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Eco Design and Sustainable Manufacturing in Fashion: a Case Study in the Luxury Personal Accessories Industry

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Abstract

The Fashion market is characterized by the rapidity with which a product becomes outmoded. Enterprises producing clothes, shoes, bags and other accessories generate wastes at a fast rhythm, due to the continuous change of collections. They must store notable quantities of textiles and components not longer used for production. Furthermore, the percentage of scraps of fabrics, leather and other materials, is often significant. Recycling can be applied to the Fashion sector in order to recuperate wastes and create original items, which can be particularly successful in a market where customers are increasing their sensitivity towards sustainability. We describe the case of a prestigious Italian brand, manufacturing high luxury leather and fabric accessories where Eco Design and Recycling have been applied. A Life Cycle Assessment of a traditional product of the company is also presented to enhance the significant aspects of sustainability in Fashion.

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1. Introduction

Before mass production, people possessed far fewer clothes and accessories. Items were tailored for the wealthy, while the lower social classes made their own clothes. Garments were used and maintained for several years by repairing and remodelling. Indeed, they could be considered long life products. The birth of ready-to-wear fashion implied the standardization of sizes and a reduction in production costs that allowed consumers to buy more clothes even if they did not fit as perfectly as the ones of the dressmakers.

At the same time, globalisation of production, increased competition and consumer demand have resulted in accelerated fashion cycles, which in turn have led to a culture of “fast” and disposable fashion [1]. Developing countries have become clothing manufacturing locations of choice, while industrialised countries, due to their higher input costs (labour, capital, energy, environmental and consumer-protection compliance, etc.) have been increasingly unable to compete with the low costs offered by emerging country producers [2]. Prices have further decreased but so too has quality. In recent decades, the idea of customization in clothing and accessories has strongly developed and the demand for more personalised products has expanded. It is in this context that Fast Fashion has appeared as a tool to satisfy consumer desire for Luxury Fashion but at affordable prices, especially for the younger generation. In fact, Fast Fashion refers to low-cost clothing collections that mimic current luxury fashion trends [3]. It is by its very nature, a fast-response system that encourages disposability [4].

The idea of sustainability was first defined in 1987 in a Report of the World Commission on Environment and Development: “Sustainability means being able to satisfy current needs without compromising the possibility for future generations to satisfy their own needs” [5]. Dimensions of sustainability have been introduced through the concept of the *Triple Bottom Line*: Environment; Economy; Society [6].

Fast Fashion brings up ethical and environmental issues as it clearly embodies unsustainability. In particular the lack of *social dimension* is evident. Fashion’s fast obsolescence is highly unsustainable and it is due to a social and cultural issue coming from a continuous desire for fashionable renewal, which individuals have in order to achieve a personal affirmation and to distinguish themselves from others. Clothes and accessories people choose to wear are strongly affected by the decision and actions of others living in the same social context. The need to continuously buy new garments is fostered by mass media and business speculations.

A formerly standard turnaround time from catwalk to consumer of six months is now compressed to a matter of mere weeks by such companies as H&M and Zara, typical exponents of Fast Fashion, with heightened profits to match [7]. Fast fashion companies thrive on fast cycles: rapid prototyping, small batches, combined with large variety, more efficient transportation and delivery, and merchandise that is presented “floor ready” on hangers with price tags already attached [8]. Technology advances such as tracking sales with electronic tills and linking these data to supplier factories with flexible production schedules has now made it possible to restock a rail with popular items as demand requires; and computer-aided design interfaced with just-in-time manufacturing methods has enabled a design sketch to be turned into a finished product in as little as three weeks [9]. Fast Fashion enterprises generally employ in-house designers who work in teams. The brand is not anymore identified with a particular stylist’s name, as it is in the case of Armani, Versace, Gucci etc.. Designers remain anonymous, the name of the brand in most cases does not have a specific meaning or correspond to the owner’s surname, this is because most of these companies are multinationals and belong to several stakeholders. Production is often located in emerging countries, such as China and Turkey.

Fast Fashion products do not last long and generate a lot of wastes, also the *environmental* dimension of sustainability is relevant. Thinking more widely, Fashion in general, more than any other industry, embraces obsolescence as a primary goal [10], on which most profits are based, in opposition to the criteria of sustainability.

Durability enjoys an easy relationship with sustainability, depending on the choice of materials. Obsolescence of fashion products instead, is mainly driven by changes in aesthetics and tied to shifting social preferences, underscoring the psycho-social nature of factors which affect the lifespan of fashion. Garments that defy obsolescence do so in informal or unintentional ways, rarely as a result of design planning or material or product qualities. Design for durability in this sector shifts away from a familiar focus on materials, products, and user-object relationships to emerging strategies of human action. While facilitated by materials, design and construction, durability is determined by an ideology of use. Clothes and accessories mainly become obsolete in psychological terms because of aesthetics, social preferences and cultural conditions [11]. Therefore, the short life cycle of

garments is not mainly due to material consumption but to social trends. However, this is not the only reason Fashion can generally be defined as unsustainable.

Beyond the social aspect of Fashion unsustainability, as already mentioned, the *environmental* factor also plays an important role. The production processes, and in particular the phases of dyeing, drying and finishing, make intensive use of chemical products and natural resources and generate a high environmental impact [12]. The textile sector has experienced significant environmental problems linked to the production process, which is characterised by the intense use of chemical products and natural resources [13]. But also the relevance of Supply Chain Management in contributing to environmental sustainability even in Fashion production must be considered, even if this kind of industry is typically studied from other perspectives (e.g. Brand management, marketing and retailing). While large companies tend to focus more on products and processes improvement, reshaping only one part of the supply chain, small companies are more often able to completely reshape their supply chain, from both the inbound and outbound perspectives putting in place practices that large companies cannot pursue, primarily for reason of scale. A green supply chain management controlled by effective drivers, practices and performance indicators is fundamental for sustainability in the fashion industry [14].

2. Luxury Fashion and Sustainability

2.1. Fast Fashion versus Luxury Fashion

Fast Fashion allows satisfying aspirations of luxury for consumers who cannot afford prestigious brands. Luxury Fashion reminds people of exclusivity, beauty and art and owning unique items from a luxury brand make them pursue their dreams and desires [3]. Fast fashion replaces exclusivity, glamour, originality, and luxury with “massclusivity” and planned spontaneity [7].

In the introduction we have mentioned the reasons why Fashion and in particular Fast Fashion can generally be considered unsustainable. Which is the relation between Luxury Fashion and sustainability? Apparently the concept of opulence and sumptuousness can remind us of unnecessary and redundant products, excessive objects that could have been made in a simpler and cheaper way, i.e. in a more sustainable manner. But this interpretation is rather superficial and doesn't consider all the involved aspects.

What matters to evaluate the sustainability of fashion is the type of production. Mass standardized fast fabrication is a completely different approach compared to manufacturing reliant on artisanal craft for a more limited production, which is typical of luxury items. Craft denotes highly skilled labour, using simple tools to make unique items, one item at a time, and accessible to only a select clientele [3]. Hermes' affluent customers, for example, might wait for several years to acquire a particular bag [15].

Can Luxury fashion, with ostensibly an emphasis on authenticity, and its concomitant respect for artisans and the environment, foster values of both quality and sustainability? Actual rather than faux luxury brands can, ironically, unite the ideals of fashion with those of sustainability [3].

2.2. Slow Fashion

The meaning of craftsmanship in manufacturing doesn't refer only to the added value of the product in terms of quality and uniqueness but also to the sustainability of the manufacturing approach. Sustainable manufacturing implies methods and techniques of production that allow workers to express their skills and creativity, contributing to the improvement of the product and the competitiveness of the enterprise. Several entrepreneurs in different industrial sectors have decided to recover the value of tradition and craftwork enhancing the positive meaning of a slow working process, which can add distinctive value to a product. The *Slow Factory* paradigm has been introduced to describe this approach [16]. The Italian entrepreneur Giovanni Bonotto, who first used this term, produces textiles and fabrics for High Fashion stylists using traditional techniques, which allow the achievement of unique and innovative products. He loves to define his factory as a contemporary equivalent of the Renaissance workshop and he claims: “Time is the new luxury”.

A taxonomy of enterprises can be defined in order to distinguish between different grades of craftsmanship employed in manufacture based on a *slowness indicator*, which can measure the “slowness of the production”. It

doesn't only consider the Lead Time of the work unit, but also the skilled craftwork performed to fabricate the product [17].

A wide range of research has been carried out in order to quantify a “craftsmanship index”, assigning a concrete value to artisanal competences. This index can be useful in understanding how to hone and develop these kind of skills, which can be of significant competitive advantage to manufacturing enterprises. A first investigation has been developed at the Italian district of luxury leather production around the city of Florence, involving prestigious companies and achieving some positive results, even if further research is required [18].

The concept of slowness has been applied to Fashion production by Kate Fletcher when she contributed in founding the *Slow Fashion* movement. For several years she has been working to push forward sustainable fashion, enhancing how the time of fabrication can be related to high quality clothes and accessories and can then be considered a valid alternative to Fast Fashion, especially if we refer to sustainability. A summary of the most significant elements characterising the Fast and Slow approaches are shown in Tab. 1 below.

Slow Fashion takes inspiration from the Slow Food movement founded by Carlo Petrini in Italy in 1986, which links the pleasure of food with the awareness and responsible nature of its production, preserving cultural and regional culinary traditions and agriculture diversity. Similarly, the slow movement in fashion doesn't simply refer only to speed. Rather it represents a different world view that names a coherent set of fashion activities to promote the pleasure of variety, the multiplicity and the cultural significance of fashion, through small-scale production, traditional craft techniques, local materials and local markets and becoming a guardian of diversity [9].

As quality, attention to detail and enhancement of the cultural connection with the territory, typical of this slow approach, require time, it can be inferred that luxury has a strong connection to sustainability, as Bonotto states.

Table 1. Comparison between some significant concepts of Fast and Slow approaches applicable to Fashion production [10].

Fast Mindset	Slow Mindset
Mass-production	Diversity
Globalisation	Global-local
Image	Sense of self
New	Making and maintaining
Dependency	Mutual trust
Unaware of impact	Deeply connected with impacts
Cost based on labour and materials	True price incorporating ecological and social costs
Large scale	Small to medium scale

3. Eco Design, LCA and the 6 Rs in Fashion

Eco Design is a sustainable design approach, considering the environmental impact of the product during its whole life cycle. Eco Design can help in reducing the ecological footprint, which is the measure of human impact on Earth's ecosystems. The life cycle of a product mainly includes 4 phases: procurement, manufacture, use and disposal.

In the Fashion world, Eco Design can be applied choosing sustainable materials, such as cotton and wool, instead of synthetic fibres and selecting processes that don't impact the environment, substituting damaging chemical substances with natural ones.

Life Cycle Assessment (LCA) is a methodology for assessing the environmental impacts and resource consumption associated with the existence of products throughout their entire life cycle “from cradle to grave” [19]. Starting from raw material extraction, it considers materials processing, manufacture, distribution, use, maintenance and repair, and disposal. LCA is an important tool to help managers to make production choices in order to increase sustainability.

Several types of software have been developed and commercialized to support and implement the LCA process. Nowadays many enterprises use software of this kind to be aware of the environmental impact of their production activity and try to make it more sustainable.

LCA can be considered a significant tool to support Eco Design, providing information that help designers in making the most sustainable choices for the product from its first phases of development.

The traditional 3R concept promoting green manufacturing technologies (Reduce, Reuse and Recycle) has been surpassed by the more recent 6R concept forming the basis for sustainable manufacturing (Reduce, Reuse, Recover, Redesign, Remanufacture, Recycle) since this allows for the transformation from an open-loop, single life-cycle paradigm to a theoretically closed-loop, multiple life-cycle paradigm [20].

Recycling can be easily applied to increase sustainability in Fashion production. Recycling is the process of collecting and processing materials that would otherwise be thrown away as trash and turning them into new products [21]. In the case of Fashion, stored unused fabrics, leather and other components are waste that can be recuperated by this methodology, obtaining new products.

The methods and techniques above described are mainly focused on the environmental dimension of sustainability. But sustainable fashion also involves an important social issue, related to the perception of the garment by consumers. The application of these practices to clothes and accessories, in particular the idea of Recycling, cannot be split from the customers' need, on which their purchase is based. This is even more valid for luxury Fashion, where often desire is the main reason pushing buyers to get an article; not for its real value and function, but for its intangible values, such as image and prestige.

It is therefore particularly significant to explore possible applications of sustainable design and production approaches at luxury brands.

4. The case study of sustainable practices applied by a luxury brand

4.1. The Borbonese company

Borbonese is a historic Made-in-Italy brand. It has a strong heritage: created in Turin a century ago, in 1910, as a bag, jewellery and accessories label, it soon joined the leading names in Italian luxury with products that expressed both class and elegance. A mark of distinction in Borbonese collections is the O.P. or Occhio di Pernice (partridge eye) print, the brand's symbol and trademark. Created in the 1970s, the O.P. texture is still the brand's emblem today and is produced through a special treatment of lamb's leather, which enhances its weave, obtaining a micro-spotted effect, typical of this *maison* production (Fig. 1).



Fig. 1. Sewing at Borbonese.

Borbonese combines precious materials and refined techniques with masterly crafting to emphasise details and characteristics. The central role of research in developing the brand's production and style has led to the creation of new ways of presenting the historic *Occhio di Pernice* (partridge eye), texture, which is produced in new and innovative variations, materials and colours.

Some bags fabricated by this firm are real icons, such as the Luna Bag (Fig. 2), based on the drawings of Giacomo Balla, one of the most important artists belonging to the Italian Futurist movement. Balla claimed in his "*Manifesto dell'abito anti neutrale*" [22] (*Manifesto of anti-neutral clothing*), the need to substitute the old, dark, oppressive garment with items more dynamic in the design and colours of fabrics, expressing more happiness and

movement. His intention was to create clothes different from tradition, more appropriate to modernity and progress. Borbonese is then an example of a brand where art joins industry.

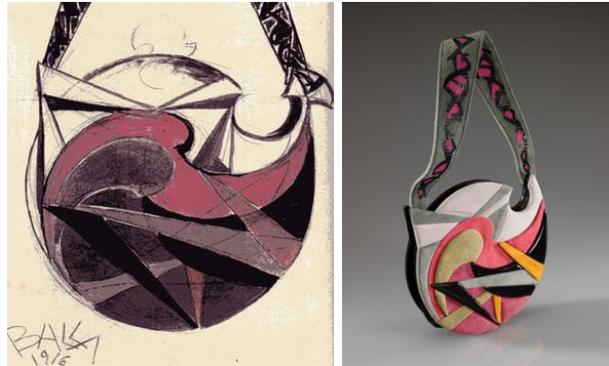


Fig. 2. (left) First sketch of the Luna Bag by Giacomo Balla, 1916. (right) The Luna Bag manufactured by Borbonese in 1986, based on the Balla's drawing.

4.2. Eco Design and Recycle of Borbonese luxury products

As with many Fashion enterprises, Borbonese must propose new models every season and launch a new collection. Obsolete materials, such as leather and accessories of past collections are then stored in warehouses and not used. A sustainable approach has been implemented recuperating these non-consumed wastes, which have been integrated into a new life cycle instead of being disposed of in a dump.

The idea to use pre-production wastes to design and manufacture a new product is based on an *Eco Design* approach and uses one of the 6 Rs: *Recycle*.

A first inventory was realized in order to understand which materials were stored and in what quantities, then a *Flash collection* of “sustainable bags and accessories” was designed and fabricated using the available articles, combining different kinds of stored leather with unused metal clasps and shoulder straps (Fig. 3 and 4). These accessories have been designed and manufactured to reduce wastes. The use of these non-employed materials to create original products shows the company's sensitivity towards sustainability.

This project can be considered a successful example of a recycling process applied to a luxury brand. Using wastes to produce luxury articles could appear a contradiction, but this experience demonstrates that it is indeed possible and that the obtained products can not only find a positioning, but have a special kind of appeal to the market.



Fig. 3. Key chain “Fiocco 3D” (3D Bow) made from recycled metal accessories and leather.



Fig. 4. (left) Key chain “Charm” and (right) Key chain “Girandola” (Pinwheel) made from recycled metal accessories and leather.

4.3. LCA of the Borbonese Savile Bag

The Savile Bag in suede partridge eye texture is one of the most traditional products of Borbonese. It is presented in every collection, being made in different materials and coming in a range of colours.

A LCA of this bag has been carried out using the open source software *openLCA*, developed by Green Delta. The study refers to the production and distribution phases in Italian and foreign shops, without considering the raw materials processes that are not performed at the company. Then the assessment can be described as “from gate to grave”.

The Inventory analysis has been realized using reports, documents, databases and interviews with Borbonese’s employees. The following points were investigated:

- The energy consumption necessary for the cutting of leather and textiles.
- Wastes and scraps produced during production.
- Transport for supplying raw materials and distributing the end product.
- Disposal.

The most significant impact corresponds to transport, because of the emissions produced in the atmosphere, mainly of CO₂.

In order to have an idea about the environmental impact at the raw materials phase, we can refer to the project Innovation for a Made Green IN Europe (I.M.A.G.I.N.E.), a study realized in four fashion-manufacturing districts located in Tuscany from 2009 to 2012. The four analysed areas were:

1. Textile manufacturing in Prato.
2. Garment manufacturing in Empoli.
3. Shoe manufacturing in Lucca.
4. Tanneries in Santa Croce sull’Arno.

From these data, it is evident that the strongest environmental footprint corresponds to the leather treatments. Tannery is considered a heavy industry not only because of the concentration of pollutants in the drained water but also for the gas emissions (organic solvents and H₂S) and for refuses produced during the product work cycle. Furthermore, it is not an exception that animals are bred and killed for the sole use of their skins at luxury companies, instead of the use of leather that comes from scraps of the food industry.

5. Conclusion

The Fashion industry is characterized by the rapidity with which a product becomes outdated. This is not generally due to the materials wearing out but rather to the constant desire of change from consumers. Social reasons are mainly at the base of customers' needs so Fashion tends to be considered unsustainable.

This study demonstrates that considering Fashion unsustainable is not the only possible interpretation. If we refer to the social dimension of sustainability, luxury brands production can have sustainable aspects, especially in regards to the slowness of production, encompassing the quality of work and life of the skilled employees who fabricate the product.

Some sustainable methods and techniques, such as Eco Design and Recycling, can well fit fashion manufacturing companies and the LCA can help designers in defining the characteristics of the product.

These ideas have been successfully applied to the prestigious Italian fashion company Borbonese to manufacture new original products using stored wastes. An LCA study has also been carried out to understand the sustainability of one of the bags produced by the company, demonstrating that transport has the highest environmental footprint. However, referring to former investigations, it is evident that in general in the textile industry the tannery phase is the one with the most impact.

The issue of sustainability in Fashion, to which customers are becoming more and more sensitive, is highly relevant nowadays and Fashion companies generally pay more attention in respecting the environment than in the past. The idea of Slow Fashion corresponds to the one at the core of Slow Food and of Slow Factory, defining another context in which the Slow approach can have a positive meaning that merits analysis and investigation.

Further research is required to better evaluate which aspects and methods can make Fashion production more sustainable.

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References

- [1] S. Black, C. Eckert, Developing Considerate Design: Meeting Individual Fashion and Clothing Needs within a Framework of Sustainability, Proc. of the MCPC 2007 World Conf.
- [2] S. E. Cepolina, Int. J. Trade, Econ. Financ., vol. 3, no. 1, 7-13, 2012.
- [3] A. Joy, F. Sherry, A. Venkatesh, J. Wang, R. Chna, Fashion Theory, Vol. 16 Issue 3 (2012) 273-296.
- [4] K. Fletcher, Sustainable Fashion & Textiles: Design Journeys. Oxford: Earthscan, 2nd edition, 2014.
- [5] Report of the World Commission on Environment and Development, the Brundtland Commission to the United Nations, Our common future, Oxford University Press, 1987.
- [6] J. Elkington, Cannibals with forks: triple bottom line of 21st century business, Capstone Publishing Ltd, Oxford, 1997.
- [7] N. Tokatli, Journal of Economic Geography, Oxford University Press, 8 (2008) 21-38, 2008.
- [8] L. Skov, Cultural Studies 16 (4) (2002) 553-69.
- [9] K. Fletcher, L. Grose, Fashion & Sustainability. Design for change, Laurence King Publishing Ltd, London, 2012.
- [10] E. Abrahamson, The Iron Cage: Ugly, Cool and Unfashionable, Organization studies 32 (2011) 615-29.
- [11] K. Fletcher, Creative Process & the Fashion Industry, 4 2 (2012) 221-238.
- [12] M. De Brito, V. Carbone, C. Blanquart, International Journal of Production Economics 114 2 (2008) 534-553.
- [13] S.Y. Lakkhal, H. Sidibé, S. H'Mida, International Journal of Agriculture Resources, Governance and Ecology 7(3) (2008) 243-255.
- [14] F. Caniato, M. Caridi, L. Crippa, A. Moretto, International Journal Production Economics, 135 (2012) 659-670.
- [15] M. Tungate, Luxury world; the past, present and future of luxury brands, Kogan Page, London, UK, 2009.
- [16] G. Campana, B. Cimatti, The slow factory: a new paradigm for manufacturing, Proceedings of the Global Conference on Sustainable Manufacturing, 2013, 273-277, Berlin.
- [17] G. Campana, B. Cimatti, Procedia CIRP Vol. 26 (2015) 287-292.
- [18] G. Campana, B. Cimatti, F. Melosi, Procedia CIRP Vol. 40 (2016) 669 - 674.
- [19] E. Westkamper, L. Altling, G. Arndt, CIRP Annals – Manufacturing Technology Vol. 49 Issue 2 (2000) 501-526.
- [20] A. D. Jayal, F. Badurdeen, O. W. Dillon Jr., I. S. Jawahir, CIRP Journal of Manufacturing Science and Technology 2 (2010) 144-152.
- [21] U.S. Environmental Protection Agency, Reduce, Reuse, and Recycle, available at: <https://www.epa.gov/recycle/recycling-basics>, 2008.
- [22] G. Balla, Manifesto Futurista, September 11, 1914.