – acronym for Enterprise Resource Planning – is one of the software industries segments where Brazilian companies are prominent. And, an important part of that distinction has to be ascribed to TOTVS.



The ERP may be defined as a framework for organizing, defining, and standardizing the business processes necessary to effectively plan and control an organization so the organization can use its internal knowledge to seek external advantage¹.

The ERP itself has precedents in much more specific software - such as the ROP (Reorder Point), MPC (Manufacturing Planning and Control), MRP (Material Requirements Planning). However, probably the beginning of a system as it is currently known would be related to the five engineers who, in 1972, established in Germany (Mannheim) the *Systemanalyse und Programmentwicklung*, which became internationally known as SAP. With short intervals, other large companies of that segment appeared: Lawson Software (1975), J.D.Edwards (1977), Oracle (also 1977) and Baan Corporation (1978).

Created in 1983, TOTVS (then named Microsiga) combined organic growth with acquisitions (Datasul and RM Sistemas, among the main ones) which raised it to a superior category of business management software companies: leader in Brazil and in Latin America. Until today, the company uses acquisitions to expand its array of competencies, to assimilate new knowledge and quickly enter new segments.

1 " Available at: <<http://www.apics.org>>. Access on: November13th, 2014.

The company started a new phase of its strategy after the 2000's, when, besides developing the ERP to its clients, it started to specialize it by segment. By doing that, the company is able to assign special attention also to the essence of the clients' businesses, integrated with the administrative-financial management.

According to the sources of the business press, in 2013 only, TOTVS purchased five new companies (PC Sistemas, PRX, RMS, Seventeen and Ciashop)². The outcome of that expansion process is a Brazilian company leader in the creation and implementation of solutions for the most diversified types of companies, in ten business segments (the so called vertical ones). Each new vertical segment corresponds to the possibility of conquering and attaining fidelity of new clients from specific economic sectors; and that sectorial specialization is what helps to explain the possibility of combining, with technical and economic efficiency, the company's performance in such different business areas.

The company considered, in several opportunities, going to the international market. It learned, not without expenditures and unhappiness, that even the closest markets are not necessarily easy, and any international

2 Available at: <<http://www.totvs.com>>. Access on: November13th, 2014.



expansion requires well-grounded strategy, familiarity with the local realities, capable of facing the challenges of diversity in one of the most idiosyncratic dimensions of the social life: the way of doing business. Even when they seem easy to learn, the local habits, the personal elements, the written and implied rules, all that represents a huge challenge. And in that field, Brazil is – with rare exceptions – a newcomer. Confident of its huge and dynamic internal market, in Brazil the competency to go international has always been restrained and evidenced very modest development. External sales are traditional and incorporated into the economy and into the industry, but the internationalization is a much more complex phenomenon than the exports. In the case of the software, exports occur only in packs; and TOTVS' systems that run on proprietary platform, are complemented by services layers such as implementation, customization, cloud and consulting, which adjust the products and services according to the clients' needs.

After attaining that understanding, the company dedicated itself to structuring of its international business, going to Latin America. In course, the project already presents very attractive results. That is the project discussed in the following pages: the design and implementation of an innovative international expansion strategy, defined and implemented to assure the competitive position beyond the Brazilian territory.

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The company has intensely used the commercial partnership composition instruments to assure its sales growth.”

2. THE STRATEGY – THE PROJECT ALIGNMENT WITH THE BUSINESS

The company has intensely used the commercial partnership composition instruments to assure its sales growth. The expansion based only on its own resources (human, financial, commercial) would inevitably be slower. It would also be subject to more obstacles than an expansion grounded on partnerships that incorporate, at each step, local competencies of professionals and companies, familiar with the markets, users and their demands and necessities.



That is how it built a broad franchised network, increasingly qualified in its tools and by which the company, on its turn, assimilates the commercial knowledge and the networking of those new partners. That is, clearly, one of TOTVS' fortresses.

The position attained in the Brazilian market is solid, but it is far from being unshakable. No position, irrespective of how assured it is or seems to be, is immune to competition and to the dynamic effects of changes. Even companies holding leadership positions need to anticipate changes. And the best way to anticipate changes, to use a well-known and valuable jargon, is to lead those changes.

TOTVS' competitors are mainly large international companies – Microsoft, Oracle, SAP. Each one of those companies has assets from very intense internationalization and counted, during such process, on the knowledge inherited from economic systems that have been in international expansion for a long time.

TOTVS has a client portfolio diversified both in size and in areas of activity – a number that totals 26 thousand in the main ERP segment. Its distributors network serves about 38 thousand medical clinics and private practices, 10 thousand small shops and retailers and more than 6.5 thousand small industries and service providers, being leader in the small and medium companies segment. It is also leader in some important segments of the Brazilian industry and economy: approximately 60% of the sugar-cane harvest in Brazil is

controlled by its systems. The company serves, yet, more than 700 education institutions. On the top of the pyramid, it is present in 27% of the companies listed in BM&FBovespa³ and in more than 46% of the Latin-American companies awarded for excellence in corporate governance.

The areas of activity are varied and they reflect the flow of acquisitions that were aimed at the company's growth and multiplication of markets and channels. Orthogonally to those several market areas wherein it is present, the company is especially dedicated to the segment of small and medium companies and, hence, occupies a large market gap that has been historically neglected by the giant competitors.

According to a survey published in April, 2014, by the São Paulo Business Administration Applied Information Technology Center of Fundação Getúlio Vargas (FGV-EASP)⁴, the market of ERPs in Brazil is disputed by five main competitors: TOTVS, SAP, Oracle, Infor, QAD, Senior and StarSoft.

Between 2013 and 2014, FGV interviewed 2.3 thousand Brazilian medium and large companies, which corresponds to 68% of the largest companies in the country. The survey separated the companies and market shares by the size,

3 Available at: <<http://www.ey.com/BR/pt/Home>>. Access on: November 12th, 2014.

4 MEIRELLES, F. S.. Pesquisa Anual CIA, FGV-EAESP. 25 ed. [S.l.: s.n.], 2014.



represented by the quantity of keyboards (workstations). According to the published results, the market was distributed according to the following table.

Table 1 - Participation of ERP suppliers in Brazilian companies according to the amount of work stations

Supplier	Total Share	Companies with up to 170 keyboards	Companies with 170 to 700 keyboards	Companies with more than 700 keyboards
TOTVS	37%	52%	41%	20%
SAP	30%	9%	24%	52%
Oracle	16%	9%	17%	21%
Others	17%	30%	18%	7%

Source: Meirelles, F. S.. Pesquisa Anual CIA, FGV-EAESP, 25a edição, 2014

TOTVS' figures demonstrate versatility unmatched by the American and German competitors, being capable of, at the same time, controlling the layers of smaller companies and offering strong competition to the larger size layer, equivalent to Oracle.

The results are the direct results from the companies' business models. TOTVS, since the beginning, focused on the segment of small and medium companies while Infor, Oracle and SAP adopted the strategy of disputing the market of the large companies. However, those companies have already noticed that, to continue growing, they will have to focus on less explored and less decided markets – all the large companies have already made their choices and they

have solutions implemented and deeply tied up in their entire process, productive and personnel structure.

In light of that new view, the Brazilian company knows that the apparent peace in dispute of its small and medium companies' niche will not last. Its international expansion strategy is aligned with that outlook and complies with three complementary objectives. First, it serves to follow-up the Brazilian clients in their natural paths of expansion. There are many Brazilian companies that look around and wish to expand to other countries, starting by the region, by Latin America. Although Brazil has large dimensions and is an extremely attractive market, its economy represents just a small fraction of the world economy; and progressively the companies, from all sectors, notice the fact that the economic dynamics of past times helped to maintain in the background. The recent growth of the region economies at rates above those of the Brazilian economy shall further reinforce the trend for going international of the Brazilian companies and, hence, strengthen the movement towards those markets.

The second factor that explains the business growth towards external markets is the construction of new sources of learning. Integration of new elements, typical of other realities, of new ways to conceive and implement business and new operational segments constitute, in all cases, opportunities for growth with diversification. By means of operating in other

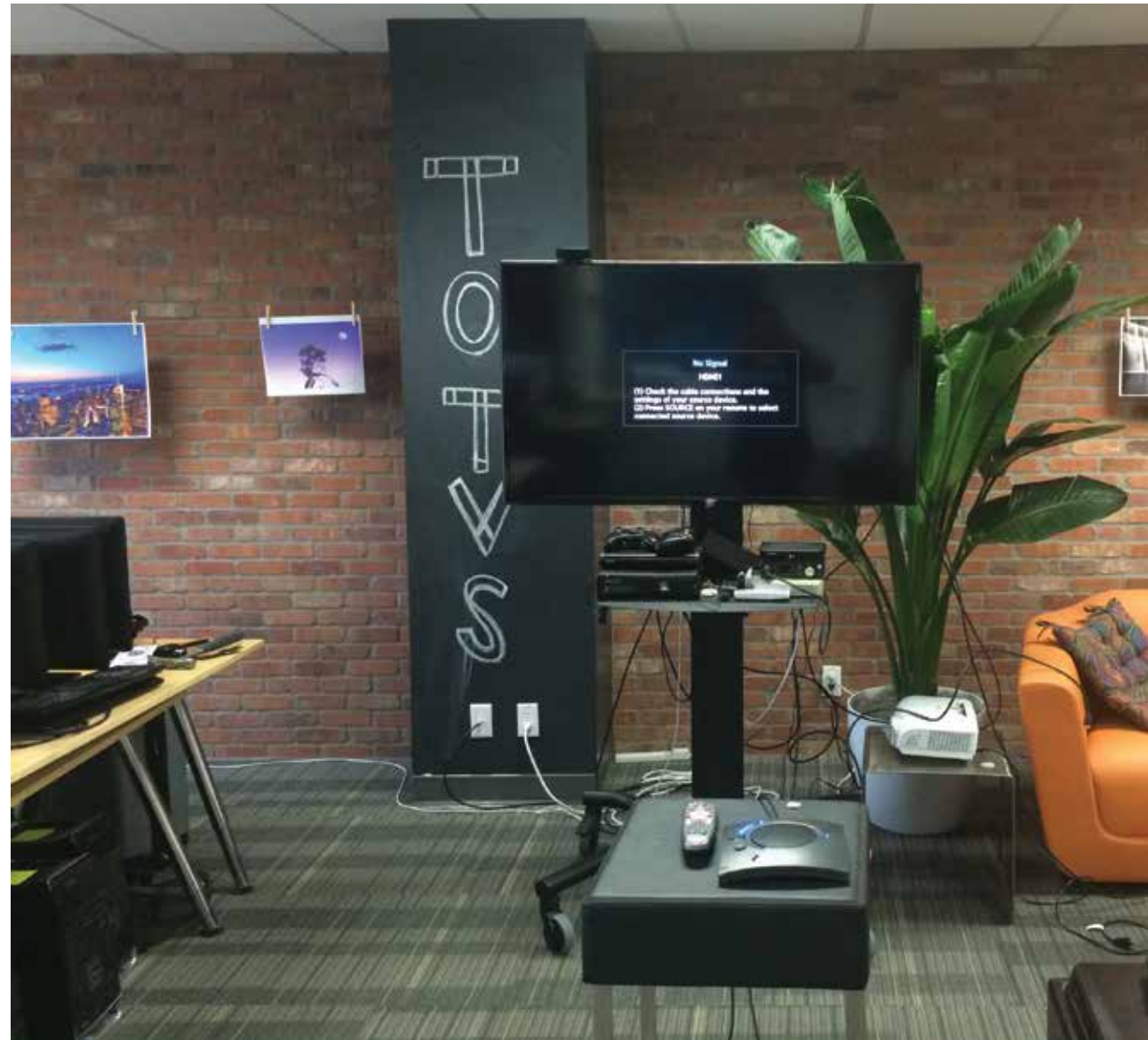
countries and assimilating elements from other business cultures, the company is able also to conquer the clients that eventually expand from those countries towards Brazil.

Last, but not least, the international challenges serve to nurture its set of technologies and business models with challenges and responses that help to strengthen its competitive basis, its corporate vitality, its perspectives. And here is the main determinant element for the company's international expansion: the strengthening of its competitiveness.

3. THE PROJECT

TOTVS' current international expansion cycle had predecessors which results fell, at those instances, behind the expectations. The first movement of the then named Microsig for internationalization occurred in Argentina, in 1997. During those initial years and attempts, a lot of lessons were learned, mainly due to the insufficient experience and the relative isolation of its strategy. The company missed other Brazilian companies, under similar conditions, to interchange ideas and experience – a feeling that the ones facing the new and opening paths necessarily have to live with.

Likewise what happened to many Brazilian companies, it started its path towards internationalization pushed by





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its clients' movement in that direction. In 1997, fourteen years after its foundation, due to the economic situation of Latin America and Argentina and the expansion of Brazilian companies towards that market, the company decided that it was necessary to support its clients that were entering that country. At that time, the means assigned for the mission were insufficient and two analysts sent to the neighboring country with the duty of making the product of (then) Microsiga "emerge" could not accomplish the intended results, but the event served as source of learning. And that learning, in a company capable of learning, serves as supply for other processes and new attempts.

After that initial attempt in 1997, Microsiga opened a subsidiary in Argentina. In the following years, between 1997 and 2003, the company opened channels in Chile, in Paraguay and in Uruguay. Between 2003 and 2004 it purchased the Mexican company Sipros and created Microsiga México. Querétaro was the place elected to host the product development and localization center for the international market. Between the years 2004 and 2006 channels were opened in Puerto Rico and in Colombia. With the purchase of the competitor RM Sistemas, in 2007, it attached a business unit in Portugal and created EuroTOTVS also based in that country. In the following year, in 2008, it opened a channel in Angola, subordinated to the Portuguese unit. By the end of 2010, it created the TOTVS LABS, in the Silicon Valley (USA), a Research and Innovation Center



working in projects of high impact for the company. In 2011, a channel was opened in Peru.⁵

The company's strategy of activities' segmentation for some sectors of the Latin-American market was also implemented in the new operations. Therefore, it focused on offering specialized solutions for Retail, Services, Agroindustry, Construction and Projects, Manufacture and Distribution & Logistics.

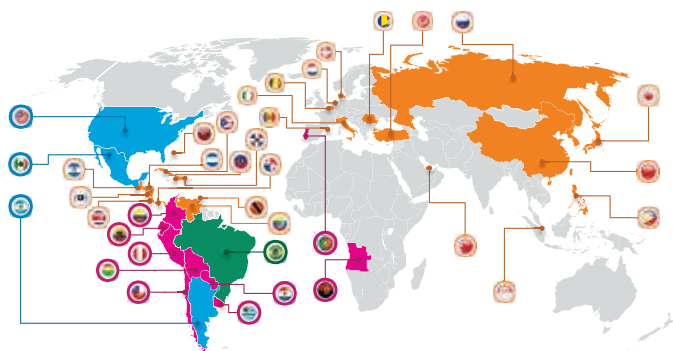
Adoption of the channels model, although having some similarities with the partnership model of Oracle and

5 Available at: <http://www.anpad.org.br/admin/pdf/2012_EPQ682.pdf>. Access on: November 13th, 2014.

SAP, is an innovation in this market. The model includes transfer of know-how and collaboration between franchiser and franchisee since the signature of the agreement and constitution of the new business. That allows the company to capture entrepreneurs in the market, with energy and capital that enhance its reach and distribution.

The figure below illustrates TOTVS' presence in the world.

Figure 1 - Illustrative map of the countries that TOTVS has local presence



Source: TOTVS' presentation to CNI (2014)

The internal examination of the former essays revealed the factors that impeded accomplishment of the results intended by the internationalization without, however, questioning the company's internationalization rationale, which continued to be seen as crucial. The main factor is associated to the perception that the external environments could be assimilated in essence according to a simple

translation of the Brazilian environment, requiring just topical minor adaptations. It is also possible that the insufficient international experience of the Brazilian companies in general is in the origin of the understanding the difficulties. In addition, it is understandable that the excitement produced by TOTVS' extraordinary performance and its success in the Brazilian market have impaired viewing the difficulties existing in other environments.

Differently from what had happened in prior expansion episodes, in this stage the company dedicated itself to paving the land by planning the actions and the adequate people to perform them. That already meant the capacity of providing itself with the proper means to face the challenges of the new projects. Clearly, a valuable lesson from the former episodes. The internationalization project in its current phase involved also a road map on the future product in the five segments of specialized activity, performing a process of sectorial segmentation of the management software products, with functionalities that are increasingly more linked to the business types.

The learning associated to the internationalization process has several components. The first one lies on the recognition of the actual importance of promoting expansion towards other markets, despite the involved risks. The second one involves execution. And, naturally, there is a special chapter: the election of people. How to choose the right people? This



challenge is verified in every organization, for any leadership role, being even worse in the case of international operation: by the nature of the process itself, of distant geography, people have to perform roles that are still under construction, which will be performed far and without possibility of monitoring by the parent company. How to combine internal resources, known, tested, predictable, with the external ones, necessary, holding essential additional competencies? How to combine the competencies developed in Brazil and for the Brazilian market, clearly a core asset of the company and a foundation of its international strategy, with the competency and humbleness to, actually, learn in other sites, other environments, where other business rules and other business practices are in effect? None of those questions is irrelevant. And, to face them, TOTVS mobilized the best of its business energy and its entrepreneur and innovative spirit.

4. INTERNATIONAL SCENARIO

The global market of management software (ERP) was estimated to be US\$ 25.4 billion in 2013, according to surveys published by Gartner^{6, 7}. The growth recorded in that year was

just 3.8%. Although very small, it was higher than the former year's growth, just 2.2%. However, that growth rate is not sufficient to support the huge and complicated expenditures structures of the leader companies of that market.

On one side, the small growth of the global market does not affect so intensely the large suppliers of ERP in the short term, as the main revenues from the total majority of those companies comes from maintenance, update and support agreements. However, that scenario opens windows of opportunity for small suppliers to blossom, innovating in market niches where the large companies cannot enter so quickly. Those new products conquer market shares that otherwise would increase the large producer's share.

The survey showed that SAP continues to be world leader in the segment. The world leader, of German origin, is followed by Oracle. TOTVS appears in that list as one of the largest companies of the world and market leader in Latin America, tied up with Concur. The remaining are spread among competitors with smaller shares. The remaining 37% are spread among competitors with smaller shares. Those figures show an important fact about TOTVS and its leadership position: second just to the large global companies and excelling companies from markets larger than the Brazilian market.

6 Available at: <<https://www.gartner.com/doc/2477517>>. Access on: November 14th, 2014.

7 Available at: <<https://www.gartner.com/doc/2477517>>. Access on: November 14th, 2014.

Some solution providers displaying notorious growth were Workday, Workforce Software, Cornerstone OnDemand and NetSuite. In common, all the five have the cloud computing platform and fast product delivery – ERPs are traditionally associated to long and expensive implementation projects. Simple products, with more modern user interface, with better information and tasks flow, which enable and incentive more collaboration across the users are necessary to meet the desires of a whole new generation of professionals, born on the age of the Internet and social networks. The suppliers that have been matching those expectations (impatience towards slow results) are experiencing high growth rates in the market layer where those requisites have higher relevance.

That movement, added to the fact that the maturing process of the main solutions has made them very similar to one another, starts to force the large solution provider companies to reinvent their products, to invest more in innovation and to accelerate the creation of new solutions.

5. RESULTS FOR THE COMPANY

The company's international expansion generates several benefits and it shall produce even more benefits when it is consolidated and attains larger volume in the company's operations. The first and main one relates to the company's image. The image in the subjective sense, with valorization

of the fact of being a company present in other markets and, therefore, capable of following-up the clients in their expansion paths. Even clients still distant from that path can recognize, in it, a forecast of their expected (or desired) future and thus can recognize themselves in it, contributing for its election as services provider or for the loyalty.

The market growth for the TOTVS products shall be, abroad, faster than the growth in Brazil. The basic reason is that the diffusion rate of the typical products in those markets is lower than the one verified in the Brazilian market.

The internationalization also produces interesting effects that nurture the company with new solutions for its core market. The company is bringing to its Brazilian clients the learning of best practices and processes in the world. One example is the exchange of knowledge and experience in certain segments of specialization of the company verified in all the markets where the company operates. So, the internationalization process, by approaching its solutions to what exists in the state-of-the-art, contributes for its thousands of Brazilian clients to become more efficient, more global, more mature. This example shows, once more, that the process of internationalization – and TOTVS' in particular – is much more than an expansion of its market limits. The internationalization represents a dynamic process, a lesson, a virtuous cycle of reinforcement and formation of new competencies, within the company's value chain and of the

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The internationalization process, by approaching its solutions to what exists in the state-of-the-art, contributes for its thousands of Brazilian clients to become more efficient.”





company's connection with its clients. Therefore, innovation associated to internationalization is unfolded into innovations in several chains and enables the horizontal character of the software to become a source for increase of the productivity and enrichment between different countries.

6. OUTCOMES OF THE PROJECT AND PERSPECTIVES

The process of internationalization has been making the company more competitive. The difficulties previously verified resulted into lessons and maturity. Looking backwards, the company understands the limitations of its own former approach to become international. But, since 2011, TOTVS has been taking much more adequate steps, strategically considered, in light of what it has learned, with less impetuosity, without underestimating challenges, operationally detailing the actions performed by specially selected individuals. The summary of that experience and learning by its executives can be divided into four groups of lessons.

Software localization involves much more than the mere translation of screens and messages into another language, as it attains peculiarities and regional features of each country and culture. Depending on the culture, even the colors attain different meanings and uses.

Another important matter involves the physical, legal and tax structure of each country. The Brazilian product, as any country's product, might not operate properly in other contexts with minor adequacies. Despite being rich, the Brazilian reality did not lead to an evolution of the product at its core included the flexibility necessary to absorb and enable coexistence of such variety of particular features, formulas, flows and respective consequences. That could only happen by the shock of the new realities. Also, the business rules embedded in the product still need to be understood, analyzed and adjusted to each new country's reality intended for the product. That requires huge effort from teams of analysis that know deeply not only the country, but the product as well. Another feature of that environment is the business practices not documented in the country's laws, but which are essential for working in that different environment.

One of the most important results of the internationalization process was the development of the product's architecture based on the actual necessities identified as a result of facing different demands, from different companies, in different parts of the world. The incremental and evolving construction of a flexible and adaptive product, capable of absorbing new realities, scenarios, practices, specificities, rules and cultural contexts, in practice, is only possible after exposition to those elements.



It is not possible to advance abroad without having the backup of those who stay in the headquarters assuring that the necessities and surprises found outside, by the front line, will be faced and overcome. During a period when the company did not have the necessary and adequate size to cope with the presented challenges, the offshore operations competed with the domestic operations and due to the distances and communication difficulties, it was a natural fact that the international operations were not

fully served. TOTVS created an area, with redundancies, mirroring the structure of the other areas to render exclusive support to the offshore operations.

Today, the company knows how to follow its international path with high security level. The foundations were and continue to be launched to become a global company. Its presence in each country always counts with more than one channel, as redundancy is the only way to expand efficiency of channels abroad. The company is heading towards having its role in a position it refers to as "Top Americas".

Internationalization is far from being a simple process or a modified extension of a company's business strategy. That applies to all the companies, including the successful ones and the leaders in their markets. The case of the international expansion presented here is an important source of learning for the Brazilian companies willing to follow that path.

More than a mere expansion of the markets served by the company, the innovative elements of that strategy reinforce its competencies and capacities to expand its horizons and strengthen its competitive capacities.



VALE

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INNOVATIONS THAT ENABLED THE ECONOMIC, ENVIRONMENTAL AND SOCIAL DIMENSIONS FOR CONSTRUCTION OF THE LARGEST IRON ORE EXTRACTION PROJECT IN THE WORLD

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How Vale reconsidered mining to become environmentally and socially sustainable and capable of assuring its competitive global presence

Mining is one of the civilization's pillar activities, providing, to the transformation means, the material that evolved along technology and enabled advance of the society's material consumption and life quality. Despite its condition of being essential to human existence, there are important restrictions to the mining activities, derived from the environmental and social impacts caused by extraction of non-renewable natural resources. Along its more than 70 years history, Vale has been developing its activities with incremental efficiency, with highlight to its commitment with the environment and society.



The project to explore a new iron mine in the Southeast of the State of Pará is a landmark for the company and for the sector as a whole. The know-how accrued in 30 years of activities in Carajás, added to its international experience, enabled Vale to use innovative technologies for extraction of iron. Yet under implementation phase and expected to start production in 2016, the S11D Project is today the largest project in the iron industry worldwide. With this new concept, Vale has been able to drastically reduce the need of deforestation in the vicinities of the mine, as well as use of water and emissions of carbon



dioxide (CO₂). Another significant effort was the application of more structured logistics, generating more efficiency in its process to outflow the production.

1. THE COMPANY AND ITS SECTOR

Vale is one of the largest private companies in Brazil and one of the main mining companies in the world. Established in the State of Minas Gerais (in 1942), under

the name of Companhia Vale do Rio Doce, currently named only as Vale, it is a global company, operating in nearly 30 countries in the five continents. Along its history, it became the largest iron ore producer in the world and the second largest of nickel, besides producing copper, manganese, iron alloys, coal, fertilizers and metals of the platinum group¹.

In Brazil, the company has activities in 13 States, which makes logistics to be an essential area for Vale, as it has high impact on its costs and, obviously, on its competitiveness. In Brazil, it also has nine port terminals and operates a railway system that exceeds ten thousand kilometers. Vale's activity is strongly linked to the natural resources and logistics integrating different transportation means.

Vale's contribution to the Brazilian balance of trade depicts its relevance in the global scenario: the company accounts for 10.2% of the values of all the Brazilian exports, considering just the sale of iron ore².

The company has a singular characteristic which is also a measure of its level of development: it is strongly

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- 1 VALE. *Projeto Ferro Carajás S11D: um novo impulso ao desenvolvimento sustentável do Brasil*. [S.l.: s.n.], 2013.
 - 2 Available at: <<http://www.vale.com/PT/aboutvale/across-world/Paginas/default.aspx>>. Access on: January 26th, 2015.



internationalized for the Brazilian standards, even when compared to other large companies. That is evidenced either in terms of exports or by its participation in production of other mineral bases, both in developed countries (such as Canada and Australia) and in new regions under development (such as Mozambique). Vale is, therefore, a Brazilian company with global action.

Vale's investment in the project for expansion of Carajás tried to mitigate all sorts of adversities typical of the large projects and restrictions presented by the regulatory activities. In absolute figures, Vale's investment is superlative: US\$ 20 billion. Evidently, such an investment, after so many years when the original investment was made in Carajás, would be hardly made under the same basis and it required the company to mobilize its best competencies. It represents an extraordinary opportunity to use the past experience in enhancing the processes, introducing incremental improvements and some totally new concepts, so new that those processes can, in certain cases, be granted intellectual property protection. This book depicts the innovative characteristics of Vale's expansion project in Canaã dos Carajás. The company intends to substantially increase the productive capacity in the Northern region through a totally new project, different from the one implemented in the 80's. In summary, besides the learning accrued along the three decades elapsed since the opening of the Carajás' mine,

Vale developed and accumulated many competencies, the result from its business history in Brazil and its acquisitions offshore. By each new enterprise, in all of its projects, new knowledge has enriched the company. Such variety of knowledge serves as the foundations for the innovative project built by Vale to expand its production.

2. THE PROJECT ALIGNMENT WITH VALE'S BUSINESS

The S11D project is Vale's bold investment to build its future as a global mining company, which market is disputed with other large companies that have the competitive advantage of location – they are established close to China, currently the largest consumer of iron ore in the world. The distance between Brazil and China, for instance, is much larger than Australia's distance, where Vale's main competitors are located. It is more than 11 thousand nautical miles separating Brazil from that country, while Australia is less than 3 thousand miles distant.

Maintenance of Vale's competitiveness requires that its advantage derived from the superior ore quality is not nullified by natural disadvantages of geography and much less by the costs of transportation or investments. The recent experience shows that the costs of investment in Brazil can be much higher and suffer the risks of being encumbered by exceptional

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events occurring in the works³. How to face the challenges of a large project under conditions of environmental protection and space sustainability of the territories? How to avoid, in a project that involves thousands of workers and a broad geography, occurrence of problems that have been making management of the new projects a process surrounded by uncertainties, risks, unforeseen events and vulnerabilities? How to guarantee shorter distance between execution and planning? How to assure that the project will meet all the environmental requirements and, more than that, reaffirm the company's commitment with the sustainable development? Vale's answers resulted into an innovative project, developed from the beginning to the end on new basis, with the best competencies of a Brazilian company of global presence.

3. THE PROJECT

The project depicted in this chapter addresses expansion of the iron ore extraction and betterment activity located in the city of Canaã dos Carajás, State of Pará. This region also includes the Carajás Mining Hub, in operation since 1985 in Parauapebas (adjacent to Canaã dos Carajás – see map in Figure bellow).

³ A recent study from the Studies for Industrial Development Institute (IEDI) shows that investment in Brazil can be more expensive than in many countries, sometimes by an extremely high margin.

Figure 1 - Location of the facilities of S11D Carajás Iron Project



Source: VALE. Projeto Ferro Carajás S11D: um novo impulso ao desenvolvimento sustentável do Brasil. [S.l.: s.n.], 2013.

In Carajás, Vale currently operates, simultaneously, four open air iron mines – there is also another phase of *opening* in the mining jargon. The hub is the largest producer of iron ore in the planet. That site holds a high quality (with more than 65% iron content) and low concentration of impurities product, which represents important competitive advantages.



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The S11D Project will provide 90 million metric tons of iron ore per year. When it has full capacity, Vale’s total production in Pará is supposed to reach 230 million tons per year (production volume more than twice the 2011 production volume, which peak was 110 million tons). In order to accomplish that condition, the project investments amount of US\$ 20 billion. From that amount, approximately 40% will be assigned for the mine and for the plant and 60% for logistic infrastructure. It is a core project for Vale to maintain and strengthen its competitive position in the global iron ore market and in the global mining industry.

The time for implementation of the current project shall be shorter than the former project. The international competitiveness of the projects, associated to a strict control of the assigned costs, times and capital demand from Vale – and from any company that wants to be competitive – great efforts that are even more essential in the current times.

The project is the outcome from five years of environmental and engineering studies. Its development included technical teams from Brazil, Canada and Australia and gathered all of Vale’s know-how of mining in Carajás and of its operations in other countries. The gathering of competencies from different teams, located at different sites of the world and working in diversified physical and regulatory environments, helped Vale to gather the best of the actual possibilities and to create new business solutions. The project also follows

the company’s *Policy on Sustainable Development*, aligned with global initiatives, such as the United Nations Pact, the Brazilian Mining and Metals Council and the Global Forum on Mining Industry Sustainability.

The experience of Vale’s more than three decades of activities in Carajás and the use of next-generation technologies and efficient productive systems put the S11D Project at operational excellence level in iron ore extraction and betterment. Its innovations guarantee, simultaneously, lower environmental impact and also lower impact on the surrounding communities, along with more competitiveness. That is not, obviously, an equation easy to face and simple to resolve. The new mine, located inside an environmental preservation unit, the Carajás National Forest, can only attain the licenses required for its exploration through a project that recognizes the needs of new concepts and innovative solutions.

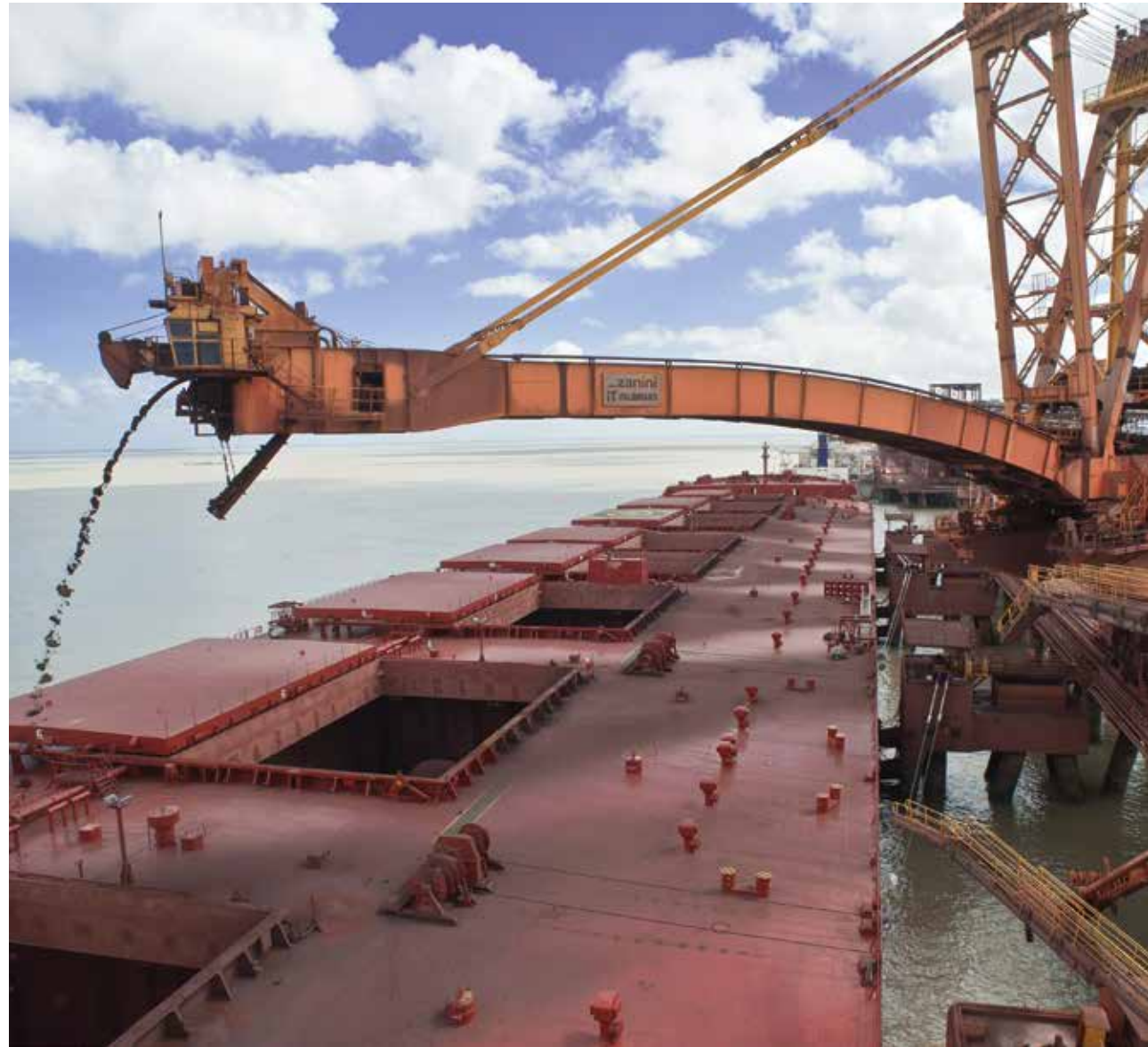
The summary of the expected project results which implementation is in progress shows, in various important basic indicators, great advantages in relation to the traditional methods in progress: saving of 93% in water consumption, 77% in use of fuels and 50% in emission of greenhouse effect gases. But not only those basic indicators experienced important changes. As one outcome of the guidelines aiming to mitigate the environmental and social impacts, it has been defined to implement the processing plant and all the industrial facilities of the project in areas previously

occupied by pastures activities, located outside the Carajás National Forest. Because of that, the impact of the mineral operation was limited to the area of the mine and all the other (processing) operations were displaced to a secondary area, previously occupied by other activities.

Likewise in other mines of Carajás Mining Hub, the S11D Project uses the open air excavation system. This system, typical of the mining activities in Brazil, presents some advantages compared to underground extraction, used in many other countries⁴: lower cost of production, facility of supervision, better work conditions and reduced risks for the workers.

The basic concept to be implemented in the new mine consists of an innovation that will be used in Brazil and in the iron ore for the first time, added by new developments introduced by Vale. The mine excavation operation is performed by a system that uses a technology named as in-pit crushing and conveying, also known as truckless. The ore is removed from the site through conveyors that transport it to the processing area. If the S11D project followed the conventional mining line, it would be necessary to have about 100 trucks out of the road for its operation. One hundred trucks with the dimensions used in this size of mines have high fixed costs,

⁴ Some mines in Brazil use this excavation system. Vale itself uses this system in its potassium mine in Sergipe.





operational costs and environmental costs. Those trucks will be replaced by conveyor belts systems that cover 37 kilometers distance in the mine itself and other ten kilometers between the mine and the betterment plant.

INNOVATIVE SOLUTIONS TO FACE THE ENVIRONMENTAL CHALLENGES

Once started up, the S11D Project will observe several procedures aimed at mitigating environmental impacts. The concern to reduce the impacts started with the location elected for the iron ore enhancement plant: an area already anthropized (with human being's interference) and outside Carajás National Forest, which will avoid the deforestation.

With the same purpose of mitigating the impact on the forest, 70% of the railway branch that will take the production up to the Carajás Railway will also be constructed in a pasture area that has long ago replaced the original forest. In the section where the railway shall pass within the limits of the conservation unit, a tunnel and a bridge will be built to avoid direct impacts on the flora and on the fauna, with additional BRL 200 million investments.

With the commitment of 'reducing the demand for new water in the operations, through new or current technologies', the

enhancement process will use natural humidity, enabling 93% reduction in consumption of water, compared to the conventional process. In addition, 86% of the water captured in Vale's facilities will be reused.

The project will also contribute to Vale's global commitment towards reducing by 50% its emissions of greenhouse effect gases projected for 2020. Three measures were taken in that sense. The one with the greater impact is the adoption of the truckless system for transportation of ore from the mine to the plant. Instead of trucks, 37 kilometers of conveyor belts will perform that duty. The replacement, besides reducing the quantity of waste such as tires, filters and lubricants, will enable 77% reduction of diesel consumption.

When compared to the conventional systems, the truckless and the enhancement of the ore by natural humidity will enable reducing by 50% the emissions of greenhouse effect gases (GEE) or the equivalent to 118 thousand tons of CO₂ per year.

The main equipment of the S11D will be powered by electrical energy. Just tractors of belts, graders and other auxiliary machines will continue to consume diesel.

Besides innovation in the process of extraction and transportation, the next stage also presents a novelty: enhancement at natural humidity, which will enable great reduction in the water consumption, compared to the





conventional process⁵. That innovative concept that Vale uses in the new product (in a unique scale) for mining activities is the result from its experience in other places, moreover in Australia, where mining occurs necessarily under conditions of reduced water availability.

Implementation of project of S11D processing plant has also been performed under an innovative concept: the modulation system. With its 67 thousand tons of steel, the plant was designed by a modular system that allows assembly of each one of the parts (modules) under favorable conditions (for instance, laying down) and at the most adequate site. After assembled, the structures are transported to the plant's region. That concept, likewise the former, also derives from Vale's international experience, in this case in Canada.

Modularization enabled Vale to shorten the plant's construction time periods by assembling a remote industrial facilities worksite, located 45 kilometers distant from the processing plant site. The solution enabled construction of the modules in parallel to the process of obtaining the environmental license. In that worksite, Vale built 109 modules that will integrate its plant. In the whole, those modules represent 67 thousand tons. The heavier ones have 1,413 tons (or the equivalent to 180 popular cars) and the

5 Vale's projections indicate that there will be saving of almost 20 million cubic meters, corresponding to the annual supply of a city with more than 400 thousand dwellers.





higher (in volume) has 23,877 cubic meters. To transport it from the 'remote industrial park' up to the plant's site, Vale constructed a road and uses special equipment units. The gains from that solution in the implementation schedule are added to the environmental and social gains.

The innovations that enabled implementation of the S11D are extended beyond the mine and the worksite created to assemble the modules. The project also innovated in its logistic processes: in the railway, using an extra locomotive during the sharp acclivities; and at the port, with the berthing system. In addition, the company has a new large capacity mining ore ship, Valemax, developed exclusively to increase the cross-oceanic volume of transported iron ore and, consequently, reduce the cost of freight per ton.

4. THE PROJECT IN THE INTERNATIONAL PERSPECTIVE

The project gathers innovations developed specifically for it and technical advances and technological developments that were used internationally in other projects. Vale's project reaches the market at an instance of reduction in the growth pace of the demand for iron ore. This concept reinforces the need of building an extremely competitive project, capable of exploring all the opportunities to obtain reduced costs and assure its market presence under profitability conditions.



Vale's international experience represented an important source of knowledge for the project definition, enabling increasing of the examined technological possibilities, which were then combined to build the innovative concepts of the S11D.

When mobilizing its teams in other mineral bases, moreover in Australia and in Canada, to capture new technological possibilities and redefine the operational conditions, Vale is promoting the integration of knowledge of its operations in building a new project with great competitive advantages.

5. RESULTS FOR THE COMPANY

Vale is one of the most internationalized of the major Brazilian companies operating in competitive markets. More than 80% of its revenue comes from sales in the external market. Vale also has 10% of its production arising out of operations located in other countries. Australia, Canada and Mozambique are countries where the company currently has operations. Vale has 26% of its capital traded in the New York Stock Exchange (NYSE). That condition grants the company the possibility of putting itself as an option for investment, aligned with its competitors. To maintain its competitive position, financing of the company's expansion projects has to be done on the same basis of its competitors, which requires high operational performance. Evidently, this fact



demands from Vale a regular flow of investments to develop new processes and improve the ones already existing.

The S11D Project intends to strengthen the company's competitive position in the global scenario, where the demand resulting from the Asian growth (moreover of China) still plays a driving role, despite the possible dampening of its demand. That scenario leads to the question: how to sustain Vale's leadership position in the iron ore market? The main outcome of the project is the company's double bet on its future, on its leadership, on the capacity of making its assets profitable as well as the capital of its investors and shareholders in increasingly sustainable and profitable operations.

The set of innovations conceived and applied in the S11D Project – shows how Vale can be globally competitive today and in the future. The project nurtures this current competitiveness with new production bases, which are redefined accurately by the set of innovations that the project has structured and implemented. A more and more innovative, technological and sustainable Vale is presented with this new S11D project.

6. OUTCOMES OF THE PROJECT

The Brazilian economy has been guided, since the 1980's, by a continuous investments economy. Instead of pulling the economic growth, the investments have been refraining growth of the economy. In other words, the companies have been postponing, as far as they can, the investments, avoiding, due to the scenario of uncertainties, commitments with more distant future. And the investments in new productive capacity are, almost always, a long-term commitment. In this case of Vale's investment, its lifecycle is 30 years, i.e., the decisions made when the investment was projected extend their effects at least for three decades.

The investments represent the most challenging of the elements that constitute the business activity. They present the challenge of facing and resolving the uncertainties of the future. Investments combine a well-resolved equation with elements of a bet: no matter how the parameters of the equation are well-

resolved, the future is uncertain and the need to raise hypotheses cannot be bypassed. How will the Chinese economy expansion be? What will the competitors do? Can recycling have substantial advancement? What about the energy price, could it be raised and affect growth? None of those questions can be answered with certainty or with high assurance, and all of them affect the business decisions, moreover the decisions of investment in long useful life projects.

The S11D Project can be considered as a new phase in Vale's life. Through that, more than 30 years after Carajás, the company steps into a new threshold of competitiveness. In fact, the competitiveness of the project, associated to the innovations incorporated and structured by it that offer Vale the key to face and defeat the uncertainties intrinsic to the investment. In that sense, the S11D is a reflection that serves for the entire Brazilian industrial system. New investments, by innovative projects, with new technologies, can guarantee more competitiveness and profitability to the operations. The competitiveness of a certain company is not a data, as it refers to a hard work construction.

7. PERSPECTIVES

Vale developed new concepts and incorporated the old ones, adjusting them to the reality known to the S11D Project. The perspectives opened by the new project and the innovations

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New investments, by innovative projects, with new technologies, can guarantee more competitiveness and profitability to the operations.”



created and incorporated by it are extraordinarily promising. The S11D is Vale's single current project aimed at increasing production. All the other projects are aimed at adjustments in the production or extension of the sites' useful life.

The innovative image of the project certainly represents an important gain to Vale in terms of company, and projection for the future. However, that gain can also be operationally translated into lower costs, whether the costs of immediate operation, or the ones associated to remediation of possible indirect effects, such as, for instance, in the communities



installed in its area of influence. The operational costs of the new enterprise, derived from the investments in innovative and high productivity solutions, are lower. And the actual product implementation, conceived such as to produce the lowest possible impacts and shorter installation time, also represent gains for the company and for the Brazilian development.

Evidenced as a project with new technologies and solutions that reinforce Vale's competitiveness, the S11D puts the company under conditions of developing new projects, with original concepts in any of its areas of operations. It is possible that Vale, with the support derived from the results of the S11D, shall become even more competitive and more global, strengthening Brazil's presence across the world. Consolidation of Vale's competitive position in a world scenario of very strong competition for markets with slower growth is the most significant gain of the project. It assures for Vale and for its clients a quality ore, produced under competitive conditions, according to more advanced parameters, in environmental and social terms.

For Brazil and for the public policies on promotion of industry and development, the stronger lesson taught by this project is the innovation transforming and enabling character. The S11D represents the demonstration that innovation can be the mainspring that shall enable investments which, otherwise, would hardly get out of the paper.



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DEVELOPMENT OF PRESSURE REDUCING VALVE FOR HYDRAULIC INSTALLATIONS



The pressure reducing valves are important elements in the hydraulic systems of large buildings, inhibiting rupture of piping and leakages. VRP Premium created a solution with technology differentiated from the others available in the market, which is easier to install and maintain, besides offering more security due to its automatic operation. The peculiarity of this company lies on the fact that it was founded by a professional without technical education or experience in the segment, who, as a manager and dweller of a building, identified points for improvement and a business opportunity. The strategy adopted by the company of establishing partnerships to supply that deficit of specialized knowledge and offer differentiated products and services as a way to be positioned in the segment, has been evidencing itself as efficient, being an example of path for innovation in the small industry.

1. THE COMPANY AND ITS SECTOR

Founded in 2005, in Balneário Camboriú – Santa Catarina, VRP Premium is a small industrial company specialized in the

manufacture of pressure reducing valves essentially aimed for the civil construction market. This type of valve is an integral part of the hydraulic systems of very high buildings and it regulates the water pressure that reaches each one of the apartments, impeding occurrence of problems such as rupture of piping or leakages.

The population dynamics consolidated decades ago in Brazil, from the population transition from the rural environment to the urban centers (including the large cities and the middle classes) has been demanding major investments on houses. Despite the public efforts and progressive entrances of private companies strongly capitalized by foreign investors, the deficit of houses and urban infrastructure continues to exist. The urbanization phenomenon has an important impact on verticalization of our cities, intensified to enable larger number of people to be established in the same geographic region.

In this aspect, the verticalizer process brings along a challenge: water distribution to the apartments, due to the required volumes and the necessary infrastructure. The pressure imposed by the water on those structures poses difficulties to repair the hydraulic system.

In general, the buildings' water container is located in the top of the building. Hence, the water pressure, due to action of the gravity, ends up being greater in the lower floors. When the building is very high, that pressure can exceed the limit



set forth by the Brazilian technical standard. Consequently, the building is subject to ruptures of the piping, both the main ones and their branches, which might result into leakage inside the houses, in pipes, connections, flexible connections, washing machines and water filters.¹

It was precisely due to a need for maintenance and repair in the hydraulic system that the idea was generated which resulted into creation of VRP Premium. Luiz Alberto Padilha, at that time a manager of a building located in Balneário Camboriú, monitored closely the difficulties found to resolve problems of leakage and rupture caused by water pressure in the piping system of his condominium. He observed that the pressure regulating valves, which have a minor impact on the total cost of a typical civil work, might generate diversified high costs and major hindrances for the dwellers when they break and need to be changed. Bothered by that reality, he decided to seek a way to reduce that problem and noticed a potential market niche and a business opportunity.

Being a business owner of another sector and without technical know-how about mechanics or hydraulics, Padilha studied the market, seeking to identify points for improvement of a segment that was still unexplored and wherein he could develop work. Most of the pressure

¹ Available at: <<http://equipedeobra.pini.com.br/construcao-reforma/35/artigo213991-1.aspx>>. Access on: December 15th, 2014.



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The project of
the new valve
was based on the
expert’s technical
knowledge added
to empirical
knowledge
attained by visits
to numberless
buildings and
construction
companies, in
different sites of
the country.”

reducing valves in civil construction are imported – the main world producers are the United States, Israel and Italy. In their majority, companies with international presence and with long time in the market. In Brazil, there are regional companies with national coverage, the main three located in the states of Paraná, Rio de Janeiro and São Paulo. In more than one case, those companies were purchased (totally or partially) by foreign companies ².

The market study performed by the businessman revealed interesting points:

- The conventional reducing valves are adjustable, i.e., they have a system with springs, screws and diaphragm which allows the output pressure to be regulated by hand. Although presenting advantages, that systems is more susceptible to mistaken maintenance practices;
- The imported products did not offer technical assistance or periodic maintenance services to their clients.

The businessman decided to invest on the development of a valve that could solve the problem of manual adjustment and that, compared to the other available ones, would be simpler

2 Available at: <<http://www.abramat.org.br/site/lista.php?secao=9>>. Access on: September 5th, 2014.

in terms of components and of the manufacturing process. In addition, it has set forth that his new company’s strategy should involve, linked to sale of the equipment, a considerable warranty term and free of charge technical assistance services, as a way to attain differentiation in the market.

In pursue of a solution for development of the new valve, an already developed technology was identified, but it had not accomplished success in the market. That technology uses a moving piston as the regulator, keeping the output pressure fixed, irrespective of the input pressure. In partnership with an expert of the area, the first VRP valve was then developed, which operating principle was based on that system. Several improvements were incorporated, such as change of the threaded connections by flanges ³, thus releasing the connections and junctions used for installation of conventional valves. The project of the new valve was based on the expert’s technical knowledge added to empirical knowledge attained by visits to numberless buildings and construction companies, in different sites of the country.

For production of the first valves, the entrepreneur opted for the self-financing. Its first “test field” was the buildings from Balneário Camboriú. In this sense, being in Balneário was a great advantage, as Camboriú is one of the most verticalized

3 Available at: <<http://pt.wikipedia.org/wiki/Flange>>. Access on: December 18th, 2014.

cities in the country. To be able to enter that market, first the company offered maintenance services for already installed building valves, as a way of conquering clients and open the way to offer its product as an alternative to substitute defective valves.

2. THE STRATEGY – THE PROJECT ALIGNMENT WITH THE BUSINESS

To act in a segment controlled by large companies, the main strategy adopted in the company's business model is the differentiation, both for the products and in the services offered. To define the project of an innovative pressure reducing valve, a detailed field search of information was performed and also the recognition of the already existing technologies, through visits to several construction companies and buildings in Brazil and abroad, besides the participation in fairs. This practice ended up being incorporated into the business, as a way of identifying trends and changes in the sector.

The visits also became the main channel for offering products to the clients, as during the opportunity the equipment is presented by means of free of charge workshops. This method is also a technique elected to convince the clients that the fixed pressure valve is more



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To act in a segment controlled by large companies, the main strategy adopted in the company's business model is the differentiation, both for the products and in the services offered.”



adequate than the adjustable conventional ones, as it is safer and more economic, in the long term.

Concerning the sales, one of the main strategies adopted to conquer clients is the offering of warranty term which is longer than the competition, added by preventive periodical maintenance. Installation of a pressure valve in a building occurs approximately between one year and one year and a half before it is delivered to the dwellers. This means that during that period, the pressure reducer is already subject to some sort of wearing out. However, the large manufacturers offer just one year of warranty, i.e., when the dwellers start to effectively dwell in the condominiums, the warranty of the competitor's reducing valve has already expired.

In fact, it is precisely after that instance that the problems related to hydraulics have more probability of occurring. And then, the competitor charges for the maintenance services. VRP (strategically) opted for offering five-year warranty, with periodical maintenances and the right to have immediate change upon confirmation of any problem, both free of charge. Therefore, maintenance already plays an important part in the business. It is done by trained technical representatives, licensed by the company itself.

Each one of the manufactured reducing valves receives a unique code, by which the company can trace and identify where it is installed, its technical dimensions, its

fixed pressure and what is the type of the material. This traceability system enables, besides administering the periodic maintenances, to identify which type of corrective maintenance is indicated for each part.

Yet related to sales, to conquer the construction companies, the company elected to have the delivery with CIF (Cost, Insurance and Freight ⁴) price: the valve is already delivered at the worksite without any operational difficulty for the one receiving it, with no need to pay the freight, as VRP becomes responsible for that cost and the associated procedures.

In 2010, the company invested in replacing the material of the valves. Today, its valves are manufactured in aluminum, which, although being an advantage in relation to the weight and manufacturing time, resulted into increase of the product's unit cost. Compared to the larger competitors, the cost of the VRP Premium valve is significantly higher. To bypass what could be a problem, the company adopted the strategy of directing its sales to the high standard construction companies, where quality is also associated to longer useful life of the products.

⁴ In this type of freight, the supplier is responsible for all the costs and risks with delivery of the good, including insurance and freight. That responsibility ends when the good reaches the destination informed by the purchaser.

Another relevant point in the business' strategy concerns personnel management. Today, the company has 12 employees in total and the absence or low productivity of an employee may impact all the rest of the team and the final productive result. Team motivation is made by incentive of active participation, in addition to bonus per produced part. Everyone is stimulated to bring new ideas and solutions, whether regarding the product or aspects of the company's operation. Hence, the employees structure has been stable and with high productivity.

3. THE PROJECT

The main technological differential feature of the VRP pressure reducing valve is its principle of automatic operation. A moving piston, inside the valve, moves by action of the water pressure inside the piping, without the assistance of any other moving force. Hence, the pressure at the valve's inlet is balanced with the pressure in the outlet, causing the piston to go up or down. That allows that only the amount of water necessary to keep a certain fixed pressure will pass through the equipment.

Besides simplicity of the mechanism and its automatic operation, the valve has another important advantage: it

eliminates the so called "Water Hammer"⁵. This phenomenon consists of a sudden and momentary change of the pressure inside the piping: with the associated impact, equipment, power house and piping may be subject to damages that lead to excessive noises and even rupture. In addition, while the competitors' equipment units can only be installed in the vertical position, the innovative product can be placed in any direction and also operates as a retention valve, impeding water back flow inside the piping.

Since its design, two aspects were considered to be strategic during development of the valve: adequacy to the standards required by the market and the guarantee of the intellectual property. Brazil does not have specific law regulating the pressure reducing valves, but compliance with the NBR 5625 and NBR 7198 technical standards of the Brazilian Technical Standards Association - ABNT is required by numberless clients. In terms of intellectual property, all VRP's products have patents of Utility Model (UM) registered with the Brazilian Industrial Property Institute – INPI. The company considers that in a highly competitive segment, the capital dedicated to that mechanism is actually a fundamental investment to maintain its strategy of differentiation.

“ Since its design, two aspects were considered to be strategic during development of the valve: adequacy to the standards required by the market and the guarantee of the intellectual property.”

5 MARTINS, J. F. *et al.* Aperfeiçoamento para a eliminação do golpe de aríete. In: 58a Reunião Anual da SBPC, 2006, Florianópolis - SC



VRP's first reducing valves were manufactured in copper and bronze, the same materials used for construction of the competitor products. In 2010, however, with a view directed to the trends of the world scenario, the decision was made to invest on a project that would enable replacement of the raw-material. As it did not have a Research and Development team qualified to perform this type of work, the company appealed to the assistance of SEBRAE-SC, which intermediated a partnership with the State of Santa Catarina Educational Society – Sociesc. Through its department of Technological Services for Companies, which counts with specialized engineers and technicians, Sociesc performed technical advisory services, which involved a study about the alternative material and possible suppliers. It was then defined that the best option for the new raw material was the aluminum.

This replacement required one year and a half of development to adjust the product design and enhance the process. Some difficulties were faced along the project, mainly problems of leakage in the valves sealing regions. Through survey with manufacture of pumps made in aluminum the company identified that the problem could be solved if the sealing areas were manufactured in bronze and if the number of components of the valve was the smaller possible. Again, to resolve a technological difficulty, the option was to establish partnership.

The specialized foundry developed a procedure to manufacture the valve, injecting the aluminum and the



bronze in the same mold, each one in a specific region of the part. In that partnership, it was established that the foundry would be responsible for the supply of cast parts and the company, subsequently would submit the parts to machining, assemble and paint the parts.

This new manufacturing process, together with the change of the raw-material, unchained several improvements in the product and in the process:

- With change of the raw-material, the valves, which until then weighted about 30 kg, were modified to weight just 12 kg;
- The cost of the freight to send the valves was reduced by 50%;
- Reduction in the number of operations within the process from 17 to just 6, resulting into reduction of the lead time and consequently, the time of delivery to the clients, which was reduced from 60 to just five days;
- On its turn, the reduction of the lead time allowed increase of the weekly manufacturing capacity by 300%, without change in the staff;
- It was possible to eliminate the monthly stock of six tons of bronze and 600 parts in cast iron, which delivery times, by the suppliers, were 60 and 45 days, respectively;

- Aluminum is a non-poisonous material and it presents the great advantage of reusing the 'chips', which are no longer wasted during manufacture of the parts, as they are cast again and used once more to manufacture new parts.

4. INTERNATIONAL SCENARIO

The market of pressure valves is not limited to civil construction. This type of equipment is largely used also in large transportation systems and water supply; in the chemical and petrochemical industry; in the energy generation and utilities sector. Therefore, the sector as a whole is highly dependent on the production levels and activities of those markets, which leverage the demand for valves.

The global economic crisis impacted the sector in 2009, through increase of international competition, resulting from the ultimate users' search for lower cost products. But, the market continued warm, mainly due to the demand of the oil and gas sector, which has been displaying sharp growth in the last five years and civil construction in the emerging countries, due to the accelerated urbanization process. In addition, the constant need for systems maintenance sustains the permanent search for valves.



Between 2009 and 2014, the valves industry growth rate was approximately 2% per year, reaching the target of USD 2 billion. This trend is mainly resulting from the strong demand for hydraulic valves for civil construction and water and sewage systems, and also for oil refineries. Due to the global competition of the sector, based on unit costs of the products, there is the trend to have contraction of the large companies' profits.⁶

This scenario of global market expansion has been attracting VRP's attention, which is considering the feasibility of beginning exports and also diversify its products line, which is today essentially directed to the construction segment.

5. RESULTS FOR THE COMPANY

The company had the opportunity of participating in the project of Industrial Hubs of the Nova Economia@ Program, promoted by SEBRAE-SC, where it participated on training and consulting sessions on management, competitiveness and market, which was very important at the instance of introducing its product in the market. The determination of seeking technological leadership and overcome the

competitors' solutions was recognized by several quality awards. That was very significant to reach strong presence in the Brazilian market and start export of its product to other countries.

After the introduced changes – improvement of the product and manufacturing process – which created the second generation of the pressure reducing valve, the company increased its revenue by 170%. Reduction of the product cost by 40% with replacement of material also enabled increase of the profit margin.

The clients' portfolio already reaches six thousand and that number increases only for two reasons. First: each building is considered as one client as maintenance of the valve will not more be a contact through the construction company, but actually of the condominium itself, which becomes independent. This means to say that the relation, although starting with a possible multiple client, becomes individual after the instance when the civil work is delivered. If the building requires maintenance or a change, it contacts the company directly, as there is specific sale agreement for each condominium. Second: large sales for groups of condominiums of the same construction company are being attained. An example of that is the sale of 470 valves to a construction company that has several civil construction works in Distrito Federal.

⁶ Available at: <<http://www.prweb.com/releases/2014/05/prweb11821148.htm>>. Access on: December 16th, 2014.

6. OUTCOMES OF THE PROJECT

A significant advantage derived from the change of the raw-material is related to the possibility of reuse of the material chips, which are sent back to the foundry. The monthly total volume reaches approximately 400 kg/week and it is converted into discount for the purchase of cast parts – that might reach BRL7 thousand/month.

In addition, the new process and the new material eliminated emission of iron soot during machining of the valves. This improvement of the work conditions, combined with reduction of waste derived from reuse of the chips, represented expressive reduction of environmental and social impact, which was recognized by the Chico Mendes Social-Environmental Award, offered by the Chico Mendes Social-Environmental Responsibility and Research International Institute to VRP Premium, in 2010.

7. PERSPECTIVES

The perspectives indicate consistent growth. The company now has strong capacity to expand its production and sales, being able to work with short terms between the order and delivery, if necessary. Aimed at the purpose of expanding its market, it has been adopting more aggressive sales strategy in the regions where it identifies higher potential for growth





of the cities, betting that the trend of urban occupation is the verticalization.

Also aiming to increase its sales, the company intends to expand the production capacity, by increase of its employees' structure. And the commissions for each one of the employees for effective sale stimulate maintenance of the already existing team.

Allied to sales, the valves maintenance area attains an important role in the future decisions as each product sold has periodic maintenance and eventually corrective maintenance linked to it. Creation of a network of commercial and technical agents will play an important part on the company's design and operation form. To consolidate after sales service is also one goal inside the strategic planning.

The company now counts with technical assistance and sales in all the States of Brazil. And it also has advanced processes of negotiation with agents in Curitiba and Cuiabá. The purpose is to have at least one agent in each state of the country, to facilitate serving old clients and conquering new ones.

The solution developed by VRP, associated to the company's structuring and the expanding market (in Brazil and the world) could give rise to an accelerated growth course and forming of a company provided with international strength and competitive capacity. That would be desirable. The passage to the new phase, of accelerated growth, would possibly involve broader and coordinated mobilization of other instruments: technological notices to bid, technical consulting services, participation in international events, possibly combined with some fort of business and financial partnership to accelerate and increase the company's chances of success.



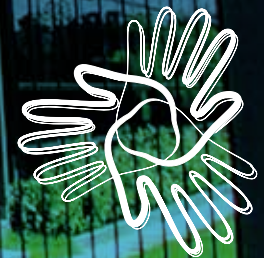
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INOVAWISE: TURNING IDEAS INTO TECHNOLOGICAL SOLUTIONS



Technological Innovation is a reality for companies of all sectors, mainly for the Information Technology area. The segment is known by the strong competitiveness – large number of players producing high technology innovations with short lifecycle. Thus, innovation is mandatory for survival and success of those companies. The experiences of companies knowingly innovative translate important lessons on the innovation's contribution for the business management. And the company, in this chapter, did not ignore the scenario unveiled before its eyes: it successfully implemented an innovation management program that reflects directly on the company's strengthening in its market of operation.

1. THE COMPANY AND ITS SECTOR

Wise is an industry participating on the Information Technology and Communication Sector, focused on the development of equipment for tests, measurements, communication analyses and maintenance of data communication lines. The company, located in Brasília, where it was founded, has been in the market for more than 26 years as the unique Latin-American manufacturer of high

speed communication analyzers. It has 100% national capital and currently supplies equipment for almost all the telephone concessionaires in the country.

The company started its history in 1988, with a fact that is repeated among successful entrepreneurs. It was founded by the electrical engineer Suely Maria Silva and by the mathematician Marcos Miranda, who worked together in the electronic equipment development area for one of the largest modem manufacturers in Brazil – at that time, they held almost 80% of the market – and who were fired after a restructuring of the company. Likewise what happens to several businessmen in Brazil, the severance ended up becoming an opportunity. Six months later, due to their know-how in the networks area, they were contacted by a company to render development services. That is when they decided to create Wise.

At the initial moment, the company's area of activities was diversified and the occupations were divided between equipment development and rendering of training and representation. The project of equipment in this area demands long time, and it might take even more than two years, thus, the team had, for some time, to offer different services within the segment of activities.

In 1990, a third partner joined the company, the electrical engineer Roberto Lucatelli, and the company entered the

incubation process of the Technological Development Center of the University of Brasília - CDT/UnB, which it continued to be part for approximately four years. He was also a participant of the second class of the Empretec¹ program, from SEBRAE, aimed at qualification of entrepreneurs, in order to provide improvement of their business performance, more confidence in the decision making process and expansion in the viewing of opportunities. According to the founder partner Suely Maria Silva, the company was one of the first to participate in the program and receive training, and it might be considered as part of the first generation of incubated companies that received the support of SEBRAE.

To be included into a technological incubator was determinant for Wise's establishment as a company, both from the perspective of management and the economic as well (mainly by the economic side, because when considering the initial stage of equipment development, the company's revenue was still small).

The first designed equipment was an Integrated Tests System, known as SIT, which is not traded anymore. The

1 Empretec is a methodology of the United Nations (UN) aimed at development of characteristics of the entrepreneur behavior and for identification of new business opportunities, promoted in about 34 countries. In Brazil, Empretec is performed exclusively by SEBRAE and it has already qualified about 190 thousand people, in 8,400 classes distributed across the 27 States of the Federation. [www.sebraemais.com.br]

entrances in the test sets ² area resulted from an adversity. The supplier of the equipment units that were used in Wise's products closed its operations without prior notice and the company was forced to develop its own test sets. Those pieces of equipment ended up entering the company's portfolio and they are still traded. That was the starting point for specialization in the tests area, where the company is prominent in Latin America.

The company counts with 42 employees, 18 of them working in the development area. The work of designing new technologies is non-stop, always following the advances of the information technology by means of innovation.

2. THE STRATEGY – THE PROJECT ALIGNMENT WITH THE BUSINESS

The company works in the segment of telecommunications, characterized by strong competition, broad infrastructure and the need to have quick answers, which requires constant innovations to follow-up the changes and market demands. Thus, innovation is much more a necessity than an option: It has strategic role in its competitiveness. But 'to turn ideas into successful projects' – the motto adopted by the

2 Test set is a piece of equipment that simulates a computer to diagnose problems in IT networks.

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To be included into a technological incubator was determinant for Wise's establishment as a company, both from the perspective of management and the economic as well.”



company – it is necessary to have good organization and management.

Besides quickly adapting to the market changes, launching better and more useful products and services in a shorter time lapse, the companies willing to innovate need to have proper strategy – projects of technological innovation involve high level of risks. Within that scenario, Wise adapted the existing methods to the company’s reality and implemented a new innovation management system.

The idea of systematizing the innovation processes came from the partner Suely while still working as Director of Technological Development Affairs of the Distrito Federal Industries Federation (FIBRA). During that period, she had the first contact with innovation management methodologies through training offered by the Brazilian Industry Confederation (CNI) as part of the Innovation Nucleus program MEI – Business Mobilization for Innovation. When identifying that the same process served to Wise’s strategic planning, she decided to implement it.

Initially, employees were trained on innovation management and later worked, together with a specialized consultant, to design the innovation management system. That process was aimed at systematizing the ideas that, until then, were

considered just as ‘opportunities for improvement’. Thus, the development that had started in 2012 ended up with the creation of InovaWise, in September, 2013. It refers to several actions aimed at promoting and developing innovation inside the company.

3. THE PROJECT

The first steps in the development of the project were the creation of the program’s name and logotype, baptized as InovaWise, followed by definition and establishment of an Innovation Policy, which lies on the company’s capacity of incorporating, in a combined manner, elements of scientific, technological and industrial policy aimed at the development of new products, services and processes.

The tool elected to guide definition of that policy was the Innovation Octagon. It is a tool developed with the purpose of assisting the potential innovator’s diagnosis, besides the design of management policies to improve their performance. This tool results from gathering of eight dimensions - strategy, relationships, culture, people, structure, process, funding and leadership – which are common in innovative organizations.

The following chart presents the main topic addressed in each one of the eight dimensions.

“

Besides quickly adapting to the market changes, launching better and more useful products and services in a shorter time lapse, the companies willing to innovate need to have proper strategy.”



CHART 1. DESCRIPTION OF THE EIGHT DIMENSIONS IN THE INNOVATION OCTAGON

Questions addressed by the tool:

1. Strategy: How does the company negotiate direction of the innovation initiatives?
2. Relationships: How does the organization use partners, clients and competitors to generate and refine ideas?
3. Culture: What does the high management say and do to create an environment that stimulates innovation?
4. People: How is the support to innovation, its incentives and recognitions?
5. Structure: Where is the innovation activity located and how is it organized?
6. Process: How are the innovation opportunities generated, developed and assessed?
7. Funding: How are the innovation initiatives funded?
8. Leadership: How clear is the leaderships' understanding about the necessity and relevance of innovation? How do the leaderships support the innovation environment?

Source: Innoscience – Consulting on Innovation Management .



With this program, the company defines its innovation strategy, defining the desired types and themes for innovation. In addition, it conveys such guidelines to its employees, creating a catalyst of creativity and a guide for the search of new ideas.

The defined innovation themes are connected to the horizons that the company deems to be strategic – they have the roles of being drivers for generation of ideas and they are used as criteria during categorization of the proposals. Thus, they define which subjects of the company demand actions, assisting with allocation of resources for innovation. Considering all the ranges of the innovation management designed in the Octagon, the implemented Innovation Policy stays connected to the company's strategic planning and reinforces the current business, also creating new business opportunities.

As part of the ideas development process, the Innovation Funnel is applied. A tool largely used in innovation management processes that presupposes finding of proposals with higher potential to become innovative solutions upon generation, development, testing and experimentation of a broad set of ideas³.

3 Wise's Innovation Portal

“

The defined innovation themes are connected to the horizons that the company deems to be strategic.”





The proposal is to start the process with a large number of ideas that demand few resources and, in the subsequent stages, reduce the number of projects according to the potential of the proposals and strategic areas and consequent increase of the resources applied in each project.

The Funnel works as a visual method to work with new ideas, providing proper basis to represent, monitor and manage innovation in the company⁴.

Among the initiatives to disseminate the culture of innovation among its employees, the following should be highlighted:

- Innovation Day – held twice a year, the distinction comes from favoring of information exchange. The Innovation days count with lectures, workshops and visits that address the subjects defined by the company;
- Innovation Portal – space created to stimulate collaboration and free expression of ideas that contribute for improvement of already existing technologies and new proposals of products/services;
- Cycle for Exposition of Innovative Ideas;
- Endomarketing tools.

4 REVISTA DE ADMINISTRAÇÃO MACKENZIE. v. 8, n.1, 2007. p. 77-107.



After definition of an Innovation Policy and well-defined targets, the team responsible for systematizing the innovation management dedicates itself for adapting already existing methodologies and tools. After this stage, the whole designed management model will be available in a manual, describing the concepts, management structure, methodologies and tools developed.

One of the actions promoted by the InovaWise program was the launching of the Bank of Ideas, aiming to stimulate the employees' participation in promotion of ideas and development of new products. Inclusion of suggestions in the Bank is made through the Innovation Portal, a tool that was created as permanent communication channel to foster proposals. Through it, employees and also clients and

suppliers have room to suggest proposals for elaboration of services and products, with the expectation of putting innovative ideas into practice.

WISE INNOVATION PROCESS:

The Process implemented by the company allows separating the project into different Phases and Gates (decision points) when the project is assessed as a whole based on the information generated during each stage. The Gate is the idea's door to enter the subsequent phase of the innovation funnel. The process encompasses, besides its employees as internal source of new ideas, the entire partners network such as universities, research institutes, clients and suppliers. Hence, the company is able to expand identification of demands and technological solutions, based on different players of the chain.

» STAGES OF THE PROCESS:

Phase 1 – Proposition of Ideas

As one of the results from the different initiatives for dissemination of the innovation culture inside the company and in its chain, proposals are registered in the Innovation Portal.



Gate 1 – Classification of the Ideas

The first decision point in the company's innovation chain consists of categorization of the ideas. The proposals are assessed every month by the Internal Innovation Committee⁵.

This process enables the company to separate the ideas into four categories and give sequence to the process, following the standard procedures adopted for each case. The ideas are assessed according to their market potential, alignment with the company's strategic purpose and framing of the technology as being of rupture or improvement.

CHART 2. MODEL FOR CLASSIFICATION OF THE IDEAS ENTERED IN THE INNOVATION PORTAL AND PROCEDURES ADOPTED.

The proposals entered in the Bank of Ideas are classified under three categories:

- **Potential Proposals:** Ideas identified as innovative, i.e., with large chances of becoming a new product. In this case, the proposal will follow to the next step of the process;
- **Improvement:** Suggestions for improvement or adequacy of the products/processes will be submitted to the quality management area;
- **Bank of Ideas:** Proposals with potential, but which are not aligned with the company's strategic planning for the period will remain available in the bank.

⁵ Responsible for assessing the Market potential of the ideas included in the bank; it assists with identifying internal competencies for the projects development and spreads the culture of innovation in the environment.



» **PHASE 2 – ELABORATION OF FEASIBILITY**

The proposals classified as potential will be detailed in a Preliminary Feasibility Record, aimed at deepening the understanding of the suggested project. Wise determines a sponsor with expertise in the area of the proposal for each study, who, together with the author of the proposal, will have 30 days to present the feasibility document to the Innovation Committee.

Gate 2 – Assessment of the Feasibility – The Innovation Committee will assess the project’s feasibility based on previously defined criteria such as market, technology, human factor and business. By the end of that assessment, a potential assessment indicator will be generated.

Gate 3 – Management’s Approval – The decision making will be based on the potential assessment indicator and approval of technology feasibility.

» **PHASE 3 – ELABORATION OF THE PROJECT’S PLAN**

The projects are formulated using the PMI (Project Management Institute) methodology, by a member of the Innovation Committee with the participation of the author of the idea.

» **PHASE 4 – DEVELOPMENT OF THE PILOT**

The Development Engineering process will be responsible for developing and monitoring the project. The Innovation Committee will define the person responsible for developing concepts that are not adequate for that department.

Gate 4 – Approval of the Pilot

Issuance of opinion considering the results of the experiments for the decision making – if the pilot will be implemented in large scale – by the Board and by the Innovation Committee.

» **PHASE 5 - IMPLEMENTATION**

At the instance when the pilot passes Gate 4, it becomes a project to be implemented. The focus is the implementation and generation of economic results.

Gate 5: Assessment of the implementation

To consolidate the process, the Innovation Committee will be responsible for the post-implementation process. The analysis will be done using the following criteria:

- Period of Occurrence – after six months from implementation of the project, the Innovation Committee will ascertain its positive results;
- Focus of the assessment – the Committee will use metrics such as Analysis of Return on Investment (ROI) and Residual Revenue (RR).

4. INTERNATIONAL SCENARIO

The telecommunications sector is remarked by constant and quick evolution of the technologies that are developed to satisfy the growing demand of users, whether by the service quality and speed dimension or by the market expansion dimension.

The data on the broadband offered by the mobile telephone systems operators indicate that Brazil closed the month of March of this year with 114.4 million people accessing the mobile broadband: the great majority (105.4 million) use their own 3G devices and other 6.9 million adopt broadband terminals, which is the case of the modems. As for 2.1 million, they are already using LTE technology accessed by their mobile devices⁶.



The massive adoption of wireless data services (3G, 4G, LTE etc.), which, at a first instance might seem a threat to the cable networks, in fact is based on those networks. In other words, the traffic of the mobile and wireless networks hugely contributes for the pressure and strangling of the data transmission physical means and, consequently, of the operator companies that maintain and explore them as well.

Maintenance of the operators' cable networks is a challenge in itself, not only by their size and complexity, but also because the technical and legal requisites are constantly changing. Operation of those communication systems requires technical teams with high level of mobility, both in urban and remote regions, which are capable of making diagnoses and effectively correcting problems.

⁶ Available at: < <http://www.redex.com.br/News/42/Conhe%C3%A7a-a-radiografia-da-banda-larga-no-Brasil.aspx>>. Access on: October 8th, 2014.



Those technical teams depend on increasingly more sophisticated test equipment, with large number of functions, so that they can bear the diversity of the technologies implemented in the network. Should those requisites not be enough, such equipment units also have to be portable, strong, reliable and easy to operate⁷.

That ecosystem includes the communication networks tests equipment industry. Today, the digital communication networks grow in use and size across the whole world. It is expected to have an increase in the demand for reliable test and measurement systems in regions such as the Americas, Asia, Pacific, Africa, Middle East and Europe. The telecommunication services market is the most profitable IT market at the global level. Gartner foresees that until 2016, the expenditures with IT will reach US\$ 3.7 trillion per year⁸.

It is expected that in 2018, the revenues of the global test equipment market will reach the milestone of 800 million dollars, compared to an estimate of approximately 585 million, in 2011. Approximately 21% of that amount corresponds to OTDR products, 14% to OLS products, 15%

7 Available at: < <http://electronicsmaker.com/why-we-see-the-market-growing-for-handheld-test-and-measurement-equipments>>. Access on: October 8th, 2014.

8 Available at: < <http://www.gartner.com/imagesrv/pdf/RESEHTPRODBROC012108.pdf>>. Access on: October 13th, 2014.

to OPM products, 5% to OLTS products, 6% to RFTS, 21% to OSA products and the remaining 18% to other products⁹.

5. RESULTS FOR THE COMPANY

The results from the InovaWise Program are directly reflected on the innovation indicators considered by the company, such as the number of products in its portfolio, growth of new products' share in the total revenue, raising of funds with the main funding agencies to financing projects and training of its employees.

The internal policies and structuring of the innovation management project led to increase of its market share, besides entrance of new clients in the company's portfolio. In 2013, participation of new clients in the total revenue corresponded to 14%.

The success of the program can be measured by renewed motivation of the employees. The project unchained preparation of new proposals presented in the portal and the employees' engagement with the business. Today,

they count with employees included in all the stages of its innovation process.

The program was also positive for the company's image. In 2013, it enabled conquering the 3rd place in the small company category of the FINEP Innovation Award and the award in the Hardware Distinction for medium and large companies, in the fifth edition of the SINFOR IT Award. In 2014, InovaWise was the winner of the National Innovation Award of CNI, in the Innovation Management modality and also the FINEP Award, Mid-Western Region, in the Small Company category. In addition, two of the company's projects were approved in the Inova Talentos 2014 program.

6. OUTCOMES OF THE PROJECT

The company adopted as a strategy for monitoring of the international market the establishment of OEM (Original Equipment Manufacturer)¹⁰ partnerships in the two dimensions – importing foreign products and selling them under Wise's trademark and exporting equipment to its

⁹ Available at: <<http://www.slideshare.net/FrostandSullivan/increasing-opportunities-for-fiber-optic-test>>. Access on: October 7th, 2014.

¹⁰ Original Equipment Manufacturer, or OEM, is a differentiated modality for distribution of original products, where they are not traded to the ultimate consumers. They are sold to other companies (named as VAR, or Value-Added Reseller) who assemble the ultimate products and sell them to the ultimate consumer. Some of the OEM products do not have the manufacturer's trademark printed on them. This decision will be at the reseller's discretion.



partners to be sold under other trademarks. This model generates transfer of know-how which is included into the national context. The company's purpose with this practice is to know the solutions that are being developed abroad and identify new positive points that can be internally absorbed.

For this year, a visit is expected to happen in an American company in order to introduce Wise's products and define how its solutions will be absorbed by the American market. The company uses the strategy of developing world distributors and partners of its field of activities to internationalize products.

7. PERSPECTIVES

All the implemented actions for stimulation of innovation and management process have enabled reaching important results for the company. Today, it is possible to state that the innovation strategy has been fundamental to keep the company competitive and on the path of the growth.

The company intends to intensify the actions aimed for fostering innovation and the number of partnerships established for new products development. The expectation is to have its portfolio increased after implementation of new ideas, which may have positive impact on its clients portfolio and expand its competitiveness in the national



and international markets. The company already observes growing indexes of its total revenue derived from products generated from potential proposals registered in the bank of ideas – the hope is that those indexes will become even more expressive in the coming years.

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