DESIGN RESEARCH APPLICABILITY ON PORTUGUESE INDUSTRY — RECIPOR S.A. COMPANY

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ABSTRACT

The present paper works on the potential applicability of design The present paper works on the potential applicability of design research based on a practical experience with the Portuguese company Recipor — Recuperação e Valorização de Resíduos (residues recovery and valuation), S.A., who's mission is to collect, treat and valuate in a profitable way plastic residues e non iron metals, with domestic or industrial origins. The ecological appeal, the economical recovery process and the innovation investment justified the choice and the decision of taking this company as a subject to study design's influence on building and confirming it's corporate identity and in the implementation of design culture and thinking. The empirical search on collecting processes, treatment and application of residues took place at the company's premises. From the direct contact with raw materials, equipment and finished products we developed a quality based methodology study. The results denoted a strong relation between the company's vision, the organizational strategy and the market's affection for recycled products. This triangulation allowed a favourable environment for a temporary inclusion of a design investigating team, and leads to the understanding that, as the high-level project orientations were exposed, the expectation increased and acquired a more instrumental format with strategic effects. Grounded on data from field literature we draw the path of thermoplastics in general and of PVC specifically. We must highlight the growth of the investment made in collecting and recycling; the birth of a European network of certified recycling companies and the enormous applicability of this material on artefact production. This project's boundaries were established by practical challenges introduced by the company's direction; namely the optimization of the plastic reel products. The team's proposals were the result of the adopted design process.

DPPI '11, Jun 22-25 2011, Milano, IT

Categories and Subject Descriptors

4. Design culture and thinking in industry (on design culture); 5. Organizing design in industry (on design management and processes).

1. INTRODUCTION

The residues issue invariably emerges related to production and consumption modes of the contemporary society. As referred by Brown (2006)[1], the economics of waste is on a collision path with the Earth's geological limits. In addition to being exhausted to the local landfill, the world is also quickly runs out of cheap oil that is used to manufacture and transport the waste.

Urban solid waste embodies what we commonly call garbage: material, substance, or by-product eliminated or discarded as no longer useful or required after the completion of a process (Press, 2011)[2]. This waste generated by human activity, which are discarded or eliminated, ends up incinerated or in landfills.

Although the garbage designation includes solid residues in general many of these can be reused or recycled, providing that the materials are properly treated. Furthermore than creating jobs and generate profits recycling permits the decreasing use of raw materials and energy, extending the useful life of landfills. According to the study by Friends of the Earth cited in The Guardian Journal (2010)[3], recycling creates 10 times more jobs per tonne than sending rubbish to landfill or incineration, with posts generated in collection, sorting and reprocessing, as well as in the supply chain and in the wider economy. Recycling however is a complex process (due to materials diversity, separation, etc.) and depends on the engagement of several actors including producers, distributors, dealers, local authorities, waste and recycling managing companies and common citizens.

The subject company lies at the end of this chain. Business is managed upon its ability to treat and valuate in a profitable manner plastic residues and non-iron metals with domestic or industrial origins. The investment in innovating industrial techniques gives the company a unique leadership in obtaining standardized materials, facilitating its upcoming use and commercialization. Among others, polyvinyl chloride (PVC) is most obtained polymer and the most used in the company's product development, existing or upcoming. Thus, this study headed for the use of recycled PVC in product development with increased value, using design and its methodologies — through research.

This process started with the intention of testing the potential applicability of design research, to contact and collaboratively work with a Portuguese producing company, contributing with its corporate identity's establishment with the long-term purpose of implementing design culture and thinking, using it not only as a innovation tool but also as strategic potential for company managing. Today, adopting the Design Ladder's scale as reference (SVID, 2011)[4], the company uses design as process, understanding that designers should integrate a product's developing team from scratch and its aware of the importance of good project managing methodologies. By not having a product developing division design is out sourced. Its product range obeys more to its condition of being a plastic recycling company than to a market surveillance approach. Although valid the urban furniture range, for instance, doesn't seem to relate to the innovation and world-class reference it's vision proclaims. This apparent lack of balance can bring consequences to the company's competitiveness but the embracing of a pro-active behaviour rather than a reactive one may be of help.

2. STUDY DESCRIPTION

The case study we are presenting has been developed in the subject of "Seminários em Design" of the Design PhD of the University of Aveiro. It supports the idea that the development of a new product results as a natural consequence of a design process that, if implemented, will facilitate the definition of feasible solutions and the comprehension of the ways in which the object meets its many functions.

This project focused on the company Recipor S.A. located in the city of Vila Nova de Gaia, which receives, collects and processes waste plastics and trades plastic raw material and products. At first, the team visited this company's facilities in order to better understand and assimilate its corporate strategy and to identify and define the problems with relevance for application of research in design.

The design process adopted by the researchers is based on the methodologies presented by Baxter (1995)[5] and Ulrich (2000)[6]. The following steps have been thus established:

1. Raised questions
2. Research
3. Problem description
4. Ideas generation
5. Concepts and ideas selection
6. Work with specialists
7. Recollection of users feed back
8. Project specifications
9. Prototype production
10. Evaluation and test
11. Project review
12. Production

In order to give a clearer perception of this study, each of these steps is briefly described next.

3. RAISED QUESTIONS

The raised questions were:

- Test the potential applicability of design research;
- Work directly with the production division;
- Work in collaboration with the company;
- Contribute to the construction and consolidating of corporative identity;
- Promote culture and design thinking;
- Create a friendly environment for design investigating teams within the company.

4. RESEARCH

For the research we wanted to:

- Immerse in the Recipor's company;
- Understand and absorb corporate's strategies;
- Identify project's opportunities;
- Contact Recipor's clients;
- Evaluate reel's operating conditions (final users);
- Analyse competitor's products.

By doing so and to pursue the established parameters we started by studying the company. Several tools were used to collect data: bibliographic research, observation, interviews, video and photographic capture, debate sessions.
On this industrial unit the several production lines were visited, namely the ones of industrial plastic residues and non iron metals recycling, the applied recycled plastic production like those of urban furniture (benches, paper baskets, plant pots, tables, composting boxes, floor grids and profiles), industrial products (reels, road sign stands and electricity enclosures) and exterior pavement (Stardeck®).

The production areas pointed out different lines of possible investigation and intervention, some listed by the company itself others by the team. Thus, considering the urban furniture collection, the necessity of redesign emerged as well as the need for new product lines due to the fact that the actual items didn't

succeed in the market as expected, consequence of various factors. Regarding the industrial products its diverse components were analysed, determining that the road sign stands and electricity enclosures could be improved in their construction and shape characteristics. In this area, Recipor indicated the plastic reel as the most representative product in sales volume, also enumerating a series of storing and transportation problems, weight and visual weaknesses, which — if solved — could make it more competitive and profitable.

The exterior pavement was regarded as a good product though, due to its competitors, the research should focus on repositioning it in the market, by design, aiming a better representation on this sector.

Besides the existing production the team pointed out some other product lines, for upcoming investment projects like domestic, garden and horticulture items.

After the initial analysis and reflection the team defined as an intervention priority the industrial reel, a consolidated product therefore elected by the company for immediate action. Hence follows the detailed description of the product and its problems.

According to Recipor, the plastic reel when compared to its direct competitor — the wooden reel — presents a group of advantages, specifically:

- Superior useful life when exposed to weather conditions, without rotting or deforming;
- Invariable weight due to humidity conditions avoiding weighting each time it's used;
- Composition made of recycled plastics;
- Competitive price;
- Possible reuse of damaged reels by substitution of it's components;
- Easy identification for the customer printed on the material;
- Simple 4 component assembly (2 pieces for the cable drum and 2 for the side wheels), easy replaceable;
- Free from the phytosanitary treatments necessary in wood products.

The industry and these investigators listed some aspects of the product that could be improved in order to make it greater. Transporting reels to customers is done in two ways: assembled or disassembled. When disassembled the company manages to transport a larger number of items but it's profit spread decreases as the customers who must themselves assemble the reels negotiate the price. If assembled, the number of despatched items reduces. Hence the two transportations modes are equivalent regarding cost. Two requests emerge then; the first related with exploring new ways of arrange the existing reels in containers, assembled or disassembled, increasing the despatched items; the second regarding the development of a new reel, maintaining an easy assembly and at the same time improving stackability.

Another problem inherent to transportation is the reel's weight. Research should focus on lighter alternate plastic materials, equally resistant, and other ways to reduce the amount of material used. The limitation of metal rods necessary to assemble the existing reels was also taken under consideration; these are made of stainless steel that make it expensive. To conclude, the renovation of its visual characteristics was also mentioned.

In order to broaden the product's vision the team pondered a visit to one of Recipor's client companies as a work strategy. The chosen company was Cabelte, a Portuguese corporation important by its technological achievements in electric and communication cables manufacturing (automotive industry wiring, optical fibres and power cables). Several problems were detected during this visit concerning the use of plastic reels; the following images illustrate the comparative analysis between plastic and wooden reels (Figure 1) and evaluating charts from the users viewpoints (Figure 2).

Before listing topics to undertake we should explain how Cabelte's products are sold, a common process in similar companies. When

COMPARATIVE TABLE PLASTIC REEL VS WOOD REEL

	Plastic Reel	Wood Reel
Price	⊕	⊖
Transportation	⊖	⊕
Assembly	⊖	⊖
Weight	⊖	⊕
Endurance	⊖	⊕
Aesthetics	⊖	⊖
Dimensions	⊕	⊕
Recycling	⊕	⊕
Material	⊕	⊖
Identification	⊖	⊕
Handling	⊕	⊕
Repair	⊖	⊕
Maintenance	⊕	⊕
Life cycle	⊖	⊕

⊕ Positive ⊖ Negative

Figure 1. Analysis between plastic and wooden reels.

EVALUATION OF PLASTIC REEL QUALITY

	Recipor	Cabelte	End user
Price	○	○	●
Transportation	●	●	●
Assembly	●	○	○
Weight	●	○	○
Endurance	●	●	●
Aesthetics	○	○	○
Dimensions	●	○	○
Recycling	●	●	○
Material	●	●	○
Identification	○	●	●
Handling	○	●	●
Repair	○	●	●
Maintenance	○	●	●
Life cycle	●	●	○

● Relevant ○ Not relevant

Figure 2. Users viewpoints.

a cable is sold the company receives from the customer a fee from each reel, which is kept in credit. When a reel is damaged the company repairs it using that credit. If the damages are irreversible and Cabelte has to buy a new reel it's cost is charged to the customer. The company has a repair service chart.

The company indicated some weaknesses for the plastic reels regarding shock resistance (it easily breaks during use, in factory, transportation and by final customers). In the same direction, the reels lower cost is interesting in initial acquisition but is rapidly

surpassed by repairing fees making it expensive for it's customers. These conditions lead to the customers' preference for wood made reels more expensive on acquisition but easier and cheaper to repair and with rare total damage situations.

The absence of an axle protection in the plastic reel, not having the metal ring found in wooden reels, tends to damage the centre hole during its refilling and defiling (Figure 3) being one of the improvement issues.

When the reels are filled with cable — becoming a so-called drum

Figure 3. Center hole. Refilling.

— an outer protection must be applied. This protection may be with wood boards nailed to the reel or with a flexible material called Nolco-flex® (Figure 4). Using wood boards increases structure and enables stacking in warehouses pleasing its owners. The Nolco-flex® protection doesn't improve the reels' structure but it's the only applicable shield for a plastic reel since wood boards can't be nailed to it.

Figure 4. Drum protection. Identification.

Cabelte also needs to attach information on the reels, like product barcodes, usually done with staples. Nails and staples don't work well on plastic and sometimes the information is lost (Figure 4).

Wood resistance to charge allow diameter reel production up to 2500 mm. Recipor's plastic reels have 1400 mm maximum diameter due to low resistance and manufacturing issues. It's important to say that larger diameter reels are used in overseas exportation where its cost is charged since there's no reuse. This could be the target market for plastic reels, single used, free from maintenance issues and profiting from its low price. However the present manufacturing technology doesn't allow it.

Stacking and transportation were also mentioned by Cabelte saying that plastic reels slide inside containers due to their low friction characteristics, lower than wooden reels. The current colour (black) and the surface of the plastic reels present some difficulties in screen painting the company's logo (as they do in wooden reels).

Accordingly to the referred issues several Cabelte customers; some considered market leaders on cable using thus a good example, still choose wood made reels showing the unenthusiastic positioning of the plastic reel. The team also observed that wood made reels arrive at Cabelte assembled (national suppliers) or disassembled (foreign suppliers). Observing the disassembled wood reels showed us its highly stackable features compared with plastic reels (Figure 5).

Figure 5. Disassembled wood made reels.

Last, the team also studied the reels' end customers, gathering more information on how the drums are handled.

5. PROBLEM DESCRIPTION

The previous analysis allowed us to list the relevant issues in design research. Below are listed the various problems encountered and their resolution possibilities envisaged by the researchers.

5.1 Packaging

- Study layout schemes in containers for shipment of existing reels, assembled and disassembled, in order to increase the current carrying capacity.
- Preparation of a new reel design capable of maintaining its easy assembly, but to monetize it's stacking (new division of drums).

5.2 Weight

- Study of a new structural design for the reel, allowing the reduction of weight.
- Search for other plastics equally resistant but lighter for the reel.

5.3 Resistance

- Study of various plastic materials for the flaps production to ensure greater shock absorption.
- Study of a plastic protection to be applied around the flaps

(bumper), allowing greater shock absorption (application in existing reels or in a new ones).
- Study of a new structural design for the reel, which guarantees greater shock absorption (alveoli, etc.).
- Study an incorporated piece of metal or more resistant plastic to prevent wear on the bore axis of the existing reel.
- Study of more resistant plastics to apply in the hole of the reel axis, at the time of injection.

5.4 Drum Protection

- Study of a protection for the entire reel with plastic parts, ensuring easy replacement.

5.5 Reel identification

- Study of technological solutions to enable the placement of this information.

5.6 Increase of friction

- Study of protection to be placed around the plastic flaps (bumper), allowing higher friction (for the existing reel or for a new application).
- Study of drawing grooves for pavement contact zones of the flaps.

5.7 Formalistic approach

- Investigate the possibility of applying other colours to the material, allowing customization of the product, according to each client.

6. GENERATION OF IDEAS

Based on the analysis of product architecture and the identified problems, the team started a conceptual approach (brainstorming) to the various possibilities to be developed in order to meet the needs identified above.

There are different creativity techniques, according to several authors, which are "systematizations of mental procedures", a "support and stimuli for the use of mind's abilities in a systematic and deliberate manner" (Tschimmel, 2002, p. 95)[7], to "organize and optimize thought, avoiding mechanical thinking based on individual experience and previous answers, to organize and reorganize information and knowledge, to direct attention" (Tschimmel, 2001, p. 8)[8]. For this task the investigators applied the brainstorming technique (Osborn, 1938)[9] as a starting point for ideas and concepts thus increasing the creative process allowing fluid, flexible and original thinking, and mind mapping (Buzan, 1974)[10] for a complete visualization of the questions' complexity, the proposals and the different analysis of the project.

Searching for solutions that reduce weight and save material, it was decided that the design of the side flaps should be rethought, in particular its outer surface, in order to create a mesh able to reduce the material in some areas. This design could still be an important contribution to provide greater strength and flexibility to each flap. It was identified in the new side wings' design the possibility for a greater ability for customizing the exterior of the reel by the customer and make a greater aesthetic value of it.

The friction issue of the flaps was also analyzed and therefore determined that this problem could be alleviated with the inclusion of grooves in its contact zones with the floor or with the stacker's forks.

As possible solutions to the transport and packaging issues, it was defined as essential to the project the volume reduction of the central body of the reel when it is disassembled and on transit. The search for solutions that allowed the subdivision the main body and that facilitate the subsequent assembly established the research path.

Aiming to maximize the capability of reels storage in available vertical spaces, a strategy was pointed out, the design of a plastic cover likely to be sufficiently flexible to wrap around the reel and at the same time able to increase the load capacity of the compression forces.

6.1 Analogies

After defining the conceptual approach strategies to the encountered problems, the team started collecting data that could help the development of several solutions for the listed problems. This data collection was initially organized to find products or product components that had some similarity with the basic operation principles of the reel (rolling, stacking, winding, etc.). Among others we identified thread reels, photographic films, measuring tapes or extension cords reels.

The group then started to a search for possible analogies to be established in formal, structural or functional levels and that where close to the conceptual solutions previously set by the team. Analogies were established with car rims, bicycle wheels, honey bee combs, retractable ladders, tractor tires, photographic film, etc. (Figure 6).

Figure 6. Analogies.

7. SELECTION OF IDEAS AND CONCEPTS

After this data collection and its analysis, the group began the formalistic development of numerous ideas to achieve the previously defined challenges. At this stage several sketched approaches (Figure 7) were produced showing some side wing examples with mesh exterior designs inspired by bee combs or car rims, sketches of different sectioning modes for the cable drum dividing it in various components with hinged connections and subsequent studies of stacking possibilities and also some applied grooves for decreasing the sliding of the reel while being handled.

The team subsequently selected some ideas and concepts considered most promising for the successful development of the

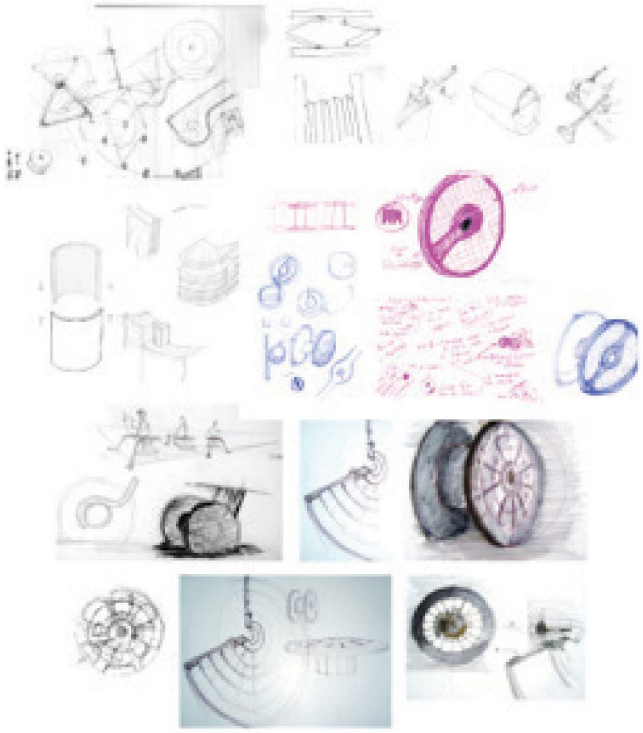

Figure 7. Sketches.

project. A detailed study of each selected idea was carried out. At this stage, the three-dimensional simulation from previous sketches of the selected proposals was required. The three-dimensional simulation was an instrument that helped validation of the formalistic choices and added technical authority allowing us to test the initial ideas using simulations for the structural requirements of the studied solutions (Figure 8, 9 and 10).

8. WORKING WITH SPECIALISTS

In the course of the studies some experts were consulted providing some important information on raw materials, about specific requirements of the manufacturing processes and the mechanical behaviour of plastics.

The team considered the possibility of adding structural additives to the PVC composition in order to strengthen it, but that would make their recycling unviable. Advices for designing structural ribs were taken under consideration; these should be essentially radial and with concentric circles so as to increase the strength of the pieces. With the same purpose the number of rods that attach the pieces should also be increased, minimizing structural weaknesses under load.

9. CONCLUSIONS

To conclude about the applicability of design in building industrial identity based on new products development was one of the project's objectives. The project took place between the university and the industry, where the meetings were yield with the investigators, the supervisors and the company's CEO. The applied methodology was Baxter's (1995) and the team followed the first 7 steps, as shown on the article: exploring research questions; research; problem definition; ideas and concepts generation; ideas and concepts selection; work with specialists and user's feed-back collecting. The remaining 5 steps; from project specification to production were also predicted as collaboration continues. Strategically, the decision of consulting companies that use the plastic reels turn out extremely useful for this research; it changed the team's initial perspective, made solely upon the manufacture's opinion, about the potential and the weaknesses of the reels. The problem definition then included different viewpoints of the same product, originating an unquestionable input on the quality of the product analysis. Thus, new items were included in the project's approach becoming significant for presented proposals. The product is technically consolidated but the company feels the need to add to it some value and, at the same time, to amplify it's best points making it better than the competitors. For this achievement the team restated the idea that design is a must-have for companies that wish to improve and develop their products, consolidating themselves within the market. Industry can trust design to help it in searching competitive advantages, as said by Peters (1995)[11]: "Everyone eagerly seeks competitive advantages; the most fertile ground for those new advantages is Design."

The opportunities born out of these moments were taken under a thoroughly selection and analysis resulting in the presented data. We thought, though, that the investigating process didn't end with the proposals for the plastic reel. We consider relevant for this study and for the industry design research field the progressive interest of the company's CEO in using design as a competitiveness tool, opening new paths in product developing based on the company's

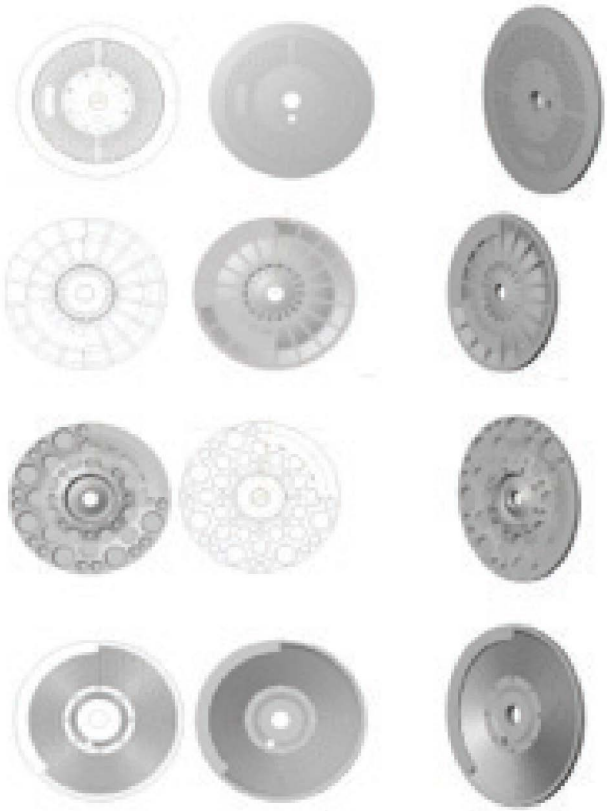

Figure 8. 3D simulations.

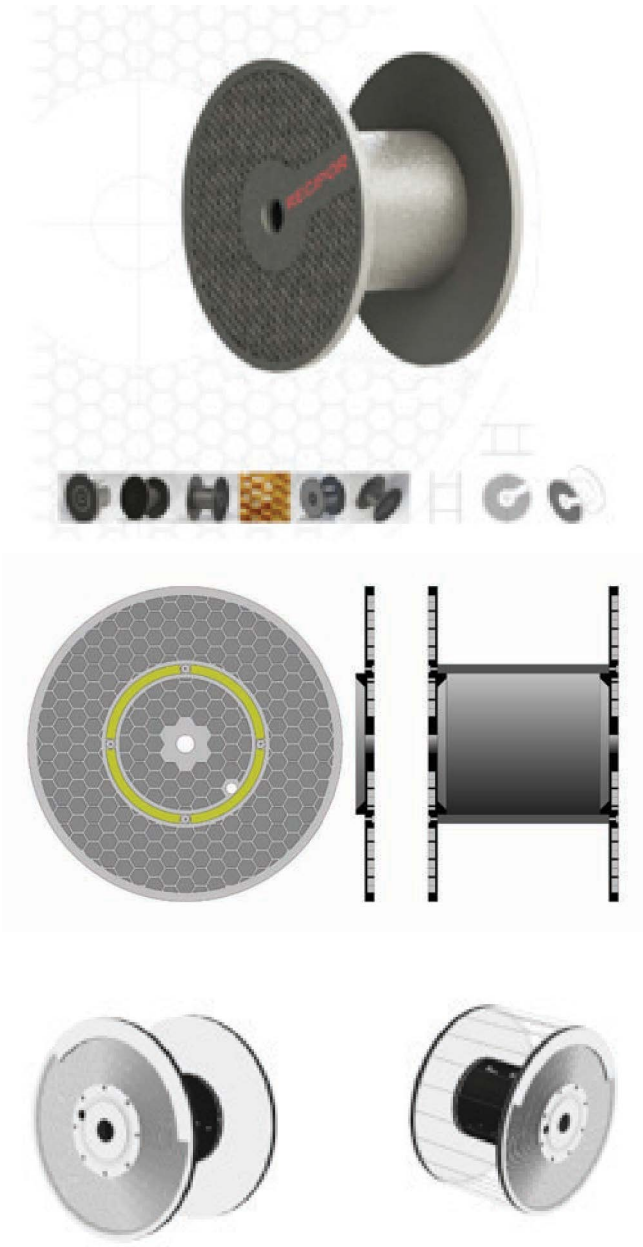

Figure 9. 3D simulations (side flaps).

technology, aiming new markets. During this collaboration with Recipor we've noticed the advantages of the external elements as a way of questioning the "normal" approach to a problem. The external perspective, free from the vicious routines within companies, was able to gather and use visions from different actors that usually don't communicate.

The incursion in the companies' universe allowed us to conclude that the relationship between industrial production phenomena and design research, if energetically planned, may be strategically accepted and replicated the managers.

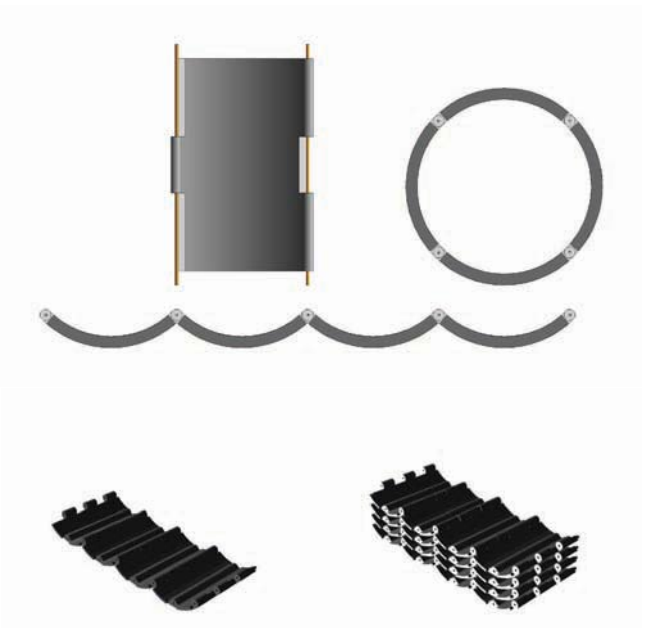

Figure 10. 3D simulations (drum division).

The investigating activity consistency with practical effects on industry will bring financial return, recognition, distinction and the projection of an innovative corporate identity, built upon ethical values.

10. ACKNOWLEDGMENTS

The team wishes to thank:

- Recipor S.A.| Eng. José de Guimarães (CEO);
- Cabelte | Drª Rita Carvalho (Directora de Marketing), Eng.º Nuno Pereiro (Director de Produção);
- Consultadoria Técnica | Eng. António Gomes (Programa Doutoral em Design da Universidade de Aveiro);
- Universidade de Aveiro.

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