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Innovation for sustainability – New product development for a Greenpeace licensed air conditioning substitute

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ABSTRACT

The paper presents a case study of the new product development that created in Brazil the Ecobrisa-EB20, a product licensed by Greenpeace, due its positive environmental sustainability compared to the air conditioning equipments it substitutes, by saving up to 95% electric energy consume. The case study is based on interviews with key professionals involved in this product development project, in order to understand the innovation management determinants that resulted in this high environmental performance product. First the paper reviews academic researches on environmental technological innovation. Secondly, the paper describes the environmental issues of air conditioning in relation to energy consume efficiency, climate change and biodiversity in Brazil. Finally, the paper presents the case study of the innovative company Viva Equipamentos on the development of the Ecobrisa-EB20 product and on how the Greenpeace license impacted the innovation process.

INTRODUCTION

Although the industrial revolution provided significant contributions to the economic development, it also generated negative side effects. In fact, year after year increases the number of evidences about the damages caused by human industrial activity to the natural environment.

For Hobsbawn (1979), the Industrial Revolution represented the most radical transformation in human life, due to the introduction of machines in the productive

operations. However, this development has also negative consequences for the environment. The United Nation's report on global environment outlook states that the year 2005 was one of the warmest years on record and it registered an unusually large number of extreme weather events. In fact, the insurance company Munich Re Foundation estimates for the year 2005 the largest financial losses resulting from weather related natural disasters amounting US$ 210 billions (Munich Re, 2006).

The poor environmental sustainability of the economy caused not only financial losses, but also negative impact in human health. The United Nations Health and Environment Linkages Initiative estimates that 25% of deaths and diseases globally are linked to environmental hazards as unsafe water, poor sanitation and waste disposal, urban air pollution, unintentional poisoning and climate change.

ENVIRONMENTAL SUSTAINABILITY

In 1987, the "World Commission on Environment and Development" defined sustainable development as the "development that meets the needs of the present without compromising the ability of future generations to meet their own needs ".

In order to better understand the role of the natural environment to the sustainable development, economists and ecologists analyzed how the natural resources impact the economic life. As result, those scholars created the concept of "natural capital", which represents the synthesis of the following contributions provided by nature to the economic activity (Pearce and Barbier, 2000):

a) Nature supplies materials (oxygen, food, drink-water and medicines) and energy as inputs for the productive operations and for the biological processes that support human life.

b) Nature acts as a sink for waste emissions generated by the economic activities.

c) The ecosystems supply services like nutrients recycling, watershed protection, erosion control, biological productivity and climatic regulation.

d) And the ecosystems have also a regenerative capacity for absorbing a certain amount of external pressures from both natural causes like earthquakes, and from causes related to human activities like pollution and biomass extraction.

Based in the natural capital concept, those ecologists and economists raised serious concerns about the future development, since numerous irreversible destructions are depleting the world stocks of natural capital. Thus, those researchers claim that it is necessary to protect the natural resources and the ecosystems services, in order to ensure the well being of the future generations. For this purpose, the value of natural capital should be better reflected in market prices and in policies impacting the natural resources allocation.

Some initiatives strive for transforming the concept of sustainable development into operational frameworks to guide the decision process in organizations. In Sweden, a multidisciplinary group of scientists created a document on sustainability principles to

help businesses improve the sustainability of their actions and investments. The “Four Sustainability Principles” state that (Robert, 2002):

“In a sustainable society, nature is NOT subject to systematically increasing:

1. Concentration of substances extracted from Earth’s crust;
2. Concentration of substances produced by society;
3. Degradation by physical means;

And in that society…

4. People are not subject to conditions that systematically undermine their capacity to meet their needs”.

In USA, the concept of sustainable development inspired the “Natural Capitalism” movement, which aims to integrate the economic life to the biological flows and cycles. To achieve this objective, the creators of the natural capitalism concept developed an economic model aligned to the natural capital protection. Representatives of the natural capitalism believe that sustainable development requires to better account the value of ecosystems services provided to human society like, for example, air purification by photosynthesis, water cleaning by plants, nitrogen fixation by bacteria, among many other services (Lovins, Lovins and Hawken, 1999).

In addition to scientists and civil society organizations, also investors are interested in the sustainability of companies, because environmental passives and ethical scandals represent risk of jeopardizing the economic value of their investments. For the Dow Jones Sustainability Indexes:

> “Corporate Sustainability is a business approach that creates long-term shareholder value by embracing opportunities and managing risks

> deriving from economic, environmental and social developments. Corporate sustainability leaders achieve long-term shareholder value by gearing their strategies and management to harness the market's potential for sustainability products and services while at the same time successfully reducing and avoiding sustainability costs and risks."

For this purpose, the Dow Jones Sustainability Indexes assess the corporate sustainability of companies in different market sectors. The assessment follows criteria in three dimensions: economic, environmental and social dimensions.

INNOVATION

For Schumpeter (1942), the technological achievements are the main determinants of the economic development, due to the process of creative destruction, in which innovations "revolutionizes the economic structure from within".

The term "innovation" is precisely defined in the academic literature. Freeman (1982) differentiates innovation from invention being that invention is the idea or the model with which to improve a product, equipment, process or a system. On the other hand, innovation, in the economic sense, it only occurs after the first commercial transaction that results from this new product, equipment, process or system.

In Brazil, a research based on 141 companies and statistical discriminant analysis found that the variables that most distinguish more innovative companies from less innovative companies are the percentage of finalized innovation projects and the number of PhDs, masters and undergraduates allocated to R&D by the number of employees (Andreassi and Sbragia, 2001).

INNOVATIVE CAPACITY

Higgins (1995) considers that long-term competitiveness depends on the ability of a company to consolidate its innovative capacity and to conduct strategic actions to improve its skills to generate innovations.

In fact, researches indicate that it is not sufficient for a company to have a R&D department, in order to have a high innovation performance, because this performance depends on the innovative capacity of the company as a whole. Thus, Arrow (1962) aims that the professional practice is an important source for innovation. Similarly, Rosenberg (1982) states that learning by doing also stimulates the organizational innovation.

In the nineties, researches demonstrated that product redesign and reverse engineering often result in more innovations that the outputs of the R&D department (Henderson and Clark, 1990).

If the organizational innovative capacity is what generates innovations, then it is important to understand which is the most impacting factor to develop this organizational innovative capacity: the management of information or the management of knowledge. As Zander and Kogut (1995) found, the focus on innovation based on organizational resources obtained a new perspective, as technology became to be analyzed not as information, but as knowledge. By doing so, the company is characterized as a set of technologies, which represent a repository of knowledge applied to problems resolution (Grant, 1996).

Papaconstantinou (1997) found that the organizational innovative capacity is function of the efforts to the creation of new products and of process improvements, is function of the work force skills, is functions of the company's ability to learn and it is function of the characteristics of the company's business environment.

In addition, the innovation process transforms the company, by increasing its internal capabilities, so that the organization becomes more flexible and adapted to the market pressures (Geroski, 1994). Therefore, innovations improve a company performance both by the result of the innovation and by the innovation process itself, which changes the organizational internal capability. Thus, the innovative capacity is developed by the activities to perform specific innovations.

INNOVATION FOR ENVIRONMENTAL SUSTAINABILITY

The Agenda 21 is a comprehensive action plan proposed by the United Nations to be implemented globally, in order to decrease the environmental impacts caused by human societies. The Agenda 21's 34th chapter conceptualizes *environmentally sound technologies* as the technologies that, compared to the technologies they substitute, protect the natural environment, are less pollutant, utilize less amounts of natural resources, more intensively recycle their wastes and final products and are more sustainable in the approaches for waste management (United Nations, 2006).

The environmental technological innovation is also defined as the processes, techniques, systems and products new or modifies, which contribute to reduce environmental damage. Moreover, this objective of environmental damage reduction can be achieved by different innovation categories: by technical innovations and by

organizational innovations, due to changes in the organizational structure or due to the introduction of new procedures and corporate practices (Kemp and Arundel, 1998).

The innovations for environmental sustainability can results in the following categories (Kemp and Arundel, 1998):

- End-of-pipe technologies
- Waste Management
- Clean technologies in the production process
- Recycling
- Cleaner products, products with low environmental impact along its life cycle
- And clean up technologies for corrective action after the environmental damage occurred.

The environmental innovations can also be characterized by innovation typology in radical innovations, incremental innovations and large-scale systemic innovations that substitute broad processes (Kemp and Arundel, 1998).

Based on 105 environmental innovations in Sweden, Hellström analyzed the features of those innovations as function of the following typology (Hellström, 2006 in press):

– Incremental innovation in components;
– Incremental innovation in architectures (changes in the way the components or modules interact in a whole system);
– Radical innovation in components;
– And radical innovation in architectures

This research found that:

- 54,3 % of the innovations were innovations in the manufacturing process: changes of components in equipments, waste reduction, energy efficiency and internal recycling;
- 30,5 % of the innovations were product innovations: improvements in current products, new raw-materials and new components for reducing emissions;
- 9,5% were radical innovations in components, as, for example a new technology to heat materials in a production line or a new technology for insecticides;
- And 16,2% were radical innovations in architectures, as a new system for water purification substituting chemical treatments by magnetic treatments, a new method for coordinating the logistical utilization of trucks and the utilization of robotic in organic farming.

The main conclusion of Hellström's research is that a very frequent approach to generate environmental innovations is to integrate new technological platforms to conventional technologies in current products and processes

In order to analyze the environmental impact caused by the economy, Tukker and Jansen (2006) reviewed eleven articles on the environmental impact caused by consumption. Those eleven researches are integrated in the program "Environmental Impact of Products" sponsored by the European Community to analyze the whole product life cycle environmental impact of the aggregated consumption of society.

Those eleven researches resulted in similar conclusions that, in Europe, around 70% of the environmental impact is caused by three consume categories: housing, transport and food. More specifically, the environmental impact is concentrated in the following products:

a) Cars and air planes;
b) Meat and dairy;
c) And constructive structures, heating and electrical products.

The consequences of this research to environmental innovations are straightforward. If most of the environmental impact is caused by a small set of products, then innovations with the higher environmental performance will probably decrease the environmental impact of those products, or instead, environmental innovations will create new products, which substitute those most harmful products.

This paper analyses the innovation management to develop a new product to substitute air conditioner in Brazil, one of the electrical equipments most responsible for the environmental impact of the housing consumption category.

ENVIRONMENTAL IMPACT OF ELECTRIC ENERGY IN BRAZIL

The demand for electrical energy in Brazil increases the environmental impact depending on which energy generation option the country decides for (Procel, 2007):

a) Hydroelectric energy – Big hydroelectric power plants cover large areas and, therefore, often change the ecosystems biodiversity and the water quality. The submerse vegetation deteriorates generating significant amounts of methane gas, which causes the greenhouse effect and climate change.

b) Coal energy – The thermal power plants that utilize fossil fuel generate green house effect gases.
c) Nuclear energy – Although the nuclear power plants are more and more secure, they present the risk of radiation to the environment.

Today, 91% of the electric energy in Brazil is generated by hydroelectric power plants.

Products with increased energy consumption efficiency avoid additional environmental impacts, by postponing the need for new power plants.

RESEARCH METHODOLOGY

To conduct this analysis, the case study research methodology was chosen. The case study is suitable for researchers to answer questions as “how” and “why”, whenever the empirical analysis focuses on a real life context phenomenon (Yin, 2005).

Since the present work aims to identify how innovation management generates a new product with high environmental performance, it will be necessary to conduct an explanatory study to understand how and why the Viva Equipamentos created the Ecobrisa evaporative cooler as a substitute for air conditioning.

For Yin (2005), research protocols define standardized procedures, in order to ensure the reproducibility of the case study conclusions, even when different researchers follow those same procedures. The case study procedures should define the main research question and the information sources.

a) Unity of Analysis - The theoretical focus of the research is the theory of innovation management, while the unity of analysis is the new product development for the evaporative cooler Ecobrisa to substitute air conditioners.

b) Research Question - In which manner did the innovation management enable the Viva Equipamentos to develop a new product with high environmental performance?

c) Information source – The data for this case study was collected by means of interview with the Viva Equipamentos entrepreneurs, who managed the Ecobrisa EB 20 product development, and by means of searching in the Internet Greenpeace site.

ECOBRISA DEVELOPMENT

In Brazil, air conditioners are responsible for around 48% of electricity consumption in offices (Laboratory for Energy Eficiency in Buildings – Univesity of Santa Catarina, 2007).

Evaporative coolers are a low energy consumption alternative to air conditioning. The Ecobrisa evaporative coolers were developed by Viva Equipamentos, a company founded by two entrepreneurs, the engineers Zsolt Makray and Paulo Gabarra, who are working together for 27 years.

In his master in Berkeley on nuclear energy, Makray was very concerned about the potential negative impacts of nuclear technology and interested himself to alternative energies. His interest to environmental sustainability developed further, so that today he owns an environmental conservation area.

Back to Brazil in the seventies, Mackray joined a PhD program on alternative energies focused on biomass. Together with other researchers, Mackray found Termoquip, a

company that builds wood gasifying plants. Gabarra integrated the Termoquip team as a young undergrad student,

In 1990, the Brazilian markets went through deep structural changes. Before this year, the government protected local producers against foreign competitors by means of barriers to importations. After this year, theses barriers to foreign suppliers decreased significantly, so that the wood gasifying business together with many other industries lost competitive advantages against foreign materials and technologies.

For this reason, in 1993, Makray and Gabarra left the operational responsibilities in Termoquip and, without capital, they founded Viva Equipamentos, which started its activities in Gabarra's garage. The business idea was to commercialize products that save energy, in order to decrease electric energy demand and avoid the negative environmental impact of building new hydroelectric or nuclear energy plants.

The entrepreneurs began with importations of heat pumps for swimming pools. However, since swimming pools heating is a very seasonal market in Brazil, the entrepreneurs searched a different product, but this time for cooling purpose, because the Brazilian market for cooling systems has more continuous and less seasonal behavior in Brazil, due to the hot tropical climate of the country.

For this purpose, Makray searched in 1996 information on cooling systems in the Internet and found the evaporative coolers as an alternative to air conditioners.

The evaporative coolers were largely utilized in USA until the thirties, but became a practically forgotten technology after the invention of the air conditional in most countries with exception of hot and dry countries like Australia, Mexico and Israel.

Evaporative coolers are equipments, in which water is evaporated directly into the air that is circulated to the space being cooled. This lowers the ambient temperature and adds moisture to the air. The main difference between evaporative coolers and air conditioning is that air conditioning compressions vapor, while evaporative coolers evaporate water.

In order to better understand the evaporative cooling technology, the Brazilian entrepreneurs traveled to visit USA producers. Since they've already developed organizational capabilities on importation of heating pumps, the entrepreneurs began their new business with importation of evaporative cooling equipments in 1997.

However, the general perception of the Brazilian market was that these imported evaporative cooler were noisy, expensive and non-esthetic. For this reason, Viva Equipamentos developed a new product line with products, which are silent, esthetic and less expensive, because they imported only the evaporative cooling media pads and utilized the remaining components from local suppliers for assembling the final product.

The media pads of the Ecobrisa evaporative coolers consist of virgin kraft paper with resin to obtain high surface area for the water flow with a special design to allow a continuous airflow.

As the first Ecobrisa evaporative cooler model was launched, its environmental appeal was focused on ozone depleting free substances and low electric energy consumption.

The North-American company that supplies the evaporative cooler media pads considers that Viva Equipamentos Ecobrisa product line is the most complete product line of its industrial clients. In fact, the Ecobrisa product line is composed of eight different equipment models for home, industrial and commercial office applications and for different area sizes.

Today, Viva Equipamentos has 43 employees and around 70% of Ecobrisa's revenue comes from the industrial market.

The idea to crate a new residential product for rooms with 20 squared meters began in 1999 as the Brazilian energy supply was having frequent shortages creating the ideal business environment for a new option for homes low energy consumption air-cooling.
In 2000, Makray became aware that Greenpeace licenses products with high environmental performance. The licensing process took a year and consisted of auditing by an expert on ecological impact of products and consisted of improvement projects to substitute PVC components by substances with less environmental impact.
The licensed product is the Ecobrisa EB20, for which the entrepreneurs required a utility patent in Brazil. The patent requirement involves, for instance, a remote control and the water repository.

For the entrepreneurs, Viva Equipamentos main organizational capabilities that contributed to the Ecobrisa EB 20 new product development were:

a) Know-how in importation – In Brazil, the process for importations is considered very bureaucratic, thus companies usually must spend a considerable time to learn how to import and to implement a reliable importation business process.
b) Product improvement engineering – Even when the entrepreneurs just imported the finished equipments, they contributed with ideas that effectively improved the product performance.
c) Application engineering in evaporative cooling – The entrepreneurs developed new models of evaporative coolers for different markets, since they imported only the evaporative cooler media pads from USA and assembled the finished product with local components.

The entrepreneurs aim that the main barriers to develop the market for evaporative coolers are:

a) Insufficient governmental support – Differently from the solar energy equipments that have fiscal benefits, the evaporative coolers do not have any fiscal incentive for producers and consumers. Thus, the high taxes for evaporative coolers, of around 30%, are a major obstacle to the development of this market.
b) Consumers paradigm – In Brazil, consumers usually believe that air conditioning is the only means for thermal comfort, so that this paradigm frequently blocks them to consider the evaporative coolers as an effective option.
c) Price – Although the evaporative coolers save up to 90% of the energy consume compared to air conditioners, the equipment price is still more expensive than the respective air conditioner. Therefore, it will be necessary to increase the

production scale, in order to the evaporative coolers compete with the big domestic air conditioners producers and with the Chinese manufacturers exporting air conditioners to Brazil.

In the other hand, the interviewed entrepreneurs think that the Greenpeace brand license is a market-facilitating factor mainly for companies with high environmental consciousness, as for instance, companies with ISO 14000 and subsidiaries of European companies. However, the entrepreneurs do not consider that usually the Brazilian final consumers utilize environmental criteria in their buying decisions.

CONCLUSIONS

This paper analyzed a new product development that resulted in an alternative to air conditioners saving around 90% electric energy.

The COPPE research center for climate change and environment (a joint initiative of the University of Rio de Janeiro and of the Ministry of Environment) found that each electric energy watt-hour in Brazil generates greenhouse gases emissions of 0.05 kilogram of CO2 equivalent yearly.

	Watts	*Consume for 8 hours/day for 9 months (kWh)*	*CO2 eq (Kg)*
Air conditioning	950	2052	100
Ecobrisa EB20	95	205	10
Ecobrisa EB20 saving	855	1847	90

Units sold	4000
Ecobrisa EB20 CO2 eq saving (tons)	359

Table 1 – Environmental performance of the Ecobrisa EB20 (From the authors, 2007)

Table 1 shows that the environmental benefit of each unit of Ecobrisa EB20 compared to conventional air conditioning equipments for 8 hours a day for the nine warmer months of the year in Brazil is 90 CO2 equivalent per year.

Since around four thousand units of the Ecobrisa EB20 were sold, the aggregate environment benefit of the EB20 is 359 tons of CO2 equivalent emissions per year.

Moreover, since the average Brazilian emissions with electricity is around 53 Kg of CO2 equivalent a year, the Ecobrisa EB20 yearly saves Greenhouse Gas emissions caused by electricity consume equivalent to around 6774 Brazilians.

Therefore, the Ecobrisa EB20 can be considered as an environmental innovation accordingly to Kemp and Arundel's (1998) definition, because this evaporative cooler is a new product that contributes to reduce the climate change environmental damage.

The Viva Equipamento's environmental innovative capacity was created before the actual foundation of this company, while the entrepreneurs were researchers ate the university and, then, as they were researchers in their company for wood based energy. As the initiatives for evaporative cooling actually began, Viva Equipamentos did not organized a formal R&D department. Alternatively, the company took initiative to redesign the imported evaporative cooler, in order to create products for new market segments, confirming Henderson and Clark (1990) statement that product redesign often generates more innovation than the R&D department does. In addition, before developing the Ecobrisa EB20, which was licensed with the Greenpeace brand, Viva Equipamentos developed seven bigger models. Thus, accordingly to Papaconstantinou (1997) findings, Viva Equipamento created organizational innovative capacity by creating new products, before the Ecobrisa EB20 new product development.

Viva Equipamento's environmental innovation capacity is also contributing to identify new products opportunities for 10 squared meters rooms to substitute small air conditioners models, for which a majority of the apartments in Brazil already have a pattern hole in the walls. This fact also confirms Geroski (1994) that the innovation process increases the organizational flexibility to satisfy the market pressures.

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