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Design Thinking methodology. A Case Study: Recycling of PET Bottles

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ABSTRACT : *Plastics pose a serious threat to the environment for two main reasons: their massive use in all types of products and their slow degradation. With the recycling of plastic, the amount of waste caused by bottles, plastic bags, containers, etc. is significantly reduced. The objective of this work is to apply the Design Thinking methodology to find a viable solution to the accumulation of PET bottles in a cooperative dedicated to the recycling of garbage in the city of Santa Fe, Argentina. A multidisciplinary team was formed between the workers of the cooperative and researchers of the UNL, who approached the problem from the vision of the needs that the recycling sector has, assimilating their way of working and fulfilling their future perspectives. This team managed to find a series of creative proposals that led to the most viable, according to the different approaches that were given to the problem, that is, to obtain a prototype of the PET thread (strapping) with its possible applications. From this first product, the so-called Recycled PET Sponge emerged, which, subject to testing, will be able to obtain information that will help the product development process to be adjusted to the client's perspectives as proposed by the applied model technique.*
KEYWORDS *Methodology, Desing Thinking, Reuse, Bottles.*

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I. INTRODUCTION

The advance of new technologies aims to improve the quality of life of people, since long before the last century has tried to achieve this goal with different inventions that have been emerging from the needs of the society of each era. However, the increase in world population boosted the manufacture of different products in an excessive way, making evident, in recent times, the environmental impact caused by the policies that drive consumerism. Concern for environmental pollution has gained strength in recent years and more and more industries are implementing processes that are "friendly" with the environment in tune with the consumer that has become more demanding in this regard.

In Argentina, 12 million plastic bottles per day of garbage accumulate, around 300 PET bottles per year per individual. Although they are fully recyclable, only 30% is recovered to manufacture textiles, brooms or new containers. It is not only a matter of pollution, but a latent business opportunity is being wasted. With a well-implemented logistics and policies that promote waste separation, a market niche with great impact on the population could be enhanced [11]. It should be noted that only 4% of urban waste is recycled in Argentina. In addition, it should be considered that plastics pose a serious threat to the environment for two main reasons: their massive use in all types of products and their slow degradation. It is estimated that it takes about 180 years to degrade, although this period varies depending on the type of plastic. With the recycling of plastic, the amount of waste caused by bottles, plastic bags, containers, etc. is significantly reduced. [10, 19].

On the other hand, with the idea of promoting the recycling of urban waste with social inclusion, the "Argentina Recycle" program has been created, which aims at the "Formalization of Urban Recovery" (RU) through the incorporation to Urban Recovery Cooperatives (CRU) in differentiated collection services in urban areas. In this way, the following actions are promoted: (i) Recover the social rights of a historically excluded group, earning an income equivalent to the Minimum Vital and Mobile Salary, and guaranteeing access to Social Security systems, (ii) Organize the work of urban recovery workers in gangs and promote the construction of popular organizations in the sector, (iii) Reduce occupational diseases and accidents in the sector, (iv) Facilitate the fight against child labor in the sector, (v) Improve the position of bottle collectors for

recycling in the urban waste market, (v) Promote interconnections between different initiatives of the social economy, (vi) Strengthen the social visualization of bottle collectors for recycling as workers and not as marginal, (vii) Reduce burial levels in landfills, (viii) Promote separation at source of urban waste, (ix) Encourage re coverage of recyclable materials, (x) Raise the environmental awareness of the population, (xi) Promote the integration of urban recuperators in the community, and (xii) Improve the hygiene of the areas of urban waste disposal [12].

Urban waste management is a global environmental problem. The irrational scheme of capitalism's own consumption generates a quantity of garbage that cannot be absorbed by the environment, whatever the method of final disposal (burial, combustion, etc.). Waste, however, has been revalued in recent years by unexpected actors: urban recuperators, who represent low-income families throughout the world who find a decent means of subsistence in urban waste. They comply, without any consideration, with a service that the State must guarantee in accordance with its internal legislation (national, provincial and municipal) and various international commitments: recover waste, recycle and minimize burial in landfills.

The urban recuperators were building organization and awareness in some cities of Latin America, achieving some level of state recognition and support. Recycling with social inclusion, elevated to the category of Popular Public Policy, is undoubtedly the best response in the Latin American context for the treatment of recyclable urban waste, since it means a considerable saving in the cost of urban hygiene services, in the environmental liability that is generated with the burial and a successful way of advancing in the distribution of delayed social rights.

In the city of Santa Fe, Argentina, the “Santa Fe Recycling Cooperative” has been formed, which functions as a reception, separation, cleaning and conditioning center for recyclable materials. From this cooperative, the need to expand the premises used for their work arose, due to the fact that the collected plastic material had increased notably in recent months.

On the other hand, the Design Thinking (DT) methodology has attracted both academic and professional interest due to the applicability of its methods to promote innovation and applicability in many areas, as in business [21]. The DT is considered a system of three overlapping spaces: viability, convenience and feasibility, in which the viability refers to the commercial perspective of the DT, the convenience reflects the user's perspective and the feasibility encompasses the technological perspective. Innovation increases when all three perspectives are addressed. The ability of the DT to solve complex problems [5] has designated it in the business environment as a promising approach to innovation. A large number of design methods and tools facilitate the DT process and support the promotion of equipment innovations, composed of designers and non-designers. From the perspective of a designer or designer of human-computer interaction, this methodology incorporates the ideation and attributes of the creative process, such as empathy for the user, and methods that include rapid prototypes and abductive reasoning [13]. From a business perspective, establishing a deep understanding within a team of specific users is one of the important components of the DT methodology [15]. Companies recognize innovation as a driver of business growth to maintain a competitive advantage in the market and as more likely to offer customers unique benefits. Understanding how innovation within teams can be supported by DT methods and tools captivates the interest of business communities. Many social companies already intuitively use some aspects of design thinking, but most fail to adopt the approach as a way to go beyond today's conventional problem solving. Certainly, there are impediments to adopt design thinking in an organization. Perhaps the approach is not accepted by the entire organization. Or maybe the organization is reluctant to adopt a human-centered approach and fails to balance the perspectives of users, technology and organizations. [2,3,4].

Design thinking can be described as "a discipline that uses designer sensitivity and methods to match people's needs with what is technologically ugly and what a viable business strategy can translate into customer value and opportunity to market "[3]. It is generally known as "applying a designer's sensitivity and methods to problem solving, no matter what the problem is, it is a methodology for problem solving and empowerment." Currently, DT has moved from product and process design to a key factor in the company's strategy [9].

At present, there are few relevant studies and the lack of specific design guidelines on how to encourage innovations with DT methods and tools that could be used by teams of non-designers, such as in a business community. In this work, a qualitative approach was used based on the proposed case study, extending previous work on DT methods and tools [7]. It should also be noted that existing studies investigate large-scale companies, while studies on the implementation of small and medium-sized enterprises (SMEs) are scarce [24].

The objective of this work is to apply the DT methodology to find a viable solution to the accumulation of PET bottles in a cooperative dedicated to garbage recycling in the city of Santa Fe, Argentina. A multidisciplinary team was formed between the workers of the cooperative and researchers of the UNL, who approached the problem from the vision of the needs that the recycling sector has, assimilating their way of working and fulfilling their future perspectives. This team managed to find a series of creative proposals that

resulted in the most viable, according to the different approaches that were given to the problem, that is, it was possible to achieve a prototype of the PET thread (strapping) with its possible applications.

II. COMPANY DESCRIPTION

The Santa Fe Recycling Cooperative is located in the city of Santa Fe. It is made up of 80 workers who, from Monday to Saturday, retrieve material in the city center, 60 are dedicated to the collection and the rest is done in the compaction area, following a schedule that has as its starting point the door-to-door search in business; and continues with the transfer to a certain corner where a truck is responsible for carrying the load to the warehouse, where they get angry before being sold to factories for recycling.

The cooperative arises in 2011 and currently works in agreement with the municipality. According to data provided by the Ministry of Environment of the municipality, an average of 22,000 kilos of cardboard, 6,800 paper, 900 scrap metal, 620 plastics, 1,480 nylons, 420 telgopor, 1,200 glass and 2,400 pieces are collected. This gives a total of 36 thousand kilos of recyclable material per month [12].

III. THEORETICAL DEVELOPMENT

Although it is thought that the DT emerged in 2008 as a product of the article in the Harvard Business Review by Tim Brown, it is a methodology that has its bases since 1919. According to Marcos Saavedra Seoane's research [17] its beginnings are attributed to the German architect Walter Gropius who founded the Bauhaus school of arts and crafts in Weimar, Germany. There was born the profession of Product Designer instructing dynamics that today characterize the DT process such as teamwork, the elimination of hierarchies in the innovation process and the approach of the project according to the needs of the user. Although the school was closed, the idea had already evolved, incorporating the emotional aspect of the consumer, a matter he found cause in Nordic designers when it comes to building cheerful and comforting spaces that counteract the climatic reality of these countries. This subsequently took the name of cooperative Scandinavian design and transcended the political, educational and social spheres, currently adding ethnographic research. With the conflicts of the Second World War, referents such as Gropius or Mies van der Rohe, they emigrated to the United States where they transmitted the vision and way of working of the Bauhaus, having a strong impact on American society since the 1950s. In the following years, technological advances, the appearance of new materials and the incorporation of soft science research on people's behavior allowed the evolution of product development management. Buckminster Fuller stood out for his work by forming multidisciplinary teams made up of engineers, industrial designers, materials and chemical scientists, in order to achieve a comprehensive vision of investment projects. He managed to develop systematic methods to evaluate and solve the problems of humanity, even among the first to talk about sustainable development or energy efficiency. At the same time arises the brainstorming technique (brainstorming) of Alex Osborn, the methodology of Operational Creativity and Synectical theory that converge in what is known today as “insights”. On the other hand, John Arnold, who revolutionizes with his ideas, insisted that the creative and engineering should be in every product development process. Arnold recruits Bob McKim, engineer, industrial designer, passionate about experimental psychology and who is credited with the concept of people-centered design for his projects. McKim discovers David Kelley, who by participating in his design program, is incorporated into the department and after a few years Kelley finally founded IDEO in 1991, Palo Alto, California. This company managed to combine all knowledge from Bauhaus to McKim, its projects were approached by multidisciplinary teams from lawyers, doctors, engineers or professors who worked transversally, revolutionizing product development management. Finally, with the founding of the Design School in Stanford, the DT methodology is completed along with the name by which it is currently known.

Companies and organizations need to innovate in response to competition and rapidly changing market demands. For this reason, DT is considered a supportive approach to a variety of business challenges that must be pursued by designers and non-designers [21]. Especially for the early stages of innovation, DT has been argued as a successful method of generating ideas [20]. In the literature, several connections between DT and innovation can be found, as well as factors that affect the growth of innovation [1,21].

On the other hand, DT can also be seen as "the application of design methods by multidisciplinary teams to a wide range of innovation challenges" [21]. Seidel and Fixson [21] studied the adoption of DT by rookie multidisciplinary teams. "If design thinking is to be widely adopted, less experienced users will use these methods together, but we know little about their effect when they are recently adopted" [21]. The implications of their study are that novice multidisciplinary teams will be more successful in the application of DT when they can be guided to combine methods, be aware of the limits of brainstorming and can move from more to less reflective practices.

In addition, companies adopt multidisciplinary teams during DT processes as a strategy to increase team performance [25]. The innovation process and how it is managed constitute a key strategic issue for companies that depend on multidisciplinary teams. In turn, the adoption of multiple design perspectives is expected to increase performance in terms of the quality of decision-making or problem-solving innovation [25]. West et al. [25] examined the relationships between team processes, leadership clarity and innovation in a health care context. In the innovation process, brainstorming models imply that group creativity can benefit from multidisciplinarity, since brainstorming groups often generate creative and novel ideas, and it is believed that the group environment causes a higher level of cognitive stimulation [14]. In addition, the highest degrees of multidisciplinarity are associated with a wider range of knowledge, skills and abilities available to a team [25].

The Product Development Process Management is complemented with innovation, increasingly focused on the customer in order to obtain a product that is successful in the market and generates acceptable profits. It is necessary to rethink the methodologies of the last century applied to the design of products since they do not always solve problems or take into account the needs of the consumer. According to the Doblin group, only 4% of the products launched in the United States have been successful, mainly because they neglect the user's vision, and focus only on their sole purpose, which is to maximize sales until the market is exhausted. The structure of the DT methodology focuses on the client, is based on the imagination and uses tools from the design field to solve complex problems, involving a multidisciplinary vision where thoughts converge from different perspectives leading to innovative solutions in business.

The communications revolution and the change that the Internet has given us opens up a huge range of possibilities to experience as creators. It allows sharing, creating ideas and working with people of different nationalities, professions, tastes and preferences. New products, new ideas, new strategies that impact society in a positive way and that get users excited are needed. The DT methodology imagines the future and explores possibilities of what could be through observation and empathy, visualizes ideas, experiments with prototypes to collect valuable information, before many resources are used in its development and finally, it ends up prevailing The best solutions. It is a link between different areas that come together to address a specific problem, trying to understand the needs of the consumer, exploiting creativity at all levels to achieve the precise solution to the issue, designing a feasible, testable prototype that allows readjustments, until being the right product in response to the original problem reaching user satisfaction.

Companies that do not yet address innovation processes tend to rely on procedures and / or ways of producing that worked well for several years, and have little capacity for internal adaptation and transformation. Because they are not flexible, it is more difficult for them to interpret the transformations demanded by markets, as well as society and consumers. Companies that have a more open attitude take risks and are aware that changing and innovating is positive, they have the ability to understand their customers, provide them with a permanent offer and adapt to connect with market demands. Companies that adopt innovation methods, such as the DT methodology, are in continuous transformation and ensure that their services and products are always relevant within the market and society. Each project in which this methodology is applied is unique and always works with a multidisciplinary team. Companies have the ability to adapt this tool to issues such as internal strategy development, production, design of services and systems, as well as marketing. It should be noted that they cover the needs of their clients in terms, not only rational but also emotional.

As mentioned earlier, applying DT, involves working with the user, collecting information that he manages and devising and designing prototypes that offer the best solutions to the problem and then test them. For this it is important to involve the entire organization, what is known as “Innovating in Experience”. DT offers an approach to change the attitude and mentality of companies and make innovation a continuous process where the protagonist is always the person [6, 8, 18, 22, 23].

IV. APPLICATION OF THE DESIGN THINKING METHODOLOGY TO THE CASE STUDY

Figure 1 summarizes the general stages that make up the application of the DT methodology [6, 14]:

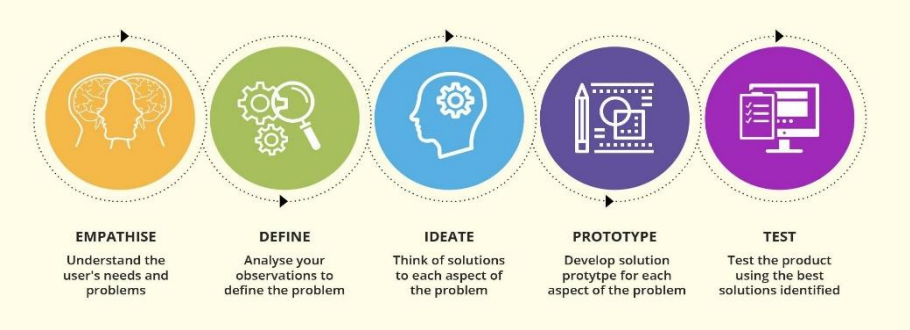

Fig.1. Stages of the Design Thinking Methodology.

As you can see the methodology consists of five stages: (i) Empathize, (ii) Define, (iii) Devise, (iv) Prototype and (v) Evaluate. Then, each one of them is applied to the proposal made by the Santa Fe Recycling Cooperative - FACCYR, "Search for the best solution to the increase of PET plastic bottle waste". The magnitude of the material to process exceeded the storage capacities of the plant, for this reason the possibility of carrying out some type of prior recycling that significantly reduced the bulk collected without significant investment should be analyzed. A multidisciplinary group is formed to address the project, which applies the DT methodology following the steps presented above. It should be noted that the methodology looks like a linear process, but in reality it is a transversal management of interactions between the user and the group that manages the project. It starts from focusing all product development management on the customer, in this case, the Recycling Cooperative.

IV.I. EMPATHIZE

It must empathize with the user and their environment, basically through observing them and the circumstances or environment surrounding the product. Great design thinkers observe the world in great detail. They observe things that others do not see and use their knowledge to inspire innovation [4].

Human needs are the starting point, we must observe what the consumer does and not what he says. For example, you can videotape the users of the product, take pictures of their daily lives and reflect images that show what they see. Then, the multidisciplinary team may ask: What? How? and because? This will provide information that will define the problem and offer solutions.

Empathy is a central concept in design thinking, and to carry it out more precisely, it can be divided into three actions:

- Observe: users and their behavior in the context of their lives.
- Meet: interact and interview users.
- Immerse yourself: experience what the user experiences.

In order to develop empathy and meet the customer or their environment, interviews are conducted with potential people who buy the product or service. To do this, you should think about the questions or conversation areas for the interview. It is suggested that five or more people be interviewed and that an interview be selected to move forward. At the end of the interview you should have information about what the user does, says, thinks and feels. You have to take the time to consider many "why" and not continue towards the solution too soon. You have to get to connect with users and know what they are interested in, what worries them, what they are passionate about.

Therefore, to "EMPATHIZE", the multidisciplinary group meets with people from the cooperative to meet them, talk about their needs and understand the problem from their perspective. You can implement group dynamics, interviews, research on the subject and even go to the recycling center to see the daily actions of employees. You have to keep an open mind so as not to judge what is received from information but rather, understand the depth of the challenge of dealing with this problem.

This first stage is an immersion phase, in which preliminary and in-depth investigation data are obtained. The most significant findings are presented as "insights" notes (ideas) and subsequently become "blueprint" tools (allows a detailed description of each stage of the process, both visible and non-visible parts), "custumer" concept maps journey map (allows to capture on a map, each of the stages, interactions, channels and elements that a customer goes through during the entire purchase cycle), which are the two main tools. From this stage the necessary information is obtained to delineate an idea of the type of client for which the solution is designed.

IV.I. DEFINE

At this stage, all possible alternatives for solving the problem will be considered, from the most obvious to the most risky, without ruling out any. It is about visualizing the future, that is, the trend of market needs, not keeping what exists today. In this phase the problem must be defined and structured in order to clarify and focus the challenge that has arisen.

Therefore, to "DEFINE", all the information collected in the previous stage is processed to understand and define the "insight" of the client (in this case the client would be the cooperative). At this stage it is clear the problem to which you want to find a solution, the objectives that must be achieved and specify the point of view of the client for which a response is going to be designed. The specific problem is the reuse of PET bottles so as to reduce the physical space they occupy and what opportunities can be achieved from reuse.

Once the problem is defined, the multidisciplinary group focuses on solving it. In the next stage, the conjunction of the different disciplines plays a very important role, allowing the problem to be approached from different approaches, creating an exchange of ideas to find the most appropriate one.

IV.III. IDEATE

The first step here is to establish a dialogue about possible solutions, carefully plan who will participate, what challenge they will be given and how the conversation will be structured. After using the design criteria to brainstorm individual ideas, participants meet to share ideas and develop them creatively, rather than simply negotiating compromises when differences arise [15].

The ideas phase generates a large number of possible solutions to the project as mentioned above. The multidisciplinary group focuses on the problem to be solved, but it should not be judged early. At the end of this phase it is necessary to express the thought with visual tools such as photos, sketches, diagrams, mobile notes to clarify concepts, etc.

It is a fuzzy front end process (front end, defined as the period between considering for the first time the opportunity of a new product and when the idea of the product is ready to enter formal development), a kind of round trip of activities between the different disciplines, where the work group is always predisposed to improve and learn from the design process in search of the optimal solution.

Brainstorming (brainstorming) is an excellent tool to use in this phase. It is a way to generate a large number of ideas that would not be possible to do individually. The intention of this tool is to take advantage of the collective thinking of the group, listen, and on the basis of other ideas build new. It is important during the "brainstorming" sessions to avoid criticizing some or rewarding others. It is about opening possibilities and creating an environment that allows all the actors of the group to participate. Extravagant ideas are welcome and all participants are encouraged to contribute fully, helping them to develop a wide range of creative solutions.

To help generate as many ideas as possible, you can also answer the following questions (five to ten ideas in each question): (i) What are the most obvious solutions to this problem? (even things that already exist), (ii) What can be added, removed or modified from these initial solutions?, (iii) How would a 5-year-old child solve the problem ?, (iv) How to solve the problem if you have an unlimited budget ?, (v) How to solve the problem if you should limit spending to the maximum ?, and (vi) How to solve this problem if you have control over the laws of nature (supernatural powers, teleportation , etc)?

Therefore, for "IDEATE", the multidisciplinary group must raise the following ideas among the possible ideas that arose:

a) Acquire extra machinery for compaction only of bottles that can then be sold to different sectors that process PET plastic.

b) Incorporate a line of processing of the bottles, separating them by colors and removing the caps, safety rings and labels that can then be compacted and sold to industries that process it for the

manufacture of pellets, sunchos and polypropylene pipes. Classification and separation adds value to the product as it sells the sale to specific factories.

c) Acquire crushing machinery for PET bottles for the manufacture of flakes that can be sold to the industries that transform them after they are melted and molded into new containers and other products.

d) To take advantage of the knowledge of the workers of the plant in the handling of the plastic material, to promote the manual recycling of these containers transforming them into handmade objects that can then be marketed with a certain added value. From this idea emerged objects like pots, decorative ornaments, curtains, brooms, slides, water diffuser, toys, boxes, bag sealers and soap holders.

e) Process the bottles with a spinning device that is easy to build and economical. In this device the bottle is placed, the desired thread size is decided and the PET thread that results from slicing the bottle with the knife edge of the device is manually removed.

From the ideas that emerged those that involved a considerable investment were not feasible, the cooperative has no chance of facing an investment. As for redirecting personnel to a new recycling line, it may not be viable because they do not have extra labor. With respect to the proposal to classify, reuse bottles in handicrafts or transform them into PET thread, they were attractive, so the next stage of "PROTECTING" some of them was carried out in order to assess their feasibility.

Among the options analyzed, the "PET thread" product has the following properties: (i) A resistance of around 200 Kgf, (ii) An elasticity of approximately 5%, (iii) Resistant to ultraviolet rays and changes in temperature, and (iv) Does not absorb water. Within the possible uses it is used to hold packages, it can be molded with temperature, it is used to make curtains, it can be woven to make bags and containers, it can be screwed onto a metal shaft bar, heated to form a spring and then rolled up on itself same allowing to make sponges similar to those of steel that are used in the kitchen for washing.

IV.IV. PROTOTYPE

It is one of the most important steps in the process. It consists of building as quickly as possible the product or service making sketches, models, scale models, etc. Experimentation is the main guide of a creative organization and the prototype is the best sales and communication tool for the project, as well as being a good learning process.

Prototypes should only demand the time, effort and investment necessary to generate useful feedback and develop an idea. The more "finished" the prototype looks, the less likely its creators will pay attention to the feedback and benefit from it. The goal of creating prototypes is not to conclude the project, it is to learn about the strengths and weaknesses of the idea and identify new directions that other prototypes could take [4].

The prototype is not always made with the final materials since it tries to accelerate the tangibility of the ideas to be able to evaluate them, redefine them and select the best one. The goal of the prototype is not to create a finished product or service, it is to shape an idea to learn about its strengths and weaknesses. For example, McDonalds 'is a company famous for applying prototype processes in all phases of innovation. In the inspirational phase, drawings, fast machines and scenarios are used to explore new services, product offerings, and customer experiences. To feed the idea of space, McDonald's has built a sophisticated prototype at its Chicago headquarters where the project team can configure all kinds of kitchen equipment, automatic dispenser and restaurant design to try new ideas. When an idea is implemented, pilot restaurants are often used to test the prototype. Another form of prototype is the use of virtual worlds or social networks. Companies can learn how to approach customers by proposing products or services before they are invested in real life. For example, through Second Life, My Space, Facebook, etc.

Therefore, to "PROTETYPE", the multidisciplinary group, after taking the most promising ideas, we proceed to assemble a prototype of the instrument used to spin the bottles. It consists of a rectangular wooden bar, with gutters in specific places with a depth of the width of the belt that is intended to be manufactured, and also requires a sharp blade of a "cutter" that will be the cutting element of the device, and then a series of screws and washers to fasten the latter to the wood. In Figure 2 you can see the prototype of the bottle cutter.

Fig.2. Instrument for manufacturing PET threads of different widths.

In Figure 3, the type of thread obtained after submitting the bottle to the cutting instrument is presented.

Fig.3. PET thread that is obtained after the spinning process.

The product obtained is a prototype and can be tested. In turn, the PET sponge is designed from the threads. It is carried out by heating the thread threaded on a metal bar using a heat gun, a spring is formed that can then be folded on itself until the sponge model shown in Figure 4 is assembled.

Fig.4. PET thread sponge prototype.

The PET Sponge has the advantage that due to its hardness it would not scratch the materials subjected to cleaning, it would be easy to rinse since it does not absorb water or dirt particles stick to it and it is a product of low processing cost, but with a Important added value for sale. It is estimated that it can be marketed at a value of USD 0.30.

IV.V. TEST

When applying the DT methodology, it is intended to quickly reach a prototype that can be tested by the user in order to obtain valuable information that serves to feed the previous stages, adjust the chosen design and improve the proposal so that the final product, which has It was thought from the perspective of the client and conceived based on their needs, can solve the original problem

Therefore, to "TEST", the multidisciplinary group, at this stage sees the non-linearity of the process, focuses on observing what works of the proposal and answering the following questions: (i) ¿Does this prototype have value for the client type that was chosen?, (ii) ¿What aspects of the prototype are worth developing?, (iii) ¿What is not attractive of the presented prototype?, (iv) ¿If I could change something of the object, what part would it be?, (v) ¿What attracts you most to this prototype?, (vi) ¿Is it sustainable over time?, (vii) ¿Does it have the potential to become a marketable product?, (viii) ¿Does it satisfy the needs of the potential consumer?, and (ix) ¿Does it solve the problem posed by the client (cooperative)?.

The fundamental basis of this stage is not to question whether the idea is correct or incorrect, but to improve the proposal to its maximum point. It is essential to return to previous stages to achieve an evolution of ideas, refine perspectives and capture from experience those points that strengthen the goals set at the beginning. The success of the solution presented is measured according to indicators that were previously established for product design.

When applying the DT methodology, the user is a strategic part in the development of the product, it is a process that aims to solve a specific problem and favors the multidisciplinary approach that is given. The fundamental thing is not the prototype but going through multiple feedback cycles that help to improve the concept, learning about the needs that are had, listening to the changes suggested by the client and iterating until creating an improved design that solves the problem.

V. CONCLUSIONS

The use of DT methods and tools is a way to incubate ideas and create innovative solutions within teams.

The objective of this work was mainly to find a viable solution to the accumulation of PET bottles in a cooperative dedicated to garbage recycling in the city of Santa Fe, Argentina. To achieve this objective, a multidisciplinary team was formed among the workers of the cooperative and researchers of the Universidad Nacional del Litoral, who approached the problem from the perspective of the needs that the recycling sector has, assimilating their way of working and fulfilling their future perspectives.

To find a solution to the problem, it was decided to implement the "DT" methodology, which allowed developing a tangible and viable product from a technical and financial point of view.

To address the problem, the five stages contemplated in the methodology were applied: (i) Empathize, (ii) Define, (iii) Ideate, (iv) Prototype and (v) Teste. In this way, the multidisciplinary group managed to find a series of creative proposals that led to the most viable, according to the different approaches that were given to the problem, that is, to obtain a prototype of the PET thread (strapping) with its possible applications. From this first product, the so-called Recycled PET Sponge emerged, which, subject to testing, will be able to obtain information that will help the product development process to be adjusted to the client's perspectives as proposed by the applied model technique.

Finalmente, se puede concluir que la Cooperativa Recicladora Santa Fe – FACCYR, en caso de aceptar la propuesta alcanzada, obtendrá los siguientes atributos:

• You will benefit by incorporating a new line of products with added value, which if imposed on the market, would obtain extra profits, without incurring a significant investment.

• The position of the cooperative in the community will be improved, and will contribute to enhance its image of current affairs and modernity.

• No significant risks will be at stake.

• No attempt will be made against other product lines.

The list of methods and tools discussed here are only a starting point for additional work in this field. Additional research could focus on how multidisciplinary teams use design methods and tools for innovation in each design phase and which are the most appropriate. Another topic of future research could be the functional diversity of a team that could maximize innovation through the use of these methods and tools. Case studies, field studies or similar companies would be enlightening for this area of research.

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