

Fashion garment manufacturing – FGM and cyclability theory

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Abstract. This article, derived from an ongoing research, presents the possibilities of reducing the inappropriate disposal of textile residues generated by the fabric cutting sector of the Fashion Garment Manufacturing (FGM). The raw material used is very varied, resulting in a large number of productive processes. FGM produces clothing that has as its main features a short life cycle, a high rate of diversification and differentiation, and small production batches, resulting in few similar parts. The production process is differentiated according to the characteristics of the fabric and the look of the garment. During the production process, at least 10% of textile waste is generated during the cutting process, which is constantly discarded in an inadequate way. The Cyclability theory is researched aiming at the possibility of reduction in the generation of waste and elimination of inappropriate disposal. The case study presents the action research carried out in three small Brazilian companies to study the applicability of the Cyclability theory.

1. Introduction

The Fashion Garment Manufacturing – FGM is the most sensitive link of the Textile Chain to planned obsolescence, resulting in an acceleration of the process of development and production of short life cycle items. The main raw materials of this product are fabrics composed of yarns with pure composition or mixtures of natural, synthetic and artificial fibers. The main end product of the chain is in the fashion industry, clothing [1]. There are numerous types of waste generated in the textile chain being discarded, mainly without major concern with the impacts to the environment.

In this research there are theoretical methodological sources of different authors, among them [2] Yin and [3] Lakatos, who did not present actions in order to enable the execution of scientific research, data collection and information of a subject inserted in a little empirical environment studied and documented. Case study and action research start from a qualitative research in which the "what", "why" and "how" questions form the basis of research and study.

The article presents an action research carried out in three complementary companies as a solution for a solid textile waste management. A company that manufactures uniforms, a textile defibration company and a non-governmental organization (NGO) that uses textile waste as raw material. During the action research there was a significant reduction in the generation of waste from the cutting



department. The remainder of the unused waste was defibrated. The material was absorbed by the automobile industry in the production of acoustic lining.

2. Theoretical basis - Textile Chain

The Fashion Garment Manufacturing – FGM is part of the Textile Chain, and each link comprises a set of industries forming a network of inputs that have been transformed into final products in order to meet the demand of final consumers. The sequence of production processes suffers more or less influence of the fashion cycle at each stage of the Textile Chain [1]. The image in Figure 1 shows all the links in the chain and the interrelationship between the participating industries. The main axis shows the production sequence that begins in the fibers ending in the retail, going through the production of fashionable clothing. In its surroundings are observed the adjacent industries that give support for the fashion clothing to materialize, such as those of beneficiation and producers of supplies and distribution equipment. This entire network is served by the machinery industry that has evolved over the past 60 years to precede this chain. It is noticed that fashion, through the Fashion Bureaux and Textile Design, influences the chain, more subtly in the fibers, and more aggressively in the retail.

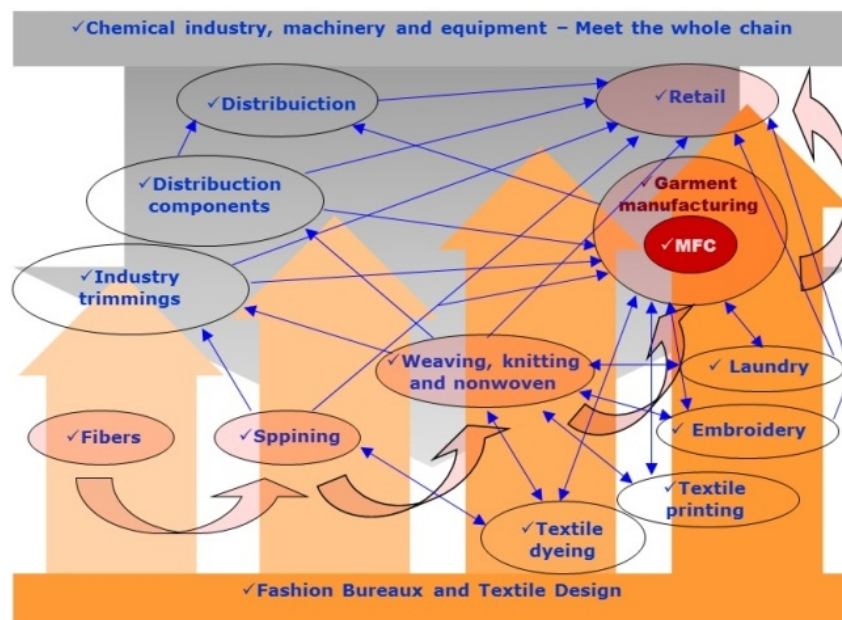


Figure 1. Textile Chain

2.1. Fashion Clothing

In each new season, the fashion clothing industry, influenced by information from the Fashion Bureaux, provides retailers with a wide variety of new products with novelties in their shapes, colors, materials and textures, making it possible to meet fashion clothing brands that meet the needs of Different consumer markets. The goal is to satisfy the desires of a conservative public, consuming a basic and classic fashion or bold and innovative or the vanguard of fashion and unusual products.



Figure 2. Fashion collection

Figure 2 presents a collection of fashion apparel, a set of garment parts developed and produced for distribution in the retail market. It is noticed that the pieces between them are quite differentiated in their forms and volumes of fabrics. In this collection are used several types of fabric, each one with specific characteristics.

3. Fashion Garment Manufacturing - FGM

The FGM production process consumes a large quantity of different types of fabric, such as flat woven, knitted fabric and others, produced with different types of yarn, twist, pure yarn, fiber blend and others, composed of various natural fibers, Artificial or synthetic, causing a great possibility of development of new clothes of fashion. As a result, there is the generation of a wide variety of solid textile waste with high harmful impact on the environment.

For each ton of product, approximately 10% of textile waste is generated. The Brazilian textile industry produces, on average, 1.878 million tons of final products. [4]. Thus, 190,000 tons of unused textile waste per year are disposed of incorrectly. According to the Brazilian law PLN No. 12,305/10, which establishes the National Solid Waste Policy (PNRS), entrepreneurs should be responsible for the proper management of waste generated.

There are bibliography citing studies that have succeeded in solutions related to the management of textile waste. Many theories are in their stages of implementation of the processes of reduction, reuse and recycling of textile materials.

4. Cyclability

The theory of Design for Cyclability described by Dr. Kate Goldsworthy [5] describes three items intended for Zero Waste Future and Creating Closed Loop Systems: Now upcycling by design, Near Design for Cradle-2-Cradle, Future Design for Material Ecologies, as shown in Figure 3.

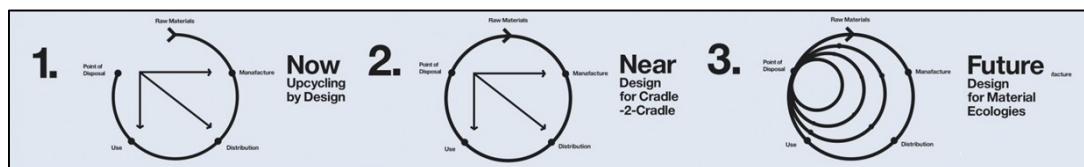


Figure 3. Creating Closed Loop Systems by Dr. Goldsworthy. Source: (Earley, 2012)

- Now Upcycling by Design: limited materials with limited life cycles. Although return journeys can be designed at the end-of-life, this approach only postpones the end of the discarded material at landfill, where it may never biodegrade, it may degrade very slowly or may add harmful materials to the environment as it degrades.

- Near Design for Cradle-2-Cradle: limited materials with unlimited life cycles. By considering the barriers to recycling as part of the design brief, connected loops can be built into the material's future

life from the outset. In a closed-loop, materials would not lose their value and would be designed to be recycled indefinitely.

- Future Design for Material Ecologies: unlimited materials with unlimited cycles. A genuinely sustainable future depends on creating interconnected loops, or cycles, for all industrial commodities. These cycles would be part of a scaled up system of material exchange which is open and dynamic, including all material resources in an infinite industrial ecology. Other complementary tools seek solutions to these issues and can be included in the new challenges.

5. Ecodesign

Ecodesign is an international concept developed by the World Business Council for Sustainable Development (WBCSD) with a holistic, conscious and proactive approach. It consists of the design of a product or service that aims to minimize the impacts caused to the environment and reduce the debt that society has established with the environment to meet the needs and desires of consumers. Ecodesign discloses respect for the environment and optimization of interactions that occur at all stages of the product life cycle, from raw material extraction, product development, production, packaging, distribution, use, recycling, incineration, etc., considering also the energy consumed in the production and conservation of the product [6].

The know-how of science and engineering is necessary to achieve certain projects and the adaptation between the various operational subsystems in order to produce the appropriate levels of volume and quality, in order to meet the real needs of the consumers. Ecodesign principles and practices have much to contribute to the urgent need for rapid and tangible progress towards a sustainable human economy [7].

6. Ecoproduct

An eco-product must respect the environment and responsibly address all stages of its development from conception to its deterioration [8], as shown in **Figure 4a**.

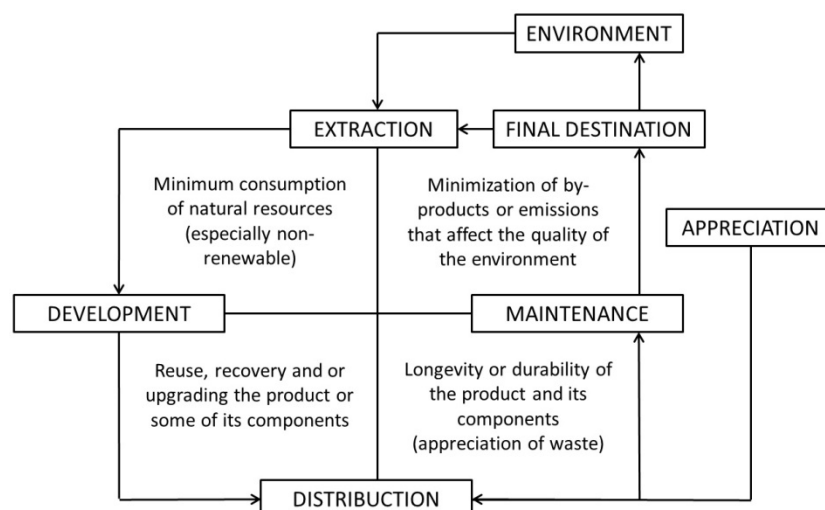


Figure 4a Life cycle of ecoproduct. Source: (CARVALHO, 2015)

7. Cradle-to-Cradle – C2C

The Cradle-to-Cradle theory comprises a conception of material use in a circular production system, or circular economy, as opposed to the linear system. This means extracting, manufacturing, using and

again making their waste available as new raw material or a new product, resulting in zero residue [9]. The authors also used concepts to distinguish recycling that results in a material that shows loss of quality, “downcycling”, as opposed to another, more useful and productive, “upcycling”.

The C2C argues that all components and raw materials used or constituents of the production process can be totally reused in the same or a new process after its useful life. This is not recycling. C2C strictly abrogates the elimination of the concept of waste and, as a new paradigm, does not accept the waste of by-products, adopting its complete extinction [10]. C2C determines that materials must necessarily generate new products of equal or greater quality than the first, even if not for the same application or for the same market. The concept advocates that the production process and the raw materials are ecologically efficient and not only efficient. Macdounough & Braungart illustrates the system with a few examples, including biodegradable fibers or intelligent fibers, which enable complete reprocessing in the textile industry, materials designed as biological nutrients such as textiles and packaging made from natural fibers that can biodegrade safely, Restoring nutrients to depleted soil [11].

8. Case Study

The company X produces uniforms for professionals working in the administrative and security area of companies, are social attire, jacket, pants, shirts, skirts. These pieces are produced with flat and composite fabrics of mixed, artificial and natural fibers. Consume in their production approximately 10 thousand kilos of fabrics per week, generating approximately 100 kilos of waste. Two years ago it started a project to reduce its waste disposal during the cutting stage and began to cut parts of the waste in formats that could be used in new products.

These new products are developed and produced by an NGO that welcomes, for the overnight stay, people in situations of extreme vulnerability who live on the streets of the city of São Paulo. These people participated in workshops and learned to produce carpets using the waste as raw material. Figures 4 and 5 show the processes of rugs made of rectangular flaps and of crochet produced with long strips of the sides of the fabrics.



Figure 4



Figure 5

A company defibrillates the waste that does not have dimensions to enable its use. These wastes are processed by machines that, after defibration, form compacted bundles of fibers. These bales are intended for the panel manufacturing and automotive coating industries. Figure 6 shows the volume of debris that is defibrillated and Figure 7 shows the lustrates the bales that are used in the automotive component industry.

**Figure 6****Figure 7**

9. Analysis and conclusion

The uniforms company began to cooperate with the NGO offering strips and rectangles of fabrics already cut into the necessary dimension for the production of carpets. It is the use of small spaces existing between the parts necessary for the production of uniforms in the company's cutting department.

As a result, time was gained in the production of carpets with increased quality and a 50% reduction of discarded waste was verified and the remainder also being sent to a defibrillator processing company for the production of automotive and acoustic coating panels.

The implementation of the project has shown that it is possible for garment companies to dispose of their waste. It is possible to see the application of the C2C system, also considering that the official responsible for the cutting department, resistant to the new recovery process, did not fully cooperate with the new procedure, from which it can be concluded that much more satisfactory results are possible.

As for the "Future Design for Material Ecologies" phase of "Design for Cyclability", the results depend on a new technological awareness accompanied by the evolution of human consciousness to the values of ethics, transparency, responsibility and desire to correct decades of environmental changes. High values of education, the principles of coexistence and community participation must also be taken into account in order for change to be positive, prosperous and effective.

In addition to legal sanctions, environmental issues have recently begun to show great global importance and brand identity, resulting in a business concern with the proper disposal of solid waste.

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