Problematization and Awareness of the Jeans Life Cycle

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Abstract. *In the present article it is discussed the implementation of a culture of reuse of materials from industrial waste using the jeans industry as a model. It was taken into account its history as a garment and its characterization as iconic clothing and consumed throughout the globe. Through the demonstration of the intensive use of natural resources from this industry and the use of this material. From the discussion of the life cycle and the historical and symbolic aspects of jeans were raised and analyzed products as solutions that are already applied in the market today. In this way it was tried to demonstrate the various uses and possibilities for the jeans, aiming to make it a material whose aspects are an incentive for the beginning of a new trend in giving a better destination to resources that are not reused and end up being considered junk.*

Keywords. *Reuse of materials, upcycling, jeans industry.*

1 Introduction

It is known that society is in a moment of great strength in the industrial sector and the consumerism, in general, reaches exorbitant levels (LOSCHIAVO, 2008). For these reasons, it is important to be aware that industrial waste is a potential part of today's abundant raw material.

The use of raw material from industrial waste is at a moment of great importance and the appreciation of these materials allows the generation of many projects focused on recycling and are increasingly part of the design agenda. In general, there is an aggravating decrease in natural raw materials. In parallel, It is perceived the increasing abundance of waste from industrial processes, coming from the widespread consumption of today's society. These wastes are often improperly disposed because there is no cheap recycling alternative.

One of the biggest great impact on the environment causers is the textile industry. It is believed to be important to implement this culture of reuse in the jeans industry. For this is a material that uses intensively natural resources in its production process. And also for its potential to generate new pregnant products, through the use of its very characteristic visual reference and very influential social symbolism. It is possible to explore its physical possibilities for its transformation into new products that have added to themselves the whole symbolic value brought by the material.

In this way, through a presentation to the material, the jeans, and demonstration of the intensive use of natural resources resulting from its productive process, the objective of this article is to foment an increase of critical thinking through analyzes of alternative forms of use for this raw material.

2 Jeans: origins, history & consumption

Initially used in ship sailing and merchant vessels in France from 1567, denim, cotton fabric without the addition of the indigo color, became popular due to its superior resistance to other fabrics. In the 19th century it began to be used in the clothing of sailors of the port of Genoa, Italy (DUARTE, 2013 apud PEZZOLO, 2007). These uniforms were nicknamed the genes by the French, a term that gave rise to the name popularly known in the USA: jeans (MÜNCHEN et al., 2014 apud BALFOURPAUL, 2004; LV; HUIGUANG, 2007; SCHWARCZ, 1999).

The first jeans trousers, the model Levi's 501, was created in 1870. Since then the popularity of the clothing only increased, first with the adhesion of the part by the cowboys of the American cinema and, later, in World War II as clothing of soldiers, spreading their popularity in Europe, (MÜNCHEN et al., 2014). In the 50s and 60s, because they were contrary to fashion, they represented a symbol of the counterculture movement, a success among young people in Brazil (FIGUEIREDO, CAVALCANTE, 2010, MÜNCHEN et al., 2014 apud LV, HUIGUANG, 2007).

From the moment it was a representative symbol of several movements, it gradually became part of the usual clothing, which increased its popularity, gaining its space on the catwalks already in the following decade (MÜNCHEN et al., 2014) and in the decade of 90 were

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consecrated as the most versatile and democratic wardrobe piece (FIGUEIREDO, CAVALCANTE, 2010).

Jeans is characterized today as a product of a high-profit market because of its universal character, fitting into different types of occasions and personal profiles (MÜNCHEN et al., 2014).

Jeans is a material of popularity among publics of all age groups, genres, culture, religions (DUARTE, 2013 apud CATOIRA, 2006; MÜNCHEN et al., 2014) and social classes, which can be used in all seasons (PANUCCI-FILHO, GARCIAS, 2010 apud SBRT 2006). The denim, dyed cotton fabric that with indigo dye gives rise to jeans (MÜNCHEN et al., 2014) is the most consumed fabric in the world (LOPES, 2011). The world-wide consumption of jeans is approximately "3 billion linear meters per year, the main consumers being the United States, Europe and Japan, representing together more than 65% of world consumption" (FIGUEIREDO; CAVALCANTE, 2010 p. 130).

Brazil is a world reference in the production of jeans, being the second largest producer, moving a sector of R$ 8 billion per year (MÜNCHEN et al., 2014 apud ABIT, 2010). The Brazilian production capacity of this fabric exceeds 600 million linear meters per year (FIGUEIREDO; CAVALCANTE, 2010), producing only 320 million pieces in 2010 (LOPES, 2011). The main producing states of Brazilian jeans are São Paulo, Ceará, Goiás and Paraná (LOPES, 2011; MÜNCHEN et al., 2014 apud ABIT, 2010).

Therefore, due to its high consumption rate, jeans represents, both nationally and internationally, abundance of raw material, which characterizes it as a material with high potential to be exploited for the use of solid waste from the textile industry.

3 The life cycle of jeans: production & environmental impacts

Knowing and understanding the life cycle of a product implies analyzing it from the "cradle to the grave", understanding the use of the materials, processes, energy of each phase, being able to evaluate the social, economic and environmental effects. The phases can be divided by: pre-production, production, distribution, use and disposal (LOPES, 2011 apud MANZINI, VEZZOLI, 2002, p.92). In this way, the processes of jeans production and their impacts will be presented below.

The traditional denim fabric is considered a twill, which is the diagonal mesh of the fabric, its construction is through two threads, a raw thread and a warp yarn, which is the set of longitudinal threads that undergo the coloration Indigo (FIGUEIREDO; CAVALCANTE, 2010; PANUCCI-FILHO; GARCIAS, 2010).

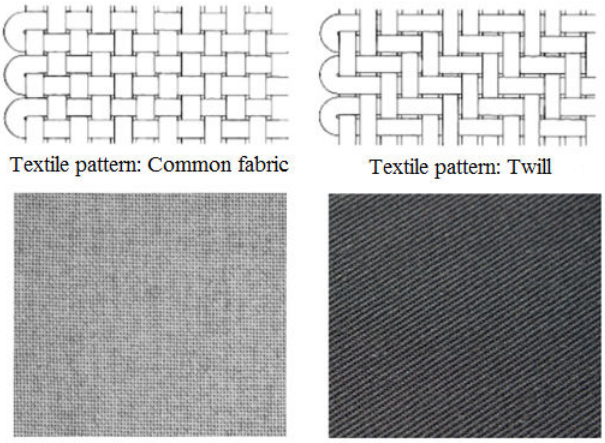

Figure 1. Twill (BROOMER, 2015).

Originally made in 100% non-organic cotton, today jeans are found in several proportions of polyester (PET) in approximately 50%, and may contain 2 to 4% of elastane. Both polyester and elastane are derived from petroleum, a non-renewable natural resource (DUARTE, 2013 apud BILISIK and YOLACAN, 2011; LOPES, 2011 apud SENAI-CETIQT, 2004).

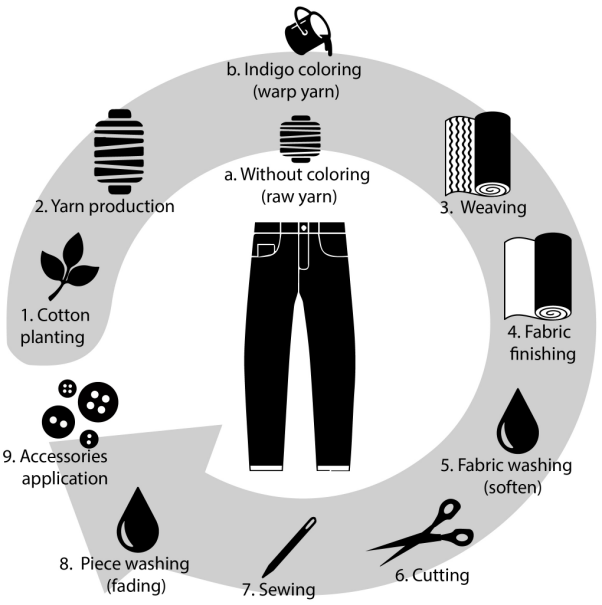

Figure 2. Productive chain of jeans (Based on Santos; Vasques, 2016).

As can be seen in the image above, to reach the finished piece of jeans takes a long way. After the production of the cotton, it is transformed into yarns, of these yarns part goes with its raw coloration for the weaving, while the other one is dyed with the indigo coloring generating the yarn of warp, that after ready are also routed to the weaving where they will be entwined with the raw yarn forming the twill fabric.

The fabric is then brushed to remove cotton particles which may have gathered during weaving and then goes to the screener, where the recurring down cotton of the brush process is removed. Sequentially the fabric is washed and softened, which will facilitate

subsequent processes. Then the assembly, cutting, sewing processes are performed, so the finished part goes to the washing process, where it receives its coloring details and then receives buttons, zippers, eyelets, labels and other finishes (SANTOS; VASQUES, 2016).

It can be noticed that the denim industry uses intensely natural resources (MÜNCHEN et al., 2014). However, only in 2006 did Levi's Strauss & Co publish the lifecycle of the 501 jeans model with the natural resources spent on making one piece: 920 gallons of water, 400,000 kW of energy, 32 kg of carbon dioxide expelled. As reported by the brand, the equivalent of keeping a hose on for 106 minutes, driving for 125,502 km and keeping a computer connected for 556 hours (FIGUEIREDO, CAVALCANTE, 2010). However, the production processes of the fabric or part are not specified (DUARTE, 2013).

In order to achieve the correct shade of blue, synthetic indigo dye tanks are used (FIGUEIREDO, CAVALCANTE, 2010), with the presence of synthetic dyes and high levels of metals, salts, surfactants, sulphides, solvents, (MÜNCHEN et al., 2014 apud SOTTORIVA, 2002), which are often discarded without any treatment, altering the aquatic ecosystem making them severely toxic (MÜNCHEN et al., 2014 apud PASCHOAL, TREMILIOSI-FILHO, 2005; DALLAGO et al., 2005; ZANONI; ALVES, 2001; VASQUES et al., 2011), the removal of color from textile effluents is one of the major industrial difficulties (MÜNCHEN et al., 2014 apud GUARATINI, ZANONI, 2000).

Until the 1980s no effect was applied on jeans, it reached its end consumer still stiffened by gum, which was gradually eliminated in household washes. At this time, industrial laundries appeared, which, due to factors related to fashion and comfort, had effects of aging, fading, dyeing among other customizations (SANTOS; VASQUES, 2016; LOPES, 2011 apud BOTTOS, 2007; CANELADA, 2011; HEISE, 2009; KNOLL, 2011 e TAVARES, 2011).

The excessive use of water is a serious environmental problem due to the high volume chemical inputs that are transported (DUARTE, 2013). It is estimated that is used 120 liters of water per garment in the laundry phase (LOPES, 2011 apud TAVARES; ARNT, 2011), or between 11,000 and 20,000 liters of water per 100 kg of clothes benefited (PANUCCI-FILHO; GARCIAS, 2010, apud ITABORAHY; SILVA, 2006).

In the laundry, expanded clay or pumice is used, both of which release fragments that acquire the color of the bath (LOPES, 2011 apud KNOLL, 2011), the most used bleaches are chlorine based (LOPES, 2011). The water used in this process is no longer reused and if not treated in its reintroduction to nature causes gradual pollution of waterways and other serious environmental problems (PANUCCI-FILHO; GARCIAS, 2011).

Even the biodegradable gum that gives the resistance to the wire when ingested by microbes, generates a greater consumption of oxygen and causes mortality of sea life (FIGUEIREDO, CAVALCANTE, 2010). Moreover, in the raw material culture of the jeans fabric, the cotton, which represents around 50% of the world's fiber production, is applied 25% of the agrochemicals consumed in the world (MÜNCHEN et al., 2014 apud EMBRAPA, 2004) .

However, there are alternatives that can minimize a part of these effects, such as ozone and tire fragments for general fading of the fabric, laser for localized fading, enzymes that can be used at all stages of the process to purify water or fade the fabric (LOPES, 2011). Other alternatives to be adopted by industries may be the optimization of processes and resources or the elimination of chemicals from production (FIGUEIREDO, CAVALCANTE, 2010). Also, organic cotton can be used in production, recycled polyester, recycled cotton, sorghum sorghum, or reduced use of dye (DUARTE, 2013).

In addition to the alternatives adopted by industries during production, it is important to remember recycling to reduce environmental problems. Considering that the main destination of jeans after the end of the cycle of consumer use are generally thrift stores, bazaars, outlets, among others (DUARTE, 2013 apud LEITE, 2009), are also often used as rags or sent to ordinary garbage, ending pu in landfills. However, they can still be used for power generation, being used in boilers, cement loading, recycling for new fabrics or non-woven fabric and reuse in general, in craftsmanship or in fashion, where the use of flaps predominates (DUARTE, 2013).

Therefore, while the reuse of the good of consumption, through the transfer to a next user, adds the value of reuse and is added economic value by the incineration system, because they are transformed into electric energy, the recycling system has the capacity to add both Economic value as environmental value (DUARTE, 2013 apud LEITE, 2009). Recycling of waste, such as industrial waste, can also help to preserve natural resources and often reduce energy consumption (DUARTE, 2013 apud JOHN and ZORDAN, 2001).

Jeans proved to be an extremely socially representative piece and a raw material, beginning with its historical influence, starting from a symbol of rebellion to fashion icon of the democracy of cultures, bodies, age groups and social classes. It proved to be timeless, being consumed from its emergence to the present day with surprising strength. But beyond all this, it has proved to be an environmental problem, through the large amount of dyes needed for its dyeing and the softening and dewatering washes and the large amount of contaminated water that these processes involve, ending up in the untreated waterways.

All these factors reinforce the need to work more with spare parts of textile companies, this raw material can incorporate all this meaning and also evidence the importance of the appropriate disposal of the material.

The transformation of the material after its industrial use, without value, can add all its historical and environmental potential to a piece of recycling if it is well treated and has its origins preserved in the product. For this reason it is believed that the work with the residues of jeans, a material with so many meanings added to its use and production, is a good strategy to take

greater steps in the intensification of the culture of reutilization of materials.

4 Alternatives for reuse of jeans and other fibers

Taking into account the large volume of industrial disposal of this type of material, companies are already developing sustainable alternatives for its reuse. Having focused not only on using the material as a fiber, but to turn it into a composite that can be destined for other uses, which can be very exploited. The selection of the products for the analysis focuses on products that have escaped the usual processes of reutilization of fabrics, such as patchwork, that is, the stitching of the flaps or the use of the residue as defibred fabric in fillings or non-woven fabrics.

The analysis uses the SWOT tool that considers four aspects of the product: strengths, weaknesses, opportunities and threats. Strengths are the characteristics that increase the competitiveness of the product, while weaknesses are characteristics that put the product at a disadvantage compared to the competition (PAZMINO, 2015).

4.1 Wootex

Wootex is a new material developed by the company VIVE, Polish, responsible for the recycling of 350 tons of textiles daily. Of these residues, a percentage of 20% ended up proving impossible to be reused due to its already very worn condition. Originally this type of waste is incinerated, which generates an emission of approximately 3.4 kilos of CO2 to each kilo of burnt textile. In this way the company decided to invest in the development of a new way of recycling the fabrics, leading to this new material. Using textile fibers and low density polyethylene, from plastic bags, through a patented process it was generated the Wootex (figure 13). The company claims that Wootex is as durable as wood, but it lasts longer. In addition it is soft to the touch and weather resistant without requiring painting, polishing or other means of protection.

Figure 3. Wootex (WOOTEX, 2016).

It is available in gray and brown colors and the proportions of fiber and polymer can be changed to a desired quality (WOOTEX, 2016). The following is a SWOT analysis of the product (Table 1).

Table 1. SWOT Wootex.

Strenght	Weaknesses
· Materials used in the manufacturing process treated in an ecologically correct manner; · Innovative product for its materials and techniques; · It has several possibilities and applicabilities; · Good mechanical and weather resistance, superior to plastic and wood; · Uses materials from disposal, which could no longer be applied to any other reuse; · It has a velvety surface; · Raw material that does not require any finishing.	· Only available in gray and brown; · It is necessary to send the product design to the company to evaluate the possibility of production; · Currently only available in the company that has patented the process.
Opportunities	**Threats**
· Alternative energy systems; · Encourages the growth of the environmentally conscious public; · Promotes products with durability greater than those offered in the market.	· Competition with polymers, which have better plastic characteristics, greater possibility of colors and lower value; · Competition with wood, for the lowest value and greater accessibility. · Public without interest in the environment and low environmental awareness.

4.2 Mosevic

Mosevic is an eyewear brand based on the reuse of industrial jeans. After four years of research, designers Jack Spencer and Alex Boswell, who already had experience with sustainable design, developed the process of transforming the material into glasses (LIVE CYCLE, 2016).

Figure 4. Mosevic (MOSEVIC, 2016).

At their studio in the UK they perform all line assembly manually. Their process consists of assembling layer by layer of jeans using a process-specific resin and then they are pressed into molds. The result is a durable and flexible composite that is precisely cut by CNC in the final format. After trimming frames are taken to a stone wash to eliminate the burrs and to expend the

material until it reaches the desired coloration. The assembly of the parts is entirely handmade where the hinges are placed and the rods are reinforced with steel cables, making them adjustable and more resistant to deformation (MOSEVIC, 2016). The following is the SWOT analysis of the product (Table 2).

Table 2. SWOT Mosevic.

Strenght	Weaknesses
· Innovative product for materials and techniques; · Uses material from disposal; · It has a good finish; · Much of the process is manual; · It offers a differentiated use to the material used; · Quality product, due to the proximity of the producer to the process; · It has attractive aesthetic characteristics to the consumer; · Uses a product with fashion maturity.	· Use of the resin; · Generation of new wastes from the machining and washing; · Impossible to reuse the material in the post-use because it is composite with resin; · Use of other materials in the finalization of the product, such as lenses, steel cables and hinges.
Opportunities	**Threats**
· Alternative energy systems; · Encourages the growth of the environmentally conscious public; · Promotes products with aesthetic characteristics different from those presented in the market; · Creation of a composite and production method that can be used in the generation of new products.	· Competition with larger and consolidated companies in the market that use polymers, or other materials that have better plastic characteristics, greater possibility of colors and lower price; · Public without interest in the environment and with low environmental awareness; · High value for the processes involved.

4.3 DenimX

DenimX is a composite of jeans and denim with bioplastics, a plastic material with numerous applications, according to figure 15. It was four years of research for the Dutch designer Marc Meijers to develop the process that can be applied to other types of textiles as well.

Figure 5. DenimX (MATERIA, 2016).

According to the source all kinds of three-dimensional materials can be created, from items such as lamps and furniture to products for the automobile industry. It is a versatile material, since aspects such as rigidity, weight and thickness can be handled according to the needs for each product. The material still brings in its visual appearance the recycled fibers of the jeans, bringing blue tones that can change according to the amount of the fibers in raw cotton or the fibers dyed with the indigo dye, that appear on the surface of the material (MMD, 2016).
The following is the SWOT analysis of the product (Table 3).

Table 3. SWOT DenimX.

Strenght	Weaknesses
· Innovative product for the materials and techniques employed; · It has several possibilities and applicabilities; · Good mechanical and weather resistance; · Uses discarded materials such as jeans and denim, and possibly polymers; · Possibility of several finishes; · It proposes its use in several sectors; · Keeps the visual appearance of the jeans fibers on the surface, dispensing dyes.	· It is necessary to send the product design to the company to evaluate the possibility of production; · Currently only available in the company that has patented the process.
Opportunities	**Threats**
· Alternative energy systems; · Encourages the growth of the environmentally conscious public; · Promotes products with aesthetic appeal different from those offered in the market.	· Competition with polymers, which have better plastic characteristics, greater possibility of colors and lower value; · Public without interest in the environment and with low environmental awareness.

It could be noticed from the analysis shown that there are several uses and possibilities for jeans (and fabrics in general) to transform it into new products. And that such products do not have to be clothing, because the physical characteristics of the fabric can be transformed. The possibilities are very extensive since the material can be used from polymer load up to fiber for resin application.

However, in all cases, although there were innovations in the process, they were unique to the application of the companies that developed them. Characterizing itself as a force in product monopoly issues, but as a weakness in the conquest of world markets, but mainly in the proposal to facilitate and encourage the reuse of materials for all layers.

It is also worth noting the aesthetics of the materials used, mainly the visual characteristics of the jeans, since they add aesthetic-symbolic value and minimize the need for the application of other materials for finishing.

5 Final considerations

For the purposes of optimizing sustainable critical thinking, this article approaches the environmental issue. The moment in which our society is located, of exploitation of natural resources and generation of solid residues that goes at the end of their life cycle to common dumps, characterizes a great waste of resources and an expressive generation of garbage.

It is necessary to create a culture of material reuse, with emphasis on the importance of the demarginalization of the use of recycled materials in new products. This factor is extremely important in order to achieve success in the creation of this culture.

Jeans have been approached as a raw material for discussion because of their historical and social representativeness, since they can be used as artifice for their acceptance in new recycled products to their aesthetic appreciation, that is, to use their physical appearance as a symbol of their relevance. And also, jeans is a material that fits the fashion trends for more than 50 years, never ceasing to be present in the wardrobe of people around the world. These factors indicate a high and constant production, which generates great environmental impacts.

It is believed that the reuse of this material in new processes will contribute to the reduction of waste generation and will become an incentive for more projects with the same objective.

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