Politecnico di Torino

Master's Degree in Engineering and Management

Master's Degree Thesis

Development of a new eco-sustainable line in the color industry

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The Carioca SPA case

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Introduction

In less than thirty years starting from today, there will be over one million tons of municipal waste. It is the prediction of the World Bank presented in the report "*What a Waste 2.0: a global snapshot of solid waste management up to 2050"*, which wants to analyze the situation of the World about waste production and recycling.

The first data highlighted in the report is frightening: if nothing will be promptly done to stop or at least slow down the phenomenon, by 2050 the quantity of urban waste produced will increase from the current 2.01 billion tons (according to the data collected in 2016) to 3.14 billion tons, which corresponds to 70% increase due, according to the report, to a constant demographic and economic growth, in addition to the ever-increasing urbanization.

Plastic waste is 12% of all solid waste produced and 90% of waste found at sea. [a]

Plastic waste is choking oceans, yet consumption of plastics is only increasing. Cities and countries are rapidly developing without adequate systems in place to manage the changing waste composition of citizens; the real problem is not so much the collection of plastic waste, but its subsequent management; it is in fact useless to collect and differentiate plastic waste if tools and resources are not available to dispose of it.

Incineration or gasification partially solves the disposal matter but they create environment questions (emissions, solid and liquid wastes); anyway, such procedures do not improve the remaining peculiarities of wastes.

For example, an estimated 1.6 billion tons of carbon dioxide–equivalent (CO2-equivalent) greenhouse gas emissions were generated from solid waste management in 2016. This is about 5% of global emissions. Without improvements in the sector, solid waste–related emissions are anticipated to increase to 2.6 billion tons of CO_2- equivalent by 2050. [a]

With those requirements, it stands to reason that recycling is the winning solution.

Perhaps today waste management is the highest budget item for many local administrations. Municipalities in low-income countries are spending about 20 percent of their budgets on waste management, on average—yet over 90% of waste in low-income countries is still openly dumped or burned. [a] As these cities and countries grow rapidly, they desperately need systems to manage their growing waste and mechanisms to pay for the essential services that keep their citizens healthy and their communities clean.

All these aspects are increasing the environmental sensibility of the people; this consumer sensitivity is driving the market towards alternative and/or complementary solutions to those provided for years by the petrochemical industry.

For this reason it could be said that, although the bioplastic market today represents only 1% of all the plastic cake, it is quite evident that this slice is destined to increase, thanks to public opinion, politics and the economy, as well as, of course, science and technology.

In this general context, the development of new ecological and recycled materials has a strategic competitive advantage for the future of a company. This has been exactly the strategic thought of Carioca, the company that will be the subject of this work of thesis.

This strategic idea was already in the mind of the company, but the real opportunity to work on new eco-sustainable materials came up when, in February 2019, one of the greatest player of the big organized

distribution, Carrefour, asks to Carioca to produce a new product line completely recyclable and eco-sustainable.

This thesis work has the objective to analyze the work done in Carioca, to create this new eco-sustainable line. Starting from the product itself and coming up to the packaging, the alternatives that have been taken in consideration, the choices that have been made and the economic and technical reasons that led to these decisions will be analyzed.

Going into more detail, the discussion will begin by talking about the Carioca company, in such a way as to give a rough idea of its history and current reality: starting from the organization up to the production and marketed products.

Then, there will be a more detailed analysis about the materials that are used today in Carioca for their standard production: first in the product itself and then for the packaging.

At this point the thesis will proceed with the analysis of the alternatives that have been taken into consideration for the realization of this new eco-sustainable line:

For the product, the material that will be considered is the EcoAllene, particularly referring to the company that holds the patent and that produces it, the properties of the material itself, and the process that leads to its fabrication. Then the evaluation phase of the product within Carioca's own production processes will be described; for this purpose, some KPIs will be defined, which will give the opportunity to make objective assessments to the various tests which will be discussed in the next phase. At the end of the discussion on the various tests the results obtained will be evaluated, comparing them with the product in virgin material also from an economic point of view.

After the part dedicated to EcoAllene, the possibility of recycling the materials currently used by the company will be taken in consideration. The same KPIs designed in the previous phase will be used to evaluate the tests made with these materials, and the same economic evaluations will be made; during this phase, the investment in an internal recycling line will also be evaluated as opposed to the outsourcing of virgin material recovery activities.

After the discussion on the product itself, the various alternatives considered for the packaging will be compared; these alternatives are mainly PLA, NatureFlex and recycled paper; also in this case the objective will be to identify the best alternative.

At the end of all this, the results obtained by the project will be evaluated from the Company's point of view. It will be done operationally speaking, and so in response to the customer request, which caused the beginning of all, but also under a more strategic and long-range view, and so evaluating what could be the possible developments, and the possible importance for the company that the new line could achieve.

1. Company Presentation

1.1 History

Carioca is an Italian company manufacturer of stationary items, dedicated mainly to children. It derives from one of the most important Italian company of the sector: Universal s.p.a.

Founded in 1956 by the innovative entrepreneur Alessandro Frola, Universal is the company that introduced in Italy the production of the felt tip pen, with the historical plant of Settimo Torinese. All the information below could be found on the web site of the company. [1]

Figure 1.1: The historical logo of Universal. [b]

The catalogue grows rapidly and in 1965 two brands are born: ***Carioca*** and ***Corvina***; these two brands obviously are still recognised today.

- The first was affirmed in the early 60s with an historical advertising campaign featuring the gunslinger Carioca Jo, still present on many of the catalog packages. It the one that in the ’80s and ’90s made it possible for the company to establish itself as the leader in the production of coloring items and educational games.

Figure 1.2: The gunslinger Carioca Jo. [b]

- The second, specialized in writing items, will fast expand itself, especially in Eastern European countries.

Figure 1.3: The classical model of Corvina 51 blue. [b]

From the end of the 90s, the company grows again and expands, starting to produce also for third parties: some of the world's leading brands, such as Craiola, Faber Castel and Stabilo and the largest private French brands, such as Carrefour and Auchan, begin to rely on the excellent production standards of Carioca.

In the first decade of the new millennium, the company opens a new factory in Settimo Torinese and, above all, lands with a new production plant also in China.

However, some investments did not bring the expected returns and, also due to Chinese high tech competition, in 2008 the company began to lose some of its main contracts and failed to maintain its production and revenue volumes of the beginning of 2000.

In the following years, the situation of Universal precipitated and the effects of the crisis became more and more evident, until 2014, when an arrangement procedure was initiated, which sold a part of the company to Carioca, a participated company owned by Enrico Toledo's family, current CEO, and some other private shareholders.

Figure 1.4: The new renewed brand. [b]

This new team of managers and shareholders is committed to reviving the fortunes of the company. Relying on the know-how and creativity made in Italy, and making some fundamental strategic changes, they set themselves the goal of strengthening Carioca's presence on the domestic and foreign markets. The new management brings the brand to expand into other sectors and into other markets, recovering many of the lost positions.

In 2016 Carioca reaches a turnover of 18 million euros.

In May 2017 Carioca spa passes under the total control of the new property;

From that moment, the company continued to grow every year, maximizing the impact of the brand and transmitting new values of quality and refinement.

New strategies turned to the care and involvement of consumers, have led to heavily enlarge the catalog; It allows also to enter in the sector of creativity and cognitive development, reaching millions of families and recovering positions lost in a difficult market, struck by the rapidity of technological innovation and the widespread use of new types of toys.

1.2 The Product

“Tool for writing or drawing by hand provided with a tip in porous material which has the function of depositing the fluid (ink), after having come into contact with the surface”. [2]

Figure 1.5: felt tip pens. [3]

The most representative product in Carioca is the felt-tip pen, and this statement is the result of the work of a committee created specifically to give a univocal definition to this instrument, which, until that moment, took a different name depending on the function for which it was being used.

The felt-tip pen is a particular type of pen, deriving precisely from a revisitation of the ballpoint pen, with two main peculiarities: colored ink, and the tip formed by porous synthetic material (felt or nylon). It is composed, as we said, by a felt tip, from which the ink comes out, by a pad, and furthermore by three plastic components: the cap, the bottom and the reservoir;

Today it is perhaps the most widespread tool for coloring, and the various types, dedicated to always different functions, are growing more and more.

The first felt-tip pen was patented in 1910 by Lee Newman, and consisted simply of a cylinder filled with colored ink and connected to a felt tip. The first types of felt tip pen introduced on the market had interchangeable tips formed by strips of felt, a mass of non-aligned wool fibers. However, the first downsides were immediately visible: the tip was easily deformed, the stroke was not very homogeneous and the bristles slightly scraped the paper. However, the felt-tip pen was a very innovative tool in the art world and highly appreciated by great artists.

From the 1960s onwards, the point is no longer a set of non-aligned wool fibers, but becomes a well-defined point with aligned fibers; this first evolution was created, and later exported all over the world, from Japan in 1963.

Then, in the 1960s, the felt-tip pens spread in an evident manner; it happens thanks above all to the innovative idea that, it was possible to write on different types of surfaces, and after that, the low cost, manageability, ease of availability and its innate ductility contributed to its rapid rise; From here, in fact, the felt-tip pen first established itself as a recreational tool, and later also became a marker and an highlighter.

Over the years, the family of felt-tip pens has evolved and expanded again, with new brands entering the market and new functions.

In 1967 the first felt-tip pen arrived at Universal; a product still unknown to the most of Italians begins to be marketed under the name of Felt Tip 67. The results are positive, the market appreciates and the product family expands. Thus was born Junior (now known as JOY), a felt tip pen that over the years will land almost all over the world.

Figure 1.6: The new Carioca JOY. [b]

The first pieces had a central colored body and a white bottom and cap, made of polystyrene.

Over the years, the felt-tip pen has evolved, even at the level of regulations; of return a product intended primarily for children must first of all be safe, allowing them to have fun without any kind of risk.

At first, for example, the hood must be adapted, and a solution was designed in a way, in which it cannot be swallowed: the minimum length is set at 60 mm and a ventilation valve is added to prevent suffocation.

The synthetic tip is blocked thanks to a new shape “a barilotto”, so that it withstands pressure and cannot be squashed inside.

Finally, as regards the inks, many rules have regulated their production over the years.

Currently the regulations in force determine the need for protection:

- A ventilated cap
- A non-toxic, super-washable and water-based ink with the addition of food dyes
- A reservoir that does not break into smaller parts but bends
- A pad locked to the central part.

Thus, with these rules, in order to guarantee the brilliance of the color and the durability of the new water-based ink, it was necessary to find a material that, unlike polystyrene, does not dry the color inside the felt-tip pen. The majority of today’s felt tip pen consists of:

- Polypropylene, a very versatile thermoplastic polymer, for the reservoir.
- High-density polyethylene for the bottom and the cap.

1.3 The Company Today

The Settimo Torinese site is today the only production center in the company. Until 2017, the production was divided between Italy and Spain but, to exercise greater control and to reduce fixed costs, it was preferred to concentrate it in the Italian plant. More than one million pieces per day are produced here, including pens, markers and highlighters that are manufactured and distributed worldwide, with a global network active in 80 countries.

Figure 1.7: The new plant of Settimo Torinese. [b]

In the plant there is an ink department, where more than 95% of the total inks are made; all based on food coloring, to guarantee washability, safety and brilliance.

On the lower level, 34 presses are present, which, through an injection molding process, give rise to the plastic components; they are able to produce up to 8 million of pieces per day.

The upper floor comprises:

- the assembly department, consisting of 32 machines, put together the different components of the felt tip pen that have been produced in the molding department or are bought from external suppliers;
- the screen printing department, where logos or customizations requested by customers are applied;
- the packing department, which thanks to 9 other machines produces the finished product; actually, not all the packages in the catalog are machinable, so, for the packaging of these items, the company relies on the work of external suppliers who receive the felt tip pens and the packages and return the finished product.

Figure 1.8; 1.9: ; A packaging machine; The warehouse. Original photos.

Finally, there is also a part of the catalogue (mainly pencils and pencil cases) that is not produced in Settimo Torinese but is directly imported from China or from India.

Today the companies of the sector lowered the production, but Carioca is among those that have resisted.

The product offer is designed to provide children with the tools to develop and express their creativity, not only at school, but also in their free time.

To guarantee an adequate proposal for these objectives, Carioca provides three product lines that consider the needs of children of different ages:

- The main line is suitable for children who are in the middle of their schooling path; the variety between products and formats is really wide and guarantees to everyone to find the best solution for themselves.
- In 2017 the “Baby” line was launched, specifically designed for children aged between 12 and 36 months; this is designed to allow them to start expressing their first ideas through design and color in total safety.
- Finally, the line "Create & Color" is the most innovative line, designed to encourage children to develop cognitive development through the play and the color.

The company has also pursued the other historic brand of Universal, "Corvina", which since 1965 has represented the company's passion for writing instruments. Over the years, the brand has grown considerably, up to become the ambassador of the most widespread ballpoint pen after the Bic.

Figure 1.10: The logo of Corvina. [b]

Finally, in Carioca there is also a promotional division, "CariocaPromo". In addition to the complete customization of each item, thanks to a vast selection of colored plastics, it is possible to customize clips and drums through screen printing, pad printing or digital printing.

Figure 1.11: The logo of the promotional department. [b]

After the difficult period ended with the change of property in 2014, with the new ownership the company has relaunched itself, and has a great desire to improve more and more through investments and targeted projects.

In fact, only from March to September of 2019:

- the proprietary e-commerce site was launched;
- the brand has landed on Amazon and e-bay;
- a picking warehouse has been set up to process orders deriving from these online platforms with a logistics system totally different from the usual one;
- the project of the new operating system "SAGE X3" has started and will go live in the first few months of 2020;
- the new photovoltaic system has been installed which guarantees (percentage) energy self-sustaining of the plant.

In the future, projects are already planned to:

- increase the space available in the warehouse;
- automate the production and logistics processes through the implementation of an MES system and a WMS
- improve the production capacity with investments in new machines

In addition, we have worked and we still work on the project that is the subject of my thesis: the study of new materials and new possibilities to design a new eco-sustainable line that meets the actual needs of the market, of consumers and especially of the world.

2. Materials currently employed in Carioca

2.1 Product.

The two plastic materials most widely used for the production of felt tip pen today are, as mentioned before, polypropylene (PP) for the reservoir and high-density polyethylene (HDPE) for the cap and the bottom.

Furthermore, for the production of pens, Polystyrene (PS) is wildly used.

These materials will be briefly described in the following paragraphs.

2.1.1 Polyethylene

Polyethylene or Polythene is one of the oldest polymers and still the most used today. Discovered almost accidentally by E.W. Fawcett and R. O. Gibson, had its first production on September 1st, 1939, the same days that World War II began. Initially it was considered only a material with excellent insulating properties from electricity. During the Second World War it was used in large quantities in radar-related applications. At the end of the war it was in danger of disappearing until it was discovered that its properties are much more versatile than expected. These discoveries marked the beginning of the revolution in the world of polymers.

HDPE is a tasteless, odorless and non-toxic polymer and therefore ideal for contact with food. Compared to the low density grade it has a higher mechanical strenght, a higher melting temperature and a higher chemical resistance.

HDPE has few ramifications, so that intermolecular forces and tensile strength are greater than in less dense polyethylene varieties. Mechanical differences are more relevant than differences in density, so that HDPE has a higher specific strength. It is also harder and more opaque and can withstand higher temperatures (120 ° C / 248 ° F for short periods, 110 ° C / 230 ° F continuously).

HDPE finds many applications and is used both alone and in combination with other materials. Some examples of objects - including many for everyday use - that use high density polyethylene are telecommunication cables, pipelines for transporting fluids, natural gas or geothermal heat, containers, watering cans, plastic furniture, such as folding chairs and tables, plastic bags, geomembranes such as canals and dock reinforcements, reusable plastic bottles, caps for bottles.

High density polyethylene is a thermoplastic polymer derived from oil. To obtain one kilogram of HDPE, 1.75 kg of oil is required, in terms of energy and raw material. So, creating new virgin material is something that impacts so much in the economy of the World natural resources.

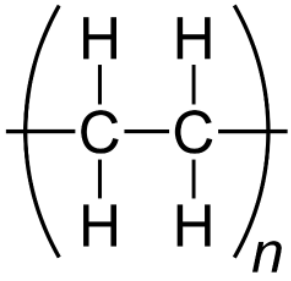


Figure 2.1: A molecule of PE. [4]

2.1.2 Polypropylene

On the other end, the industrial birth of Polypropylene is to be found in 1957, when the company Montecatini first produced this material through the stereospecific polymerization process, discovered and developed by Giulio Natta. The latter received the Nobel prize in 1963 for chemistry for this discovery, together with his colleague Ziegler. This process has been called "Ziegler-Natta polymerization" and it is considered a milestone in the evolution of the chemistry of plastics.

Polypropylene is a thermoplastic, colorless and indore material having a specific weight of 0.90-0.91 g / cm^3. The properties of the polymer depend on the degree of isotacticity. Unlike polyethylene whose density varies in wider limits (between 0.92 and 0.96) and whose crystallinity passes from 60 to 90%, polypropylene has a lower variability both in density and crystallinity.

The values of surface hardness and abrasion resistance are very high. The latter is much higher than that presented by high density polyethylene.

Polypropylene is a very versatile material, which is widely used as food grade plastic, for example for rigid food containers, such as margarine trays, yogurt jars, plastic cups for coffee or caps for plastic bottles, or for tools and accessories such as colanders. Polypropylene is also used as a packaging material to produce bags, ropes, strings and wefts for carpets. Even the dashboards of cars, labels of plastic bottles, many laboratory equipment, hail nets, CD cases, disposable syringes, sound-absorbing panels, some sutures for surgical operations and many other materials can be made of polypropylene.

Polypropylene can also be produced in form of fiber, passing the melted polymer through tiny nozzles. These fibers find application in the textile industry, which uses them for velvety carpets, upholstery, blankets, underwear and sport-technical apparel, but also for engineering works, to give greater toughness and elasticity to concrete matrices, and to produce diapers and tea bags.

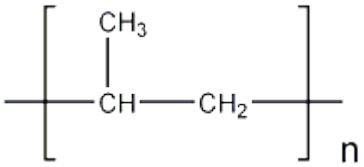


Figure 2.2: A molecule of PP. [5]

2.1.3 Polystyrene

Polystyrene is a thermoplastic aromatic polymer with a linear structure. At room temperature it is a glassy solid; above its glass transition temperature, around 100 ° C, it acquires plasticity and is able to flow; it begins to decompose at 270 ° C.

Polystyrene was first discovered in 1839 by Eduard Simon, a Berlin apothecary. It is transparent, hard and rigid. It also has discrete mechanical properties and is resistant to many aqueous chemical agents. It is also an excellent electrical insulator for capacitors.

Polystyrene is generally sold in the form of small spheres or small transparent chips, suitable for being melted and injected into molds or processed, by calendaring, into sheets for thermoforming or for coupling.

It can be easily colored, both with glossy and matt colors. The addition of the dye can be done at the time of molding, adding the pigment directly into the mold, or before molding, incorporating the pigment into the mass of the polymer before reducing it into chips for molding.

Polystyrene (PS) is used in many application sectors due to its mechanical and electrical properties.

- In the food industry it is used to produce cutlery and plastic plates, egg wraps, yogurt jars.
- In manufacturing industry it is used wherever a rigid and economical plastic is needed.

For all these characteristics, it is the chosen material for all the Corvina produced in Carioca.

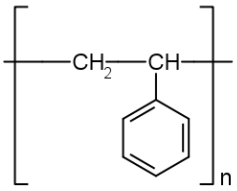


Figure 2.3: A molecule of PS. [6]

2.1.4 Molding Process in Carioca

The plastic components of Carioca products are made through an injection molding process; the plastic material in granules is melted and injected at high pressure inside a mold. Depending on the amount of material being injected, a complete cycle can last from 15 to 25 seconds and for each cycle the number of pieces obtained depends on the number of figures present on the mold.

The raw materials are managed centrally with three silos; each silos can contain up to 50 tons of material, and is connected through a circuit to all the presses.

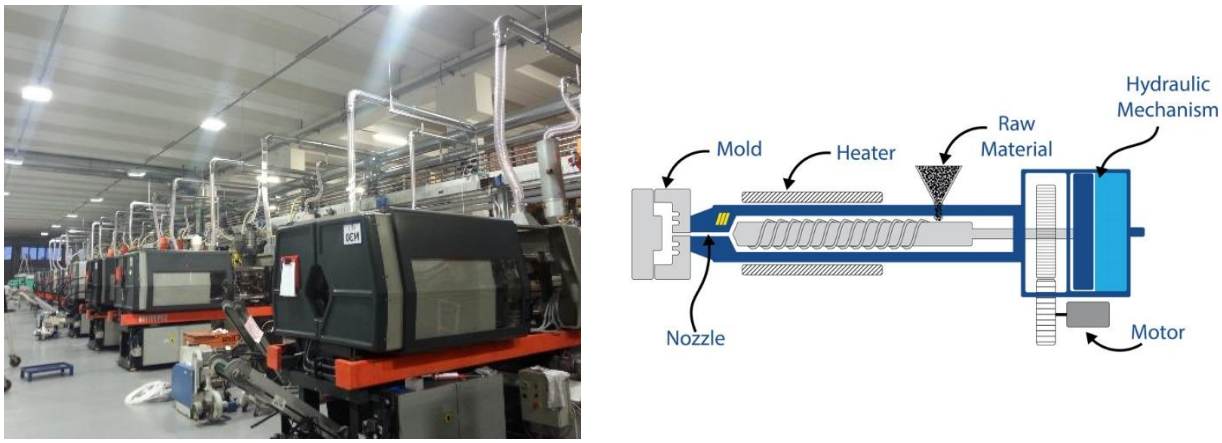


Figure 2.4: The molding department in Carioca and the scheme of an injection-molding machine. [4]

The process could be described as follows:

- The raw material in granules is sucked directly from the external silos into the hoppers, while the powder dye is loaded by hand.
- Downstream of the hoppers, the material falls into the cylinder of the plasticizing screw which, by rotating and moving backwards, allows it to descend and mix with the coloring master, added in a proportion equal to the 3% of the quantity of plastic material.
- The mixture is introduced into the cylinder of the press and here, by heating and friction, it is melted. After that, the two half molds are approached by a worm screw and locked with maximum closing force.
- Then the injection process takes place: the screw moves quickly forward, and, like a piston, forces the molten material into the mold cavity. The screw continues to be pushed forward with a lower

pressure than the injection one, maintaining the thrust on the material, until it solidifies. Specifically, two different types of injection are used:
    - at riser: every mold gives a scrap due to the injection, the riser, which slides into a grinder and is immediately recycled in the following cycles.
    - with hot chamber: there is a branched metal distributor in the fixed part of the mold, which connects to the various figures by means of sliding channels ending with a nozzle from which the injected material comes out.
- Each press is connected to two cooling circuits; the first is interconnected to the mold, while the second to the oil tank used by the hydraulic circuit.
- Finally the screw cylinder retracts for a new cycle; the two half-shells are separated and the half-shroud falls into the container below the press.
- The components thus obtained do not require further processing, but must be kept at rest to allow them to stabilize during the next 24 hours.

2.2 Packaging.

No type of packaging is produced internally in Carioca.

Talking about imported products, they are obviously bought already packaged and ready to be sold.

Production items, instead, after the assembly, must be packaged. This can be done in machine, if the pack conformation allows it, or manually.

It is possible to divide the world of Carioca packaging into 4 main types:

- Paper Wallet
- Paper Box
- PVC blisters
- PVC Flow-Pack

Figure 2.5: the main four different types of packaging in Carioca. [b]

In the company, there are packaging machines that automatically process paper boxes up to a format of 12, and paper wallets up to a size of 24. All other formats (carioca formats start from 6 and go up to the “color meter” that contains 96 markers), are packaged by hand: either by small external companies, or through an internal packaging department, which I dealt with in first person in the last period.

Conversely, all flow packs and blisters are packaged in the machine by a specialized external company, which receives all the various components from Carioca and returns the finished product, ready to be sold.

Packaging, as the product itself, due to the nature of the product and the reference standard consumer, must be as beautiful and attractive as possible. Most of the time, it must give the possibility to see the product contained in it in such a way that it is easy for the final consumer to go and make his own choice based on his own need.

Precisely for this last reason, giving the consumer the possibility to see the product, has now become a standard in Carioca. For PVC, the transparent nature of the material makes it very simple; as far as the paper is concerned, a window on the packaging is needed; to this aim, it is necessary to request specific dies to the suppliers, which obviously require a higher cost for the production of this type of pack.

3. A new Eco Sustainable Line - Product

“The transition to a more circular economy, in which the value of products, materials and products resources is maintained as long as possible and waste production is minimized is an indispensable component of the European Union's efforts to develop an economy that is sustainable, releases few carbon dioxide emissions, uses the resources efficiently and remain competitive. This transition offers Europe the opportunity to transform the economy and generate new sustainable competitive advantages.” This, besides being an essential measure for the fate of the planet, seems to be an opportunity not to be missed for European companies.

In fact, in addition to reducing energy consumption, carbon emissions into the atmosphere and protecting the planet from irreversible damage to the climate and the environment, “the circular economy will boost the competitiveness of the Union by protecting businesses from resource scarcity and price volatility.”

The EU certainly has a great role to ensure that the necessary conditions are created to ensure that the circular economy is carried out; a plan in this regard has been created. “The objective is to guarantee existence of an adequate regulatory framework for the development of the circular economy in the single market, in the give clear signals to economic operators and society in general on the way to follow for as regards the long-term objectives in the field of waste, as well as in preparing a vast series of concrete and ambitious actions to be implemented by 2020. Action at EU level it will stimulate investment and create uniform conditions of competition, break down obstacles arising from European legislation or its inadequate application, will investigate the single market and will ensure favorable conditions for innovation and the involvement of all stakeholders.”

The actions would have to support the circular economy

- At every stage of the value chain: production, consumption, repair and regeneration, waste management and re-entry in the economy of secondary raw materials.
- At every level: Member States, regions, cities, businesses and citizens.

This are exactly the intentions of the EU declared in the action plan from which are taken some of the sentences above.

Every innovation of any kind comes to life because it is driven by two main components

- A cultural and social context that needs something to which innovation can find a solution.
- The market demand that makes the realization of innovation economically attractive.

This was exactly what happened in his small to Carioca.

Therefore, within this context, and driven by the request of a great customer like Carrefour, Carioca decided to launch the project for the construction of the new eco-sustainable line.

The line has been thought to be composed by the following items:

- CORVINA WHT, WHT BALL PEN
- JOY FINE TIP, WB FINE TIP
- BRAVO, PERMANENT MARKER MAXI TIP
- JUMBO, PERMANENT MARKER SUPER MAXI TIP
- MEMOLIGHT, HIGHLIGHTER MEMOLIGHT
- MINI MEMOLIGHT, HIGHLIGHTER MINIMEMO
- MEMORY, HIGHLIGHTER MEMORY

In the next chapters some possible alternatives that have been taken into consideration to develop this new line, both at the product level and at the packaging level, will be discussed; the discussion will deal with the tests carried out, the assessments made, and the final choices that have been taken.

3.1 EcoAllene

3.1.1 Product Presentation

EcoAllene is a new and innovative material (family of materials) resulting from the recycling of waste from materials with different components glued together, that is formed from a plastic film and a metal film. These information has been written also with the help of the web sites in the sitography at points [7] and [8].

The product is manufactured using a patented European patent licensing process, licensed by the Swiss company REPLAN Global Sagl, which is the sole proprietor of trademark, patent, technical experience, and procedures for the production of this material.

The patent is the result of an experimentation concluded with the implementation of an experimental plant (built in 2013) that has allowed a first industrial production used for producing samples in several industrial sectors, sold successfully on the market. This production process has its innovation in the treatment of these waste: different attempts were made on the market before, to disjoint the two or more components of the polylaminate material (plastic film + metal film) leading to unsatisfactory results due to a low performance (products showed very low remaining characteristics) and cut down the necessary investments for the technology.

A variance, the production of EcoAllene is done without separating the two or more components but keeping them aggregated in a new formulation.

This innovation reduces the cost of recycle, allowing a strong competitiveness of the new product compared with the direct competing plastic materials.

The production of EcoAllene starts from the waste of food & beverage cartons (commonly named “Tetra Pak”); this types of pack are obtained from different layers matching, each of them with a distinctive function; from the most external:

- Paper fibres: to give structure and UV protection;
- Aluminum (AL): to guarantee UV protection;
- Polyethylene (Po or PE): to waterproof and to comply with laws about food contact.

These latest two are called “PoAL multi-layered system”: they are considered not-recyclable, as, in the paper mill they are usually discarded after the recovery of paper fibers.

In order to give an idea of the possible impact of this innovation it could be said that only in Italy, in 1 year, 1400 mln boxes of Tetra Pack are wasted.

The innovation of the production of EcoAllene gives the opportunity to create a new ecological plastic material, with a wide variety of uses for recycling objects that are otherwise destined for incineration or dump, such as liquid food packaging, oil-based bags, packaging of sweets, non-composted capsules for hot drinks, ecc…

EcoAllene is not only a simple product derived from recycled materals, but it is 100% further recyclable, theoretically endlessly; therefore, it fits perfectly into the circular economy model.

As mentioned, innovation lies in the process, such that EcoAllene™ has been awarded from Italy Republic President, Giorgio Napolitano, as the "Sustainable Development Award 2010" for its process of high environmental engagement:

As mentioned above, the tetrapak, or in any case, the polylaminate, arrives in the paper mill, and is purified from most of the paper contained in it.

After that, the PoAl arrived in the plant, that is spread over a hundred meters. The material in input is presented in the form of bales of 500kg that are inserted in the loading pit. At this point it could be possible to divide the process in three macro-phases.

- **Washing, shredding and drying:** a conveyor belt brings the material to a first wash, not before being passed on a check point, where any visible foreign materials can be intercepted and destined for recovery. During the washing phase, a deep recovery action of the residual cellulose from the passage in the paper mill is carried out. On exit from the first washing, the material undergoes a second mechanical cleaning, therefore it is dimensionally reduced.

  This is done in a system called "planetary"; here, shredding occurs in order to allow machinability of the waste and "management" of the size of aluminum present in the waste, which in origin can be up to 30 cm x 15 cm, and at the end it is reduced up to less than 1mm x 1 mm. After that the material undergoes the drying process.

- An **agglomeration** in a densifier, to make uniform the material and prepare it for the enrichment and extrusion phase;

- The **extrusion** allows obtaining the final material starting from the formulations (basic raw material + filler and/or additive); it is prepared to be sold in general market or finalized to the specific customer with "tailor made" recipes. This part of the process is carried out with a "twin" system to ensure the optimal mixing of the various recipe components, in addition to a degassing step.

Figure 3.1: The process. [d]

The material is then tested in the laboratories and completed according to the recipes required by the market. All additive materials are of Eco origin or come from recycled materials, in fact, according to Italian legislation, in order for a company to declare to sell a recycled product, it must be composed of at least 95% of products deriving from recycling. Ecoplasteam is certified and therefore must comply with this legislation.

Here below there are some original photos of the plant of Spinetta Marengo.

Figure 3.2: From the left, the material that comes from the paper mill; the plant from the high, the last step of the process, in which the EcoAllene is stocked in 1000 kg bags. Original photos.

The features that make EcoAllene particularly interesting, especially if compared to another raw material (in particular to a recycled one) are listed as follows:

- It is a 100% green product;
- It disposes of large and constant availability of raw material to production: recycled products on the market come from the production waste. This situation leads to significant variability in this material features, with particular focus on the difficulty in processability due to the different type of waste. Conversely, EcoAllene is a material that comes from certified and always constant scraps, in fact, the combined inner part of food packaging is a constraint related to the regulations on the protection of the contents both for contamination and for uv radiation; this makes EcoAllene a top-of-the-range material with a high level of features and processability.
- Easy decorable and therefore customizable; in addition, the metal effect of the aluminium gives an uncommon and particular aesthetical aspect.
- Additionally recyclable: starting from a low-tech base product, allows the recyclability of EcoAllene manufactured in the same base material production chain;
- Easy to be processed: EcoAllene's raw material constant availability is a guarantee of repeatability of process parameters over time and in batches supplied;
- Economic competitiveness: the EcoAllene recycling process is highly competitive and the independence from the oil price makes the material independent from sharp price fluctuations.
- Certification: today talking about ecology has become a fashion trend. As it often happens in these cases when an interest is so diffused, the level of the discussion and the proposals become in a dangerous way more uncertain. a lot of companies define themselves “ecological”, offering eco-friendly and recycled products often of a doubtful provenience equipped with logos of fantasy to emphasize this sensibility. Not many people are able to provide certifications about their own products and diffusing production “made in China” increases these uncertainties. The market is not capable to distinguish the true from the untrue. For this reason, EcoAllene™ represents a certainty for the market: there is control of the entire production cycle and the precise derivation of the wastes, which this new material derives from.

3.1.2 KPIs

In order to use this ecologically revolutionary material, it was necessary to make some tests to evaluate the best possible way to introduce EcoAllene in the company.

A necessary condition for the feasibility of use was the possibility of continuing to produce through the same machinery already present in the company; this obviously would have avoided having to make further investments and to go to change the infrastructure for the new material ad hoc.

All tests have therefore been carried out on existing machinery, without making any structural changes to the production plant in Carioca.

Furthermore, in order to be used, the EcoAllene should have guaranteed performances very close to the virgin materials used today for production in Carioca. The eco-sustainability must be, in fact, an added-value of the product, that must not affect the quality and functionality of the latter; otherwise the competitive advantage, which can be potentially be reached, cannot be considered sustainable.

By monitoring during tests, it was possible to achieve the aforementioned objective; five KPIs were defined:

-Moldability: the production process in Carioca starts with the molding; so, a material that must become a finished product in Carioca must have great attitude to be molded.
To be considered printable, the tested material must be able to pass through the nozzles currently present in the molds currently in use in Carioca; after that it has to be enough fluid to fill all the figures necessary to complete the finished piece.
Everything must take place at the same temperatures, and according to the same cycle used today for the virgin material; this, again, in order to avoid further “ad hoc” investments for a line that will remain, at least initially, a niche, and to guarantee the continuation of the operation of the current mechanism.

The products marketed by Carioca have the peculiarity of having details with extremely small finishes; to obtain this type of products, equally small nozzles and injection points are required, and therefore it is more difficult for a material to be considered printable in all its aspects.

The moldability is therefore inevitably linked to

- The fluidity of the material, that must be such as to allow it to fill in the entire figures
- The purity of the material: in fact, impurities larger than the points of injections would block the leakage of the material, thus making it impossible to fill the figure. Furthermore, this type of problem can also lead to serious damage of the entire mold, even reaching its final breakage.

In order to evaluate the various tests carried out, considering the possible consequences of a possible defect, even if minimal, in the printability, it was decided to clearly distinguish the results obtained, without taking into consideration the possibility of having half-measures:

- “+” → the test was successful and therefore the product can be considered printable.
- “-“ → the test did not give a positive result, or in any case, for some reasons, the material cannot be considered printable.

-Purity: In order to be used in Carioca, a material must have a percentage of pollution really low. The purity of the material is very important to ensure that the finished product will be of good quality.

Furthermore, this feature is extremely linked to printability (as already discussed), and to weldability.

In order to evaluate the various tests carried out, it was not possible to talk about acceptable percentages. Therefore, a classification that reflects the degree of purity of the tested material has been created:

- "0" → The pollution present in the tested material doesn't give the possibility to perform the molding process.
- "1" → The material is moldable, but the quality of the final product is not acceptable; the quality of the final product cannot be considered acceptable if one, or more than one, of the following characteristics are not satisfied:
    - The finished product must resemble as much as possible the virgin product from an aesthetic point of view. The final consumer is attracted by the beauty of the product, which therefore, to be appealing to the market, must respect the aesthetic standards dictated by the products currently on the market.
    - The tactile sensation during the use must be pleasant and above all, must not create inconvenience to the user; a very polluted material can for example lose pieces that can be annoying or can also hurt the user. This absolutely must not happen, also because we are always talking about a product that, most likely, will be used by children.
    - The smell must not disturb the user. To achieve this, the smell of the material should be as neutral as possible. EcoAllene has an intrinsic odor of its own, which may not be pleasant to the consumer; this feature can somehow be attenuated and neglected; having said that, however, the sensation must not be worsened by the presence of any pollutants.
- "2" → The material is both printable and acceptable in terms of quality, but the impurities present do not make the welding process possible.
- "3" → The purity of the material is to be considered acceptable to be used as the main protagonist of the new eco-sustainable line.

-Physico-Mechanical properties (P-M properties): this parameter was defined to assess how the elasticity / rigidity of the material, its strength and its conformation are suitable for the production of Carioca products.

To monitor the progress of the tests in an objective manner, the following evaluation method was created:

Three sub-indicators have been designed with relative objective tests, which could give unequivocal results; each of these tests can give positive or negative results; in the first case the relative sub-indicator assumes value 1; in the second case it assumes a value of 0.

The physical-mechanical characteristics of the tested material can be considered acceptable only if the sum of the values assumed by the sub-indicators is equal to 3.

The sub-indicators are as follows:

- The seal: it can be divided into
    - Hermetic seal: it is obtained when two components are assembled by means of a tight seal that totally prevents the passage of fluids. To evaluate this feature, the so-called "Bubble test" is employed. This simply consists in dipping the component to be tested in water, and in blowing air from the other end which is kept open; if the creation of bubbles occurs, the bubble test fails, as it is clear that the fluid has managed to pass the closure subjected to testing. In the event that the bubbles do not form, it can be said that the tested closure hermetically holds.
    - Mechanical seal: in order declare that the mechanical seal exists in the assembly of two components, it must happen that the force necessary to separate the aforementioned components must be greater than 50 N. To evaluate this feature, a dynamometer in tensile configuration is utilized. This is necessary for two reasons:
        - The product has to be performant and so the pad should not be easily removed.

- Carioca products are considered toys and therefore fall under the N71-1 standard for games used by children over 3 years.

These two types of seals must be present differently depending on the components and products:

- CORVINA WHT, JOY FINE TIIP, JUMBO, BRAVO: the hood and the bottom must hold hermetically with the tank; the bottom must also hold mechanically with the tank.
- MEMOLIGHT, MINI MEMOLIGHT, MEMORY: The hood and the bottom must hold hermetically with the tank; this feature has not to be tested because the part that is in contact with the cap is composed by the same virgin material used today; The mechanical seal will be tested with the welding process.

Depending on the product taken into consideration, the seal sub-indicator takes the value 1 if and only if all the seals required for that product are verified.

- Planting: during the assembly of the products, the production cycle involves the planting of tip and bottom (only of the tip in the case of the highlighters) inside the tank. It is necessary that during this process the conformation of the material is such that the components do not break.
  The importance of this feature is striking, since it is unacceptable that a part of the production process causes breakage of the tested material.
  In addition to testing inside the actual machinery, a dynamometer working in compression mode (IMADA, Model HV-500N II) was used to evaluate the force necessary to plant the component inside the tank.
  For example, to pant the tip into the product Bravo, using virgin material, a force of 15,6 N is necessary and the composition of PP has to withstand the process without breaking the tank. The sub-indicator can take value 1 if and only if there is no broken pieces during the assembly phase.

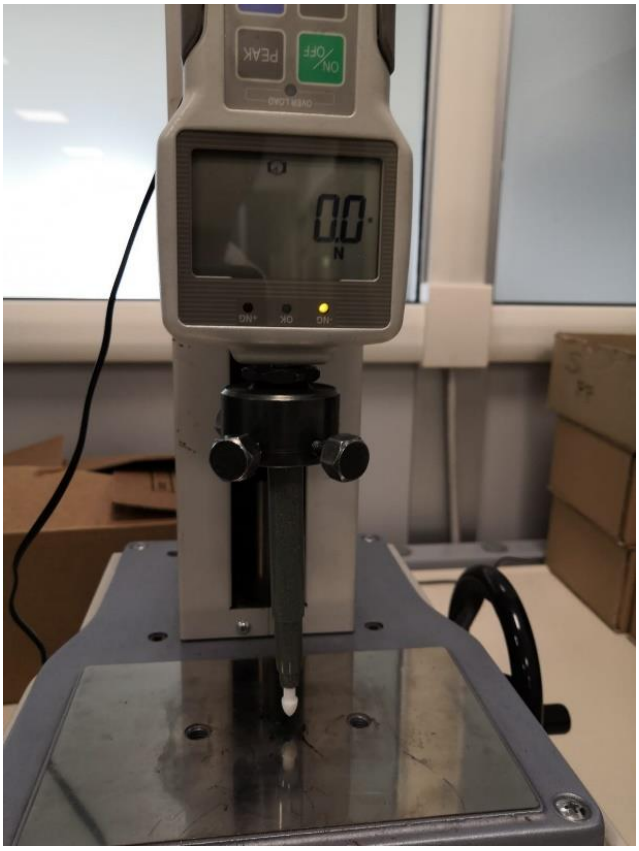


Figure 3.2: the test with the dynamometer. Original Photo.

- Resistance to deformation: it means how much the material is able to remain intact placed under the efforts that may occur during the use of the product.
  To evaluate this sub-indicator, a compression dynamometer was used to identify which force should be applied at the point normally used for use (the center of the tank) to reach the point of yield of the material.
  The sub-indicator also in this case assumes value 1 if the necessary force is higher than the canonical 50 Newton.

As previously mentioned, the value of the " physical-mechanical properties " indicator is equal to the sum of the values of the sub-indicators listed.

-Weldability: it is the attitude of a material to be welded; in other words, it is the property on the basis of which, pieces of a material can be joined to other pieces of the same or other materials, if brought to temperatures close (but lower) to their melting point.

The parameter is not significant for all the products of the new line; in fact, only the highlighters in Carioca are subjected to this process. In any case, the final objective of the tests was from the beginning to find (if possible) a conformation of the material that could be used for all the products in the range, in order to standardize the processes and not create all the management complexities that derive from diversification.

As stated above, weldability can be checked hermetically and mechanically. To evaluate the first one it is only necessary to verify that, during the normal use, the welding does not give up; to check the second one instead, the same dynamometer is used with the same parameters described for the sealing of the non-welded components. From here it was possible to create the evaluation scale used for the tests:

- "0" → the material does not weld.
- "1" → the material is welded; it keeps hermetically but not mechanically.
- "3" → the material is welded; it holds both hermetically and mechanically.

-Decorability: considering the type of product sold by Carioca, the ability of a material to be personalized is a very important feature.
The appearance is obviously a dominant variable in the world of colors, and therefore the material, which the products are made of, must be as beautiful and attractive as possible.
The tests were carried out on the three possible types of decoration that are used in Carioca: screen printing, pad printing and hot stamping.

Depending on the product, the type of decoration that is used with the virgin material has been tested and also in this case a scale of evaluation has been created:

- "0" → The material cannot be decorated using the technique used on the virgin product.
- "1" → The material can be decorated using the technique used on the virgin product, but the quality of the same is not acceptable from a point of view of palatability towards the final consumer.
- "2" → The material can be decorated using the technique used on the virgin product, the quality of the same is acceptable from a point of view of palatability towards the final consume, but the decoration evanishes if subjected to simple external stresses. The test is done manually by a quality operator.
- "3" → The decorability can be considerate in line with qualitative standards of Carioca.

3.1.3 Testing Phase

Subsequently to an analysis carried out by marketing and quality, together with the customer decided on the conformation and the materials, which the products of the new eco-sustainable line should consist of.

In table 3.1 the result of the analysis mentioned above is shown.

Model	Material of the body	Color of the body	Material of the cap	Color of the cap	Tip holder	Clip	Material of the bottom	Color of the bottom
CORVINA WHT	Ecoallene	Grey	PP virgin	Colored as ink	NA	NA	PE HD Virgin	Colored as ink
JOY FINE TIP	Ecoallene	Grey	PP virgin	Colored as ink	NA	NA	PE HD Virgin	Colored as ink
JUMBO	Ecoallene	Grey	PP virgin	Colored as ink	NA	NA	PE HD	Colored as ink
BRAVO	Ecoallene	Grey	PP virgin	Colored as ink	NA	NA	PE HD	Colored as ink
MEMOLIGHT	Ecoallene	Grey	Ecoallene	Grey with colored dot	PP virgin colored	NA	NA	NA
MINI MEMOLIGHT	Ecoallene	Grey	Ecoallene	Grey with colored dot	PP virgin colored	NA	NA	NA
MEMORY	Ecoallene	Grey	Ecoallene	Grey	NA	PP virgin colored	PE HD Virgin	Colored as ink

Table 3.1: main features of the gamma.

The initial idea has been to keep all the EcoAllene parts of the natural color of this material; this is because, despite the EcoAllene lends itself very well to the colors, for a company that produces substantially colors, it is very important the feeling that the product makes to the final consumer. In order to do it, it is important that the color is very beautiful, and possibly, that it is the more similar as possible, to the color of the ink.

To reach this point, we realized that it would take some time and some experience with the material.

Therefore, it was decided to use the natural color of the EcoAllene; this is a gray a little dirty, which by itself (also according to the people of Carrefour) gives the consumer the idea of an eco-sustainable product that is presumably looking for.

In order to give color to the product the focus has been on:

- The typical decorations of Carioca products: screen printing, pad printing and hot stamping.
- Parts such as caps, bottoms, clips or bit holders, which have been left in virgin material colored in the same color as the ink.

However, tests have been made with the colored material, and it has been seen that it is absolutely possible in the future to switch to colored EcoAllene for the entire line.

Nevertheless, when this decision will be made, an in-depth study of the inks to be used will be necessary to ensure that the first impression of the final consumer would be the best possible.

In choosing the parts to be kept in virgin material, however, care was obviously taken to keep the highest possible percentage of the product in Eco material, but making sure that the final product would still have in the simplest possible way:

- Sufficient color, to make the best possible feeling in the final consumer.
- Sufficient hermetic and mechanical seals where it is necessary.

Test 1

The materials tested in this first phase has been:

- Basic EcoAllene
- EcoAllene blend 15% PP (recycled)

All other plastic materials (not EcoAllene) are recycled material derived from the consumption chain and not from the waste of the companies.

The results are collected in the table T1. The wording “NA” stays for “NOT AVAIABLE”.

Test 1	Moldability	Purity	P-M properties	Weldability	Decorability
CORVINA WHT	-	0	NA	NA	NA
JOY FINE TIP	-	0	NA	NA	NA
JUMBO	-	0	NA	NA	NA
BRAVO	-	0	NA	NA	NA
MEMOLIGHT	-	0	NA	NA	NA
MINI MEMOLIGHT	-	0	NA	NA	NA
MEMORY	-	0	NA	NA	NA

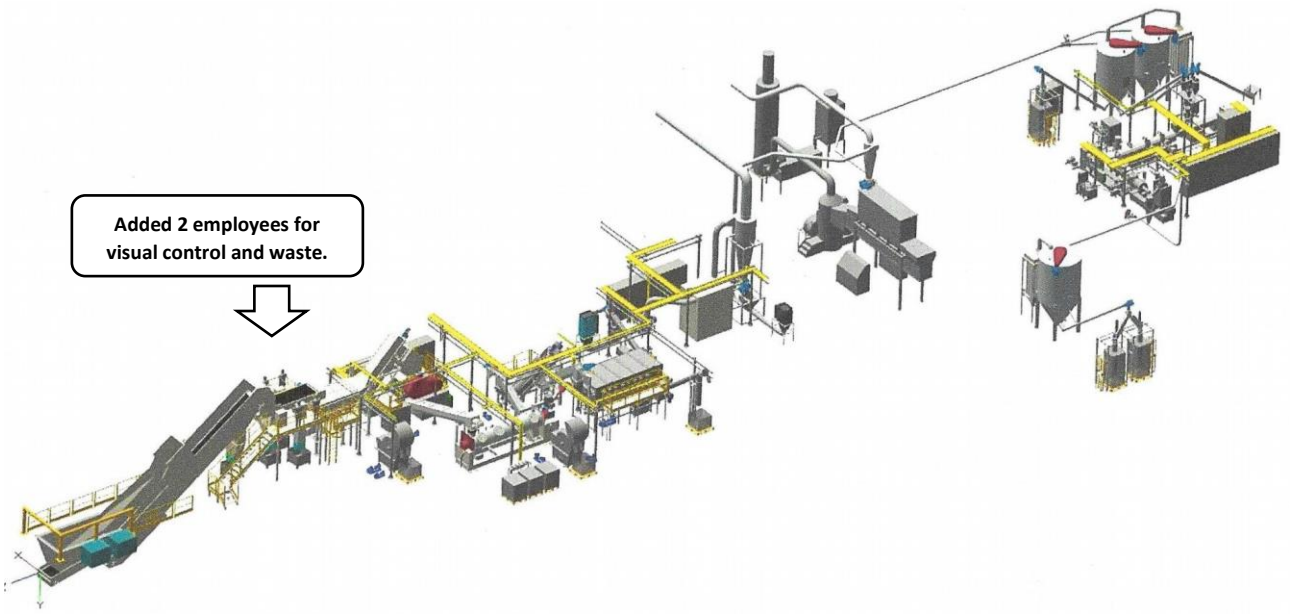
Table T1: results of test 1.

The main issues of this first test has been that the impurities contained in the material are absolutely excessive; so as to clog the leakage of the fluid from the mould injection points in many cases.

The consequences of this anomaly were that:

- It was impossible to proceed with an automatic cycle;
- The material stopped at the nozzle mouth risked to compromise the integrity of the mold in its entirety;
- The other KPIs could not be tested.

In order to remedy to these problems, Ecoplasteam increases the interception of pollutants and foreign bodies in the process phase, also adding a visual step done by two dedicated employees at the beginning of the process.



- *Figure 3.3: Changes in Ecoplasteam plant after test 1. [d]*

Test 2:

The materials tested in this second proof has been:

- Based EcoAllene;
- EcoAllene blend 15% PP (recycled).

The results are collected in the table T1. The wording “NA” stays for “NOT AVAIABLE”.

Test 2	Moldability	Purity	P-M properties	Weldability	Decorability
CORVINA WHT	-	0	0	NA	2
JOY FINE TIP	-	0	0	NA	2
JUMBO	+	1	0	NA	2
BRAVO	+	1	0	NA	2
MEMOLIGHT	+	1	0	0	2

MINI MEMOLIGHT	+	1	0	0	2
MEMORY	+	1	0	0	2

Table T2: results of test 2.

The main issue was that impurities continue to persist in the material.

In the case of the Corvina WHT and the JOY fine tip, the problem encountered in test 1 persists: the impurities block the flow at the injection points and make it impossible to complete the molding phase. This happens in particular to these two products due to the simple fact that they are composed of parts of smaller dimensions and therefore the injection points of the molds are smaller than the other products.

For the remaining part of the range the molding phase is passed in this test; the degree of pollution is however excessively high to guarantee an acceptable quality to the finished product. Besides, the rigidity was not acceptable for none of the tested products, in part because of the pollution and in part due to the characteristics of the product itself.

Furthermore, it is clear from this test that the basic EcoAllene cannot be the final choice for the composition of the new range.

In fact, two inevitable problems are immediately deduced:

- The rigidity of the product cannot be even remotely comparable to that of current products; this leads to two further possible consequences:
  - the product can easily be broken by those who are using it, which can most likely be a child;
  - the product can break in the machine during the assembly of the components, creating enormous quantities of waste.
- Compatibility with current processes cannot be considered acceptable; as mentioned the choice of the material must fall on a solution that keeps the processes and the functioning of the current machinery substantially unchanged: it was immediately noticed by these first tests that it cannot be obtained with the EcoAllene base.

The consequences of this anomaly were:

- The inability to proceed with automatic cycle on WHT and Fine Tip;
- The Impossibility to go the market with none of the tested products;
- EcoAllene base has been excluded from the alternatives.

In order to improve the results of this test Ecoplasteam:

- Add at the end of the process, upstream of the phase of compounding, a 0.4 mm mesh filtration system. This value has been defined on the basis of the Carioca injector diameter: Ø 0.7 mm.
- Creates a new blend with 35% of PP.

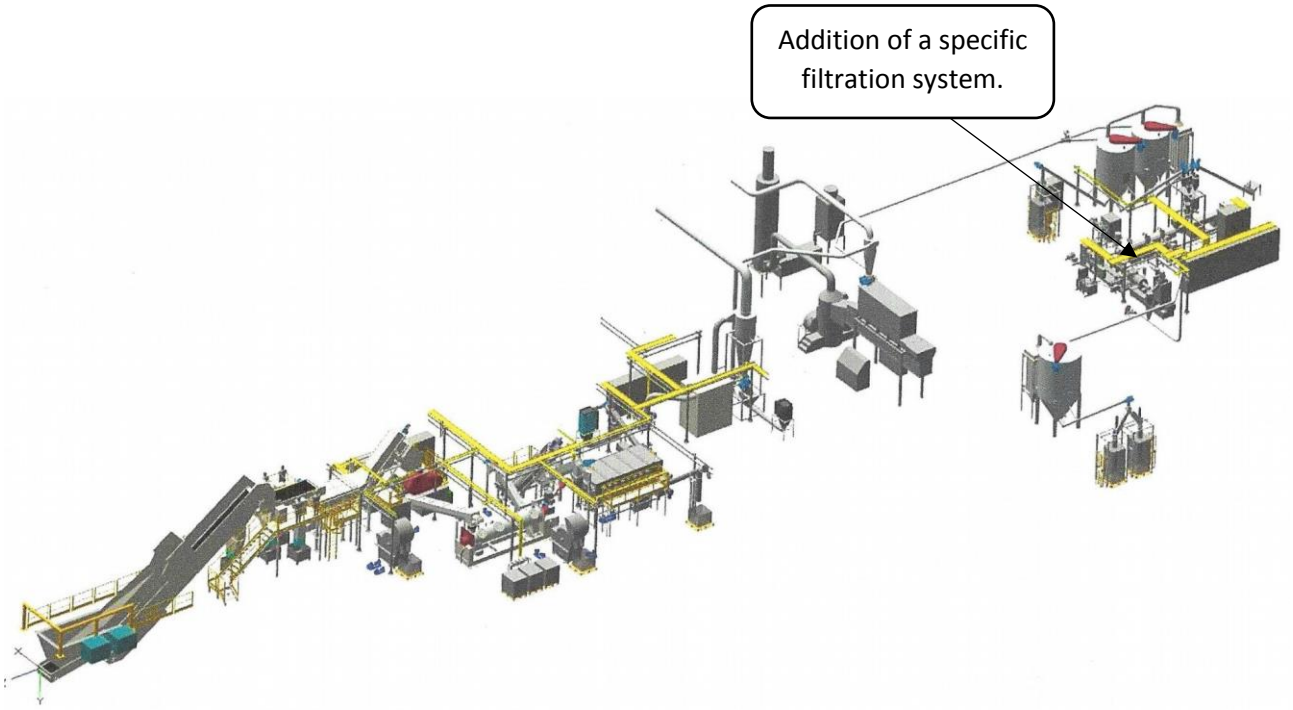


Figure 3.4: Changes in Ecoplasteam plant after test 2. [d]

Test 3

The material used for this test has been the EcoAllene blend 35% PP (recycled).

The results are collected in the table T3.

Test 3	Moldability	Purity	P-M properties	Weldability	Decorability
CORVINA WHT	-	0	0	NA	3
JOY FINE TIP	-	0	0	NA	3
JUMBO	+	1	1	NA	3
BRAVO	+	1	1	NA	3
MEMOLIGHT	+	1	1	0	3
MINI MEMOLIGHT	+	1	1	0	3
MEMORY	+	1	1	0	3

Table T3: Results of the test 3.

Despite the efforts of Ecoplasteam to improve the process based on the needs of Carioca, the problems of Test 2 reappear in the same form.

The only improvement with respect to the previous test has been that now the Decorability could be considerable already acceptable, like it could be seen in Figure 3.3.

Figure 3.3: decorations on two pieces of BRAVO. Original Photo.

Ecoplasteam, therefore, comes back again to work on the process.

- After a first interlocutory phase due to a situation totally in going against the trend with process changes, a step by step analysis of the process was chosen.
- In particular, attention was paid to residues in silos upstream of the cutting phase in the head and before packing. A deviation has been created to bypass the silos and go directly to packaging avoiding pollution from residual stock.
- Enhancement of silos agitator motor to avoid the formation of permanent residues on the bottom.
- Added additional interceptions during the process.
- Materials reproduced from scratch with a new compound mix for the purpose of increasing the form.

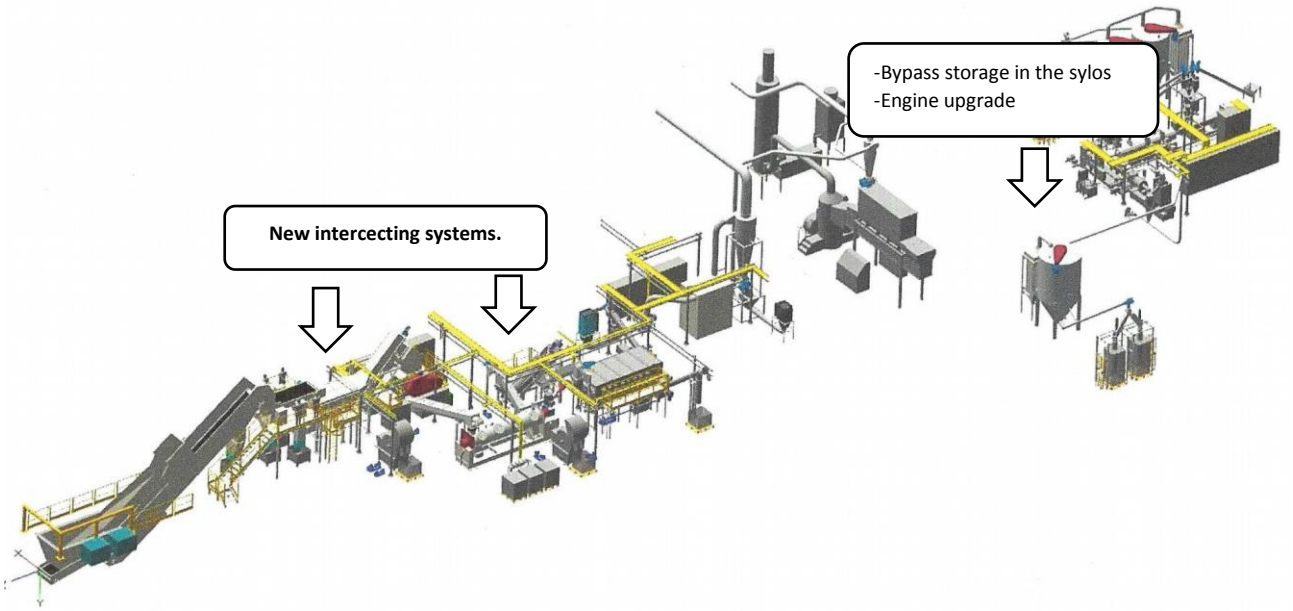


Figure 3.5: Changes in Ecoplasteam plant after test 3. [d]

Test 4

The material used for this test has been once again the EcoAllene blend 35% PP (recycled).

The results are collected in the table T4

Test 4	Moldability	Purity	P-M properties	Weldability	Decorability
CORVINA WHT	-	0	NA	NA	3
JOY FINE TIP	-	0	NA	NA	3
JUMBO	-	0	NA	NA	3
BRAVO	-	0	NA	NA	3
MEMOLIGHT	-	0	NA	NA	3
MINI MEMOLIGHT	-	0	NA	NA	3
MEMORY	-	0	NA	NA	3

Table T4: results of test 4.

The test was totally unsuccessful; the issue of this test has been that the material swelling leaving the cylinder.

The consequences of this anomaly were:

- The inability to proceed with molding;
- The printing was inconstant and there were missing or over-compacted details.

The problem was attributed to the recycled PP used for the blend; Ecoplasteam has therefore changed the source of supply of the materials to create the blends; new formulations have also been created.

Test 5

For this test has been used

- EcoAllene 35% PP
- EcoAllene 35% PEHD

Both blends were tested on all products, and the most suitable blend was chosen for each part. These choices are reported in Table 3.2 here below.

Model	Material of the body	Material of the cap	Tip holder	Clip	Material of the bottom
CORVINA WHT	EcoAllene blend 35% PP	PP virgin	NA	NA	PE HD Virgin
JOY FINE TIP	Both unsatisfactory blends	PP virgin	NA	NA	PE HD Virgin
JUMBO	EcoAllene blend 35% PP	PP virgin	NA	NA	PE HD
BRAVO	Both unsatisfactory blends	PP virgin	NA	NA	PE HD
MEMOLIGHT	EcoAllene Blend 35% PEHD	EcoAllene blend 35% PP	PP virgin colored	NA	NA
MINI MEMOLIGHT	EcoAllene Blend 35% PEHD	EcoAllene blend 35% PP	PP virgin colored	NA	NA
MEMORY	EcoAllene Blend 35% PEHD	EcoAllene blend 35% PP	NA	PP virgin colored	PE HD Virgin

Table 3.2: Choices of blends after Test 5.

The results are collected in the table T5.

Test 5	Moldability	Purity	P-M properties	Weldability	Decorability
CORVINA WHT	+	3	1	NA	3
JOY FINE TIP	-	0	0	NA	3
JUMBO	+	3	3	NA	3
BRAVO	+	3	2	NA	3
MEMOLIGHT	+	3	3	3	3
MINI MEMOLIGHT	+	3	3	3	3
MEMORY	+	3	3	3	3

Table T5: results of test 5.

There is still a problem with the printability of the joy; this is essentially due to a particular element of this type of felt-tip pen: the cage that holds the point planted inside the tank. As this historic Carioca felt tip pen was originally designed, this element is essential for the success of the product. The problem that this component carries with it is the exceptionally small size of its finishes, which still create problems with the molding of the product in this test.

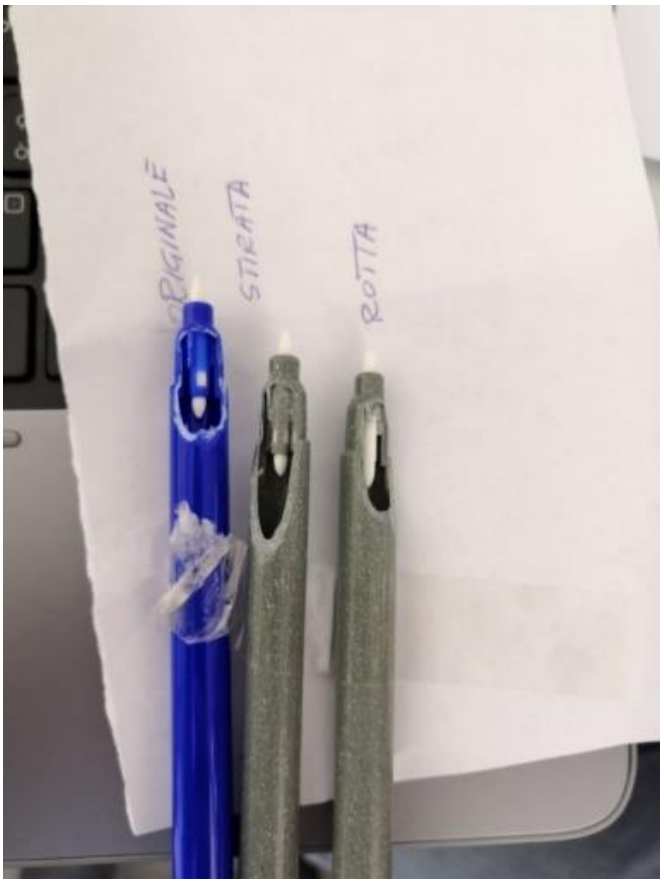


Figure 3.6: the problem of the JOY. Original photo.

The Joy could be easily re-engineered by excluding the component that creates these problems, but a drastic change in processes and machinery would be intrinsic in re-engineering, which we has been said from the beginning that it was not acceptable.

In this phase there was also an other important problem: in fact for CORVINA WHT and for the BRAVO, the planting phase in machine led to the thank failure.

In reality the problem was different for the two products:

- For the CORVINA WHT, the tip broke the tank at the time of planting; the problem therefore lies in the fact that the tip goes too far beyond the point at which it should stop itself, according to the real characteristics of the product; however, this can easily be solved by setting up the machine.
- For the BRAVO instead the problem lies in the fact that the tank at the point insertion point is not strong enough to allow the tip to enter without breaking; in this case, therefore, the setting of the machine cannot help, but the resistance of the material must be increased.

The two different breakages could be seen in Figure 3.7:

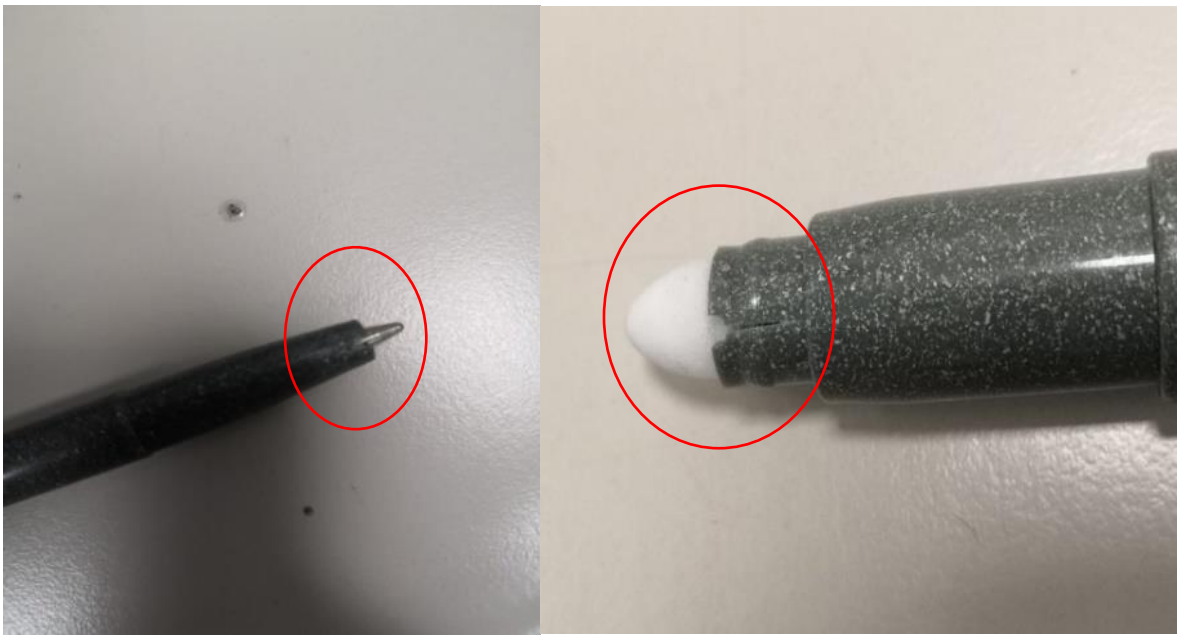


Figure 3.7: on the left the CORVINA WHT, on the right the BRAVO. Original Photos.

For the BRAVO, the problem of the planting appears using the formulation of EcoAllene blend 35% PP; what it could be possible to do is to repeat the test, using an additive called "Impact modifier" that increases the resistance of the material.

Using the formulation of EcoAllene blend 35% PEHD, instead, the seal during the planting process is excellent; the problem, however, shifts to the seals, hermetical with the hood, and mechanical with the bottom. In fact, by changing the basis of the blend they are not at all satisfactory, since the blend used leads to much greater withdrawals than those of the virgin.

For these reasons, the values of the KPI "P-M properties" are still not entirely positive on these two products.

Ecolpasteam, in order to solve the last issues starts to evaluate some additives to increase rigidity and fluidity.

Test 6

For this test has been used substantially three new formulation of the material:

- EcoAllene blend 35% PS
- 95% of EcoAllene 35% PP + 5% of Impact modifier
- 95% of EcoAllene 35% PEHD + 5% of Impact modifier

The test has been done only on the products that had still some problems; the Corvina, the Bravo and the JOY.

The results are collected in the table T6.

Test 6	Moldability	Purity	P-M properties	Weldability	Decorability
CORVINA WHT	+	3	3	NA	3
JOY FINE TIP	+	3	3	NA	3

JUMBO	+	3	3	NA	3
BRAVO	+	3	3	NA	3
MEMOLIGHT	+	3	3	3	3
MINI MEMOLIGHT	+	3	3	3	3
MEMORY	+	3	3	3	3

Table T6: results of test 6.

As predictable, the Corvina planting problem was solved simply by adjusting the machine in a way that the tip was not to allowed to go too deep and so to broke the tank. Despite the problem of planting was solved, another test was done with a blend with the PS, in order to bring the recycled product as close as possible to its virgin counterpart.

Despite the problem of planting was solved, another test was done with a blend with the PS, in order to bring the recycled product as close as possible to its virgin counterpart.

The results obtained were excellent and therefore the final choice fell to the latter tested blend.

As far as the JOY and the Bravo are concerned, both blends of the previous test have been retried, with the addition of the 5% of this fluidifying and reinforcing additive.

For both, the blend with PEHD was the one that brought the most satisfying results:

- the JOY cage was no longer a problem for molding, and this led to having all the other parameters perfectly in line with what was desired.
- the additive made sure that the excessive withdrawal found in the previous test no longer occurred; therefore sealing problems that still persisted with the 35% PEHD blend have been resolved.

The sixth test has therefore solved all the remaining problems, and therefore here below, in the table 3.3, there are the definitive materials of different components.

Model	Material of the body	Material of the cap	Tip holder	Clip	Material of the bottom
CORVINA WHT	EcoAllene blend 35% PS	PP virgin	NA	NA	PEHD virgin
JOY FINE TIP	95% (EcoAllene Blend 35% PEHD) + 5% Impact modifier	PP virgin	NA	NA	PEHD virgin
JUMBO	EcoAllene blend 35% PP	PP virgin	NA	NA	PEHD virgin
BRAVO	95% (EcoAllene Blend 35% PEHD) + 5% Impact modifier	PP virgin	NA	NA	PEHD virgin
MEMOLIGHT	EcoAllene Blend 35% PEHD	EcoAllene blend 35% PP	PP virgin colored	NA	NA
MINI MEMOLIGHT	EcoAllene Blend 35% PEHD	EcoAllene blend 35% PP	PP virgin colored	NA	NA
MEMORY	EcoAllene Blend 35% PEHD	EcoAllene blend 35% PP	NA	PP virgin colored	PEHD virgin

Table 3.3: definitive choice of the materials.

3.1.4 EcoAllene from an economic point of view.

It is clear that the world needs a strong and decisive turnaround concerning environmental sustainability.

This "need of the world" translates almost automatically, for the sensitivity of the subject, or even just for a sort of fashion, into a need of the consumer.

The eco-sustainable line described in the thesis work was initially the answer to the request of a big customer like Carrefour.

However, taking into consideration what is actually becoming a need of the final consumer, the possibility for Carioca through this line can be much more important than simply satisfying a customer's request.

Creating an eco-sustainable line with a product such as EcoAllene could create the opportunity for Carioca to enter into what in economic terms is called "Blue Ocean", i.e. a sector almost completely unexplored at the moment, in which no player has still established himself as a leader, and in which no standard has been created yet.

This is the real added value of the project: the opportunity for Carioca to establish itself in a sector that is growing exponentially and to use this sector to grow together with it.

Precisely for this reason the company's goal is not to make large margins on this line; the only factor that must be taken into consideration from an economic point of view in order to be able to say that the project makes sense is the sustainability of material costs.

So, talking about the costs of EcoAllene, it can be said that, being independent from oil as a raw material, the price of EcoAllene is highly competitive and stable in relation to similar products on the market, such as polypropylene and polyethylene. It can be said in fact that to date the price per kilo of the EcoAllene is identical to that of Polypropylene.

Two other observations, one positive and one negative, which over time should go to compensate each other, are worthy to mention:

- On one hand, the specific weight of EcoAllene is about 10% higher than that of Polypropylene; therefore, if we consider that the two prices per kilo are almost identical, we can say that EcoAllene is slightly more expensive than Polypropylene.
- On the other hand, the fact that EcoAllene is not tied to the price of oil makes its price constant over time, and in the long run this characteristic certainly becomes an advantage in favor of EcoAllene.

It can be concluded that, at the material cost level EcoAllene makes it possible not to have to consider additional costs in the long term, as compared to the current ones.

Therefore, also considering the fact that the final material was chosen in such a way as not to have to make further investments in machinery, it can be said with certainty that the project of creating the new eco-sustainable line is economically advantageous in itself, and furthermore creates a Blue Ocean's opportunity really very interesting for the company.

In table C1 there are the additional costs in percentage product by product; it can be considered for the JUMBO the same values of the BRAVO.

Type of product	Product sold	Additional cost	Comment
MEMORY	HIGHLIGHTER MEMORY	-2,9%	Reduction
MEMOLIGHT	HIGHLIGHTER MEMOLIGHT	0,0%	Identical
MINI MEMOLIGHT	HIGHLIGHTER MINIMEMO	+1,8%	Increase
CORVINA WHT	WHT BALL PEN	+0,2%	Increase
JOY FINE TIP	WB FINE TIP	+0,6%	Increase
BRAVO	PERMANENT MARKER MAXI TIP	+0,5%	Increase

Table C1: costs in percentage for EcoAllene.

Doing a mean of the additional costs of the different products, assuming the same amount of sales for all the products in the Gamma; it can be said that the change from virgin material to the EcoAllene could be considered indifferent from the point of view of the costs.

3.2 Recycle Materials Used Today

Another possibility to take the company towards an eco-sustainable road, is to create a product line by recycling the same identical virgin materials used today.

This type of solution has also been taken into consideration in Carioca. The same tests done for EcoAllene have been made to verify its technical feasibility, which can then be evaluated through the same KPIs defined for the innovative material mentioned above.

Also for this type of solution it is thought that the best choice was in general to leave in virgin material the details such as, for example, cap, bottom or clip and in recycled material the body or however the larger parts.

This, as for the EcoAllene, because coloring recycle materials is not so simple, so, in a first phase, it is better to use all the recycled material of a single color; in the case of EcoAllene this color was grey (its natural color), in this case the color is black.

The colorability of the re-extruded material is in fact even smaller than that of EcoAllene.

The extrusion process, in fact, is based in practice on putting all the material of various colors in the same hopper in order to be shredded and to form a new material, and so, from the mixture of various colors the resulting product can only be very dark.

In reality, some colorability tests have already been done on a grey base, (of which I enclose the photos) but, the results were not enthusiastic, and so, at the moment, the most viable solution is to use particulars in virgin material to give color, and maintain all the recycled parts in a single black color.

3.2.1 Testing Phase

The tests were carried out on the same products as the range hypothesized for Carrefour. To do the tests, the material discarded from the normal production of the Settimo Torinese factory was re-extruded. To do this, the waste material was sold to an external company, at a discounted price compared to the virgin; the same company has re-extruded the aforementioned material, and has consequently created the recycled material. Carioca then bought back the recycled material, to go to the machine in order to create the products to be tested.

In the following paragraph, it will be seen how this procurement process of recycled material, is only one of the possible alternatives.

As predictable, the performances of the re-extruded material are very similar to those of the virgin; certainly something is going to be lost in terms of physical-mechanical properties, but this loss does not absolutely go to affect those that are the necessary requirements to make the product performant. In fact, the product turns out to be sufficiently resistant in the point of greatest use, it doesn't give any problem in the planting phase, and the hermetic and mechanical seals can be considered both satisfactory.

The moldability is excellent, since the material is exactly the same used in production normally; in fact, even the problematic cage of the JOY has been quietly printed with excellent results.

The process of re-extrusion by definition simply goes to give a second life to the input material, and therefore the purity of the material at the outlet, can only be the same as that of the input material.

Also from the point of view of weldability, the fact of using the same materials leads to excellent results. The welding properties obviously depend on the compatibility of the two materials to be welded; in this case, the materials are practically not changed compared to traditional products, and therefore the results do not change.

Also from the point of view of decorability the material does not give any kind of problem.

Therefore, in table "T1bis" it has been reported the evaluation scheme used for the EcoAllene, in which there are positive values for each KPI taken into consideration, right from the first test.

Test 1 bis	Stampability	Purity	Rigidity	Weldability	Decorability
CORVINA WHT	+	3	3	NA	3
JOY FINE TIP	+	3	3	NA	3
JUMBO	+	3	3	NA	3
BRAVO	+	3	3	NA	3
MEMOLIGHT	+	3	3	3	3
MINI MEMOLIGHT	+	3	3	3	3
MEMORY	+	3	3	3	3

Table T1bis: results of test 1 bis.

3.2.2 Economic Point of View

In table C2 there is the same analysis done for the EcoAllene:

Type of product	Product sold	Additional cost	Comment
MEMORY	HIGHLIGHTER MEMORY	-9,2%	Reduction
MEMOLIGHT	HIGHLIGHTER MEMOLIGHT	-5,2%	Reduction
MINI MEMOLIGHT	HIGHLIGHTER MINIMEMO	-5,5%	Reduction
CORVINA WHT	WHT BALL PEN	-4,6%	Reduction
JOY FINE TIP	WB FINE TIP	-4,1%	Reduction
BRAVO	PERMANENT MARKER MAXI TIP	-4,2%	Reduction

Average Reduction	5,5%

Table C2: costs in percentage for re-extruded virgin material.

It can be said that, assuming a uniform sale on the various products of the future Eco Range, the use of the re-extruded material would lead to an average saving of 5.5% compared to the primary alternative of the virgin material.

Therefore, having said previously that the use of the EcoAllene would not lead to any substantial change in terms of costs, compared to the virgin material, it can be said that the alternative of the re-extruded virgin material would lead to an average saving of 5.5% compared to the alternative to using EcoAllene.

Moreover, this type of solution could give the possibility to reuse the production waste that today in carioca amounts to about 50 tons per year.

Without using any of this waste it can be sold at around 31% of the starting price to a company specialist in the recovery of plastic materials. So the production waste in normal conditions leads the company to a loss of 69% of the virgin's price.

Wanting to buy this recycled material to go on the market with an eco-sustainable product, the price needed to pay is around 81% compared to that of the virgin. Assuming that to be competitive, the Eco line will have the same public price as a traditional line, the same revenue achieved by paying the full price of the material, could be achieved with a cost of only 81%; this therefore leads to a potential additive margin of 19% of the cost of the virgin.

Hence, through a purely mathematical reasoning, it is easy to get the conclusion that the creation of a line through the re-extrusion of virgin materials would lead to savings on production waste. In fact, the cost of the waste would go from 69% to 50% of the standard price. That, considering the 50 tons a year would be already a very important result.

In the following table it is resumed what it has just been explained normalizing at 1 the cost of virgin material.

Cost of virgin material	1
Price at which the waste is sold	0,31
Cost of recycled material	0,81
Cost of the waste in normal condition	0,69
Potential additive margine of Eco line	0,19
Cost of the waste with Eco line	0,5

This result can still be improved through an investment in an internal recycling line.

The line would have to be composed by shredders, an industrial mixer and an extruder; The waste material must in fact be shredded in the shredders, then passed into the mixer in order to create a mixture as homogeneous as possible, and finally must undergo the extrusion process.

Figure 3.8: a shredder and a mixer for plastic materials. Original Photos.

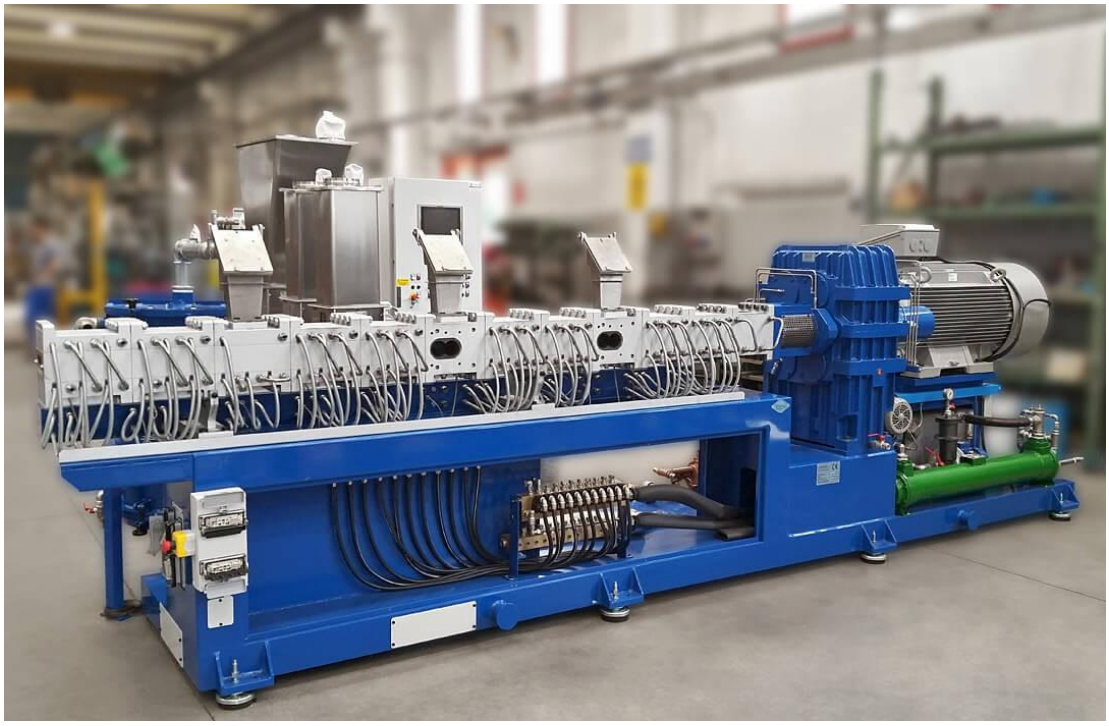


Figure 3.8: An extruder for plastic materials. Original Photo.

By recycling internally, it could bypass the passage from the specialized company, saving on the cost of processing. As previously stated, in fact (keeping the normalized costs as in the previous table) the waste material is sold at 0.31 and repurchased at 0.81.

Considering that to run a 50-tons per year recycling line, it may be reasonable that will be needed a person for a third of his annual time. Considering this, we can think that the cost of managing the line will be around € 10000 per year.

The initial investment would amount to around € 1000000, and taking into account only the 50 tons of annual waste and considering only the savings on the cost of the waste, it would pay for itself in less than three years.

3.3 Final Decision

Regarding the material to be used for the line dedicated to Carrefour, the customer decided to use the EcoAllene.

At the marketing level, the use of a new material, totally recycled and recyclable, coming from polylaminates, and therefore from post-consumption, is a choice that works much more than the simple recycling of traditional plastic materials.

This was probably the reason that led the customer to lean towards this alternative, and for the same reason, even for the eco-sustainable Carioca brand line, the EcoAllene will be the material on which it will focus more.

This, despite the fact that the other alternative certainly had lower costs, and despite the fact that the technical tests were much simpler and more immediate on the recycled internal materials.

The fact that at the marketing level the EcoAllene works better, it can be found trivially also in the simple sensation that the products in the different materials leave at first glance.

The felt tip pen in recycled PP, for example, with its glossy black color, looks like a simple felt-tip pen in PP, uglier than traditional due to the lack of color.

The EcoAllene felt-tip pen, on the other hand, with its ugly dirty gray color, paradoxically manages to create the right feeling in the consumer right from the start; in fact, looking at that felt-tip pen, arise from the beginning the thought of the recycled product, Eco, which is exactly what the hypothetical target customer of this gamma wants to find.

Therefore, paradoxically the particular "ugliness" of the EcoAllene also contributed to the choice.

However, even the re-extruded virgin material will be used in parallel. Indeed, within the Eco range of the Carioca brand, in addition to the EcoAllene products, there will also be recycled products in PP, PS and PEHD.

To carry out this part of the project, the investment for the internal production waste recycling line mentioned above will be made; this will therefore reduce the problem of production waste to a minimum, as well as obviously increasing the eco-sustainable range and therefore increasing company turnover and profit.

4 A new Eco Sustainable Line - Packaging.

Before discussing the alternatives considered for packaging, it is necessary to make a first clarification about two terms that are often confused: "Biodegradable" and "Compostable".

A biodegradable element is in fact not even automatically compostable. To clarify, let's start from the definition: biodegradable is defined as any material that can be broken down by bacteria, sunlight and other natural physical agents into simple chemical compounds such as water, carbon dioxide and methane. A process that involves a multitude of materials but that can provide for each element its time, even long, of degradation. However, European legislation establishes stakes. To be defined as biodegradable, a product must decompose by 90% within 6 months.

Conversely, it is defined compostable (transformable into compost, a natural fertilizer) the material, which is not only biodegradable, but also disintegrating and whose decomposition process takes place in less than 3 months.

But how does it affect the everyday life? It concerns, for example, when a bag has to be put in the garbage collection bin. In order to throw away only the food and organic waste that can legally enter the composting process, it is important to be careful to choose bioplastic or paper bags only to collect this waste. In fact, the biodegradable envelopes are not compostable and therefore should not be mixed with the organic. However, biodegradable plastics must be thrown away in plastic.

Here below are listed the alternatives that have been taken into consideration for the packaging of the Eco line.

4.1 NatureFlex™.

Figure 4.1: The logo of NatureFlex™. [9]

NatureFlex™ is a range of specialty packaging films developed by Futamura to offer packaging material options that give strong environmental support towards increasing consumer demand for more environmentally responsible packaging. Many of the information about this material are taken from the websites in the sitography [10] and [11].

NatureFlex™ uses films that are based strongly on renewable resources. Most renewable bioplastics come from materials such as corn, potatoes or wheat. However, NatureFlex™ films are based on cellulose. Cellulose is one of the most naturally abundant organic material.

This cellulose is derived from renewable wood pulp that is sustainably harvested from FSC managed forests. NatureFlex™ films are certified ASTM D6400 for bio-based content, and depending on the grade of film, the bio-based content can vary from 90% to 99%.

NatureFlex™ provides suitable packaging for a wide variety of food service products, such as, to-go, confectionary and bakery item. Resistant to grease, oil and fats, the films are microwave and conventional oven safe (recommended maximum 390ºF, 30 minutes).

The film features a unique heatseal resin on each side and has a super wide range. This leads to fantastic machine performance. NatureFlex™ static-free films can used on many different packaging machines, including flow-wrap and overlap.

NatureFlex™ films have a coating that can be tailored to varying degrees of moisture barrier. This helps maximize the shelf life of your products. The deadfold is spot on and the gloss of the film enhances the presentation of the products.

NatureFlex™ films are fully certified to the American (ASTM D6400) and European (EN13432) norms for 100% compostable packaging. Proven to be suitable for home composting, they are also marine degradable.

Futamura is one of the most innovative global companies in the films industry today, with a supreme depth of knowledge both of its products and its markets. Their success lies in their specialist skills in BOPP and cellulose film development, production and coating, meeting customer needs through strong research and development and high quality products.

The distributor of the material in Italy is "Eurofilm"; with this company we discussed the possibility of using this material for the packaging of our Eco line.

In the case in which this material will be used for the Eco line, the choice would be a packaging in the form of the flow pack.

So, in order to evaluate the costs, it is necessary to make a comparison, between the normal flow pack utilized in Carioca and the one done in NaturFlex.

As mentioned above, the Caricoca flow pack needs to be a coupled 20 + 20 mycron, and must be printed in at least 4 colors.

The prices below are based on these needs and on a MOQ of 200 kg of material.

It could be said that the impact of the possible change of material with the above conditions is an increase of the cost of the packaging of about 5%.

4.2 PLA.

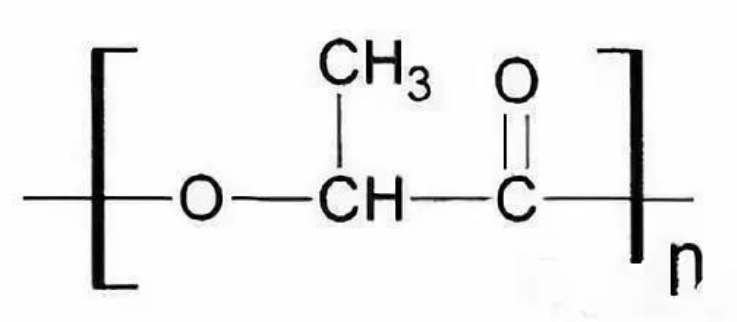


Figure 4.2: Synthesis of PolyLactic Acid. [12]

Polylactic acid is the polymer of lactic acid. PLA was been the second bioplastic commercialized and sold on large-scale. It derives from the grinding of corn and is to be considered biodegradable, although it requires precise conditions to trigger the decomposition process.

The production can be summarized in two distinct stages:

- synthesis by fermentation and isolation of lactic acid,
- polymerization of the acid obtained.

As raw materials, sugar, molasses and whey are used. Just as it is produced, it is not biodegradable; it becomes so, after hydrolysis at a temperature greater than 60 ° C and humidity greater than 20%. Plastics of common use have an average life that can vary from 100 up to even 1000 years. PLA, on the other hand, has much shorter biodegradation times: depending on the environments, in which it is abandoned, it has an average life span ranging from 1 to 4 years.

PLA is the most used material for products made by 3D printer. Its technical characteristics and its degree of sustainability make it suitable for replacing common plastic in many applications.

Using PLA, the best packaging solution would be to create a blister pack composed of recycled cardboard and a PLA valve.

This type of pack must be compared, in terms of costs, with Carioca blisters.

It can be said that this solution would lead to a 16% cost increase compared to traditional packaging.

4.3 Recycled Paper

Figure 4.3: Symbol of paper industrial recycling. [13]

Another type of solution is to use recycled cardboard to reproduce those that already in traditional lines are printed cardboard packaging.

The contraindication of the cardboard is obviously the fact that, not being transparent, it does not allow the final consumer to see the product through the packaging.

The only way to ensure that this can happen the same, despite the non-transparency of the paper, is to create windows inside the boxes.

In order to create these windows it must however be requested from the paper mill, the creation of an ad hoc die board, obviously more complicated, and therefore more expensive, compared to what could be a uniform pack.

This type of boxes, however, as already mentioned in the initial part of the thesis, are already used in Carioca; therefore, this alternative could be compared with traditional boxes at cost level.

Obviously the use of recycled cardboard leads to savings, and this is around 6%.

4.4 Final Decision

Unfortunately, PLA is not suitable for withstanding too high temperatures; its integrity is not guaranteed above 50 degrees centigrade. However, Carioca products are sold all over the world, and therefore in warmer countries, especially in the trucks or containers in which they are transported, they are subjected to temperatures that far exceed the aforementioned threshold. Especially for this reason, as well as for reasons of cost, the hypothesis of the PLA was discarded.

The hypothesis of the NatureFlex, on the other hand, was rejected for problems of Minimum Order Quantity. The supplier with whom we had started a collaboration, Eurofilm, required too high minimum production volumes for a line, that for Carioca is something of totally new, which, at least initially, will not reach very high volumes.

To stay within the costs on which all the estimates had been made, in fact, the supplier required a MOQ of 200 kg, while Carioca, at least initially could have been able to buy at most 100 kg. With the volumes that would have been used in Carioca, the costs required by the supplier would have increased a lot, and therefore it would no longer be possible to stay in the price range agreed with the customer.

Therefore, having discarded the other two hypotheses, the solution for which Carrefour opted was recycled cardboard.

This has no problem of temperature resistance, and although it is necessary to create a window to allow the consumer to see the product, the cost is far lower than the other two alternatives. Moreover, it has already been said that, compared with the version used in the standard lines, obviously recycled cardboard produces savings that can therefore also lead to an increase in the margin.

5 Conclusions

Carrefour decided to start the sale with a range consisting of 6 of the 7 products on which all the previous tests were conducted.

Below are the photos of the official mock-ups of this range. The products lack the pad printing the final definition of the artworks were not concluded yet in September 2019.

Figure 5.1: From the left, CORVINA WHT, WHT BALL PEN; JOY FINE TIP, WB FINE TIP; BRAVO, PERMANENT MARKER MAXI TIP. Original photos

Figure 5.4: MEMOLIGHT, HIGHLIGHTER MEMOLIGHT; MINI MEMOLIGHT, HIGHLIGHTER MINIMEMO; MEMORY, HIGHLIGHTER MEMORY. Original photos.

It can be concluded that is possible to find new alternative materials to traditional plastics, to create new eco-sustainable line.

The main customer who gave the decisive push to start with the project decides to launch of the new private label line in November 2019.

Having achieved this goal, opens up the possibility for the company to create a sustainable competitive advantage over direct competitors.

In fact it has been seen how consumers feel the need to have the opportunity to safeguard the planet in every aspect of their lives. People's awareness of environmental sustainability is increasing day by day, and people are finally starting to react to these needs of the planet. The target customers of this type of products are therefore continually increasing, boosting the hypothetical demand; this is demonstrated by the fact that more and more new companies working in the world of sustainability are being born, and that they are achieving excellent results, growing continuously.

The market appears to be ready for this type of innovations, indeed, it is the market that pushes them to be implemented.

Hence the situation allowed the launch of this new line, also because at the moment none of the competitors has achieved the leadership in what could become a new sector.

This research can potentially open the doors of a "Blue Ocean" for the company, creating the prerequisites for a strong acceleration of growth.

The project will continue through the launch of a Carioca brand line that will include both products in EcoAllene, such as those that will be launched shortly for Carrefour, and products composed of various recycled plastic production materials.

To carry out the second type of products in the line, an important investment will be made for setting up an internal recycling line, which will allow the company to lower the costs of recycled production, as well as almost eliminating the costs of waste production.

Moreover, at the product level, the studies and tests that will lead to coloring the parts in recycled material will be deepened, without going to affect the nature of the product. The consumer will in fact have to continue to have the same impact with the product despite the color; it must therefore continue to look like what it is, ie a recycled product.

In terms of packaging, if, as hoped, production volumes will increase over time, the idea of NaturFlex, and therefore of compostable packaging, will become feasible again.

The alternative will continue to be taken into consideration, and when the right conditions will be verified, it will be possible to consider the use of this very innovative material, or others that in the meantime could be proposed.

The sustainability of our planet is something of really important; companies can do a lot to improve current conditions, and at the same time, innovation in this field can help them to grow more rapidly, and probably also to gain important competitive advantages on their direct competitors.

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