TÊXTEIS TRIDIMENSIONAIS A PARTIR DE UMA PERSPERCTIVA DO DESIGN DE SUPERFÍCIE

Three-dimensional textiles from a surface design perspective

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Resumo: O design de superfície é comumente visto como estampas em tecidos. Entretanto, os têxteis fornecem superfícies muito mais complexas, como os têxteis tridimensionais. De acordo com suas funções técnicas e estéticas, os tecidos 3D tem ampliado sua abordagem e usos. Uma análise dos têxteis tridimensionais a partir da perspectiva do design de superfície visa apoiar essa nova abordagem.

Palavras chave: Design de superfície, têxteis tridimensionais, funções técnicas e estéticas.

Abstract: Surface design is commonly seen as pattern prints on textiles. Textiles provide surfaces that are more intricate though, like three-dimensional textiles. According to its technical and aesthetical functions, 3D textiles are expanding its approaches and uses. Analysing three-dimensional textiles from a surface design perspective aims to support this new approach.

Keywords: Surface design, three-dimensional textiles, technical and aesthetical functions.

Introduction

While surface design is commonly used in relation to pattern prints on textiles, any surface that has a design can be defined as a surface design. This is regardless of the base material, with either a two dimensional or three-dimensional (3D) structure. Surface design is a term vastly used in fashion design but this term can equally be applied to any textiles for interior design, architecture, and even technical textiles for automotive industry or medical textiles, as much as other materials in engineering, product or graphic design (RUBIM, 2004;

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RÜTHSCHILLING, 2008; SCHWARTZ, 2008). For Rowe (2009) the fabric surface is an integrated part of the whole and should be seen not just as an aesthetic function of the product but also as a statement of the quality of the textile.

Since anything that can be seen, used or touched can be considered a surface, textiles with 3D effects can also be considered a surface design (BRIGGS-GOODE, 2011). Many researchers contributed to characterize and outline surface design, with different approaches, from visual and tactile perceptions to modular geometrical structures, through graphic design and product design, textile pattern print techniques and practices (RÜTHSCHILLING, 2002; RUBIM, 2004; RÜTHSCHILLING, 2008; SCHWARTZ, 2008; RINALDI, 2009; DE FREITAS, 2012; RINALDI, 2013). Considering these approaches, it becomes easy to recognize that the surface design extension is very comprehensive and multidisciplinary, with several materials, manufacturing processes and applications yet to be considered more closely.

Three-dimensional textiles have been more widely explored by designers in the last two decades with several functionalities, which are expanding their boundaries and applications. Mcquaid (2005) reported that the textiles can provide stronger, faster, lighter, safer and smarter performances than conventional materials across a variety of disciplines and functions. With a constitutional or structural approach, as in Schwartz's surface design proposal, that consider the relevance of material and production process in the surface design development (SCHWARTZ, 2008; RINALDI, 2013), so is the approach of this study. Therefore, although the current approach on three-dimensional textiles focuses on practical and technical functions, "textiles are transcending their traditional functions" (QUINN, 2010) and being constantly reinvented. Considering the 3D textiles are approaching aesthetic functions as well, one must consider expanding its definition from a surface design perspective.

This paper aims to insert three-dimensional textiles as part of surface design textiles, including knitted, woven, braided and non-woven textiles with 3D effects instead of limiting this field to pattern prints. As 3D textiles are expanding within and beyond technical textiles and are still novel and innovative, it would

benefit from being categorized as surface design. Comprehending 3D textiles as surface design is an attempt to clarify possible applications and expand its end uses, which is not only for academic purposes, but also has commercial and technical interests and benefits.

Surface design

When thinking of surface design in relation to textiles most designers understand it as pattern prints with aesthetic and symbolic functions. Since in surface design it is very common design for continuous surfaces such as fabrics, carpets and wall papers, it is easy to understand such understatement (RUBIM, 2004). According to Rüthschilling (2008) the origin of the expression surface design was restricted to the textile design. As reported by Rubim (2004) surface design involves textile design in all specialties, and also covers design of papers, ceramics, plastics, rubber and can even be combined with graphic design, such as in illustrations or website interface. Rüthschilling (2008) also states that as surface become more important in everyday life, the term surface design is no longer restricted to only a specific material.

Schwartz's (2008) expand surface design definition by analysing according to three different approaches: (1) how it is represented: the representational approach; (2) according to materials and manufacturing processes: the constitutional approach; and (3) according to the relation between user, object and environment: the relational approach. Therefore, analysing surface design according to these approaches, it needs to be addressed not only regarding aspects related to form or relation to the user/subject, but also to the criteria necessary for its production (SCHWARTZ, 2008). According to Laranjeira and Marar (2014) surface design is an interdisciplinary area with multiple subdivisions based to the formal composition of the object, the materials, techniques and manufacturing processes used in the development of the project.

Surface design is constantly evolving, which allows new applications in the most different media and scales, showing the importance of understanding, researching and developing new types of surfaces. For Rüthschilling (2008) the

surface can be perceived as two-dimensional or three-dimensional with visual, tactile, functional and symbolic properties. To Rubim (2004) any surface can receive a surface design project, which is mainly two-dimensional, but can also be three-dimensional and its function is mainly aesthetic. However, with textile advances it can now be two or three-dimensional and have practical or technical functions as well.

New technologies are being incorporated in textile production processes, creating a new relationship with the user. The textile surface is being modified not only for aesthetic functionality, but for technical/practical functions too. The smart textiles connecting LEDs, changing shapes according to the environmental temperature, and charging mobiles are examples of how textiles with a technical function came to change the surface design concept. According to Matilda (2005), although technical textiles are a small segment in the textile industry, it involves lot of research and experiments, but "are some of the most innovative and purest examples of design today". Textiles can be purely functional and not have aesthetic function as a requirement, but the result also achieves that. The fact is that regardless of the focus, if more technical or more decorative, textiles are incorporating new functions with new applications, which will have a huge impact in its field.

Three-dimensional textiles

Three-dimensional textiles can be produced by using different techniques such as weaving, knitting and braiding and, in general, are manufactured for technical applications in industrial textiles, such as, fiber-reinforced composites (GOKARNESHAN E ALAGIRUSAMY, 2009) and functional clothing for sports or protection (CHEN, 2015). Visual and aesthetic functions of three-dimensional textiles are more evident in garments for fashion design and soft textiles for interior design. Chen (2015; CHEN E HEARLE, 2016) specify 3D textiles as a material that "has either an overall 3D shape or a more complex internal 3D structure or both" and it can be single-layer or multiple layer, hollow or solid.

In 1960, 3D knits were first applied to engineering projects, even though it was developed in the nineteenth century. Three-dimensional knits can be obtained using different technologies and methods. According to Ionesi *et al.* (2010) the knitting methods that can be used to produce a third dimension are: (1) multi axial, with the insertion of additional yarns in several directions; (2) sandwich or spacer, with the knitting of independent layers connected by wires or by the structure itself; and (3) 3D effects, with the knitting of tubes or shapes and volumes by altering structural parameters.

Three-dimensional knits with 3D effects can be produced in various ways, both in circular or flat knitting machines. Three-dimensional knitting allows for modification of the surface, creating layers, thickness, resulting in countless outcomes depending on the material (MACIEL, 2014). 3D knits as a textile surface can be applied to various technical fields, such as aeronautics, automotive, medicine, construction and protective equipment (IONESI *ET AL.*, 2010; PENCIUC *ET AL.*, 2010; BLAGA *ET AL.*, 2011; IONESI *ET AL.*, 2012).

Three-dimensional woven fabrics have been widely used as composite structural components in aviation, civil engineering, sports and other areas. There are plentiful ways to produce 3D textile composites, and weaving is the most common method for high production speed and flexibility, which allows for the creation of a large range of structures. Three-dimensional woven fabrics are used for composite textile applications due to their excellent physical, mechanical and thermal properties and dimensional stability, among other characteristics. This performance depends on the type of fiber and the construction of the composite structure (GOKARNESHAN E ALAGIRUSAMY, 2009; ANSAR *ET AL.*, 2011). Extending the application of three-dimensional woven fabrics, in addition to composite applications, can lead to new developments, structures and effects as well as new techniques and features.

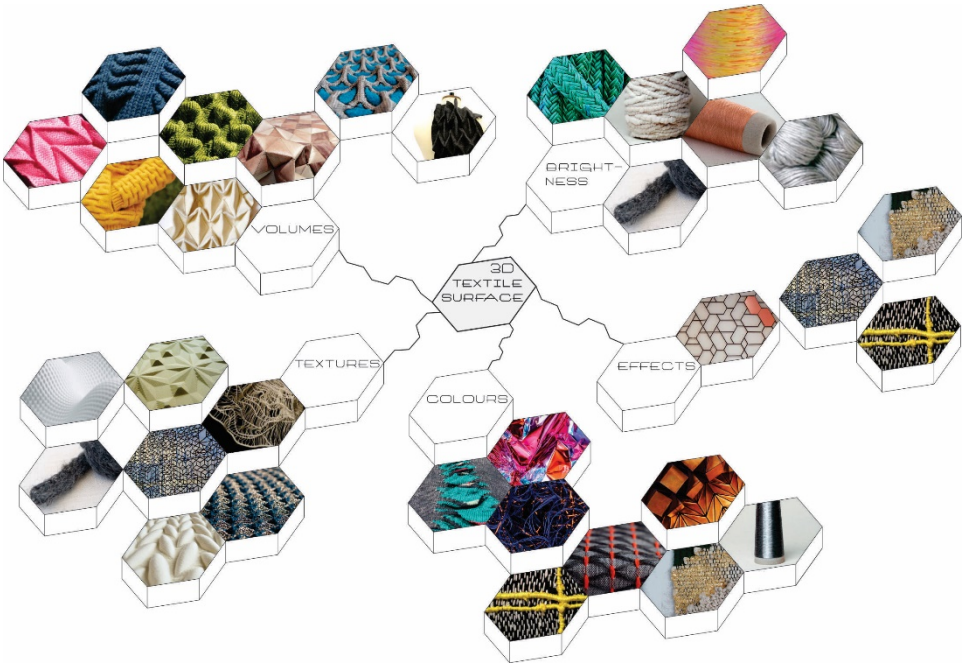
From the many versions of definition of 3D textiles researchers and scientists differ to define 3D fabrics and its structures (ISLAM, 2016). For Chen and Hearle (2016) the performance and the manufacture of the 3D textiles using conventional and innovative technologies are the most important aspects to have different applications. On this paper, any fabrics that have textures, shapes or

structures that create three dimensions with substantial thickness are considered 3D textiles.

Currently, a lot of research in textile surface is carried out by designers and engineers exploring the relationship between the surface and the structure of fabrics, using the versatility of textile as a creative medium (GALE E KAUR, 2002). To Maciel *et al.* (2016) “the extent to which 3D textiles can be designed and produced is allowing a dramatic increase in the development of structures with distinct functionalities”. Most 3D textiles with technical functions are developed with an engineered design approach and its commercial use is still limited (CHEN, 2015). So, to expand the market of 3D textiles to other applications that enable it to achieve their full potential, new approaches considering aesthetic demands in addition to its technical functions can be necessary. By analysing three dimensional textiles from a surface design perspective might help with this new approach.

Surface design should be planned as part of the object and, therefore, follow a new product development methodology, that value the object by its surface feature and functionalities. The approach to design a surface can be driven by the ability to stimulate sensations and perceptions, so that it is considered an elaborate, designed element (MACIEL, 2014). Thus, surface design can cover all kinds of intervention on the surface of a product or structure, such as textures, volumes, brightness, colours and effects on textiles, as illustrated in Figure 1. With that said, the development of three-dimensional textiles can be approached as a surface design development.

Figure 1 - Interventions on surface design of 3D textiles.



According to the skills of each designer, creativity and needs, different applications and functionalities, the combination of such techniques can be used to develop other techniques that lead to different shapes and 3D effects (PENCIUC *ET AL.*, 2010). Furthermore, it is important to emphasize that, increasingly, designers have been developing 3D textiles which have both strong technical and aesthetic functions, creating new products that are more appealing to the user. According to El Mogahzy (2008), this presents a design challenge to balance functionality and styling simultaneously. Bringing three-dimensional textiles to be discussed and classified as surface design might contribute to an understanding of such a novel category in textiles.

Conclusions

Surface design is an expanding field and with the constant development of new materials and technologies it will keep developing. For that reason, continuous definitions and classifications should be developed as it expands. On textile and other products and materials, surface design is usually associated to pattern print, but it is much wider than that. By researching surface design, it shows that more definitions can be addressed to three-dimensional textiles.

This indicates the assortment and potential of textile surface design and the increasing significance this field has, especially with three-dimensional textiles and its applications. Considering that 3D textiles are a field in increasing development it is recognised that defining it will not be an easy task. This paper approach on three-dimensional textiles from a surface design perspective shows the importance to provide some definitions for surfaces and applications of 3D textiles soon.

This research in three-dimensional textiles will support an upcoming development that explore its performance for interior design applications, which can have more benefit by having a 3D textiles classification on surface design. A new approach of textile surface design that focusses on the manufacturing processes and functionalities can support the establishment of three-dimensional textiles as surface design and increase its applications, research and development as main focus of new products.

Acknowledgments

The first author has been supported by CNPq - Conselho Nacional de Desenvolvimento Científico e Tecnológico - Brazil and this work had the HWU Annual Fund Grant Application 2017 support.

References

ANSAR, M.; XINWEI, W.; CHOUWEI, Z. Modeling strategies of 3D woven composites: a review. **Composite structures,** v. 93, n. 8, p. 1947-1963, 2011. ISSN 0263-8223.

BLAGA, M. et al. Interactive application for Computer Aided Design of 3D Knitted fabrics. "eLearning and Software for Education" (eLSE), 2011, 02: Central and Eastern European Online Library, 2011. p.433-440.

BRIGGS-GOODE, A. E. **Textile Design Principles, Advances And Applications**. Burlington

Cambridge: Burlington : Elsevier Science, 2011.

CHEN, X.; HEARLE, J. **3D Textiles: Modelling, computerized manufacture and applications**. 3D fabrics & their applications. Roubaix, France: ENSAIT**:** 21-30 p. 2016.

CHEN, X. E. **Advances in 3D Textiles**. Elsevier Science, 2015.

DE FREITAS, R. O. T. Os processos geradores das ações comunicacionais táteis no design de superfície. **Congresso Internacional da Associação de Pesquisadores em Crítica Genética,** v. x, 2012.

EL MOGAHZY, Y. **Engineering textiles: Integrating the design and manufacture of textile products**. Elsevier, 2008. ISBN 1845695410.

GALE, C.; KAUR, J. **The textile book**. Berg, 2002. ISBN 1859735126.

GOKARNESHAN, N.; ALAGIRUSAMY, R. Weaving of 3D fabrics: A critical appreciation of the developments. **Textile Progress,** v. 41, n. 1, p. 1-58, 2009/04/03 2009. ISSN 0040-5167. Disponível em: < http://dx.doi.org/10.1080/00405160902804239 >. Acesso em: 2014/04/15.

IONESI, D. et al. THREE - DIMENSIONAL KNITTED FABRIC WITH TECHNICAL DESTINATION. **BULETINUL INSTITUTULUI POLITEHNIC DIN IASI Publicat de Universitatea Tehnică „Gheorghe Asachi" din Iasi,** v. Tomul LVI (LX), Fasc. 3, 2010, 2010.

IONESI, S. D. et al. **Shape modeling of 3D knitted fabrics**. International Congress IFKT. Sinaia, Romania**:** 926-931 p. 2012.

ISLAM, M. A. **An overview of 3D woven textile composites and its applications**. 3D fabrics & their applications. Roubaix, France: ENSAIT**:** 133-156 p. 2016.

LARANJEIRA, M.; MARAR, J. F. CAOS & COMPLEXIDADE: DESIGN DE SUPERFÍCIE E OS NOVOS PARADIGMAS DA CIÊNCIA. **Educação Gráfica**, p. 204-204, 2014. ISSN 2179-7374.

MACIEL, L. **Joias em malha com efeitos 3D: estendendo os limites da tecnologia**. 2014. 113 (Mestrado em Design e Marketing). Departamento de Engenharia Textil, Universidade do Minho, Guimaraes, Portugal.

MACIEL, L.; OLIVEIRA, N.; ROCHA, A. M. **Knitting with 3d effects - investigating fabrics' ability for wellbeing applications**. 3D Fabrics and their applications. BOUSSU, F. e CHEN, X. Roubaix, France: ENSAIT**:** 73-80 p. 2016.

MCQUAID, M. **Extreme textiles: designing for high performance**. New York: Princeton Architectural Press, 2005. ISBN 156898507X.

PENCIUC, M.; BLAGA, M.; CIOBANU, R. Principle of creating 3D effects on knitted fabrics developed on electronic flat knitting machines. **Buletinul Institutului Politechnic DIN IASI Publicat de Universitatea Tehnică „Gheorghe Asachi" din Iasi Tomul LVI (LX), Fasc,** v. 4, 2010.

QUINN, B. **Textile futures: Fashion, design and technology**. Oxford, UK: Berg Publishers, 2010. ISBN 9781845208080.

RINALDI, R. M. **Contribuição da comunicação visual para o design de superfície**. 2009. 155 (Mestrado). Faculdade de Arquitetura, Artes e Comunicação, Universidade Estadual Paulista (UNESP), Bauru.

_____. **A intervenção do Design nas Superfícies Projetadas: processos multifacetados e estudos de caso**. 2013. 204 (Doutorado). Faculdade de Arquitetura, Artes e Comunicação, Universidade Estadual Paulista (UNESP), Bauru.

ROWE, T. **Interior textiles Design and developments**: New York: Woodhead Publishing Limited 2009.

RUBIM, R. **Desenhando a superfície**. São Paulo: Edições Rosari, 2004. ISBN 8588343312.

RÜTHSCHILLING, E. A. **Design de superfície: prática e aprendizagem mediadas pela tecnologia digital**. 2002. 187 (Doutorado). Faculdade de Educação, Universidade Federal do Rio Grande do Sul, UFRGS, Porto Alegre.

_____. **Design de superfície**. Porto Alegre: Editora da UFRGS - Universidade Federal do Rio Grande do Sul, 2008. ISBN 9788538600350.

SCHWARTZ, A. R. D. **Design de superfície: por uma visão projetual geométrica e tridimensional**. 2008. 200 (Mestrado em Desenho Industrial– Área de concentração: Desenho de Produto). Faculdade de Arquitetura, Artes e Comunicação, Universidade Estadual Paulista, Bauru.