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THE DEVELOPMENT OF "GREEN" PRODUCTS: THE CHALLENGE OF INTEGRATING "GREEN" COMPETENCIES ALONG THE Supply CHAIN

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ABSTRACT

This paper considers product differentiation strategies in which businesses aim to develop innovations with reduced environmental impact throughout the life-cycle, which assumes the involvement of the production chain. It highlights the strategies employed by a producer of PET resin, to launch onto the Brazilian market a fiber manufactured from recycled plastic, called Alya ECO. Research takes the form of a case study, with collection of secondary data, analysis of documents and realization of semi-structured interviews. On this basis it was possible to reveal the complexities of integrating "green" competencies into product development, marked by increasingly intense social and legal pressures and by the presence of multiple stakeholders with diverse motivations, conceptions and managerial capacities to deal with the environmental issue. With that, this paper attempts to advance our understanding of the managerial, technical and operational issues facing the integration of development strategies for "green" products in terms of the Brazilian reality. In this way, Project Alya ECO has demonstrated that, from an environmental perspective, the traditional limits on corporations are no longer applicable to the development of new products, calling for vision and control over the entire product lifecycle. By integrating the notion of circularity, the business in question demonstrated its capacity to perceive another relationship with its stakeholders and, from that, build a strategy which allowed it to reduce its costs of materials, pay fewer taxes and prepare for new regulatory obligations. In particular, the incorporation of the environmental dimension into the product strategy implied a change in the conventional concept of its supply chain towards the adoption of a closed-loop supply chain. This means that the success of Project Alya ECO depended not only on the capacity of executives to manage environmental innovation strategies, but also on their ability to integrate the activities of other partners into the production chain. In this way, the logic of antagonism (win-lose) was transformed into a perspective of cooperation (win-win) in the approach to relationships between environmental objectives and business strategies.

1.INTRODUCTION

The interaction between businesses, society and the environment modifies management and performance assumptions. The problem therefore arises of how to innovate while at the same time conserving natural resources without causing harm to society (GILLEY, 2000; MILES, COVIN, 2000). A greater understanding of the role of technology in the organization of production and its effects on our society and environment has led to questions on the standard of operations of business organizations and their consequences (DAROIT, NASCIMENTO, 2004; SHARMA, 2000).

In this context, the creation of innovations and technological evolution come to be conditioned by factors besides those determining the accomplishment of profits from economically more efficient processes, and new managerial perspectives begin to

emerge as being essential to the maintenance of production processes. Within this context, policies aimed at the development of sustainable products require the integration of economic, social and ecological issues along the entire production chain. To achieve this, there is a necessity to transform the paradigm based on the indiscriminate use of resources as a source of competitive advantages into another which, through the adequate utilization of resources, prevents their exhaustion and substitutes them with others that do not cause environmental harm.

Businesses that find in ecology a driver of innovation, reposition themselves with regard to the environment. Such an approach may take shape through ecodesign practices which require an evolving production chain, where companies associate with one another for the purpose of developing new products with a lesser environmental impact and to establish new approaches towards innovation. This has direct implications for the strategic management of environmental issues, by seeking to transform investments into sources of competitive advantage.

In this sense, this paper aims to identify the conditions that justify the incorporation of environmental strategies into product development and creation of innovations. Specifically, to understand the difficulties facing the production chain in the development of products from recycled materials. This investigative initiative gains further importance in that it shows the need for more systematic studies on product development strategies from the perspective of their environmental impact along the production chain. Bibliographic references in this field of activity in Brazil are rare and dispersed, even though it shows significant economic expression and is attracting increasing interest from business, government and society alike.

In order to address the proposed objectives there will be a brief revision of the literature relating to the construction of a closed-flow strategy for the development of "green" products, as well as the necessary "green" competencies for such an undertaking. The remainder of the paper will focus on the strategies employed by an Italian multinational company – a major producer of PET resin (polyethylene terephthalate) – to launch in Brazil a fiber manufactured from recycled plastic packaging, thereby ending the first cycle of the product and initiating a second, as noble as the first. The results indicate that environmental demand stimulates creativity and can lead to wider product evolution: novel functionalities, materials, technologies and uses.

2. MOTIVATIONS FOR THE ADOPTION OF ENVIRONMENTAL STRATEGIES IN PRODUCT DEVELOPMENT

The involvement of businesses in environmental problems acquires strategic importance given that it increases public interest, as well as the interest of stakeholders, with regard to environmental issues (BARBIERI, 2004). Experience shows that such an attitude has difficulty in arising spontaneously. There are three basic reasons why companies improve their environmental performance: first, the regulatory framework is moving towards stricter requirements in respect of environmental protection (LAU, RAGOTHANAMAN, 1997; ANTUNES *et al* 2003); second, the market is evolving (as much with regard to suppliers as consumers and competitors) (AZZONE, NOCI, 1998; GILLEY, 2000); and third, awareness is changing, with the increasing discovery and publicity of the causes and consequences of environmental damage (Rosen, 2001; TOMS, 2001; MILES, COVIN, 2000).

Businesses that anticipate in the attendance of new demands from their stakeholders by means of legitimate and reliable actions end up establishing an important strategic edge (BARBIERI, 2004). Those adopting a pro-active attitude, and

viewing environmental requirements not as costs but as opportunities to innovate – improving their processes and products –, frequently accomplish a more favorable competitive position, reducing costs and/or increasing the value of their products (ANTUNES *et al*, 2003). Therefore, the change from a logic of antagonism (win-lose) to a perspective of cooperation (win-win) in tackling relations between environmental objectives and business strategies becomes imperative (ANTUNES *et al*, 2003; AZZONE, NOCI, 1998).

In fact, companies whose objective it is to exploit the advantages of strategic environmental management need to plan new proposals for the development of their products (JABBOUR, SANTOS, 2006). However this argument is more developed theoretically than in terms of day-to-day organizational practice (KAEBERNICK et al, 2003). The development of "green" products will be the great challenge facing businesses, given that this type of strategy requires the development of diverse organizational competencies (HART, 1995).

3.BUILDING A CLOSED-FLOW STRATEGY

Fundamentally, ecological products do not exist (KAZAZIAN, 2005). Each of the product life stages generates inputs and outputs that will have environmental impacts. These stages must be analyzed starting with product conception because each one has potential for environmental optimization: in the selection of raw materials, technologies and manufacturing processes, in the logistical organization; in the context of usage and in the final processing of the product (KAZAZIAN, 2005; MANZINI; VEZZOLI, 2002).

This approach facilitates a much wider vision of the product life, its future and end of life, including the value with which it may attributed at the point of possible reintegration into another product's cycle. Therefore, it can be said that ecodesign – or ecoconception – is an approach towards continual improvement, given that no state is absolute or enclosed. According to this approach, the environment is as important as technical feasibility, costs control and market demand (KAZAZIAN, 2005). Ecodesign is therefore a project model oriented by ecological criteria (MANZINI, VEZZOLI, 2002). The issue will always be to seek a closed-flow cycle that embraces synergy between the actors.

It is believed that the potential for the environmental improvement of a product is defined in the initial stages of its development, more than in the procedural stages of production, logistics and recycling, when the product is fully determined and available to the market (NIELSEN, WENZEL, 2002). Any approach towards environmental integration starts with knowledge of flows and their impacts and continues with the execution of proactive approaches grouped under the generic term of ecoefficiency.

The concept of ecoefficiency, introduced by the World Business Council for Sustainable Development (WBCSD), translates the notion that it is possible to reconcile the environmental performance of businesses with economic performance. Ecoefficiency consists of the supply of goods and services that satisfy human necessities and increase the quality of life, at competitive prices, with a progressive reduction of the ecological impacts and intensity of resources in their lifecycle, to a level compatible with the Earth's estimated sustainability capacity (DeSIMONE, POPOFF, 1997). In summary, the concept of eco-efficiency means to produce more (and create greater value) with less (resources and waste products).

Eco-efficiency can be achieved through changes in the productive processes (for example, by closing materials cycles and promoting energetic efficiency), from

innovation at the level of product design (ecodesign) to changes in the product-consumer relationship. In this last case, by adopting for example the concept of the producer's extended responsibility which widens the treatment of a company's environmental impacts to the entire lifecycle of its products, from the upstream aspects of the production chain, relating to the supply of materials and services, to the impacts taking place in the phases of utilization and final destination of the products (ANTUNES et al 2003).

Integrating the idea of the cycle into the manufacture of products implies that, gradually, all manufactured products acquire a new essential function: recoverability (KAZAZIAN, 2005). Recovery refers to all resulting stages, whether reutilization of the product or its components, the recapture of energy through incineration or of materials through recycling. Ideally, all elements of a product should be able to circulate indefinitely – or at least for the longest possible period – in successive cycles of utilization (KAZAZIAN, 2005).

A closed-flow strategy indicates that the company is in control of the entire product life-cycle, in particular the end of life. Once returned, the product is remanufactured, updated to be sent back to the market or disassembled for the reutilization of certain parts in new products. In this way, new industrial structures are created: two factories within the same production location; one that produces, another that remanufactures or recycles used or returned products.

Such transformations also lead to the reorganization of the role of businesses in the economic cycle. Manufacturers of finished goods also become producers of secondary raw-materials and of services (MANZINI, VEZZOLI, 2002; NOCI, 1995). Obviously, closed-flow strategies require significant logistical organization, even if only due to the obligation to maintain a direct relationship with clients who, therefore, cannot be geographically overly widespread (KAZAZIAN, 2005).

3.1 Integrating environmental criteria into product development

Integrating environmental criteria into the product development process requires managerial, technical and operational changes in order to create a "green product project" (Kruwet *et al*, 1995). **Figure 1** summarizes such criteria:

Figure 1: environmental criteria for product development

Managerial - Co-design: participation of suppliers in the product project - Systematic Vision: comprehensive assessment of the environmental consequences of both products and processes.
Technical - Ecodesign: consideration of *ecodesign* techniques as strategic tools for product development.
Operational Changes to the logistical project implying consideration of: - Product structure; - Individual components; - Disassembly operations; - Reverse logistics; - Planning and control processes.

Source: adapted from KRUWET *et al* (1995); AZZONE, NOCI (1998)

In **managerial** terms, two elements are important in transforming the ecological challenge into a competitive dimension: (1) The participation of suppliers in the product project. According to the experience of innovative businesses, the introduction of co-design (carried out in conjunction with suppliers) allows such companies to anticipate pressures and more widely identify different options during the project phase. A product's environmental characteristics are frequently influenced by the composition of its raw materials, in addition to their quality. For example, it is impossible to recycle a product if one material is incompatible with another (NOCI, 1995). (2) A more profound consideration of complementary products resulting in environmental consequences. For example, a manufacturer of washing machines should consider itself as not only a manufacturer of machines, but also take into account that its product forms part of a process that allows the consumer to have clean clothes.

From a **technical** point of view, product managers should consider ecodesign techniques as strategic tools in the development of new products (AZZONE, NOCI, 1998; Dewhurst, 1989). Considering that "green" themes can represent a significant motivating factor for product differentiation, the introduction of and/or greater focus on the execution of recycling or disassembly in the project allows the product manager to identify the ideal trade-off between a product's environmental compatibility and its contribution to business profitability.

Product managers need to introduce significant changes to the project logistic to consider an operational criterion of defining a product's specifications. From an ecodesign perspective, such orientations may be grouped among four classes (KRUWET, *et al*, 1995): (1) Product structure: The need to minimize the variety of materials, reduce the number of items in the composition of materials and facilitate access to more valuable and dangerous materials. (2) Individual components: Avoidance of materials that is incompatible with the recycling process. (3) Disassembly operations: Use of elements that can easily be disassembled, reducing the number of connections as well as the need for destructive disassembly techniques. (4) Logistics: The project team must consider the possibility of stamping the material with a number that identifies its nature and whether it may be recycled, supply all information necessary to make the recycling process easier, and adapt the project for transportation after usage. (5) Planning and control processes: modification of the strategy formulation process, including it in budgetary activities.

Special attention should be given to the logistics process. The change in the traditional view of the product life cycle to the "cradle to cradle" approach requires introducing the concept of the closed-loop supply chain. The viability of the majority of innovations in green products depends very much upon whether it is possible to achieve effective management of the reverse flows of goods (Starik, Rands, 1995; Steger, 1996; Zikmund, Stanton, 1971). From this perspective, individuals in charge of the logistics process can assess, for example, whether a planned green product may easily be recovered for use in another industry.

Since it is impossible to maintain direct control over the entire product lifecycle and due to the multidimensional nature of "green" competencies, innovative businesses are motivated into defining cooperative relationships with external stakeholders and considering communication as a basic element for the amplification of the desired environmental results (AZZONE, NOCI, 1995). Executives should be involved in the introduction of vertical cooperation along the supply chain (suppliers and clients). Specifically, for suppliers this requires: (1) the frequent exchange of information to

assess the best environmental properties of supplied materials and to identify how they might affect the end product's overall environmental performance; (2) the provision of significant support for improving the environmental management systems of suppliers with less expertise in this area.

From a broader perspective, integrating the ecologic dimension into the strategic formulation process frequently forces executives to rethink their general business strategies and, specifically: (1) to modify the strategies based on cost, since the improvement of the company's environmental performance generally requires the acquisition of and/or internal development of new technologies, thereby affecting the economic results in terms of the additional expenses for new investments. (2) to change strategies based on differentiation: in particular, the opportunity to acquire a good market share or participation in the niches of a new market can favor redefining the specifications of the product project in favor of the product's higher environmental compatibility. (3) to alter integration policies both downstream and upstream. Programs with a view to improving the environmental performance of a key product may encourage managers to modify their upstream integration choices: considering programs based on recycling, the product planning and engineering can oblige the company to manufacture internally components that were previously manufactured by external suppliers. Inversely, the increasing interest in reducing the amount of waste products sent away for disposal can lead managers to reexamine their downstream integration choices. In this case, some businesses establish reverse channels in the supply chain within the corporation, in order to facilitate the return of products at the end of their lives (GUPTA, 1995; LEVY, 2000).

4. METHODOLOGICAL STRATEGY

The research question of this study is: how and why an organization would include the environmental variable in the strategic decisions of products? Specifically, by understanding the difficulties facing the production chain in the development of products with recycled materials. Before research questions of this nature, the validity and relevance of exploratory studies as a research strategy are strengthened (BRUYNE, *et al*, 1991). Furthermore, it is worth highlighting that environmental studies, through the actual multidimensionality of the phenomenon, require inter-, multi- and trans-disciplinary constructions, which strengthen the execution of the exploratory research and the recourse to qualitative strategies for data collection.

Therefore, the present research takes the form of a case study as proposed by Yin (2005), relying on various sources of evidence: collection of secondary data, documentary analysis and realization of semi-structured interviews. The investigation, exploratory in character, focused on the environmental strategies of an Italian multinational – a major producer of PET resin (polyethylene terephthalate) – to launch in Brazil a fiber manufactured from recycled packaging.

The selected company, M&G Resinas e Fibras, belongs to Italian corporation named Gruppo Mossi & Ghisolfi. It began its operations in Brazil in 2002 by acquiring the polyester division of Rhodia. Therefore, M&G inherited the environmental policy that had been put in place by the Rhodia group since the eighties in Brazil. It is currently the second largest producer of PET resin in the world, surpassed only by the American firm Eastman/Kodak. In addition to having factories in Mexico and Italy, the company has investments in the United States and the United Kingdom. In Brazil M&G has four factories whose purpose is the production of PET resin, the polyester fiber and

the recycling of PET packaging. It has close to 60% of the market share of PET resins in Brazil, following its acquisition of all shares in Rhodia-Ster in 2002.

Data collection (carried out between February 2006 and April 2008) was accomplished through the construction of a database with secondary data about the company and selected product and through semi-structured interviews with representatives from M&G's managing body who were directly involved in the development of the recycled fiber at that time. From within the company, interviews were conducted with the product and research and development managers, as well as the Director of Recipet (the group's recycling entity). Interviews were also held with qualified informants from institutions representing the interests of businesses with activity in the recycling of packaging in the country. The Director of Communication of the Brazilian PET Industry Association (ABIPET) and the President of the Brazilian Business Commitment for Recycling (CEMPRE) were both interviewed.

The interview outline was intended to explore profoundly issues relating to the criteria for development of a "green" product, especially with regard to the "why", "what" and "how" of the processes taking place within the chain. Themes such as the following were contemplated: current structure of the chain and its historical evolution; managerial strategies adopted by the different actors involved in the chain in coping with demands for quality, reliability, productivity and ecoefficiency, with emphasis on three major segments (corporate, government and civil society); managerial, technical and operational challenges confronted during product development; certain characteristics of the consumer market; and tendencies in the evolution of recycling.

Likewise, other sources of evidence were investigated through the collection of specific secondary data, such as: national and international non-government organizations, and national and international industrial and business associations. The collection and analysis of data were processed on the basis of theoretical framework already outlined, as per the strategies described in Figure 2.

Figure 2 - Data Collection Strategies

Data Source	Collection Technique	Collection Target
Primary	Semi-structured personal interview	Three managers/director of Gruppo M&G, directly involved with product development. Two qualified informants, selected from among representative groups of industry – ABIPET, CEMPRE.
Secondary	Bibliographic research	Literature on environmental management, with emphasis on innovation and regulation, reverse logistics, ecodesign, lifecycle and "green" competencies
	Documentary analysis	Documents and studies, available on internet portals created by governmental bodies (IBGE, 2000; LIMPURB, 2004; Directive 94/62/EC) and institutions representing the interests of businesses and organizations involved with PET recycling (ABIPET, CEMPRE, NAPCOR, PLASTIVIDA) - Articles from newspapers of general and business interest

With these strategies it was possible to reveal the complexities of integrating "green" competencies into product development, marked by increasingly intense social and legal pressures and by the presence of multiple stakeholders with diverse motivations, conceptions and managerial capacities to deal with the environmental

issue. With that, an attempt is made to advance our understanding of the managerial, technical and operational challenges involved in integrating strategies for the development of "green" products into the Brazilian reality.

5. THE MANY LIVES OF PET

PET polymer is a polyester developed by the English chemists Winfield and Dickson in 1941. It obtained rapid growth, initially by substituting cotton as a textile fiber and then in the 80s through the application of films for packaging. PET is the name given by the market to polyester destined for the production of packaging, the most common of which is destined for the soft drinks market. Therefore, PET is a so-called "bottle grade" polyester in contrast to its similar use in the textiles sector which is known as "fiber grade". It is necessary to consider that the "fiber grade" polyester – employed in the production of fibers and filaments – and the "bottle grade" polyester are two products with the same raw materials base, however, during their manufacture they are mixed with different additives in accordance with their final intended use (R&D Manager).

However, one of the most important aspects concerning the utilization of PET in the packaging industry was the challenge in recycling a material that, if improperly disposed of after usage, can become a significant source of social and environmental problems (ZANIN, MANCINI, 2005).

The director of Recipet indicated that in 2005 the PET recycling industry in Brazil attained a level of 174 000 tons, that is 47% of the total amount of PET produced during that year. It is a significant percentage, especially when taking into consideration that 30% of the more than 5 thousand municipal districts do not have any form of garbage collection and little more than 200 of them operate a system of selective collection (IBGE, 2000). As in the case of other recyclable materials, PET waste is obtained through informal selective collection, by garbage collectors and scrap dealers, who usually, due to the lack of an appropriate policy on solid waste, still acquire it directly from garbage dumps and the streets.

As a result, the development of the Brazilian recycled PET market has required substantial concern along the entire chain with regard to the quality of the product in its second lifecycle. Furthermore, it poses a significant technological challenge to develop new applications (Recipet Director). Such efforts to recycle have given rise to a variety of technologies and centers of research and development with a strong involvement in the sector. Zanin and Mancini (2005) list 28 Brazilian universities and research centers that are carrying out investigations relating to recycling and reutilization of waste, above all focusing on technological development.

In order to improve recycling in the country, various institutions were established by industry during the 90s. The most important of these are: ABIPET – a body linked to the PET production chain – which is responsible for technical and operational issues concerning the market, the publication of actions and information and empowerment of partners; CEMPRE which is responsible for increasing the recycling activity of all materials; and Plastivida Socio-environmental Institute of Plastics, an association established by the Brazilian Chemical Industry Association (ABIQUIM).

Currently, PET polymer is one of the most recycled plastics in the world, owing to its extensive range of applications, from textile fibers to packaging (NAPCOR, 2004). According to ABIPET (2005 b), Brazilian transformers are large (45%) or medium-sized (35%) businesses. Textile fibers make up the main use of recycled PET in Brazil, 37.1% in 2004 (ABIPET, 2005 b), as in the rest of the world. In the United

States, for example, 54.6% of recycled PET was utilized by the textile industry (NAPCOR, 2005). A significant further amount is used to mold auto parts, as well as in the manufacture of carpets, pillow filling and packaging for cleaning products.

Brazilian legislation (Resolution no. 105, ANVISA 1999) has vetoed the utilization of plastic materials originating from packaging, fragments of objects, recycled or previously utilized materials, with the exception of PET. The principal requirement for the use of recycled PET in contact with food items is registration of the product with ANVISA. The packaging must be labeled with name of producer, batch number and the phrase "PET-PCR" (Resolution no. 20, ANVISA, 2008). Therefore, its utilization depends on the registration of specific technological processes for the obtainment of these materials. For this purpose, the so-called bottle-to-bottle technologies have been developed which involve different stages of washing, decontamination, crystallization, solid-state post-condensation and extrusion of PET (SPINACE, PAOLI, 2005). In Brazil, *"there are already four industrial plants producing with this system"* (ABIPET manager).

The urge for regulation stems from the risk of impregnation of toxic chemical products (through storage of pesticides, automobile products, solvents and microbiological action on food residues, among others) during the reutilization of packaging for other purposes (SANTOS, *et al* 2004). Certain European countries, as well as the United States and Canada, have already adopted regulated technologies for the utilization of resins recovered from plastic materials, in food packaging, especially those manufactured from PET. In the United States, such utilization already represents 14.3% of recycled PET (NAPCOR, 2005).

Even with favorable legislation, *"various specificities of the Brazilian reality bring serious obstacles to the utilization of recycled PET for food packaging: difficulties with inspection, lack of selective collection, collection from garbage dumps and mixing of dry and wet garbage at origin"* (CEMPRE President). It seems clear that PET recycling needs to advance in terms of quality and reliability in order to overcome technical barriers to allow the application of plastics across a wide range of segments, including direct contact with food items. Bottle-to-bottle recycling is a challenge for the PET market that, once the legal, technical and operational barriers have been overcome, will close the resin's lifecycle.

Another limiting factor is the supposed consumer resistance to recycled products (ABIPET manager). In contrast to the paper sector which has established a "brand" from recycled paper that is synonymous with social responsibility, in the world of polyesters industries still fear rejection by the public who might imagine that PET recycled fiber must be less expensive and, therefore, of lower quality and/or harmful to health. *"Everyone fears that the public may think that the products are of low quality by using something that comes from garbage"* (Czapski, 2003, p.20). It is within this context that Project Alya ECO was born and became an integral part of the environmental strategy of M&G. It is presented below.

5.1 Alya ECO: a strategic approach to environmental issues

By the end of the 90s, Rhodia-ster (at the time a subsidiary of the French Rhodia Group, and today part of the Italian corporation Gruppo Mossi & Ghisolfi – M&G Resins and Fibers) had the need to launch a new brand for its line of textile products. The company's cut polyester fibers, a raw material utilized to compose threads employed in a wide range of clothing and decorative products, were utilizing the Tergal

brand. *"The Tergal brand was well recognized in Brazil and internationally in the 60s and 70s, but had shown evident signs of aging over the course of time"* (product manager).

Market research carried out by the company on consumers, from institutional (spinning mills, weavers and clothes manufacturers) to end consumers, revealed that the brand no longer carried the same vitality of the past and that its rejuvenation would be a costly exercise with no certain result. The decision, at the end of 2000, was one of creating a new brand that would be more appropriate for naming a family of products – still under development – to substitute an existing one.

"The chosen name was Alya. However, for the launch it was necessary to select a product that simultaneously symbolized the technical innovation and market-leading aspect which the new brand should suggest" (product manager). Among the products at an advanced stage of development was a very fine polyester fiber, for use in spinning machines and focused on the clothing market, whose distinguishing characteristic was the fact that is manufactured 100% from PET. "Nevertheless, it was not obvious that a polyester directed at bottles could be utilized in the manufacture of textile materials" (R&D manager).

Textile fibers made partially from recycled polyester were not a technical innovation in themselves and, even at that time, the product was already fairly well known. In 1979, Wellman – a nylon and polyester producer and recycler from South Carolina, USA – developed the first fibers to be manufactured by this route. Just a small amount of material of recycled origin was utilized in the composition and these fibers were thick, made for filling toys and simple upholstered products, or the manufacture of less technical non-woven products. These products demanded little with regard to the performance of the fiber, with minimum attributes of physical resistance and volume being sufficient.

Over the course of time, this transformation from bottle into fiber was technologically improved, and products created with this technique became more capable of accomplishing a more extreme list of demands. One reality, however, would not change: fibers made from recycled material were inferior in terms of their technical performance to comparable ones made from virgin material. The challenge of producing a polyester fiber with correct performance, made 100% from recycled raw material, presented a much greater challenge. This difficulty was also based on the variability of recycled material, in addition to the issue already considered with regard to the slightly different composition between polyesters intended for textile and packaging usages.

The process for production of polyester fibers from traditional raw materials (PTA – purified terephthalic acid; and MEG – monoethylene glycol) is strictly controlled, in order to guarantee that the final product is extremely uniform, and so that it does not cause variations in processing at a later stage. In the case of recycling of bottles there are many different possible variations that, alone or in combination, can cause problems for the stability of the final product. Some of the principal technical difficulties are: (1) Different PET manufacturers with small differences in the specification of raw materials or additives; (2) PET manufactured on very different dates, with the consequent divergence of additive types which develop over time; (3) PET with different viscosities depending on the requirements of a particular machine or packaging type; (4) Bottles manufactured by different equipment in the production of packaging, with different degrees of stretching; (5) Possible mixtures of PET with other materials, such as those composing the label and cap, for instance, usually made from other types of plastics.

All considered, the technical challenge turned polyester fiber manufactured 100% from recycled PET into a great innovation, and would allow the Alya brand to be presented to the market in association with a truly differentiated and technologically advanced product, in addition to the enhanced market possibilities provided by its ecological appeal.

The project to transform PET bottles into a substantially fine fiber involved teams from Recipet – M&G's recycling business – in the area of Research & Development and at the Poços de Caldas plant. One of Alya ECO's distinguishing characteristics is its fineness: it is finer than cotton fiber. That was one of the challenges in its development, even for a company such as M&G which was already producing recycled fibers, albeit thicker, for carpets.

5.2 Project Alya ECO: Integrating "green" competencies

Technical problems with the production of the fiber were resolved thanks to the expertise of the company in the production and processing of the polyester, a market in which it has been active for decades. And complex aspects linked to the recycled raw material were dealt with thanks to Recipet, which has exclusively worked with PET recycling issues since 1995.

The following is a very relevant observation for the success of the project: Recipet was created immediately after Rhodia-Ster was incorporated, with the objective being for the company to be involved during all phases of the PET production chain, beginning with the production of its main raw material (PTA), passing through to the manufacture of PET and the packaging, then finally arriving at the recycling of the bottles. One of the risks in utilizing recycled materials as part of the composition of another product lies in the solidity of the supply chain. In this case, M&G integrated part of the reverse channel to within the corporation, in order to facilitate and guarantee the return of PET packaging to the production cycle.

The task has been greatest and has required special attention during the phases of development and manufacture of the PET packaging. *"The use of materials that are difficult to separate from PET such as those in labels, glue, caps and seals, for example, can be prejudicial to the quality of the recycled resin or may even render the process unviable"*, explains Recipet's director.

To raise awareness in the packaging sector about the subject, Abipet launched in 2005 a document entitled: "Guidelines for the PET bottles project", with recommendations on the technical characteristics of the packaging and its accessories to be followed by designers (ABIPET, 2006 b). The idea is to avoid the use of inadequate materials, which would be difficult to separate and would compromise the quality of the recycled resin. The document is being distributed via the specialized media, in workshops and in visits to large companies which manufacture packaging.

In the post-consumption phase, Recipet's director points out that the major difficulties are found in the lack of an environmental culture with regard to the Brazilian consumer, who typically mixes recyclable materials with organic garbage at origin, and in the logistics, due to the inexistence of selective garbage collection. The challenge to be overcome lies in improving quality. Incentivizing cooperatives of garbage collectors has also been part of the work in integrating the reverse channel. After collection, sorting and bundling, in large part carried out by garbage collectors and scrap dealers, the reutilization process continues with the separation by colors of the discarded packaging. Pre-washed and ground, it is transformed into flakes and passed through a

refining process, with further washing, drying and passage through decontamination chambers.

In order to produce Alya ECO, these flakes are submitted to a process of refusion, filtration, granulation and crystallization within Recipet. It is this material which goes to the Poços de Caldas factory in Minas Gerais for transformation into fiber. As the product was innovative not only from the technical point of view but also brought with it a differentiated appeal with regard to the consumer market, the company considered that a different approach was necessary, encompassing the entire production chain of the textile sector, so that all links of this chain might acknowledge and take on board the advantages brought by the new product.

Manufactured from recycled PET bottles, Alya ECO, a polyester fiber, was launched during the São Paulo Fashion Week (SPFW), in the summer collection of 2001/2002 created by the stylist Carlos Miele, of M.Officer, and manufactured with indigo produced by Santista, in a mixture of Alya ECO with recycled cotton. In this way, it simultaneously reached a wide range of textile subsectors, in addition to associating a cutting-edge product with an event recognized as a stage for equally innovative launches. As the fruit of Project Alya ECO – which united Rhodia-ster, Santista and M.Officer and involved the participation of CoopaRoca, a cooperative of artisans from the Favela of Rocinha, in Rio de Janeiro –, the collection reached consumers in the 80 stores of the brand and in another 500 multibrand establishments, including outside the country. Figure 3 summarizes the principal managerial, technical and operational challenges faced during the project.

Figure 3: Principal challenges of Project Alya ECO

Managerial - Product substitution: exchange of Tergal for the new brand Alya = innovation and forefront - Development of a polyester fiber produced from recycled PET - Involvement of different teams: factory (product development and R&D) and RECIPET
Technical Difficulties with recycled PET: (1) difference of origin – variable specifications for raw materials or additives; (2) different manufacturing batches – divergence in performance of additives; (3) different viscosities – depending on the machine or packaging; (4) differences in machinery – with diverse degrees of stretching; (5) mixtures of PET with other materials or plastics [label and cap]
Operational 1. Product structure – Involvement of ABIPET in publishing the characteristics required by the facilitating project for the recycling. Launch: “Guidelines for the PET bottles project” 2. Project logistics – Downstream: collection difficulties given the lack of selective collection and consumer habits; importance of garbage collectors in the collection and sorting process [training of cooperatives] Upstream: development and launch of Alya ECO along entire textiles chain: M&G; Santista; M.Officer and CoopaRoca.

Source: research data

Project Alya ECO also received an ABIT Award (the Brazilian Textiles Industry Association) in 2001 in the innovation category. Combining technology and creativity,

the Alya line was born, ready to innovate in the world of fibers and their applications. Alya ECO represents the second cycle of polyester which has previously fulfilled its function as packaging. With the advantage that the excellent properties of polyester allow a lossless recycling process: one ton of PET is equal to one ton of fiber.

Therefore, Rhodia-ster's initial goal of launching a new brand for its family of textile fibers was reached, besides having become an award winning project that united a production chain with objectives that profoundly aligned with the modern practices of environmental responsibility, while still being profitable for the companies involved. *"Alya ECO is proof that we can turn recycling into an economically viable process, involving all links in the chain"* (Kröeger, 2001).

M&G is continuing work on the development of diverse applications for recycled PET, together with several partners. *"This will help to create a demand for recycled PET"*, says Recipet's director. The magnitude of Project Alya ECO appears to be consolidating in the actions of different stakeholders. The theme of the São Paulo Fashion Week (SPFW) in 2007 was sustainability and was supported by Banco Real. *"To look at SPFW through the lens of sustainability is to see at much more than a series of parades. The event's vision is the construction of a culture of Brazilian fashion where everyone wins, with sustainability as one of the principal pillars"* (BANCO REAL, 2007). Besides utilizing recycled or recyclable materials, the idea of the event was to promote the development of the sector's production chain, involving recyclers of PET, producers of the fiber, stylists, weavers, communities of seamstresses and embroiderers and even foreign buyers. *"This is the convergence point of the partnership: the construction of a better world"* (Banco Real, 2007).

Thus, by integrating the environment with an opportunity in its product development strategy, the company in question implemented a win-win approach. In summary, it may be concluded that the company has adopted a pro-active attitude and considered environmental requisites as opportunities for innovation, improving its processes and products, while consequently obtaining a more competitive position, reducing costs and/or increasing the value of its products.

6. **FINAL CONSIDERATIONS**

The case study in question raises certain considerations. First, Alya ECO's creation integrated the company's "green" competencies by taking control of the entire cycle of the polyester – from purified terephthalic acid (PTA) to recycling. In this way, M&G found in the new product an innovation factor, and repositioned its strategies by associating them with respect for the environment. The implications for organization range from operational to strategic aspects. They involve as much the positioning of the company in markets which have environmental concerns as a requirement, to the exploitation of emerging opportunities and the development of organizational competencies along the production chain.

The multidimensional nature of "green" competencies led the company to define cooperative relationships both internally and externally. Internally it had to bring together efforts from the teams responsible for product development and R&D, and the team at Recipet, in the search for technical and managerial techniques for the problem. Externally it successfully united a diverse range of stakeholders, for example, ABIPET, for dissemination of awareness/knowledge among packaging designers, industries and training of cooperatives of garbage collectors; the chain of textile clients for development of fabrics manufactured from the recycled fiber and the launch at SPFW. Throughout these actions, communication received special care.

M&G was able to initiate exchanges of secondary raw materials and cooperate with complementary businesses to offer to the market a fiber made from recycled PET, while altering the downstream and upstream integration policies in the production chain. In this case, M&G benefitted by having RECIPET to facilitate the return of packaging to the production cycle. Furthermore, it amplified relationships with other stakeholders, such as institutions, investors and associations.

Owing to the development of recycled PET fiber, M&G was able to improve its reputation in the market and anticipate the future of its products line. The initiative increased the company's public visibility, reaching a large number of stakeholders and demonstrating its social responsibility.

Accordingly, Project Alya ECO has shown that from the environmental perspective, the traditional limits of corporations no longer apply to the development of new products, requiring vision and control over the entire product lifecycle. Through integrating the notion of circularity, the company in question demonstrated its capacity to perceive a different temporal relationship, and from that, build a strategy which allowed it to reduce its costs of materials, pay fewer taxes and prepare for new regulatory obligations.

Improving the relevance of the ecological role, as much in competitive as in economic terms, implied in a change in the concept of the company's supply chain from a logic "embedded" in the production chain to an approach based on the closed-loop supply chain. This means that the success of Project Alya ECO depended not only on the executives' ability to manage activities based on a strategy of environmental innovation, but also on their skills on integrating the value chain of the company with the activities of partners along the production chain. Consequently, it transformed the logic of antagonism (win-lose) into a perspective of cooperation (win-win) in the approach towards the relationships between environmental objectives and business strategies.

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