Design for Sustainability Framework Applied to the Problem of Garment Waste: A Brazilian Study

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ABSTRACT

In this paper, we present a brief overview of the garment waste situation in Brazil, the potential design-based strategies for minimizing the environmental, social and economic problems caused by the incorrect disposal of this material and for revaluing it. Based on our own nine years' experience investigating this problem, we then situated our activities in an evolutionary framework of Design for Sustainability (DfS), built based on a previous model proposed by Ceschin and Gaziulusoy (2016). As result, it was possible to present a clear and comprehensive overview of how design can contribute to the garment waste issue, in terms of evolutionary innovation levels.
Key Words: Garment Waste, Design for Sustainability, Design Strategies, Framework.

1. INTRODUCTION

1.1 The problem: Garment waste in Brazil and in the state of Paraná

Garment waste represents around 2,6% of urban solid waste in Latin America, including Brazil (HOORNWEG e BHADA-TATA, 2012). This means approximately 1,8 million of tons/year of garment waste produced in Brazil, and 9,1 kg/year per person. Even if this average is lower than countries like the United States (70 kg/year per person) and the UK (30 kg/year per person), the consumption and disposal of the garment in Brazil are growing. Fashion (including textile and garment industries) is the fourth largest economic activity in the world and concentrates 5,7% of manufacturing and 14% of employment in the globe (UNIETHOS, 2013). Brazil occupies the fifth position among the textile manufacturers and fourth among the garment producers (ABIT, 2013). Textile and garment sector is responsible for significant environmental impacts, being the waste of materials the most relevant. Cut phase is the most determinant for the waste, whose rate is around 15-20% in the brazilian garment industries (PEREZ & MARTINS, 2016; MCQUILLAN & RISSANEN, 2011; GUIMARÃES & MARTINS, 2010). Although the textile and garment waste is considered inert and in spite of that not directly contaminant, they are related to several other problems including the depletion of non-renewable resources (like fossil fuels), habitat destruction and soil depletion (landfills and irregular disposal), toxic and GhG emissions (from burning, a practice still common in Brazil). The problem is aggravated in Brazil because of the lack of effective and efficient collection and destination systems for this type of waste in the cities, despite the country have approved a Solid Waste National Policy in 2010 (BRASIL, 2010); unfortunately, this policy does not include specific reccomendations for the textile and garment sector, although other sectors are cited. In Brazil, only 13% of urban solid waste is recycled or composted, the rest is sent to landfills or even dumps, and the selective collection programs do not include textile and garment waste as recyclable material. In the state of Paraná, we iddentified about 800 companies in the garment sector, and by combining fragmented data of different researches (STUTZ & MARTINS, 2015; HONORIO et al, 2016; SENAI, 2016; LOURENÇO, 2018; HOMSE, 2017) we could estimate around 10.300 tons/year of garment waste, being 5.900 from post-consumption and 4.400 from industries (SAMPAIO et al, 2018). We also iddentified recycling of garment waste as an interesting strategy that is now subexplored, but with a high potential for innovation. Beyond that, we identified the development of new materials from solid waste recycling as a potential solution not only to help to face the problem of garment waste, but also for revaluing it, and so, creating new value chains. So, in this paper, we present different DfS approaches for the textile waste problem we have investigated in the period of 2009-2018, in a chronological and evolutionary way. Considering our own previous research experiences, in this study we searched for a **theoretical structure** that could allow us: to look for our own research in a critical and retrospective way; to organize the research history and evolution; to identify lack of theory, methods and tools; to see opportunities for new studies.

2. THEORETICAL BACKGROUND

Ceschin and Gaziulusoy (2016) proposed an interesting framework that allows visualizing the potential contributions of design for sustainability in different levels of action. In this structure they positioned the main relevant DfS approaches, organized in four levels:

- Product, that includes strategies of Green Design, Biomimicry, Ecodesign, Cradle to Cradle (C2C) Design, more focused on the environmental aspects of the products, or even Emotionally Durable Design, Design for Sustainable Behavior or Product Design for the Base of Pyramid (BoP), that emphasizes respectively behavioral, emotional and/or socioeconomical aspects of the user/consumer;
- Product-Service System, including eco-efficient Product-Service System (PSS), PSS for the BoP (Base-of-Pyramid), and the Sustainable PSS Design;
- Spatial-Social, that involves strategies more focused on environmental aspects, like Systemic Design, or on the social dimension, as found in the Design for sustainable Social Innovation;
- Socio-Technical System, that includes the strategy of Design for System Innovations and Transition, dedicated to developing solutions that imply in new ways of production and consumption;

Due to the simplicity and clarity of this framework, we adopt it as an initial structure to positioning the different possibilities of design action we have experienced in our research projects, as it follows.

3. RESEARCH METHOD

Beyond the literature review of the garment waste problem in the world and in Brazil, we used in this study two main methods: first, a chronological and evolutionary exploration of our own experiences in research projects for the problem of garment waste in the state of Paraná/Brazil since 2009; second, the critical appreciation of the Ceschin and Gaziulozoy's framework for the DfS approaches (CESCHIN & GAZIULUSOY, 2016), its complementation with three additional levels and positioning the DfS approaches we adopted in our research projects.

4. RESULTS AND ANALYSIS

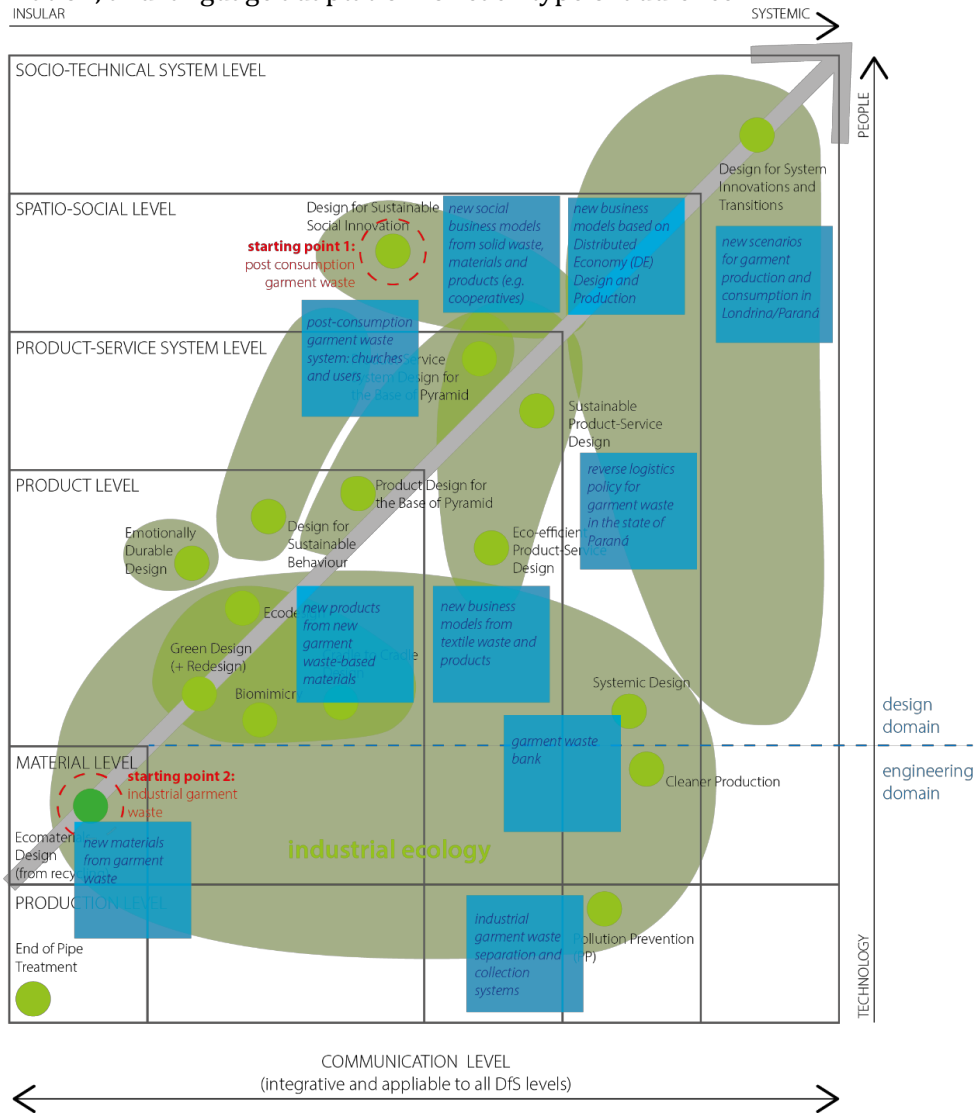
4.1 Cronological and evolutionary history of research projects

Since 2009, we have explored the problem of garment waste in the state of Paraná in different levels of study, in an evident evolutionary but spontaneous way. We can present this history in terms of four phases: In Phase 1, we started by investigating the possibilities of reusing the waste to create handicraft products (2009-2010); In Phase 2, we started to explore new techniques of reusing the garment waste to produce industrial products, and zero waste methods to reduce the waste in industry (2010-2012); In Phase 3, we perceive that these solutions were not enough to deal with the amount of waste produced by the companies, so we started to investigate solutions by recycling the waste and converting it in new materials, in partnership with chemistry researchers. This resulted in four different methods of recycling a specific type of synthetic textile waste, made of PA66 and elastane. In parallel, we developed products with these new materials to verify its innovation potentiality (2013-2015); From the success obtained in Phase 3, in Phase 4 we started to investigate how to improve the collection and destination system for the garment waste, both industrial and post-consumption. At the same time, we collaborated with the state of Paraná's government to build up a preliminary reverse logistics plan for the garment sector, using design in a more strategic way to plan more systemic solutions (2015-2018). From this very brief description, and using the Ceschin and Gaziulosoy's framework as reference, we could then organize the design actions we have explored in a more comprehensive and evolutionary way; this work involved two main phases and allows to visualize the big picture of possible DfS approaches for the garment waste problem.

4.2 Phase 1: Adapting and complementing the Ceschin and Gaziuluzoy's framework

To separate, collect, destinate and revalue the garment waste, we consider here the material life extension and revalorization as the main life cycle design strategy, that can be applied in six different levels of intervention: Production Level, Material Level, Product Level, Product-Service System Level, Spatial-Social Level, and Socio-Technical System Level. The two first levels are proposed by the author based both on the experience obtained in the four phases of research previously described and in his doctorate investigation, in which he developed a methodology for innovation from solid waste (SAMPAIO, 2017); the other four levels are based on the DfS Evolutionary Framework, as proposed by Ceschin et al (2016). The two complementary levels - Production Level, Material Level, and Communication Level – are described as it follows. The adapted framework is presented in Figure 2. The first level – Production - includes the improvement of the inputs flow (materials, energy, water, technology, etc.) necessary to the manufacture of garment products, and the output at the end of the process (garment waste and emissions). This is a technology-centred level, in which design usually does not intervene, containing the strategies of end-of-pipe and pollution prevention techniques; however, we consider that designers can also act in this level by proposing improvements in the flow of the inputs (materials, water, energy) and outputs (emissions and waste). The second level – Material – is related to develop solutions for the waste using the Materials Design approach, combined with recycling processes. Here, we propose to consider the development of new materials from recycling solid waste as a design activity, that can be developed in partnership with other knowledge areas like chemistry and materials engineering. In our own research experience, we could confirm the effectivity of this interdisciplinary approach. Recycling is an activity related both to the strategies of pollution prevention or P2 (reduction, reuse, recycling, treatment, and disposal) and cleaner production (P2 plus Design for Environment and Life Cycle Assessment), and the industrial ecology as a whole; thus, we also propose here the design of new materials from solid waste as a design activity integrated with these strategies. It is important to highlight that cleaner production is a wider strategy

that encompasses not only products but also services, in an integrated, preventive and continuous way (UNEP, 2013). We also propose to align the material development with the approach of systemic design, considering aspects like local networks and involvement of stakeholders, and wastes as resources. Complementarily, we propose a seventh level – Communication – that pervades all the previous levels, dedicated to the application of Design for communicating the sustainability aspects of the project. This level was included based on our empirical experience in the research projects, and on the model of Four Orders of Design (Communications, Objects & Artefacts, Interactions, Systems & Environment) as proposed by Buchanan (1982). In our previous experience, we could note the importance of having effective and efficient communication along the project, informing the project partners, scientific community and society about the evolution and results of the investigation. This requires different depth levels of information, and language adaptation for each type of audience.



[Figure 1] Design ideas in each level of the framework

4.3 Phase 2: Generating and positioning ideas from the framework

In figure 1, we also present how the framework was used as a tool to generate and organize design ideas of solution we have explored for the problem of garment waste, considering each level of action. At the first level – Production – we proposed the intervention of designers to improve the process of quantification, separation, storage, collection, and transport of the garment waste; At the second level – Material – we considered garment waste as the starting point to interdisciplinary development of new materials guided by design, in parallel to product development (3rd level); at the third level – Product – we adopted a combination of active experimentation with the materials waste in the laboratory (producing what we called "material prototypes", or "protomaterials") applying a user-centered design method for the products (producing product prototypes). As result, we obtained many viable ideas for three different

applications for living spaces: decoration, surfaces, and lightning. At the fourth level – Product-Service System – we designed business models proposals for exploring the material and product innovations in the market and submitted them to a selective process for incubating new business in the university innovation agency. In this process, the researchers (most of them undergraduating design students) developed a deeper understanding of issues like business models, management, market positioning, corporative identity, and other related themes. For the fifth level – Socio-Spatial – we developed both *top-down* and *bottom-up* strategies focused on the post-consumption garment waste. In the first case we collaborated with the Paraná's state government to develop a ideas for a reverse logistics plan (policy and strategy) for the garment sector, based on the Solid Waste National Policy (BRASIL, 2010); As a *bottom-up* strategy, we proposed in this plan to include the existent structure of catholic and evangelic churches as social agents to receive and destinate the garment products disposed of by the users/consumers, an evident social innovation initiative. Another proposal, now focused on the industry waste, was the planning and implementation of an organization destinate to collect, separate, classify and send the garment waste to various useful applications, or at least to energy recovering. This venture, "Banco de Resíduos de Londrina" ("Londrina Waste Bank") was inspired by the "Banco do Vestuário ("*garment bank*") of Caxias do Sul" and "Retalho Fashion" of São Paulo (SINDITÊXTIL, 2017), two similar Brazilian initiatives (BRASIL et al, 2014), and included the low-income workers that collect solid waste as an important socio-economic agent (SINDITÊXTIL, 2013). The sixth level – Socio-Technical System – is the only we are just beginning to explore and can include the development of new scenarios for the production and consumption of garment in the city Londrina and its metropolitan region, and the state of Paraná in general. At this level, we are starting to explore the potential and limitations of the Distributed Economy concept, including both Distributed Design and Distributed Production, and specifically, its applicability in the garment waste reverse logistics and garment waste bank for the state of Paraná (RAMOS, SAMPAIO, MARTINS, 2018). This type of exploration demands the participation of other system actors that we still did not could integrate into our projects.

4.4 Analysis

As it can be seen in Figure 2, the adapted framework was a useful, clear and effective tool that allowed us to position and visualize the many design initiatives we have proposed for the problem of garment waste along the last nine years of research and development. By complementing the 4-level model of Ceschin and Gaziulusoy (2016) with the three additional levels that resulted from our own empirical experience, we consider that this paper contributes to growing the body of knowledge in DfS in two main aspects: 1) Expanding the Ceschin and Gaziulusoy's framework with other levels that allow to include other possible design interventions, namely the improvement of production and distribution flows and the design of materials; 2) Applying this expanded framework to a particular problem of sustainability, in this case, the garment waste. Fortunately, we believe these contributions are aligned with the conclusions pointed out by Ceschin and Gaziulusoy at the end of their paper, when they propose: *"Finally, from a design practice perspective, the framework might be used by practitioners and organisations to navigate the complex DfS landscape, or to identify the appropriate approaches to be adopted in relation to specific sustainability challenges"* (CESCHIN & GAZIULUSOY, 2016). We believe this is the case in which we could not only navigate but adapt and identify a relevant application for that tool.

5. IMPACTS ON SUSTAINABILITY

Considering the extent of the different design interventions in each level of the proposed framework, a lot of benefits can be pointed out. Environmental benefits include: reducing raw materials needed to produce new garment (if the waste is recycled and reapplied in the garment sector) or other products (if the waste is used to substitute current materials); reducing the pressure in the landfills and dumps, by delaying the disposal of materials in these places; reducing the toxic emissions and soil depletion and contamination associated with the disposal in these places; avoiding the toxicity for human, animal and environment health, and global warming effects related to the GhG (greenhouse gas) emitted by burning the garment waste; reducing the indirect impacts caused by the transportation of the garment waste to landfills and dumps, usually located far from the urban spaces. Economic benefits can be seen both in terms of cost reduction of treating the garment waste and potential profit derived from the new value chains created to

revalue the material. Finally, social benefits can be seen both in terms of the reduction of impacts on human and animal health, as well as the living spaces in which they live, specially the low-income people, and the new opportunities of labor and income associated with the creation of new value chains.

BIBLIOGRAPHY

Associação Brasileira da Indústria Têxtil e de Confecção (2013). *Perfil do Setor: Dados gerais do setor atualizados em 2013, referentes ao ano de 2012.* Retrieved from http://www.abit.org.br/site/navegacao.asp?id_menu=1&id_sub=4&idioma=PT

Brasil, M., Pilla, A., Pinto, M.G., Pereira, S.T., Martins, S.B. (2014). *Banco de vestuário de Caxias do Sul: instituição referência em responsabilidade ambiental e social aplicado aos resíduos sólidos do setor têxtil e de confecção.* In: Anais do 5º Simpósio Paranaense de Design Sustentável, n. 5, Curitiba, Anais 5º SPDS.

Brasil – Governo Federal (2010). *Decreto nº 7.404, de 23 de dezembro de 2010. Regulamenta a Lei no 12.305, de 2 de agosto de 2010*. Brasília. Retrieved from http://www.planalto.gov.br/ccivil_03/_ato2007-2010/2010/Decreto/D7404.htm

Buchanan, R. *Wicked Problems in Design Thinking.* Design Issues, 8 (2), 5-21, 1992.

Ceschin, F., Gaziulusoy, I. (2016). *Evolution of design for sustainability: From product design to design for system innovations and transitions.* Design Studies (2016). Retrieved from http://dx.doi.org/10.1016/j.destud.2016.09.002

Guimarães, B. A.; Martins, S.B. (2010). *Proposta de metodologia de prevenção de resíduos e otimização de produção aplicada à indústria de confecção de pequeno e médio porte*. Projética, Londrina, v.1, n.1, p. 184-200.

Homse, R. A. M. (2017). *Resíduos descartados como rejeito por cooperativa de catadores: composição e análise da perda de receita.* Trabalho de Conclusão de Curso de Graduação apresentado à disciplina Trabalho de Conclusão de Curso 2. – Engenharia Ambiental, Universidade Tecnológica Federal do Paraná, Campus Londrina. Londrina, PR.

Honorio, I.D.; Pereira, S.T.; Pinto, M.G.; Perez, I.U.; Martins, S.B. (2016). *Gestão de resíduos têxteis no setor de confecção de moda da região de Londrina*. In: 12º Colóquio Nacional de Moda. 9ª Edição Internacional, 12, 2016, Anais...João Pessoa, 2016.

Hoornweg, D., Bhada-Tata, P. (2012). *What a Waste: A Global Review of Solid Waste Management*. World Bank.

Lourenço, V A. (2018). *Análise gravimétrica dos rejeitos da reciclagem da cidade de Londrina.* Trabalho de conclusão de curso. Graduação em Administração. Universidade Estadual de Londrina.

Mcquillan, H.; Rissanen, T. (2011). *Yield: making fashion without making waste.* Retrieved from http://yieldexhibition.com/yieldexhibition-catalogue.pdf. Accessed 17 /04/ 2012

Perez, I. U.; Martins, S. B; Sampaio, C.P.; Bruno, A.P.; Pinto, M.G. (2016). *Fashion and clothing products life cycle: environmental impacts and sustainability strategies*. In: 3rd International Fashion and Design Congress, 3º CIMODE, Proceedings…Buenos Aires.

Ramos, B.; Sampaio, C.P.; Martins, S.B. (2018). *Aplicabilidade dos conceitos de produção distribuída e design distribuído na moda*. In: 14º Colóquio Nacional de Moda.11ª Edição Internacional, Anais...Curitiba.

Sampaio, C. P. (2017). *Modelo FLOWS: Modelo integrado de P&D em resíduos sólidos com base em liderança, grupos criativos, design e sustentabilidade* (Doctoral thesis). Faculdade de Arquitetura da Universidade de Lisboa - FAUlisboa. Lisboa.

Senai. *Questionário sobre resíduos sólidos com 32 empresas do Estado do Paraná.* Documento interno, 2017.

Sinditêxtil (2017). *Retalho Fashion.* Retrieved from http://www.sinditextilsp.org.br/index.php/retalho-fashion

_____ (2013). *Inclusão social e preservação ambiental por meio da reciclagem de resíduos têxteis: Retalho Fashion*. 2013. Retrieved from http://sinditextilsp.org.br/retalho_fashion/site/apresentacao.pdf

Stutz, A.N. (2015). *Gerenciamento de resíduos têxteis na Região de Curitiba.* Trabalho de conclusão de curso para a Especialização em Moda, Produto e Comunicação da Universidade Estadual de Londrina.

UNEP (2014). *Emerging Environmental Issues 2013. Division of Early Warning and Assessment* (DEWA). United Nations Environment Programme (UNEP) p. 98-101.

Uniethos (2013). *Série de Estudos Setoriais Sustentabilidade e Competitividade na Cadeia da Moda.* São Paulo. Retrieved from http://www.siteuniethos.org.br/wp-content/uploads/2013/11/UNIETHOS_03_versao_digital.pdf